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Integrated Urban River Corridors

Spatial design for social-ecological resilience in Bucharest and beyond

Dissertation

for the purpose of obtaining the degree of doctor
at Delft University of Technology
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Chair of the Board for Doctorates
to be defended publicly on
Thursday 20 December 2018 at 12:30 o'clock

by

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Dr. J.A. Lopes Gil has, as supervisor, contributed significantly to the preparation of this dissertation.

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To Ioana

For reminding me that the world is fuzzy.

Preface

This thesis has grown out of a combined passion for cities and rivers. Throughout the years, I have become increasingly fascinated by urban rivers. My first encounter with rivers as a designer was during my master thesis in architecture, in which the assignment of a contemporary art gallery on the bank of River Drava in Maribor, Slovenia, drove me to study the structural and physical relationships between the city and water in the riverfront (Forgaci, 2010). I understood that the river and its banks do not constitute a barrier, but a limit that has a 'thickness' enforced by transversal relations, manifested in a stratification of functions, uses and users, spaces and buildings, formed by the historical development of the city close to water.

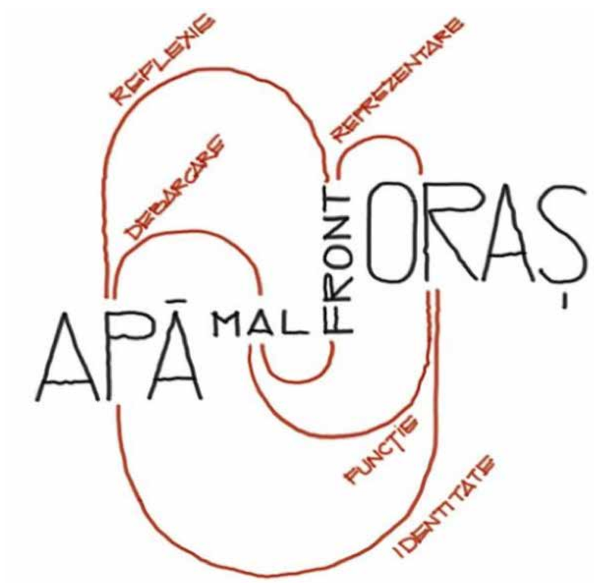

Diagram of the functional and physical relations between water and the city in a conceptual representation of a riverfront section, comprising the elements (in black, from left to right) the water, the embankment, the built front, and the city, and the relations between those elements (in red) reflection, disembarkation, representation, function and identity. Source: Forgaci, 2010.

As a student in the European post-master in Urbanism at TU Delft, my fascination with rivers grew further as I became more familiar with the Dutch landscape and with the TU Delft school of urbanism and landscape architecture. For instance, I learned of the Dutch *Layers Approach* (De Hoog, Sijmons & Verschuuren, 1998, cited in van Schaick & Klaasen, 2011), which, by its simplicity yet essential way of describing the spatial configuration and dynamics of the urbanised landscape, remained a key reference in my subsequent work. Moreover, I have had the experience of the Randstad, a place where I barely felt the pressure of urbanisation, yet I have been living in one of the densest megalopolises in Europe, a place where I could go anywhere by bike and train without feeling the need to own a car, but also a place where the relation between land and water is of an utmost cultural importance. During my post-master studies, I also had the chance to be acquainted with the school of thought of Bernardo Secchi and Paola Viganò at IUAV Venice. There I learned to ask fundamental questions and to work with scenarios stemming from the contemporary urban condition, characterised by changing mobility patterns, climate change, social inequalities, as well as urban and natural environmental pressures on humans and ecosystems.

Following these experiences, my thesis in urbanism (Forgaci, 2013), entitled *Bucharest: Between North and South*, returned to the river as a strategic urban space, which could potentially restore connections between the two halves of Bucharest, restore ecological and environmental conditions in a city-wide green corridor, and, as such, to become a backbone of sustainable urban development. Under the guidance of Daan Zandbelt (TU Delft) and Bernardo Secchi (IUAV Venice), I learned of the structuring potential of rivers on a metropolitan scale and of the importance of geomorphological conditions, that is, the fact that a river is not just a line, but also a valley, a fact often overlooked, especially in the case of canalised rivers found in low-lying geographic locations, such as River Dâmbovița of Bucharest.

Having lived, studied and worked as an architect for almost a decade in Bucharest, and thus having experienced the presence (and absence) of River Dâmbovița and River Colentina, choosing it as the object of study in my Ph.D. research was straightforward. This way, I could achieve an in-depth understanding of the place and a sustained communication with local actors, while gaining wider knowledge of how urban rivers in general can improve the spatial quality, functioning and resilience of the cities that they cross. Encouraged and inspired by my promotor Arjan van Timmeren, I could continue during my Ph.D. research the explorations on the urban river corridors of Bucharest, while taking the challenge of urban resilience as an overarching concept. I learned that urban resilience as a way of thinking is a concept of utmost importance for dealing with contemporary social-ecological urban issues that has to and can be constantly trained through spatial design in order to strengthen the urban environment against acute shocks and chronic stresses.

The design explorations and the design workshop carried out during my stay in the Netherlands and presented in this thesis, have furthered my understanding that the problems of the urban river corridors of Bucharest, including their poor contribution to urban resilience, are not unique, but representative for many other riverside urban areas around Europe and the rest of the world. Although the thesis focuses on the case of Bucharest, and it offers a predominantly Euro-centric perspective, it illustrates the wider relevance of the subject matter with references to urban rivers form other countries and continents as well.

Apart from urban rivers, I was interested in pursuing evidence-based design and design-driven research, that is, to find potential ways to combine knowledge, skills, competences, and discoveries between research and design. Recognising the need for these approaches in dealing with the complexity of the current urban condition, I adopted a range of tools and methods for spatial and network analysis to describe the urban environment, such as MatrixGreen for patch network analysis and Space Syntax for street network configuration analysis, and design-driven research methodologies, such as the design workshop combined with design explorations through urban river projects.

Overall, these three motivations—urban rivers, evidence-based design and design-driven research—constitute the building blocks of this thesis, founded on the concept of resilience. Urban river corridors as social-ecologically integrated urban spaces and their manifestation in the context of Bucharest are closely described in Part 1 of the thesis, while evidence-based design and design-driven research are tackled in Part 2 and Part 3. Although these three parts, named *Context*, *Assessment* and *Design*, are presented in a linear succession, they also represent the elements of a non-linear design process, in which interlinkages, feedback loops, iterations, and overlaps are possible. I hope that this thesis will contribute to a better understanding of the relationship between cities and rivers, and to the combined practice of research and design.

Acknowledgements

In spite of all the appearances, a Ph.D. is far from being an individual journey. I was very lucky to have been accompanied, inspired, supported, encouraged and stimulated by so many people, whom I will do my best to acknowledge here.

First of all, I would like to express my deepest gratitude to my promotors Arjan van Timmeren and Machiel van Dorst and to my daily supervisor Jorge Gil. With his broad and inclusive view of urbanism, Arjan van Timmeren has inspired me to consider all the facets of the urban environment as a complex system, including its metabolism, ecology, economy and governance, and thus to adopt a transdisciplinary perspective in my work. I was also very fortunate to be stimulated and encouraged by him to continue my previous work and to develop a design-driven thesis. As a student at TU Delft, I learned from Machiel van Dorst how to observe and reveal patterns in the urban environment, how to formulate hypotheses, how to underpin them with theory and how to apply them in design. During my Ph.D. research, he has taught me how to make one step back and to reflect before getting lost in detail. This is a lesson I learned both for research and for life. He has also reminded me of an often-forgotten fact: that urbanism is, above all, about people. I am equally thankful to my daily supervisor Jorge Gil for coaching me throughout my last year by keeping me alert and pulling me back from dead ends. From Jorge Gil I learned how to set up and implement the indicator system and the assessment framework developed in this thesis. All in all, the completion of my dissertation would not have been possible without the unwavering support of my supervisors. My special thanks are extended to my former supervisors Egbert Stolk, for guiding me in the first years of my research and for our insightful discussions on design thinking and transdisciplinarity, and Juval Portugali, whose fundamental questions have made this thesis much sharper. Moreover, I would like to thank the independent members of the doctoral committee, Angelica Stan, Sybrand Tjallingii, Paola Viganò, Dirk Sijmons, and Carola Hein, for accepting to be part of my defence and for their valuable feedback, enriching the end of my journey as a Ph.D. researcher.

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The design workshop organized in Bucharest in 2017 gathered a large group of people who had a positive impact on this thesis. First of all, I wish to thank the 32 excellent master students, EMU post-master students, Ph.D. candidates, and young professionals, who spent one intensive week to design on the two rivers of Bucharest and to test the design instruments developed in this research. Their contribution was essential for the design-driven methodology of this thesis. I would also like to acknowledge Angelica Stan, Gabriel Pascariu and Claudiu Runceanu, from the management of UAUIM-FU, for supporting the design workshop, and to Andreea Acasandre, Alexandru Belenyi, Simona Butnariu, and Andrei Mitrea, from the teaching staff of UAUIM-FU, for their valuable input in the design sessions of the workshop. I must thank Ioana Tudora and Andrei Ionel for taking us on two adventurous and inspiring site visits along the rivers of Bucharest, and Teodor Frolu and Vlad Stoica who inspired the workshop participants with their lectures during the visit of River Dâmbovița. The inspiring lectures of Constantin Radu Gogu, Liviu Ianăși, Gabriel Pascariu and Cristian Tetelea in the daily seminars, as well as the evening lectures of Birgit Hausleitner, Taneha Kuzniecow Bacchin, Șerban Țigănaș, Ștefan Ghenciulescu, Andrei Mitrea, Arjan van Timmeren and Machiel van Dorst are also acknowledged with gratitude. I am grateful to the jury members of the design workshop formed by Ellen Fetzer, Cristian Iojă, Matei Bogoescu, and Arjan van Timmeren, for their thorough evaluation of the design projects developed in the workshop. I would also like to thank Iulian Canov, Cristina Zlota and Vlad Stoica for hosting us in their workshop space at La Firul Ierbii. Furthermore, I extend my thanks to Bram van der Grinten, Kristel Aalbers, Roberto Rocco, and Radu Ionescu for their valuable advice on preparing the design workshop.

Special thanks to Maria Alexandrescu, Irina Băncescu, Daniele Cannatella, Marcin Dąbrowski, Anca Ioana Ionescu and Toader Popescu for their valuable feedback on my chapter manuscripts. I am also grateful for the assistance provided by Vincent Babeș with some of the maps used in this research, and to my colleague Daniele Cannatella for assisting me in the analyses carried out for the assessment of urban river corridor Dâmbovița. Thanks should also go to my companions in design Maria Alexandrescu and Anca Ioana Ionescu. Our work has been inspirational in developing elements of the design-based research approach presented in this thesis. Thanks also to my colleagues Birgit Hausleitner, Janneke van der Leer, Sitong Luo, Daniela Maiullari, Bardia Mashhoodi and Alex Wandl, who stimulated me to cross the finish line, and to Margo van der Helm for magically solving all administrative issues.

Last but not least, I must thank Ioana, my partner in life and in work, for our inspiring conversations, her sharp critique, and for supporting me unconditionally and with utmost patience.

Contents

PART 1 Context

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List of abbreviations

CAS	Complex Adaptive System
CAQDAS	Computer Assisted Qualitative Data Analysis Software
CEE	Central and Eastern Europe
CS	Corridor Segment
BSC2035	Bucharest Strategic Concept 2035 (CSB2035 in Romanian)
DEM	Digital Elevation Model
EEA	European Environment Agency
ES	Ecosystem Services
FUA	Functional Urban Area
GBI	Green and Blue Infrastructure
GI	Green Infrastructure
GIS	Geographic Information System
GUP	General Urban Plan (PUG in Romanian)
LUZ	Larger Urban Zone
MEA	Millennium Ecosystem Assessment
OSM	OpenStreetMap
PPA	Problem-Potential Analysis
QDA	Qualitative Data Analysis
RBD	River Basin District
SER	Social-Ecological Resilience
SES	Social-Ecological System
TEEB	The Economics of Ecosystems and Biodiversity
TRU	Territorial Reference Unit
UA	Urban Atlas
URC	Urban River Corridor
VGI	Volunteered Geographic Information
WFD	Water Framework Directive
WSUD	Water Sensitive Urban Design
ZUP	Zonal Urban Plan (PUZ in Romanian)

Summary

This thesis focuses on *Urban River Corridors (URCs)* as spaces of *social-ecological integration* par excellence—that is, spaces where the interaction between the urban systems (carrying the 'social-') and the river system (carrying the '-ecological') is (potentially) the most intense. The general hypothesis is that with an integrated spatial understanding, planning and design of rivers and the urban fabric surrounding them, cities could become more resilient, not just to flood-related disturbances, but to general chronic stresses as well. Hence, the thesis addresses a number of spatial problems arising from the loss of synergy between the natural dynamics of rivers and the spatial configuration and composition of urban areas that they cross, namely: the relationship between fluvial geomorphology and urban morphology weakened by river-taming operations; the physical barrier caused by riverside vehicular traffic; the latent flood risk built up through resistance-based flood-protection measures; the diminished capacity of urban rivers to provide ecosystem services; and the reduced scalar, (and implicitly) social and ecological complexity of urban rivers after rationalisation.

Drawing on theories of social-ecological resilience and urban form resilience, on conceptual and analytical tools from the fields of spatial morphology and landscape ecology, and on explorations through urban river design projects, the thesis departs from the research question

"How can social-ecological integration be spatially defined, assessed and designed in Urban River Corridors?"

Accordingly, it constructs a *theory of social-ecologically integrated Urban River Corridors*, in which it proposes a *spatial-morphological definition*, *an assessment framework*, and a *set of design principles and design instruments*. These three components of the theory represent the descriptive, analytical, and normative claims advanced in the research, respectively. The thesis employs a mixed methods research strategy that combines methods of both quantitative and qualitative nature as part of a transdisciplinary design study approach. As the object of the design study, the case of Bucharest crossed by URC Dâmbovița and URC Colentina is used to contextualise the spatial-morphological definition, and to demonstrate, develop and test the proposed assessment framework and design principles, with a distinct set of methods in each of the three parts of the thesis.

The first part places URCs in a wider theoretical and empirical context. A transdisciplinary literature review is carried out to distil environmental-ecological, social-economic, planning-governance and spatial-morphological knowledge into four key properties of URCs—*connectivity*, *open space amenity*, *integration* and *multiscalarity*—and to adopt a method of URC delineation. A historical overview of Bucharest's URCs and a qualitative data analysis of 22 expert interviews is conducted to describe the past dynamics and the current state of URC Dâmbovița and URC Colentina. The history of the two rivers shows a process of radical transformation from a flooding and dynamic river valley to a canalised stream and cramped urban space (River Dâmbovița) and from a pestilential wetland to a succession of lakes and parks designated as a metropolitan recreational area (River Colentina). In the expert interviews addressing the current state of the two URCs, Dâmbovița was described as inaccessible, disruptive, unattractive and artificial from both social and ecological point of view, but also, in terms of potentials, as a major axis of urban development and potentially the largest public space of the city. URC Colentina, as revealed in the analysis of the expert interviews, is currently inaccessible and fragmented by lakeside privatisation and it lacks cohesion due to contrasting social and spatial peripheral conditions. Yet, most experts considered that it is potentially the largest recreational space and green corridor in the metropolitan area of Bucharest.

Based on the spatial-morphological definition of URCs and on existing approaches to assessing urban rivers, the second part of the thesis develops an assessment framework, that is, a structured indicator system and a method for the assessment of social-ecological integration. The indicator system is structured in a hierarchy of social and ecological categories under connectivity (longitudinal, lateral, and vertical connectivity) and spatial capacity (spatial diversity, quality and composition). The method of assessment confronts values given by indicators from corresponding categories (e.g. social lateral connectivity with ecological lateral connectivity) in a mirrored social-ecological assessment chart and highlights areas of potential for improved social-ecological integration on the scales of the corridor and the corridor segment. Informed by the key problems and potentials derived from the analysis of the expert interviews, a complete assessment is carried out on URC Dâmbovița and a demonstration of wider application is given on URC Colentina. Corridor-segment assessment shows that URC Dâmbovița currently has a high-to-medium longitudinal connectivity, medium-to-low lateral connectivity and low vertical connectivity, as well as a medium spatial diversity and quality, and a medium-to-high spatial composition. The social-ecological profile of URC Dâmbovița highlights potential improvements on the ecological dimension for centrally located corridor segments and a potential increase in spatial diversity and composition on the social dimension in peripheral segments. The application of the assessment framework to different site conditions is briefly demonstrated on URC Colentina with an indicator of street network accessibility (also used in the assessment of URC Dâmbovița) and green space coverage (specific to URC Colentina).

Building on principles of urban and landscape design and informed by design explorations through four urban river projects carried out by the author, the last part of the thesis develops four design principles, namely *Interconnectedness*, *Absorptive Capacity*, *Social-Ecological Integration*, and *Interscalarity*, derived from the key properties specified in the spatial-morphological definition of URCs. *Interconnectedness* and *Absorptive Capacity* are principles that guide the design of *elements* found in the networks and open spaces of the URC, while *Social-Ecological Integration* and *Interscalarity* reveal systemic and scalar *relations* among those elements. Finally, the design principles are translated into four corresponding design instruments—*the Connector*, *the Sponge*, *the Integrator* and *the Scaler*—, meant to aid designers in building social-ecologically integrated URCs. A design workshop organised in Bucharest is employed to demonstrate and test the use of the design instruments in the design process and their impact on the design projects. The workshop participants evaluated the design instruments as overall useful and easy to use, but also gave valuable suggestions for improvements in their application in the design process.

The thesis concludes with a reflection on theoretical, methodological and practical implications of the research. By drawing parallels between the spatial-morphological definition, assessment and design of URCs, on the one hand, and the spatial properties and models of social-ecological resilience, on the other hand, it argues that social-ecologically integrated URCs have a potentially positive impact on general urban resilience. This last part discusses challenges and opportunities of the transdisciplinary design study approach and the mixed methodology, gives possible usage scenarios for the assessment framework and design instruments, and reflects on the wider applicability of the research for urban and landscape design beyond the case of Bucharest.

Samenvatting

Dit proefschrift gaat over *Urban River Corridors (URC's, 'stadsriviercorridors')* als ruimten van *sociaal-ecologische integratie* bij uitstek, dat wil zeggen ruimten waarin de interactie tussen de stedelijke systemen (het sociale aspect) en het riviersysteem (het ecologische aspect) in werkelijkheid of in potentie het meest intens is. De algemene hypothese is dat, wanneer we een geïntegreerd ruimtelijk begrip hebben van rivieren en hun stedelijke omgeving, steden zodanig kunnen worden gepland en ontworpen dat ze beter bestand zijn tegen overstromingen en soortgelijke verstoringen, maar ook tegen algemene chronische problemen. Het proefschrift behandelt een aantal ruimtelijke problemen die voortkomen uit het verlies van synergie tussen de natuurlijke dynamiek van rivieren en de ruimtelijke configuratie en samenstelling van stedelijke gebieden die ze doorkruisen, een verlies dat tot uiting komt in de volgende zaken: de verzwakte relatie tussen de geomorfologie van rivieren en stedelijke morfologie, veroorzaakt door maatregelen om de rivier te temmen; de fysieke barrière veroorzaakt door voertuigverkeer langs de rivier; het latente overstromingsrisico dat door beschermingsmaatregelen groter is geworden; het verminderde vermogen van stedelijke rivieren om aan het ecosysteem bij te dragen; en de verminderde scalaire, en dus ook sociale en ecologische complexiteit van stedelijke rivieren nadat ze aan de stedelijke omgeving zijn aangepast.

Met als uitgangspunt theorieën over sociaal-ecologische veerkracht en veerkracht van de stedelijke vorm, conceptuele en analytische hulpmiddelen uit de ruimtelijke morfologie en landschapsecologie, en onderzoek naar ontwerpprojecten voor stedelijke rivieren, is de onderzoeksvraag van het proefschrift:

"Hoe kan sociaal-ecologische integratie ruimtelijk worden gedefinieerd, beoordeeld en ont-worpen voor Urban River Corridors?"

Hiervoor wordt een theorie van sociaal-ecologisch geïntegreerde Urban River Corridors geconstrueerd, met een voorstel voor *een ruimtelijk-morfologische definitie*, *een beoordelingskader* en *een verzameling ontwerpprincipes en ontwerpinstrumenten*. Deze drie componenten van de theorie representeren respectievelijk de descriptieve, analytische en normatieve beweringen die in het onderzoek worden gedaan. Het proefschrift maakt gebruik van een onderzoeksstrategie met gemengde methoden, zowel kwantitatieve als kwalitatieve, als onderdeel van een transdisciplinaire aanpak van ontwerponderzoek. Als object van het ontwerponderzoek wordt de casus van Boekarest met de URC's Dâmbovița en Colentina gebruikt om de ruimtelijk-morfologische definitie van een context te voorzien, en om het voorgestelde beoordelingskader en ontwerpprincipes te tonen, te ontwikkelen en te testen, met verschillende methoden in elk van de drie delen van het proefschrift: kwalitatieve data-analyse van expertinterviews (deel 1), een indicatorsysteem en een methode om sociaal-ecologische integratie te beoordelen (deel 2), en een ontwerpworkshop (deel 3).

In het eerste deel worden URC's in een bredere theoretische en empirische context geplaatst. Door middel van een transdisciplinair literatuuronderzoek wordt milieu-ecologische, sociaal-economische, plannings-/bestuurs- en ruimtelijk-morfologische kennis gedistilleerd voor vier belangrijke eigenschappen van URC's (*connectiviteit*, *open-ruimtevoordelen*, *integratie* en *multiscalariteit*), en wordt er een methode vastgesteld om de grenzen van URC's te bepalen. Er wordt een historisch overzicht van de URC's van Boekarest gegeven en er wordt, bij gebrek aan uitgebreide literatuur over recente stedelijke transformaties, een kwalitatieve data-analyse van 22 expertinterviews uitgevoerd om de vroegere dynamiek en de huidige staat van de URC's Dâmbovița en Colentina te beschrijven. De geschiedenis van de twee rivieren toont een proces van radicale transformatie van een dynamische riviervallei met overstromingen tot een gekanaliseerde stroom en een krappe stedelijke ruimte (de Dâmbovița), en van een rottend moerasland tot een serie meren en parken die zijn aangewezen als grootstedelijk recreatiegebied (de Colentina). In de expertinterviews over de huidige toestand van de twee URC's werd de Dâmbovița beschreven als ontoegankelijk, verstorend, onaantrekkelijk en kunstmatig, vanuit zowel sociaal als ecologisch oogpunt, maar ook, in termen van potentieel, als een belangrijke as van stedelijke ontwikkeling, en potentieel de grootste publieke ruimte van de stad. De Colentina, zo bleek uit de analyse van de expertinterviews, is momenteel ontoegankelijk en gefragmenteerd door privatisering van de oevers van de meren, en mist cohesie als gevolg van contrasterende sociale en ruimtelijke omstandigheden aan de randen van de URC. Toch waren de meeste experts van mening dat het potentieel de grootste recreatieve ruimte en groene corridor in het metropoolgebied van Boekarest is.

Op basis van de ruimtelijk-morfologische definitie van URC's en bestaande benaderingen voor het beoordelen van stedelijke rivieren, wordt in het tweede deel van het proefschrift een beoordelingskader ontwikkeld, dat wil zeggen een gestructureerd indicatorsysteem en een methode voor de beoordeling van sociaal-ecologische integratie bij URC's. Het indicatorsysteem is gestructureerd in een hiërarchie van sociale en ecologische categorieën van connectiviteit (longitudinale, laterale en verticale connectiviteit), en van ruimtelijke eigenschappen (ruimtelijke diversiteit, kwaliteit en samenstelling). Bij de beoordelingsmethode worden waarden bij indicatoren uit overeenkomstige categorieën (bijvoorbeeld sociale laterale connectiviteit met ecologische laterale connectiviteit) tegenover elkaar gezet in een gespiegelde sociaal-ecologische beoordelingsgrafiek, en worden gebieden aangeduid die potentieel hebben voor verbeterde sociaal-ecologische integratie op de schaal van de corridor en van het corridorsegment. Naar aanleiding van de belangrijkste problemen en kansen die zijn afgeleid uit de analyse van de expertinterviews, wordt een volledige beoordeling uitgevoerd voor URC Dâmbovița en wordt er een demonstratie gegeven van een bredere toepassing voor de URC Colentina. Beoordeling van corridorsegmenten toont aan dat URC Dâmbovița momenteel een hoge tot middelgrote longitudinale connectiviteit heeft (doorlopende paden langs de rivier en een gedeeltelijk verbonden netwerk van groene ruimten langs de corridor), een middelgrote tot lage laterale connectiviteit (gemiddelde toegankelijkheid en mogelijkheid tot oversteek van de rivier, en gedeeltelijke aanwezigheid van groene corridors in de dwarsrichting), en lage verticale connectiviteit (slecht contact met het water), en daarnaast een middelgrote ruimtelijke diversiteit en kwaliteit (bijvoorbeeld gemengde gebruiksmogelijkheden, zichtbaarheid van de rivierruimte), en een gemiddelde tot hoge kwaliteit van ruimtelijke samenstelling (bijvoorbeeld een redelijke beschikbaarheid van openbare ruimten en groene ruimten). Het sociaal-ecologische profiel van URC Dâmbovița laat potentiële verbeteringen van de ecologische dimensie zien voor centraal gelegen corridorsegmenten en een potentiële toename van ruimtelijke diversiteit en samenstelling op de sociale dimensie in segmenten aan de rand. De toepassing van het beoordelingskader op verschillende gesteldheden van de locatie wordt kort getoond voor URC Colentina, met een indicator voor toegang vanaf het wegennet (ook gebruikt voor de beoordeling van URC Dâmbovița) en voor de hoeveelheid groene ruimte (specifiek voor de URC Colentina).

Voortbouwend op principes van stedelijk en landschapsontwerp en gebruikmakend van door de auteur uitgevoerd ontwerponderzoek van vier stedelijke rivierprojecten, worden in het laatste deel van het proefschrift vier ontwerpprincipes ontwikkelt, namelijk *Interconnectedness* (onderlinge verbondenheid), *Absorptive Capacity* (absorptievermogen), *Social-Ecological Integration* (sociaal-ecologische integratie) en *Interscalarity* (interscalariteit), afgeleid van de sleuteleigenschappen (connectiviteit, open-ruimtevoordelen, integratie en multiscalariteit) zoals gespecificeerd in de ruimtelijk-morfologische definitie van URC's. *Interconnectedness* en *Absorptive Capacity* zijn principes die bepalend zijn voor het ontwerp van elementen in de netwerken en open ruimten van de URC, terwijl *Social-Ecological Integration* en *Interscalarity* systemische en scalaire relaties tussen deze elementen blootleggen. Ten slotte worden de ontwerpprincipes vertaald in vier hiermee corresponderende ontwerpinstrumenten: *de Connector*, *de Sponge* (spons), *de Integrator* en *de Scaler* ('schaalbepaler'), die bedoeld zijn om ontwerpers te helpen bij het verbeteren van sociaal-ecologische integratie in URC's. In een ontwerpworkshop in Boekarest werd het gebruik van de ontwerpinstrumenten in het ontwerpproces en hun invloed op de ontwerpprojecten gedemonstreerd en getest. De deelnemers aan de workshop beoordeelden de ontwerpinstrumenten over het algemeen als nuttig en gebruiksvriendelijk, maar gaven ook waardevolle suggesties voor verbeteringen in de toepassing ervan bij het ontwerpproces.

Het proefschrift wordt afgesloten met een overweging van de theoretische, methodologische en praktische implicaties van het onderzoek. Door parallellen te trekken tussen enerzijds de ruimtelijk-morfologische definitie, beoordeling en ontwerp van URC's, en anderzijds de ruimtelijke eigenschappen en modellen van sociaal-ecologische veerkracht, wordt betoogd dat sociaal-ecologisch geïntegreerde URC's een potentieel positieve impact hebben op de algemene stedelijke veerkracht. In dit laatste deel worden de uitdagingen en kansen van de transdisciplinaire ontwerpstudiebenadering en de gemengde methodologie besproken, er worden mogelijke gebruiksscenario's voor het beoordelingskader en de ontwerpinstrumenten gegeven, en er wordt gereflecteerd op de bredere toepasbaarheid van het onderzoek voor stedelijk en landschapsontwerp op andere locaties dan Boekarest.

Rezumat

Această teză are ca subiect central *Coridoarele de râu urban (CRU)* privite ca spații de *integrare social-ecologică* prin excelență, respectiv spații în care interacțiunea între sistemele urbane (reprezentând latura sociala) și sistemul râului (reprezentând latura ecologică) este (potențial) cea mai intensă. Ipoteza generală este că o înțelegere integrată a spațiului râurilor împreună cu țesutul urban înconjurător conduce la o planificare și proiectare urbană mai rezilientă, atât la șocuri puternice precum cele create de inundații, cât și la constantele stresuri cronice la care este supus orașul. Prin urmare, teza abordează o serie de probleme spațiale rezultate din lipsa de sinergie între dinamicile naturale ale râurilor și configurația sau compoziția spațială a zonelor urbane pe care le traversează, respectiv: relația slăbită între geomorfologia fluvială și morfologia urbană generată de lucrări de regularizare a râurilor; bariera fizică creată prin flancarea râului cu artere majore de trafic; riscul latent la inundații dezvoltat prin măsuri de protecție împotriva inundațiilor; capacitatea diminuată a râului de a furniza servicii de ecosistem; reducerea complexității scalare[1] și implicit diminuarea complexității social-ecologice a râurilor urbane ca urmare a lucrărilor de regularizare.

Bazându-se pe teorii din domeniul rezilienței social-ecologice și al rezilienței formei urbane, pe instrumente analitice din câmpul științific al morfologiei spațiale și ecologiei peisajului și prin proiectarea exploratorie a râurilor urbane, această teză caută răspuns la următoarea întrebare de cercetare:

Cum se poate defini, evalua și proiecta din punct de vedere spațial fenomenul de integrare social-ecologică în contextul coridoarelor de râu urban?

Pentru a răspunde acestei întrebări, lucrarea construiește *o teorie a coridoarelor de râu urban integrate social-ecologic*, în cadrul căreia propune *o definiție spațial-morfologică*, *o schemă de evaluare* și *un set de principii și instrumente de proiectare*. Acestor trei componente teoretice le corespund respectiv aserțiuni descriptive, analitice și normative generate în procesul de cercetare. Strategia de cercetare implică o metodologie mixtă, combinând metode de natură calitativă și cantitativă în acord cu tipul de studiu propus, respectiv o cercetare de proiectare transdisciplinară. Ca obiect al acestui studiu, cazul Bucureștiului traversat de coridoarele râurilor Dâmbovița și Colentina este reprezentativ pentru a contextualiza definiția spațial-morfologică și a demonstra, dezvolta și testa cadrul de evaluare propus și principiile de proiectare printr-un set distinct de metode în fiecare din cele trei părți ale tezei: analiză calitativă bazată pe interviuri cu experți (Partea 1); un sistem de indicatori și o metodă pentru evaluarea integrării social-ecologice (Partea 2); o metodologie de testare a instrumentelor ce include un workshop de proiectare urbană (Partea 3).

Prima parte plasează CRU într-un context teoretic și empiric mai larg. Printr-o sinteză de literatură trans-disciplinară sunt distilate cunoștințe din ecologie și științele mediului, de natură socială și economică, de planificare și guvernare urbană și de natură spațial-morfologică, pentru a fi corelate mai apoi și organizate sub patru proprietăți cheie ale CRU: *connectivity* (conectivitate), *open space amenity* (spațiu neconstruit ca resursă), *integration* (integrare) și *multiscalarity* (multiscalaritate), generând totodată o metodă pentru delimitare spațială a CRU. Un rezumat istoric al condiției CRU ale

1 Complexitatea scalară se referă la explorarea sistemului râului, dincolo de scara problemei identificate, la mai multe scări geografice (ex: de la scara bazinului hidrografic până la scara segmentului de râu si a detaliului de mal) pentru a-i întelege dinamicile în relație cu geomorfologia, morfologia orașului, ecosistemele și sistemele sociale.

Bucureștiului, în contextul absenței unui studiu de literatură elocvent care să discute transformările urbane recente și o analiză calitativă bazată pe 22 de interviuri cu experți locali sunt utilizate pentru a descrie atât dinamicile trecute, cât și condiția actuală a CRU Dâmbovița și Colentina. Istoria celor două râuri arată un proces radical de transformare: de la un sistem de râu dinamic bazat pe cicluri naturale de inundații la un fir de apă canalizat și un țesut urban încorsetat spațial (râul Dâmbovița); de la un teren mlăștinos pestilențial la o succesiune de lacuri și parcuri proiectate ca o zonă de recreere la nivel metropolitan (râul Colentina). Interviurile cu experții descriu starea actuală a celor două CRU. Dâmbovița este descrisă ca fiind inaccesibilă, ca un element de ruptură, neatractivă și artificializată atât din punct de vedere ecologic, cât și social. În același timp pare să reprezinte o resursă importantă, fiind o axă majoră pentru dezvoltarea urbană cu potențialul de a deveni cel mai mare spațiu public al orașului. CRU Colentina, precum a fost descrisă în interviurile cu experții, este în prezent inaccesibilă și fragmentată spațial de privatizări ale terenurilor aflate la marginea lacurilor, pierzându-și prin urmare coerența spațială din cauza condițiilor sociale și de periferizare, generatoare de contraste. În ciuda acestor afirmații, majoritatea experților au considerat că poate deveni cel mai mare spațiu recreativ și coridor verde la scara zonei metropolitane a Bucureștiului.

Bazat pe definiția spațial-morfologică a CRU și pe metodele existente angajate în analiza râurilor urbane, a doua parte a tezei dezvoltă un cadru de evaluare, respectiv *un sistem structurat de indicatori* și *o metodă de cuantificare* a *integrării social-ecologice* pe CRU. Sistemul de indicatori are o structură ierarhică, organizată pe criteriul social și ecologic în categoriile de: conectivitate (longitudinală, laterală, verticală) și capacitate spațială (diversitatea, calitatea și compoziția spațiului). Utilizând o schemă de evaluare în care criteriul social și ecologic sunt plasate în oglindă, această metodă confruntă valori ale indicatorilor din categorii corespondente (ex: conectivitate socială laterală cu conectivitate ecologică laterală), subliniind zonele cu potențial de integrare social-ecologică la scara coridorului sau segmentului de coridor. Bazată pe problemele și potențialele derivate din analiza interviurilor cu experții, o evaluare completă a setului de indicatori este aplicată în cazul CRU Dâmbovița. Pentru a demonstra viabilitatea metodei dincolo de cazul Dâmboviței, metoda este aplicată parțial și pe CRU Colentina. Evaluarea la nivelul segmentului de coridor arată că CRU Dâmbovița are în prezent o conectivitate longitudinală medie spre ridicată (căi continue de circulație pe margine râului și o rețea de spații verzi discontinuă de-a lungul coridorului), o conectivitate laterală medie spre slabă (accesibilitate medie către râu și posibilități limitate de traversare a râului, prezență parțială a coridoarelor transversale verzi), o conectivitate verticală slabă (lipsa posibilității de contact cu apa), o diversitate și calitate spațială (prezența funcțiunilor mixte și vizibilitatea râului) de nivel mediu și o compoziție spațială medie spre ridicată (caracterizată de disponibilitatea moderată a spațiilor publice și a zonelor verzi).

Profilul social-ecologic a CRU Dâmbovița subliniază și sugerează potențiale soluții de îmbunătățire a condiției ecologice pentru segmentele de coridor poziționate central, cât și potențiale soluții pentru creșterea diversității spațiale și a compoziției urbane cu impact social, pe segmentele de coridor localizate periferic. Pentru a demonstra aplicabilitatea acestei metode și pe alte cazuri, posibil caracterizate de condiții diferite ale sitului, metoda acestui sistem de evaluare a fost aplicată pe CRU Colentina, prin măsurarea indicatorului de accesibilitate a coridorului prin trama stradală (aplicat și în cazul CRU Dâmbovița) și a indicelui de ocupare cu spații verzi (specific CRU Colentina).

În baza unor principii de proiectare urbană și amenajare a peisajului și prin proiecte exploratorii aplicate de autor pe patru râuri urbane, ultima parte a lucrării dezvoltă patru principii de proiectare, respectiv: *Interconectedness* (interconectivitate), *Absorptive Capacity* (capacitate de absorbție), *Social-Ecological Integration* (integrare social-ecologică) și *Interscalarity* (interscalaritate). Acestea sunt derivate din cele patru proprietăți cheie specificate în definiția spațial-morfologică a CRU: connectivity (conectivitate), open space amenity (spațiu neconstruit ca resursă), integration (integrare) și multiscalarity (multiscalaritate). *Interconnectedness* și *Absorptive Capacity* sunt principii menite să ghideze procesul de proiectare a tipurilor de *elemente* spațiale identificate în cadrul rețelelor (de trafic, ecologice, hidrografice) și spațiilor libere ale CRU. În completare, Socio-Ecological Integration și *Interscalarity* scot în evidență *relațiile* sistemice și scalare între elementele identificate. În final, principiile sunt transformate în patru instrumente de proiectare corespondente lor: *the Connector* (conectorul), *the Sponge* (buretele), *the Integrator* (integratorul) și *the Scaler* (instrumentul scalar), menite să ajute proiectanții și să susțină integrarea social-ecologică în procesul de proiectare a CRU. Un workshop de proiectare organizat în București a fost utilizat ca metodă de testare a eficacității instrumentelor în procesul de design și al impactului pe care ele îl au asupra calității proiectelor rezultate. Participanții la workshop au evaluat instrumentele ca fiind utile și ușor de aplicat, indicând pe de altă parte sugestii de îmbunătățire a implementării lor în procesul de proiectare.

Această teză se încheie cu o reflecție asupra implicațiilor teoretice, metodologice și practice ale cercetării. Prin trasarea de conexiuni între definiția spațial-morfologică, evaluarea și proiectarea CRU, pe de o parte, și proprietățile spațiale și modelele din reziliența social-ecologică, pe de altă parte, teza susține faptul că CRU integrate social-ecologic pot avea un impact pozitiv asupra rezilienței urbane generale. În această ultimă parte se discută provocările și oportunitățile pe care un studiu de proiectare transdisciplinar și o metodologie mixtă le prezintă, se oferă posibile scenarii de utilizare a schemei de evaluare și a instrumentelor de proiectare, și se reflectează asupra aplicabilității cercetării în proiectarea urbană și a peisajului, dincolo de cazul orașului București.

1 Introduction

§ 1.1 Background

There is no better way to introduce urban rivers than by acknowledging their historical significance as prime locations for settlement. The ancient valleys of the Yellow River in China, the Tigris and Euphrates of Mesopotamia, the Indus of today's India and Pakistan, and the Nile of Egypt are considered, at least in Eurasia and Africa, the cradles of civilisation. It was there, in those valleys, where the challenge of survival in the face of seasonal floods and the necessity of maximising land fertility prompted the first engineering works in the form of irrigation and flood control systems, dikes, embankments and canals (Wylson, 1986). Ever since those early civilisations, rivers have enabled important functions, such as navigation, irrigation, industrial and domestic water supply, defence, and energy production, most of which became vital for the survival and flourish of human settlements all over the world.

Although rivers had gained cultural significance and became elements of identity in the ancient civilisations, in time their utilitarian dimension grew stronger. Already in the Middle Ages, the river in Western cultures "was not exploited as something pretty to look at and enjoy aesthetically"; instead, it was used as a "principal highway, source of drinking water, and power for industry (e.g., to operate grain or timber mills)" (Kostof, 1992, p. 40). Once "the European city emerged from medieval limitations" during the 16th and 17th centuries and urban development swiftened in the 18th century, rivers regained their civic importance: fortifications were replaced with promenades, parks and public squares (Wylson, 1986, p. 12). Shortly after, the technical advances brought by industrialisation in the 19th century reversed once again the balance. From the urban waterfront as a space of civic value, as envisioned in the Renaissance, the river was restored to a utilitarian infrastructure, either occupied by industrial traffic and structures, or "vulnerable to re-use for inner-city highway development" (Wylson, 1986, p. 13). The 'machinery' built around rivers to optimise the delivery of utilitarian functions has become more and more widespread and sophisticated. Canals, weirs, dams, culverts, sluices, ditches, bridges, dikes, and hydroelectric stations are just a few of the technological innovations devised, assembled and optimised to 'adjust' river valleys to human needs.

The resistance exercised by these engineered devices on the natural dynamics of rivers has reached a tipping point. The pressure of climate change and the growing number of flooding events have rendered resistance-based strategies obsolete and have started the transition towards more resilient approaches. Moreover, the social dimension—mainly concerned with public access and provision of amenity—has been increasingly contested. Under this changing paradigm, several projects have already been implemented worldwide. Examples include the so-called daylighting projects, such as the Cheonggyecheon in Seoul, river restoration projects, such as the Kallang River in Singapore or the Isar in Munich, and public space reclamation projects such as the pedestrianisation of the banks of the Seine (Figure 1.1). What all these projects have in common is a renewed awareness of how important rivers are for the life of the city. Some of these projects emphasize the social dimension by investing in riverside public space, while others include ecological values as well.

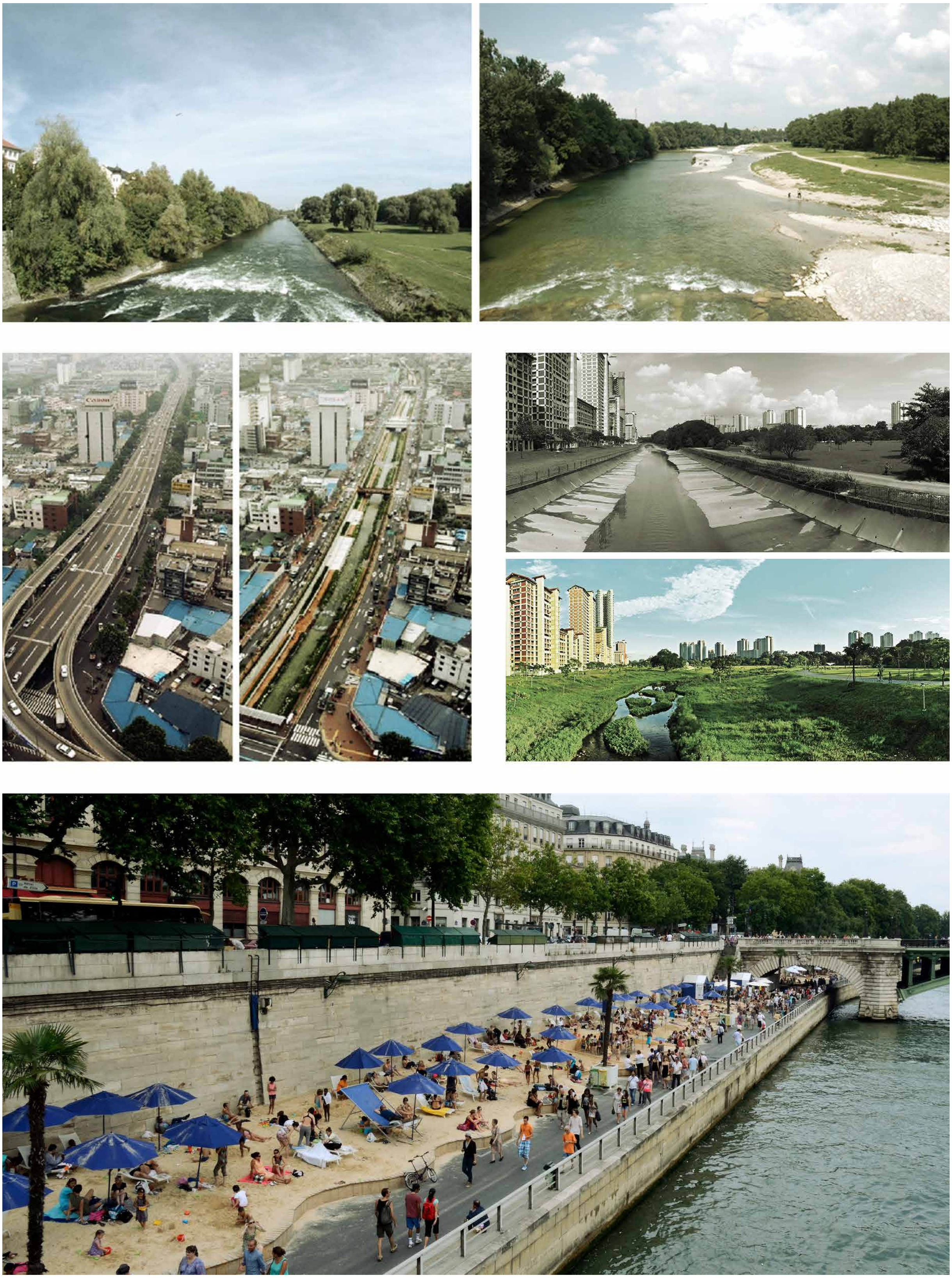

FIGURE 1.1 Examples of urban river transformations around the world: Isar River, Munich (top); the Cheonggyecheon Stream, Seoul (middle left); Kallang River, Bishan Park, Singapore (middle right); 'Paris Plages' on the Seine (bottom). Sources: restorerivers.eu/wiki/ (top); Seoul Metropolitan Government (middle left); Ramboll Studio Dreiseitl (middle right); Peter Haas via Wikimedia Commons (bottom).

TOC

Today, most cities around the world are located near a river.[2] In Europe (Figure 1.2), examples include capital cities crossed by great rivers, like the Seine in Paris, the Thames in London, Tiber in Rome, Spree in Berlin, Danube in Vienna, Bratislava and Budapest, Vistula in Warsaw, Vltava in Prague, and Sava in Zagreb or Belgrade, but also smaller-size rivers, including the tributaries of those large rivers, such as River Lea in London, Canal Saint-Martin in Paris,[3] Ljubljanica in Ljubljana, Manzanares in Madrid, or Dâmbovița and Colentina in Bucharest.

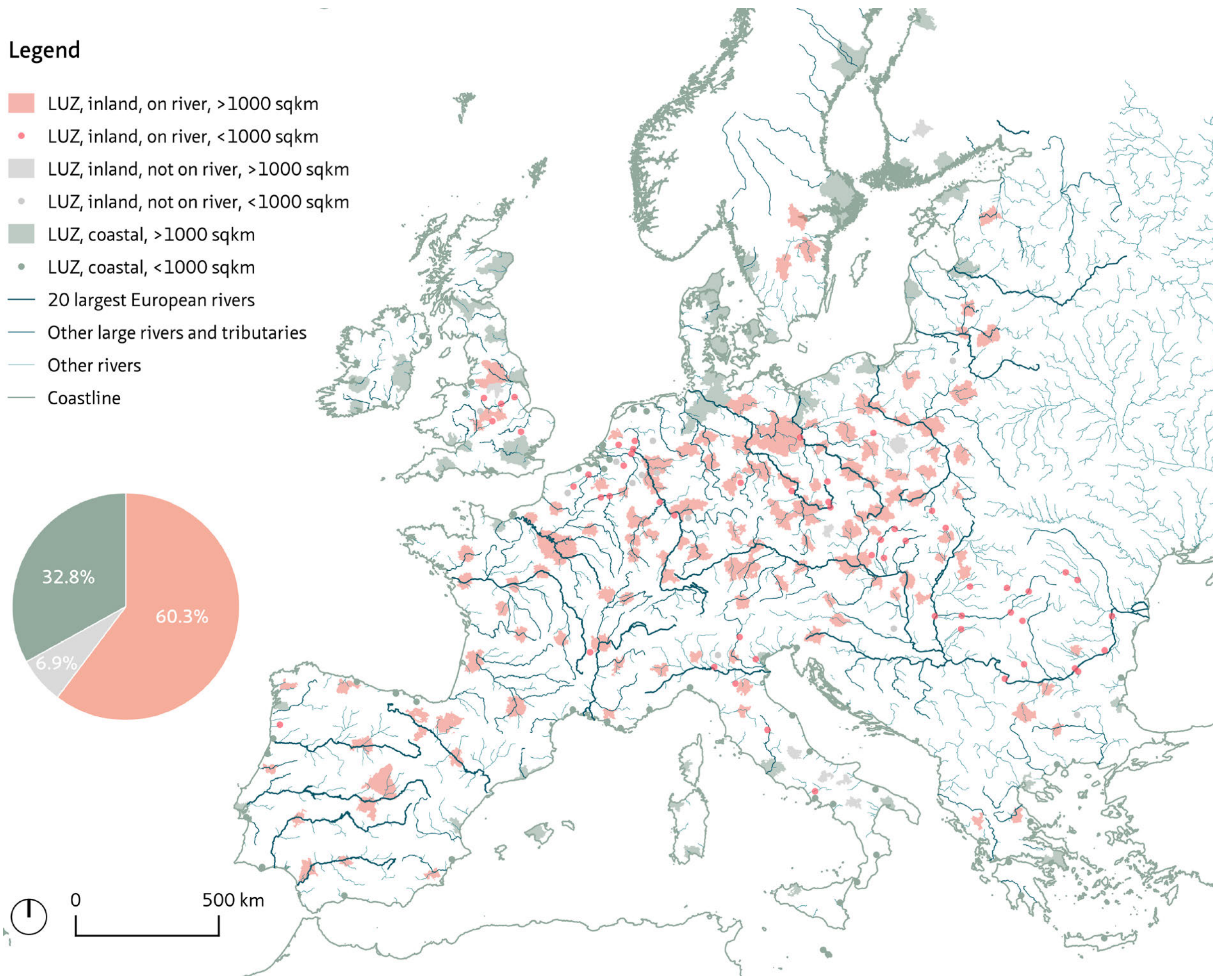

FIGURE 1.2 Large Urban Zones (LUZ) in Europe classified according to their position in the river network: crossed by rivers (red); on the coast (dark grey), and not crossed or bordered by water (light grey). In this classification, river-crossed cities represent the highest percentage (60,3%). This percentage is even higher if coastal cities in delta or estuarine locations are considered. Data source: EEA Urban Atlas (UA), EEA European Catchment and River Network System (ECRINS) data.

2 Even coastal cities are most of the times located in a river delta or estuary.

3 Although Canal Saint-Martin is completely artificial, it has had an important utilitarian and social function since its construction in the early 1800s under Napoleon I.

Such small rivers are of particular interest. Due to their size, they were relatively easier to tame than large rivers and have developed stronger bonds with the cities. Some cities were even named after those secondary rivers. For example, Vienna was named after River Wien (Wienfluss), a right-bank tributary of the Danube, which was crucial for harvesting hydraulic energy through weirs and mill creeks since medieval times until mid-19th c. (Hauer, Hohensinner, & Spitzbart-Glasl, 2016). Dutch 'Dam' cities, including Amsterdam and Rotterdam, had originated, as their name suggests, around dams placed on secondary rivers—the Amstel and the Rotte, respectively—at the confluence with a larger water body—the Ij in case of Amsterdam and the Maas in Rotterdam. The importance of these secondary rivers, however, has diminished, as soon as waterborne transportation was moved to larger channels or other modes, and hydraulic energy was superseded by other sources. The main functions that these rivers have kept, at least at the scale of the city, are industrial water supply, drainage and flood control.

All in all, the shifting history of urban rivers has led to an amorphous and contested urban space, which is yet to be understood if a more resilient and sustainable relationship between the 'urban' and the 'river' is to be attained. Current urban planning and design approaches, some of which are hinted to in the examples given above, signal the need for a reconsidered social and ecological dimension in addition to the utilitarian functionality of rivers. What are the key problems that contemporary urban rivers face, as depicted in current practices and as informed by their history, requires a closer look.

§ 1.2 Problem statement

This thesis responds to a widely acknowledged problem: the loss of synergy between the natural dynamics of rivers and the spatial configuration of cities that they cross. As described in this section, the problem is four-fold: (1) river-taming operations weakened the physical interactions between the river and the city; (2) on the long run, flood-protection measures aiming for resistance to water dynamics increase the potential risk of flooding; (3) the multiple environmental and social benefits of rivers have been restrained; and, as a result, (4) the scalar complexity of urban rivers has been reduced.

FIGURE 1.3 River Tietê bordered by Avenida Marginal Tietê in São Paulo. Photo credit: Reginaldo Bianco.

§ 1.2.1 The river as a barrier

The problems caused by rivers in the rapidly growing cities of the 19th and beginning of 20th century needed urgent and concrete solutions. The engineering goals pursued in most European cities at that time—providing flood-safety, separating sewage, protection from malaria, etc.—were well justified (see, for instance, the transformations of River Dâmbovița and River Colentina described in Section 3.3). The design of these infrastructures, however, failed to incorporate the dynamics and the spatial qualities of the rivers. Instead, rivers were straightened, sealed, culverted, dammed, diverted. The alteration of river trajectories left a strong mark on the urban fabric. Often, large urban areas (sometimes even historical centres) were trimmed and replaced with new riverside developments, road infrastructure, or land left in an uncertain development state.

River engineering was also consonant with vehicular traffic infrastructure. Thoroughfares were often built along the river to accommodate through-movement and high-level traffic distribution in the city (Figure 1.3). Once river transformations were implemented, the number of pedestrian crossings was decreased and replaced by less and larger crossings designed mainly for vehicular traffic (see, for instance, the transformation of River Dâmbovița in Figure 3.7). All these changes transformed rivers into physical barriers cutting the urban fabric instead of blending with it.

FIGURE 1.4 The rising water of the Danube approaching the centre of Budapest on 8 June 2013. Photo credit: AP Photo/MTI, Sandor Ujvari.

§ 1.2.2 Latent flood risk

Among the main reasons for river engineering were the floods threatening developing urban areas located in the river plain. A system of flood protection measures—canals, dams, dikes, polders, and retention lakes—were implemented to mitigate floods or to displace them to other locations outside the city. This attitude claimed resistance against the threats of natural water dynamics but failed to account for the uncertainties arising from human-nature couplings (Liao, 2012). Meanwhile, climate change has increased the number of flood-related disasters and resistance has been losing ground against changing hydrologic regimes. Extreme river flood events have been recorded in cities all over the world, the most affected being the largest urbanised areas of the developing south. The tendency is to upgrade flood protection measures, but this is increasingly recognised as an unsustainable strategy, because it shifts the problem to the future. Thus, the latency of the problem must be acknowledged. Latent flood risk refers to the discrepancy between currently observed flood risk and potential flood risk which is defined theoretically based on long-term urban river dynamics. This means that even in urban areas where the hydrological system has been brought to a relatively controlled state and floods have not yet occurred (Figure 1.4), the risk of flooding must be considered.

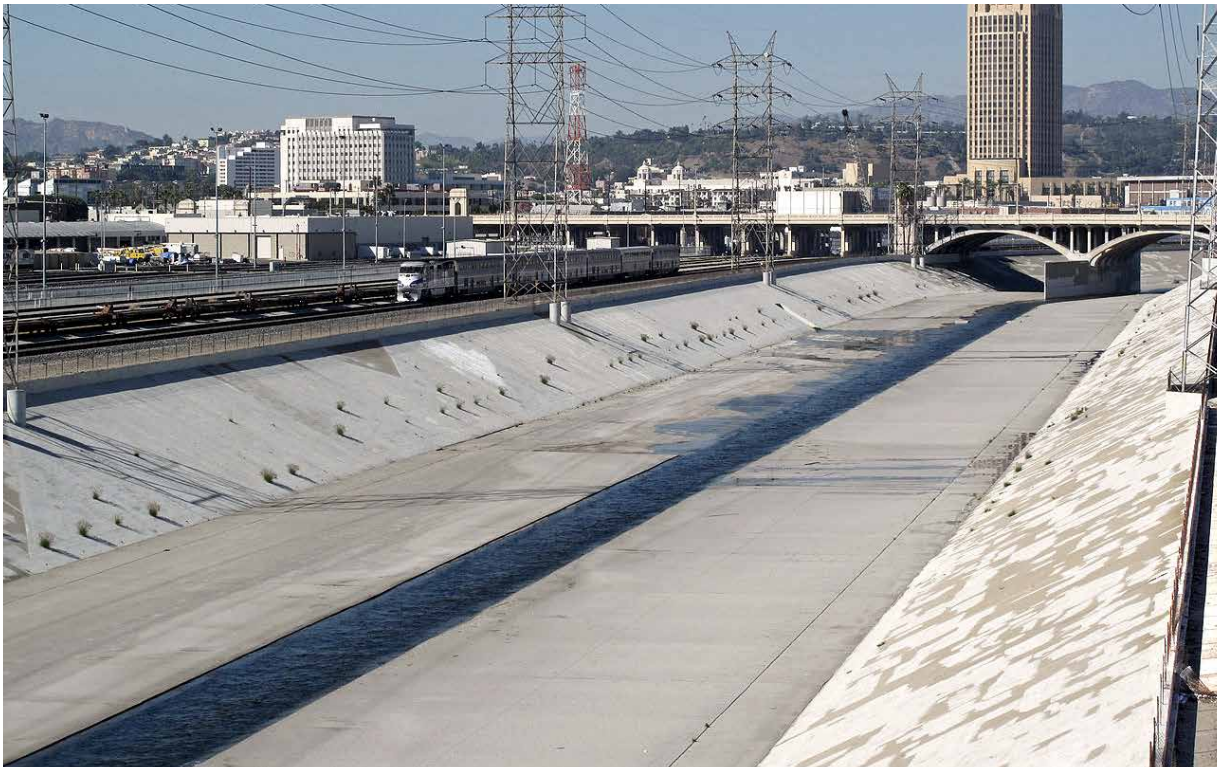

FIGURE 1.5 Channelized Los Angeles River. Photo credit: Downtowngal on Wikimedia.org.

§ 1.2.3 Lack of ecosystem services

The abandonment of riverside areas, especially starting with the industrial revolution, deprived the city of the ecological, psychological, social, and structural benefits of rivers. Considering that the river is often the place where the city started to grow and where, in consequence, the density of historical layers and urban systems is the highest, decoupling from the river led to problems of both functional and cultural nature. The loss of riparian vegetation reduced the micro- and meso-climatic benefits of rivers, the sealing of the riverbed and the increased imperviousness of the surrounding urban fabric led to excessive drainage and flash floods, the accessibility, attractiveness and, hence, the amenity value of rivers as public spaces has decreased (Figure 1.5). Even though the multiple social and ecological benefits of urban rivers have been recognised, implementation is long due.

§ 1.2.4 Reduction of scalar complexity

The last, maybe less evident, problem is related to the scales of the river and it derives from the first three. Urban rivers have always been subject to negotiation among hydrological, ecological, and social drivers. The inherent complexities of the river system were reduced upon human occupation with interventions on different scales. Catchment-scale dynamics were altered either with deviations inside the catchment or with artificial transfers across catchments. For instance, thanks to inter-basin connections in inland Europe, navigation has even been enabled on continental scale. On smaller scales, river rectification and canalisation have reduced lateral river dynamics and riparian ecological complexity.

River transformations have also impacted the scales of the city. The richness of interactions with the river has been reduced. Riverside traffic corridors shifted the scale of the urban river to the larger metropolitan scale of the street network, while creating physical barriers at human scale. Similarly, utilitarian approaches focusing on city-scale issues such as flood protection or storm water drainage, reduced the micro-scale environmental benefits of the river.

Together, the four problems—the river as a barrier, latent flood risk, lack of ecosystem services, and reduction of scalar complexity—are markers of reduced urban resilience to sudden shocks (e.g. floods) and to social and environmental stresses affecting the city on a daily basis. They raise challenges but might also provide levers to the practice of resilience-driven urban design and planning.

§ 1.3 Theoretical framework

Two overarching challenges were pointed out in Sections 1.1-1.2: the need for more resilient approaches and a better definition of the amorphous space surrounding urban rivers. Accordingly, this thesis departs from two branches of urban resilience theory—social-ecological resilience (Section 1.3.1) and urban form resilience (Section 1.3.2). Tasked with operationalising resilience, tools and techniques of spatial morphology and landscape ecology (Section 1.3.3) are employed. The theories of urban resilience provide the wider theoretical frame and key concepts, whereas spatial morphology and landscape ecology offer the means to represent, analyse, and design urban rivers (see key definitions in Table 1.1). As it will become clear by the end of this section, it is at the intersection of these domains where the theory of, and design principles and instruments for, social-ecologically integrated urban river corridors are developed.

TABLE 1.1 Definition of key concepts used in the theoretical framework.

TERM	DEFINITION
Social-ecological resilience	"the ability of a complex socio-ecological system to change, adapt, and, crucially, transform in response to stresses and strains" (Davoudi, 2012, p. 302)
Urban resilience	"the ability of an urban system—and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales—to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity." (Meerow, Newell, & Stults, 2016, p. 45)
Urban form resilience	"resilient urban form is generally defined in both static and normative terms as dense, inclusive of a diversity of building types, founded on co-ordinated and robust movement infrastructure and accommodating of multipurpose or 'flexible' open spaces" (Davis & Uffer, 2013, p. 11)
Spatial morphology	Spatial morphology "combines the qualitative study of individual urban forms, such as streets, squares and buildings typical for urban morphology [...] and the quantitative approach of spatial analysis that rather look at cities as spatial systems [...]"(Erixon Aalto, Marcus, & Torsvall, 2018, p. 6)
Landscape ecology	the study of "the interaction between spatial pattern and ecological process—that is, the causes and consequences of spatial heterogeneity across a range of scales" (Turner & Gardner, 2015, p. 2)
Social-ecological integration	a property of social-ecological systems to sustain synergies and to alleviate conflicts between the patterns and processes of coexisting ecological and social components. (Developed from Barthel et al., 2013)
Urban river corridors	Spaces of social-ecological integration par excellence, urban river corridors are spatial morphological units combining the geomorphological features of the river valley with the morphology of the urban fabric developed along the river. (Developed from Baschak & Brown, 1995; Lerner & Holt, 2012)

§ 1.3.1 Social-ecological resilience

Resilience was first popularised by ecologist C. S. Holling (1973) in his seminal article 'Resilience and Stability of Ecological Systems', in which resilience was defined, in contrast to stability, as "a measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables" (Holling, 1973, p. 14). In a later article, Holling (1996) distinguished between *engineering resilience*, referring to a system's ability to bounce back to a previous equilibrium state after being disturbed, and *ecological resilience*, i.e. the ability to maintain key functions in face of disturbance (Meerow & Newell, 2016) or "the magnitude of the disturbance that can be absorbed before the system changes its structure" (Holling, 1996, p. 33). As opposed to engineering resilience, ecological resilience recognises the existence of multiple equilibrium states and that an ecosystem might shift to a different state once a certain threshold is crossed.

A third type, *social-ecological resilience* (Folke, 2006), also called evolutionary (Davoudi, 2012) or progressive resilience (Vale, 2014), is defined as "the ability of a complex socio-ecological system to *change*, *adapt*, and, crucially, *transform* in response to stresses and strains" (Davoudi, 2012, p. 302, emphasis added). This third type extends the former ecological understanding of resilience—in which ecosystems were already seen as dynamic, complex, and adaptive—to the realm of social-ecological systems (SESs) theory (Folke, 2006; Gunderson & Holling, 2002; cited in Meerow & Newell, 2016). There are three underlying assumptions in social-ecological resilience: that SESs are linked, i.e. the social system is not external, but coupled to and part of the ecological system; that SESs are complex adaptive systems exhibiting non-linear dynamics of change; and that "building adaptive capacity for resilience is the key objective of governing [SESs]" (Wilkinson, 2011, p. 151).

Two additional attributes of resilient systems appear in the definition of social-ecological resilience: *adaptability* and *transformability* (Folke et al., 2010; Walker, Holling, Carpenter, & Kinzig, 2004). "Adaptability is the capacity of a SES to adjust its responses to changing external drivers and internal processes and thereby allow for development within the current stability domain, along the current trajectory. Transformability is the capacity to create new stability domains for development, a new stability landscape, and cross thresholds into a new development trajectory. Deliberate transformation requires resilience thinking, first in assessing the relative merits of the current versus alternative, potentially more favorable stability domains, and second in fostering resilience of the new development trajectory" (Folke et al., 2010, para. 24). This "dynamic interplay of [resilience as] persistence, adaptability and transformability across multiple scales and multiple attractors in SESs" form the framework of 'resilience thinking' (Folke et al., 2010, para. 23).

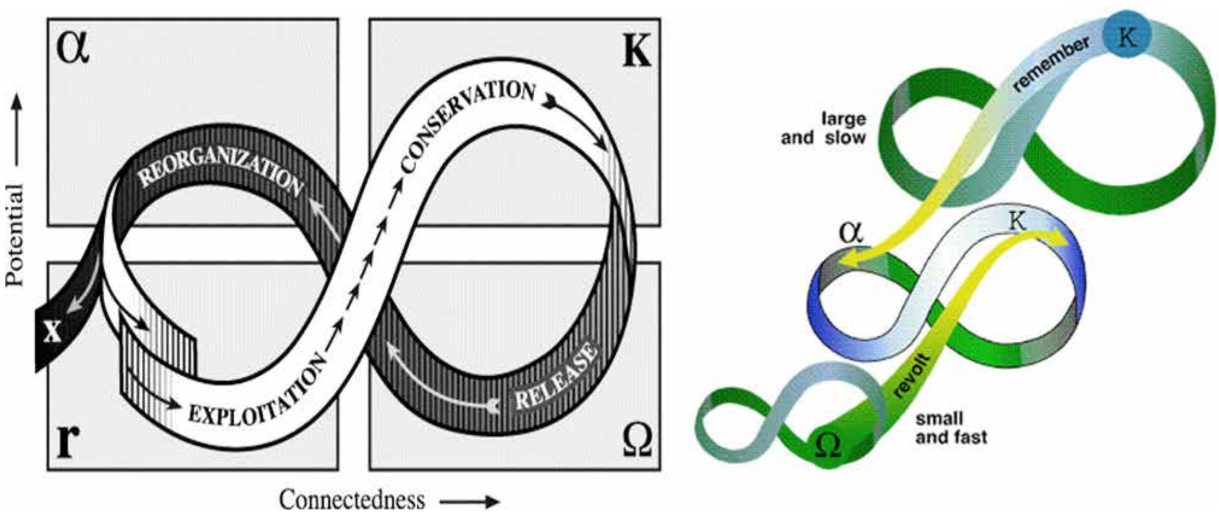

FIGURE 1.6 The Adaptive Cycle (left, Folke et al., 2010) and the Panarchy model (right, Gunderson & Holling, 2002). Source: Resilience Alliance. Retrieved from: https://www.resalliance.org/glossary (Accessed: 1 August 2018).

Central to resilience thinking are the concept of the *Adaptive Cycle* and the *Panarchy model*. The adaptive cycle is "a heuristic model that portrays an endogenously driven four-phase cycle of social-ecological systems and other complex adaptive systems" (see Table 1 in Folke et al., 2010). As shown in Figure 1.6 (left), the cycle is described as four-phased trajectory: a "foreloop" of rapid growth (the so-called r-phase), characterised by high resilience and a phase of capital accumulation (K phase), in which resilience is decreased, and a "backloop" comprising a sudden collapse of structure and relationships (Ω) and a phase of reorganisation (α) in which the system is renewed. The panarchy model is "a heuristic for understanding how complex systems progress over time through multi-scalar adaptive cycles of destruction and reorganization" (Gunderson & Holling, 2002, cited in Meerow et al., 2016, p. 40). The panarchy model underpins the evolutionary meaning of resilience by combining multiple adaptive cycles in a nested hierarchy at multiple spatial and temporal scales (Davoudi, 2012).

Challenges and opportunities of a 'boundary object'

One of the core qualities of resilience is that it is a 'boundary object' (Brand & Jax, 2007) or 'bridging concept' (Davoudi, 2012), meaning that its interpretable nature makes it easily understandable and transferable across disciplines. Brand and Jax (2007) state that this vague and malleable character of resilience is particularly suited for inter- or transdisciplinary work dealing with social-ecological systems (in the sense of social-ecological resilience as defined by Folke, 2006), or according to (Vale, 2014, p. 199), "the term may legitimately serve as a vital and welcome intellectual bridge, both in theory – and more importantly – in practice." It is not a surprise then to see the growing popularity of resilience in policy discourse (Weichselgartner & Kelman, 2015) and its proliferation from the original ecological definition to several other disciplines, such as disaster management, psychology, economy, and urban planning.

At the same time, Brand and Jax (2007) warn that, due to the diluted meaning of resilience, "both conceptual clarity and practical relevance are critically in danger" (Brand & Jax, 2007, para. 2). Some scholars even argue that resilience might become 'just another buzzword', 'empty signifier', or 'old wine in new bottles' (e.g. Davoudi, 2012; Müller, 2011; Weichselgartner & Kelman, 2015), like sustainability, vulnerability and adaptability. Opinions also differ on how resilience is related to the already established discourse of sustainability and on different degrees of normativity. Picket et al. (2014, p. 144), for instance, present resilience as "a non-normative conceptual scientific model" which is key to operationalising the normative, socially constructed goals of sustainability.[4] Weichselgartner and Kelman, on the other hand, suggest that "resilience should be transformed from a mainly descriptive concept ('what is done') into one which includes a normative agenda ('what ought to be done')" (Weichselgartner & Kelman, 2015, p. 250). Such a hybrid concept—i.e. one in which descriptive and normative connotations are mixed—is social-ecological resilience (Brand & Jax, 2007).

According to Weichselgartner & Kelman (2015), the assertion that resilience is an integrating concept lacks empirical evidence and, therefore, decisions about resilience must consider the already existing practices of risk and sustainability. They point out the essential role of geography in integrating the natural environment, the built environment and society, as opposed to the more disciplinary approaches of ecology, psychology and engineering engaged in resilience.

Another important stream of criticism of resilience comes from social theorist, concerned that the system-based models of ecological resilience, namely the adaptive cycle, do not represent social dynamics (Meerow & Newell, 2016). Proponents of social-ecological resilience respond to this critique by specifying that the adaptive cycle is a tendency, i.e. a guiding model acknowledging human agency in the social system, rather than a deterministic model as it is applied in ecology.

Situating resilience in urban design and planning

Recognising the challenges and opportunities outlined above, Pickett et al. (2014) set out to situate resilience in the urban design and planning practice by distinguishing the core meaning of resilience from metaphors, most commonly connoting some form of 'bounce-back-ability' to some pre-disturbance state, and from operationalising models, such as social interpretations of the adaptive cycle. A sustained attempt to clarifying the core meaning of resilience can be traced in a number of questions recurring in literature: "resilience of what to what?" (Carpenter, Walker, Anderies, & Abel, 2001) "and at what temporal and spatial scales?" (Weichselgartner & Kelman, 2015), "and for whom?" (Vale, 2014), as well as "when, where and why?", to complete Meerow and Newell's (2016) "five Ws of urban resilience".

4 According to Brand & Jax (2007), the three pillars of sustainability are (1) social equity and well-being, (2) economic viability or feasibility, and (3) environmental or ecological integrity.

Depending on the kind of system or disturbance, resilience can be *specified* or *general* (Folke et al., 2010; Walker & Salt, 2012). In response to the question "resilience of what to what?", specified resilience is the "resilience of some particular part of a system [...] to one or more identified kinds of shocks", while general resilience is defined as "[t]he resilience of any and all parts of a system to all kinds of shocks, including novel ones" (see Table 1 in Folke et al., 2010). Applied to cities, these two views are equally important. Cities are not only facing acute shocks, such as floods or earthquakes, but also chronic stresses affecting cities on a daily basis, like high levels of pollution, lack of green spaces, severe heat waves, and heavy congestion, just to name the predominant ones (da Silva & Moench, 2014).

These two types of disturbances determine different responses. According to Vale (2014), resilience has been employed in urban planning and design in two modes: *reactive/restorative* and *proactive/preventive*. The reactive mode focuses more on post-disturbance retrofitting and recovery management, whereas proactive resilience aims to "anticipate future problems and seek proactive solutions that enhance the quality of both public and private living spaces" (Vale, 2014, p. 194). The reactive/restorative mode is most frequently adopted as an attempt to return to a pre-disturbance state after an acute shock has occurred. In addition to anticipating sudden shocks, the proactive/preventive mode can consider the slow dynamics of chronic stresses as well. In this mode, urban design and planning can be involved earlier in the process. Notwithstanding the importance of reactive/restorative approaches, the proactive/preventive mode is of special interest for urban design and planning, as it can integrate general resilience properties (Carpenter et al., 2012) into a wider framework of general urban resilience (Forgaci & van Timmeren, 2014). Focused on spatial properties, such a framework could deliver design and planning principles.

The question of scale, and implicitly the establishment of system boundaries, encompasses all the other questions. Linked to scale is the issue of who decides and who benefits from resilience-driven planning decisions. This means that there are 'winners' and 'losers' either among the actors affected by planning decisions within the system or outside of it. This leads to the question of where the spatial boundaries of the urban system are. The inherent social and environmental unevenness of the city makes any reference to resilience of an entire city over-simplified (Vale, 2014). In this sense, finding spaces of strategic resilience-building, becomes an important task in resilience-driven urban planning and design.

Part of the definition of resilience is that it is a time-related concept. For when to employ resilience is important in both reactive and proactive approaches. Although uncertainty is acknowledged in urban resilience, understanding past occurrence of disturbances, recoveries, adaptations and transformations is a necessary prerequisite both for responding to events after they have occurred and for anticipating future disturbances. If the focus of proactive approaches is on short-term disruptions, persistence might be the main goal, while addressing long-term stresses might require some degree of transition or transformation (Meerow & Newell, 2016).

Why resilience is promoted needs careful consideration. Resilience in itself is not good or bad, as undesirable states may be highly resilient too (Walker & Salt, 2012). The goal of resilience building, with focus on either the process or the outcome, determines whether the status quo, adaptation or transformation are desirable (Meerow & Newell, 2016).

§ 1.3.2 Urban form resilience

The 'urban' in urban resilience literature is used in a very inclusive way to describe the urban environment as a totality of "social, biological, built and geophysical components" (Pickett et al., 2014, p. 144), on several spatial and temporal scales. This inclusive description poses some difficulties to answering the questions outlined in Section 1.3.1. What is it exactly that needs to gain resilience? What are the disturbances acting upon the urban environment? Where are the urban system's boundaries and who is included? How did the city react to past disturbances? Social-ecological resilience provides a conceptual frame for understanding the urban system, but it does not provide the spatial tools necessary for urban design and planning. A branch of urban resilience which is highly relevant in this sense, is *urban form resilience*, concerned with the way in which the spatial composition and configuration of the urban fabric influences urban resilience. Resilient urban form is defined as "dense, inclusive of a diversity of building types, founded on coordinated and robust movement infrastructure and accommodating of multipurpose or 'flexible' open spaces" (Davis & Uffer, 2013, p. 11).

As a normative approach, urban form resilience aims to measure and assess urban form against given resilience targets, and to provide principles and tools for urban design and planning. To that end, it uses indicators derived from spatial properties of resilience. Looking at attempts at quantifying or assessing resilience, different sets of properties can be identified in studies of general resilience (e.g. Carpenter et al., 2012; Walker & Salt, 2012). Upon examining those properties,[5] a few observations can be made. The first observation is that some properties—diversity, robustness, modularity, redundancy, openness, reserves, nestedness, self-organization—have direct spatial implications, whereas others—responsiveness, monitoring, leadership, trust, social networks, coordination—are less influenced by spatial conditions.

The second observation is that the properties are not independent or mutually exclusive. Some can be described or even determined by others. This is the case, for example, of redundancy, that is, the spare or latent capacity for rise in demand or loss of supply. In one way or another, each property is a variation of redundancy expressed as some kind of extra capacity. Diversity, for instance, provides several solutions to the same problem (response diversity), or solutions that can address several problems (functional diversity) (Carpenter et al., 2012; Norberg & Cumming, 2008). In this sense, diversity is a form of redundancy. Modularity, that is, the capacity of parts of a system to decouple in case of a disturbance, implies that the system is decentralized, thus redundant, to a certain extent. In another definition, Carpenter et al. (2012) even defines diversity in terms of modularity.

Redundancy, can be considered a point of departure in looking at the resilience of the urban fabric. To a certain extent, there is built-in redundancy in every urban system. This is visible especially (but not exclusively) in historical cities, i.e. cities developed in an incremental way throughout history and less affected by top-down (modernistic) planning decisions. The redundancy of their spatial configuration may be ascribed to high levels of road network connectivity, availability of open and distributed spaces, (spatial and functional) diversity and self-organization.[6]

5 A comprehensive review of general resilience properties is outside the scope of this thesis.

6 See Section 7.3.1 for a detailed discussion on redundant road networks.

§ 1.3.3 Spatial morphology and landscape ecology

Landscape ecology and spatial morphology offer empirical, analytical and design tools to operationalise resilience. *Spatial morphology* "combines the qualitative study of individual urban forms, such as streets, squares and buildings typical for urban morphology [...] and the quantitative approach of spatial analysis that rather look at cities as spatial systems [...]" (Erixon Aalto et al., 2018, p. 6). In contrast to traditional typology-morphology approaches, space-morphology has a strong *topological* dimension, i.e. it uses networks to represent the space of movement and to analyse complex urban configurations. *Landscape ecology*, defined as the study of "the interaction between spatial pattern and ecological process—that is, the causes and consequences of spatial heterogeneity across a range of scales", combines the spatial approach of geography[7] with the functional approach of ecology (Turner & Gardner, 2015, p. 2). Landscape ecology resorts to a model called *land mosaics* (Forman & Godron, 1986) to describe and analyse landscape composition and configuration. Principles of landscape ecology, as the ones developed by Dramstad et al. (1996), have been proven useful in guiding landscape design and planning (Ahern, 2013).

Spatial morphology and landscape ecology provide the vocabulary and tools necessary for the implementation of spatial-ecological resilience and urban form resilience. This way, the urban environment can be perceived, analysed and designed as a conjoint social and ecological landscape. The tools and methods of analysis, as well as principles of the two approaches will be further described in Chapter 5 and Chapter 7.

§ 1.3.4 Conceptual framework

As illustrated in Figure 1.7, the core concept developed in this thesis is *social-ecological integration*.[8] Building on the descriptive, analytic and normative goals of social-ecological resilience and urban form resilience and equipped with the tools and techniques of spatial morphology and landscape ecology, social-ecological integration is proposed here as a normative concept capable of operationalising social-ecological resilience. In general terms, social-ecological integration can be defined as the capacity of social-ecological systems to sustain synergies and to alleviate conflicts between the patterns and processes of coexisting ecological and social components. It builds on general properties of resilience, it addresses chronic stresses, and it adopts a proactive approach, by pooling the resources and adaptability of the social and ecological components of the system.

Applied to the urban environment, social-ecological integration focuses on enhancing the composition and configuration of urban spaces which can potentially fulfil ecological and social goals in a combined way. As mentioned earlier, the urban environment is seen as a social-ecological landscape in which all spaces can, potentially and to a certain degree, provide social-ecological integration. However, the unevenness of the urban landscape makes some spaces more suited than

7 As opposed to the more disciplinary approaches of ecology, psychology and engineering, geography integrates the natural environment, the built environment and society (Weichselgartner & Kelman, 2015)

8 Integrated (as opposed to segregated) SESs (e.g. Barthel et al., 2013) or coupled human and natural systems (e.g. Liu et al., 2007) have been increasingly employed in SES research and in integrated geography.

others. *Urban river corridors (URCs)*, chosen as areas of focus in this thesis, are spaces of social-ecological integration par excellence, where the interaction between the social systems of the city and ecological systems is (potentially) the most intense. URCs are defined here as spatial morphological units combining the geomorphological features of the river valley with the morphology of the urban fabric developed along the river. An in-depth review of the literature on social-ecologically integrated urban river corridors will follow in Chapter 2.

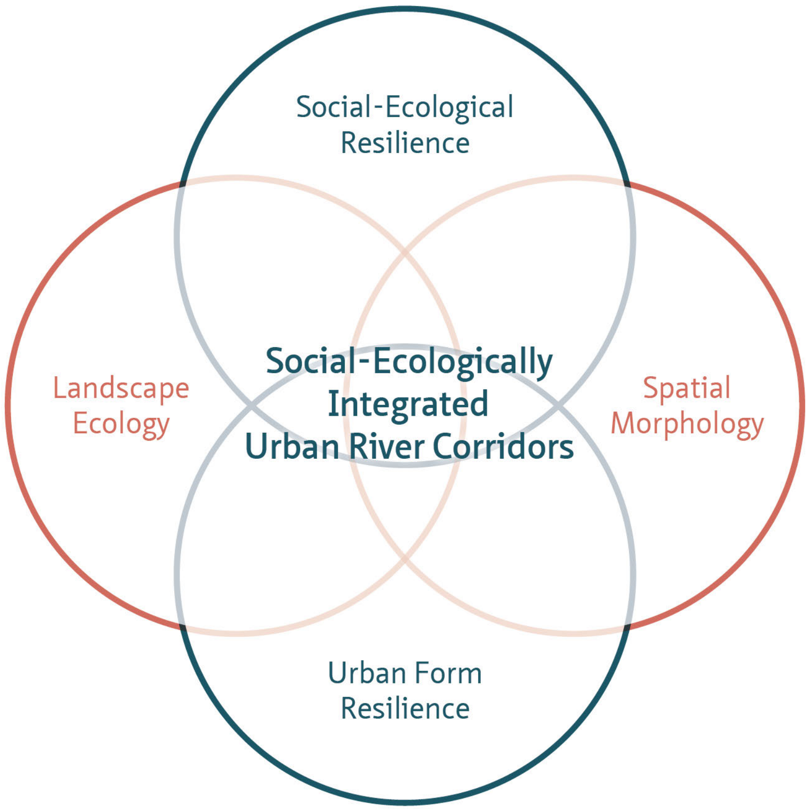

FIGURE 1.7 Conceptual framework: social-ecologically integrated urban river corridors as a normative concept at the intersection of the theoretical fields of social-ecological resilience and urban form resilience and the analytical domains of landscape ecology and spatial morphology.

§ 1.4 Research questions and objectives

Having established the normative value of social-ecological integration and the spatial-morphological potentials of URCs, the main research question naturally follows:

How can social-ecological integration be spatially defined, assessed and designed in Urban River Corridors?

As shown in Table 1.2, each chapter of the thesis responds to a sub-question and addresses a number of objectives.[9] Sub-question 2 ("What are the spatial-morphological conditions for achieving social-ecological integration along urban rivers?") prompts the literature review carried out in Chapter 2, which is meant to develop a transdisciplinary knowledge base on urban rivers for the rest of the thesis. Sub-question 3 ("How has the social-ecological relationship between Bucharest and its rivers evolved through time?") and Sub-question 4 ("What is the current state of knowledge on Bucharest's URCs?") will be answered in Chapters 3 and 4, respectively, to analyse the historical development and current state of urban rivers in a real-world context: the URCs of Bucharest. Sub-question 5 ("How can the social-ecological integration of urban river corridors be assessed?") and Sub-question 6 ("To what extent are the URCs of Bucharest social-ecologically integrated?") prompt the investigation of how URCs can be assessed in general and in the empirical context of Bucharest. Finally, Sub-question 7 ("How can the design of URCs be guided towards social-ecological integration?") and Sub-question 8 ("How do design instruments aid the design of better integrated urban river corridors?") detail the third part of the main research question, that is, the development of design principles and design instruments for social-ecologically integrated URCs.

TABLE 1.2 Sub-questions and objectives used to answer the main research question.

SUB-QUESTION	OBJECTIVES
SQ2: What are the spatial-morphological conditions for achieving social-ecological integration along urban rivers? (Chapter 2)	**Objective 2.1**: Identify key properties of URCs.
	Objective 2.2: Formulate a spatial-morphological definition of URCs.
	Objective 2.3: Devise a method of spatial delineation of URCs.
SQ3: How has the social-ecological relationship between Bucharest and its rivers evolved through time? (Chapter 3)	**Objective 3.1**: Describe the geographic context of Bucharest's URCs.
	Objective 3.2: Describe the spatial-temporal dynamics of Bucharest's URCs.
SQ4: What is the current state of knowledge on Bucharest's URCs? (Chapter 4)	**Objective 4.1**: Summarise the spatial effects of post-socialist transformations on URCs in Central and Eastern Europe.
	Objective 4.2: Identify the current problems and potentials of Bucharest's URCs related to urban development.
SQ5: How can the social-ecological integration of URCs be spatially assessed? (Chapter 5)	**Objective 5.1**: Review current approaches to the assessment of urban rivers.
	Objective 5.2: Build an assessment framework for social-ecological integration in URCs.
SQ6: To what extent are the URCs of Bucharest social-ecologically integrated? (Chapter 6)	**Objective 6.1**: Assess social-ecological integration in URC Dâmbovița.
	Objective 6.2: Demonstrate the wider application of the assessment framework on URC Colentina.
SQ7: How can the design of URCs be guided towards social-ecological integration? (Chapter 7)	**Objective 7.1**: Formulate design principles of social-ecologically integrated URCs.
	Objective 7.2: Explore URCs through design.
SQ8: How do design instruments aid the design of better integrated URCs? (Chapter 8)	**Objective 8.1**: Develop a set of design instruments to apply the design principles of social-ecologically integrated URCs.
	Objective 8.2: Demonstrate and test the design instruments on the URCs of Bucharest.

9 To maintain the correspondence with chapter numbers following this introductory chapter, the numbering of the sub-questions and the objectives starts with 2, i.e. with the sub-question and objectives of Chapter 2.

§ 1.5 Approach

As pointed out in the theoretical framework, operationalising social-ecological resilience requires a proactive approach capable of addressing the complexity of the urban environment, the uncertainties of future events, and the limitations of disciplinary models. To meet these challenges, the thesis adopts a *transdisciplinary design study* approach, the elements of which—*design* and *transdisciplinarity*—are described in Sections 1.5.1-1.5.2.

§ 1.5.1 Design study

A design study combines two distinct domains of activity: research and design. Research is a systematic enquiry aimed at advancing generalizable knowledge (Groat & Wang, 2013), whereas design is concerned with devising "courses of action aimed at changing existing situations into preferred ones" (Simon, 1996; cited in Groat & Wang, 2013, p. 24). Research is question-driven, while design is problem-driven. Besides these differences, there is also a necessary reciprocal relationship. In Groat and Wang's words, "design and research constitute neither polar opposites nor equivalent domains of activity. Rather, the relationship between the two is far more nuanced, complementary, and robust." (Groat & Wang, 2013, p. 18). Building on this complementarity, several approaches, such as *study by design* (de Jong & van der Voordt, 2002), or *evidence-based design* (Zeisel, 2006), have already integrated design into research. Although some minor differences exist between these approaches, what they have in common is the systematic involvement of design in the process of inquiry.

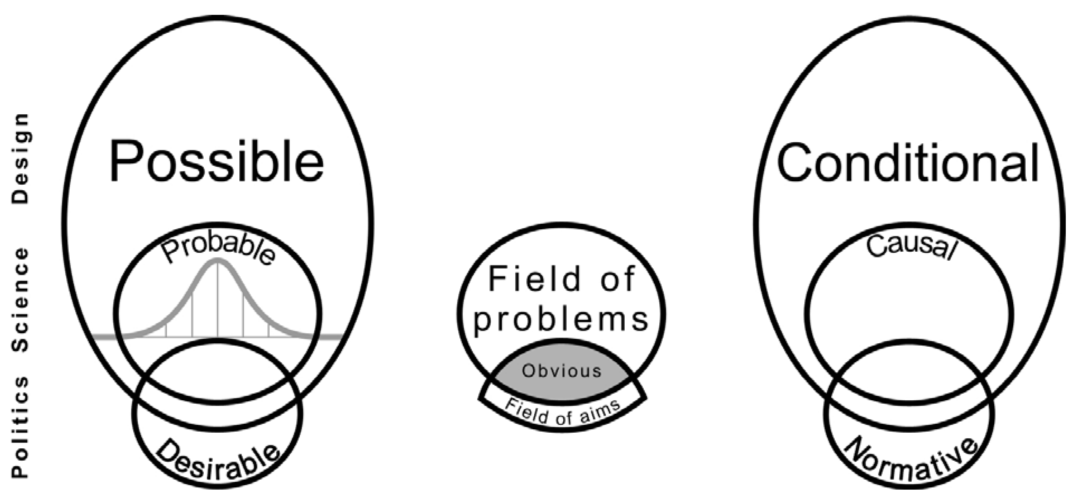

FIGURE 1.8 Possible, probable and desirable futures, as depicted by Taeke de Jong (2012, pp. 16–17).

But in order to employ design in research, a different way of thinking is required. In his account of modes of reasoning in environmental design, Taeke de Jong (2012) conceptualises design in relation to probable, possible and desirable futures (Figure 1.8). Within his scheme, the field of possibilities for design extends beyond what is probable, meaning that it requires a conditional rather than causal reasoning. Such a reasoning is also called *abductive*, which is different from deductive and inductive modes of inference that are predominant in science. Abduction, called also hypothesis, presumption, and retroduction by Charles Sanders Pierce[10] or productive reasoning by March (1984), entails making an "inference to the best explanation" or, most simply, an "educated guess." Abductive logic is typical to design thinking as it entails figuring out the thing to create and the working principle that can lead to an aspired value (for a detailed explanation of the three types of inferences see, for instance, Groat & Wang, 2013, pp. 33–36).

In practical terms, design has at least two applications. It is, as described above, a *problem-solving activity*, as it responds to real problems, commissions, assignments, but it is also—and this is often overlooked—a *knowledge producing activity*, as explained by Viagnò (2010). Christian Salewski states, in a similar manner, that "designing is one of the few truly integrative tools to develop solutions for complex tasks under the acceptance of fundamental uncertainties. Designs need to be informed by research, but they are also fundamental to provide necessary directions, focus, and frames for good research" (Salewski, 2013, p. 18). As a problem-solving activity in a real-world context, design deals with wicked problems, which can be addressed, on one hand, with trial and error in a non-linear, iterative process and, on the other hand, by having an overall under-standing of contextual dynamics the object of design is part of. In this sense, *strategic*, *systemic* and *adaptive design* (Ahern, 2011, 2013), as well as *design experiments* (Felson & Pickett, 2005) must be incorporated in a design study.

This research uses design in three ways: *as a starting point* or *hypothesis*, *as a way of exploration*, and *as a way of testing*. As a starting point and as a way of exploration, the research was informed by river design projects carried out by the author prior to and during the research (see Boxes 7.1-7.4 in Chapter 7). As a way of testing, a design workshop was used an integral part of the research strategy (see Chapter 8). The research does not culminate in a design, but it offers a set of principles and instruments to guide and aid the design for social-ecological integration.

§ 1.5.2 Transdisciplinarity

In addition to its application in problem-solving and knowledge production, design is increasingly seen as "*an integrative activity* across disciplines" (Ahern, 2013, p. 1204, emphasis added), or one in which integrated knowledge can lead to integrative spatial quality (Khan, Moulaert, Schreurs, & Miciukiewicz, 2014). This is visible in approaches such as design-decision research, collaborative design, or scholarship in public (Groat & Wang, 2013), and in a general tendency towards disciplinary de-specialisation in the design fields (Waldheim, 2016). Overcoming disciplinary boundaries is also a fundamental prerequisite of how the research is conducted. In a wider scope, sustainability scholarship entails an "undisciplinary journey" in which methodological groundedness and epistemological agility become core competencies (Haider et al., 2018, p. 191).

There are two barriers to transdisciplinarity in the field of design. The first is within the domain of design itself, between landscape architecture/urbanism/design/planning and urban design/planning. Beyond their categorisation as disciplines, these are activities, each with a specific spatial focus and guided by a distinct body of knowledge, even though they often act upon the same spaces.

10 The term abduction, used interchangeably with hypothesis, presumption, and retroduction, was coined by pragmatist philosopher Charles Sanders Pierce in the 19th century.

A transdisciplinary design approach does not separate urban design from planning, nor does it regard built form and the landscape as separate fields of study and intervention. The second barrier is visible in the difficulty of communicating knowledge across disciplines. Although some attempts of overcoming them exist—landscape urbanism (Waldheim, 2016), urban ecological design (Palazzo & Steiner, 2011), or landscape ecology (Ahern, 2011) are some—, design is still mainly confined by the first barrier. The integrative potential of design is yet to be fulfilled, and one way to that end is to devise a visual body of knowledge which can facilitate communication across the second barrier as well.

The subject matter of this thesis—social ecological integration of urban river corridors—requires opening up to an 'ecology of ideas' (Montuori, 2013) scattered across different fields of knowledge—river ecology, hydrology, environmental history, river restoration, civil engineering, urban and landscape design, urban and regional planning, to name just a few of the ones which were encountered during the research. For analytical purposes, transdisciplinary knowledge will be categorised in Chapter 2 into four thematic domain families—*environmental-ecological*, *social-economic*, *planning-governance*, and *spatial-morphological*—, each informed by several disciplines.

§ 1.6 Methodology

Determined by the transdisciplinary approach and the nature of the research question, the thesis adopts a *mixed methods research design*, or *combined strategy* (Groat & Wang, 2013), as it mixes elements of a case study design and logical argumentation[11] under the overall approach of a design study. This research design is particularly suitable, considering the complexity of the context and topic of enquiry, the exploratory nature of design, the variety and changing nature of data sources, and, consequently, the need for triangulation. This strategy of inquiry is rooted in a *pragmatic worldview*, as "it is not committed to any one system of philosophy and reality" (Creswell, 2014, p. 11). Instead, it is problem-centred, it is concerned with applications situated in a plural reality and it is free in combining different methods, techniques and procedures of both qualitative and quantitative nature.

The investigation involves the intensive study of a single "typical" case (Gerring, 2007, p. 49), which is "*representative* [emphasis added] of the phenomenon under study"—the city of Bucharest and its two rivers. According to Yin's typology,[12] the present study may be classified as *theory-building*, as it is instrumental in exploring and to explaining the phenomenon at hand. It is *exploratory* in its search for principles and *explanatory* in its aim for generalisable knowledge. Case studies typically incorporate multiple sources of evidence. As shown in this section, the thesis employs various data sources, such as historical analyses, diachronic mapping, expert interviews, spatial and network analyses.

11 Groat & Wang (2013) identify seven research strategies in architecture and allied fields: historical research, qualitative research, correlational research, experimental and quasi-experimental research, logical argumentation, and case studies and combined strategies.

12 Yin (2003) classifies case study designs into linear-analytic, chronological, theory-building and unsequenced.

§ 1.6.1 Research design

As shown in Figure 1.9, the research is organized in three packages that correspond to the three parts of the thesis (outlined in Section 1.8)—Context, Assessment, and Design—, each consisting of a different set of methods (see Table 1.3 for a complete list of methods).

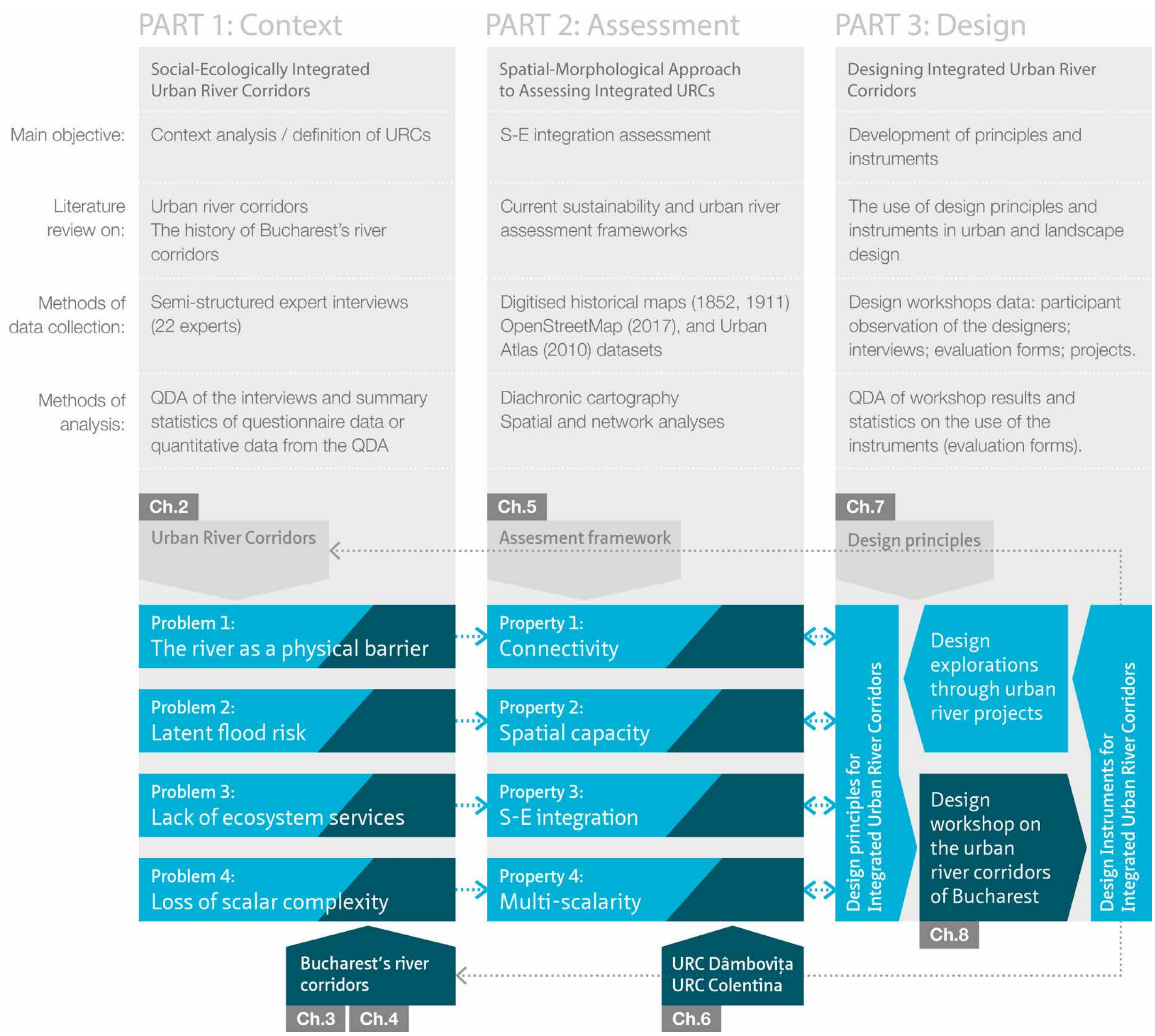

FIGURE 1.9 Research design diagram.

The *transdisciplinary literature review* conducted in Chapter 2 is critical for integrating the knowledge on URCs and to prepare the conceptual framework for consequent empirical work. The four key properties of URCs are derived from a systematic analysis of the subject matter across domains. The review of literature is also important in the historical study of Bucharest's URCs presented in Chapter 3 and in the first part of Chapter 4. In addition, Part 2 and Part 3 draw on existing literature in the development of the assessment framework and the design principles, respectively.

TABLE 1.3 The methods used in the thesis, in relation to the sub-questions and objectives used to answer the main research question.

OBJECTIVES	METHOD(S)*
SQ2: What are the spatial-morphological conditions for achieving social-ecological integration along urban rivers? (Chapter 2)	
Objective 2.1: Identify key properties of URCs.	Conduct ***a transdisciplinary literature review*** on urban rivers and the development of the concept of urban river corridors.
Objective 2.2: Formulate a spatial-morphological definition of URCs.	Following the spatial-morphological definition (Objective 2.2) and building on existing ***methods of river corridor delineation***, formulate the procedure required to delineate URCs.
Objective 2.3: Devise a method of spatial delineation of URCs.	
SQ3: How has the social-ecological relationship between Bucharest and its rivers evolved through time? (Chapter 3)	
Objective 3.1: Describe the geographic context of Bucharest's URCs.	Describe the catchment- and metropolitan-scale conditions of the URCs of Bucharest (literature).
Objective 3.2: Describe the spatial-temporal dynamics of Bucharest's URCs.	Summarise the history of the transformations of Dâmbovița and Colentina in relation with the spatial development of Bucharest (literature).
SQ4: What is the current state of knowledge on Bucharest's URCs? (Chapter 4)	
Objective 4.1: Summarise the spatial effects of post-socialist transformations on URCs in Central and Eastern Europe.	Literature review of post-socialist urban transformations.
Objective 4.2: Identify the current problems and potentials of Bucharest's URCs related to urban development.	***Content analysis*** of ***semi-structured interviews*** with local experts from different disciplines involved in planning, governance or design of- or in Bucharest's URCs.
SQ5: How can the social-ecological integration of URCs be spatially assessed? (Chapter 5)	
Objective 5.1: Review current approaches to the assessment of urban rivers.	Literature review on methods of assessment and spatial indicators of URCs.
Objective 5.2: Build an assessment framework for social-ecological integration in URCs.	Devise an ***indicator system and an assessment framework*** based on current approaches (Chapter 5/Objective 5.1) and the key properties of URCs (Chapter 2/Objective 2.1).
SQ6: To what extent are the URCs of Bucharest social-ecologically integrated? (Chapter 6)	
Objective 6.1: Assess social-ecological integration in URC Dâmbovița.	Make a selection of indicators based on the issues highlighted by the local experts in Chapter 4 and on criteria specified in the assessment framework and carry out the assessment on URC Dâmbovița.
Objective 6.2: Demonstrate the application of the assessment framework on URC Colentina.	Demonstrate the use of the assessment framework on URC Colentina.
SQ7: How can the design of URCs be guided towards social-ecological integration? (Chapter 7)	
Objective 7.1: Formulate design principles of social-ecologically integrated URCs.	Based on the key properties and principles of URCs identified in the transdisciplinary literature review (Chapter 2/Objective 2.1) and current sustainable urban design principles at large (Chapter 7/Objective 7.1), devise a set of spatial-morphological principles.
Objective 7.2: Explore URCs through design.	Explore the design of URCs through riverside urban and landscape ***design projects***.
SQ8: How do design instruments aid the design of better integrated URCs? (Chapter 8)	
Objective 8.1: Develop a set of design instruments to apply the design principles of social-ecologically integrated URCs.	Translate the design principles into procedures that are easily communicable and applicable in the design process.
Objective 8.2: Demonstrate and test the design instruments on the URCs of Bucharest.	Conduct a ***design workshop*** as a research methodology to demonstrate and test the use of the design instruments.

** Some objectives are accomplished by literature review. Methods are **emphasized**.*

In Part 1, the empirical case of Bucharest and its URCs is analysed through *content analysis* of qualitative data obtained from *expert interviews*. A thorough description of the methods, techniques and procedures of data collection and analysis can be found in Chapter 4. The methods used in Part 2 are mainly analytical. Various methods of *spatial and network analysis* were used in this part. Geographic data used in the analyses was retrieved mainly from secondary sources, such as OpenStreetMap and Urban Atlas data. The development of the assessment framework and the implementation methodology are described in Chapters 5 and 6. Part 3 involved *design explorations* for the development of design principles and a *design workshop* used to test and demonstrate the design instruments derived from the design principles. Considering the qualitative nature of the workshop, a *multi-method approach* was adopted in the data collection process. The full methodology and procedures of the workshop are described in Chapter 8.

The three parts of the thesis are assembled into an *exploratory concurrent mixed methods design* (Figure 1.10), adapted from what Creswell (2014) calls an exploratory sequential mixed methods design. The QUAL>QUAN sequence of Creswell's model is connected to a recursive design component informed by both the QUAL and QUAN components. It is not a sequence concluded with an interpretation, as in Creswell's model, but an iterative process, in which the result is the design component.

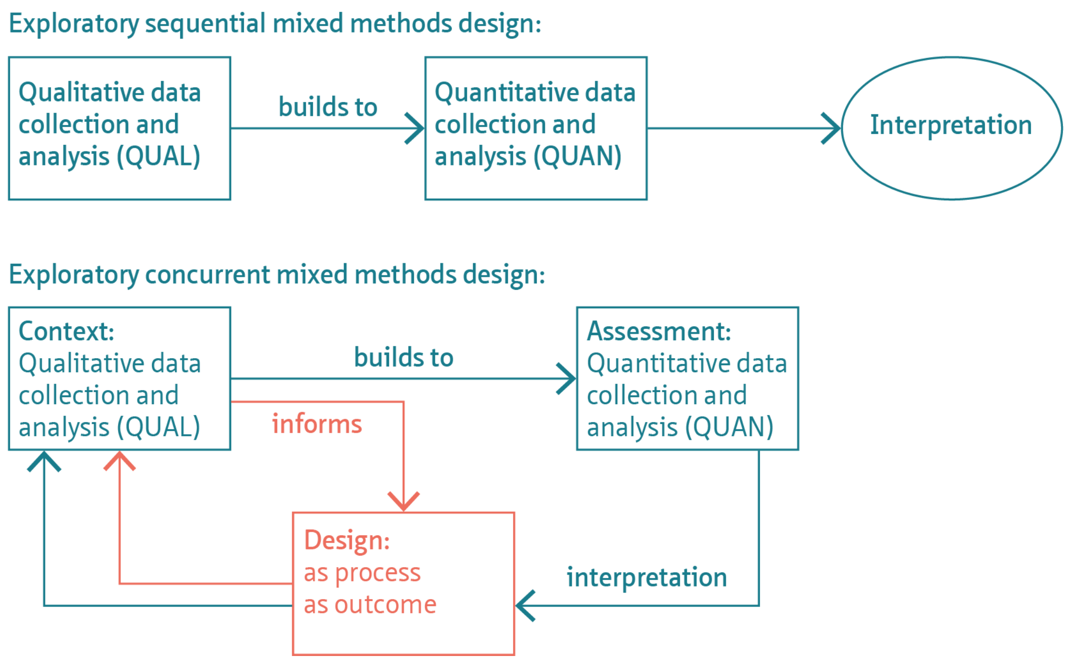

FIGURE 1.10 Diagram of the *exploratory concurrent mixed methods design* used in the research (bottom), adapted from Creswell's (2014) exploratory sequential mixed-methods design (top).

§ 1.7 Relevance

With its aim to further transdisciplinary knowledge and application on urban rivers and to apply that knowledge through a design-driven research strategy, this thesis addresses both researchers in urban design and planning and actors from the wider public involved in the development of urban rivers.

§ 1.7.1 Societal relevance

Terms such as 'sustainability', 'resilience' and 'adaptability' have been proven powerful (at least in a metaphorical and rhetorical way) in addressing the issues of globalization, urbanisation and climate change. Yet, due to their ambiguous meaning, their operationalisation remains difficult. While cities are expanding and densifying, environmental issues such as overheating, floods, and pollution, but also the degradation of public space, increasingly impact the life of citizens. If defined, assessed and designed properly, URCs can have a considerable contribution to mitigating or alleviating these societal challenges. Recognising this potential, this research aims for societal impact in at least three ways:

- the transdisciplinary knowledge assembled in this thesis may inform and facilitate collaborative and participatory design with actors involved in the spatial development of riverside urban areas;
- the assessment framework can facilitate the acquisition of empirical evidence for better informed decision-making in the planning and design of riverside urban transformations; and
- the design principles and instruments may support design practice in devising solutions which are more integrative and forward-looking.

§ 1.7.2 Scientific relevance

The methodological and conceptual breadth of this research raises several challenges regarding research quality, consistency, and focus, but, for the same reason, it also tackles several issues of high scientific relevance:

- still sparingly applied to urban resilience research, the spatial-morphological approach presented here can facilitate the adoption of resilience theory by urban design scholars;
- the visual and conceptual vocabulary of the transdisciplinary knowledge developed in this thesis may clear the way for further transdisciplinarity research on urban rivers;
- the concept of social-ecological integration, as defined and applied in this thesis, may provide strategies and heuristics for implementing urban resilience; and
- the transdisciplinary approach and design-driven research methodology employed in this thesis (referred to as a transdisciplinary design study) offers a potential pathway to researchers involved in similar research strategies.

§ 1.8 Thesis outline

As shown in Figure 1.11, the thesis is divided in three themed parts: *Context*, *Assessment* and *Design*. This structure resembles the main stages of an evidence-based design process and makes the transition through descriptive, analytical and normative claims as the thesis advances. Although the chapters follow an overall line of argumentation, the three parts are coherent modules that can be read separately.

Part 1 consists of three chapters and establishes the theoretical and empirical context in which URCs are investigated. *Chapter 2* is a transdisciplinary literature review, in which key properties and principles of URCs are distilled from four domains of knowledge, referred to as the environmental-ecological, social-economic, planning-governance, and spatial-morphological dimensions. The chapter ends with a spatial-morphological definition and a method of spatial delineation of URCs. *Chapters 3 and 4* introduce the URCs of Bucharest from a historical perspective and in their current state, respectively. *Chapter 3* describes the transformations of the rivers form mid-nineteenth century until the fall of Communism in 1989 in relation to the spatial dynamics of the city. Post-communist transformations are examined in detail in *Chapter 4*. After situating the case in the literature on Central Eastern European post-communist transition, an in-depth analysis of expert interviews is conducted to reveal the current state of knowledge on Bucharest's URCs. This chapter represents the knowledge base for the applications presented in Chapter 6 and Chapter 8.

The two chapters of **Part 2** develop and demonstrate the use of a framework for the assessment of social-ecologically integration in URCs. Guided by the key properties of URCs (Chapter 2) and informed by current assessment methods found in literature, *Chapter 5* develops an indicator system and an assessment procedure. The framework is then applied on the two URCs of Bucharest in *Chapter 6*. First URC Dâmbovița is assessed, and then URC Colentina is used to demonstrate the wider application of the indicator system.

In **Part 3**, the thesis turns to a design approach. *Chapter 7* formulates four design principles informed by the key properties of URCs identified in Chapter 2, design explorations carried out by the author in urban river projects, and principles currently employed in urban and landscape design. *Chapter 8* elaborates design instruments meant to aid the application of the design principles in the design process. The chapter reports on a design workshop which was organised in Bucharest to test and demonstrate the use of the instruments.

Chapter 9 summarises the findings of each chapter and answers the main research question, it reflects on methodological and epistemological challenges related to the research design, it discusses the wider implications and applicability of the research outcomes, and gives recommendations for future research.

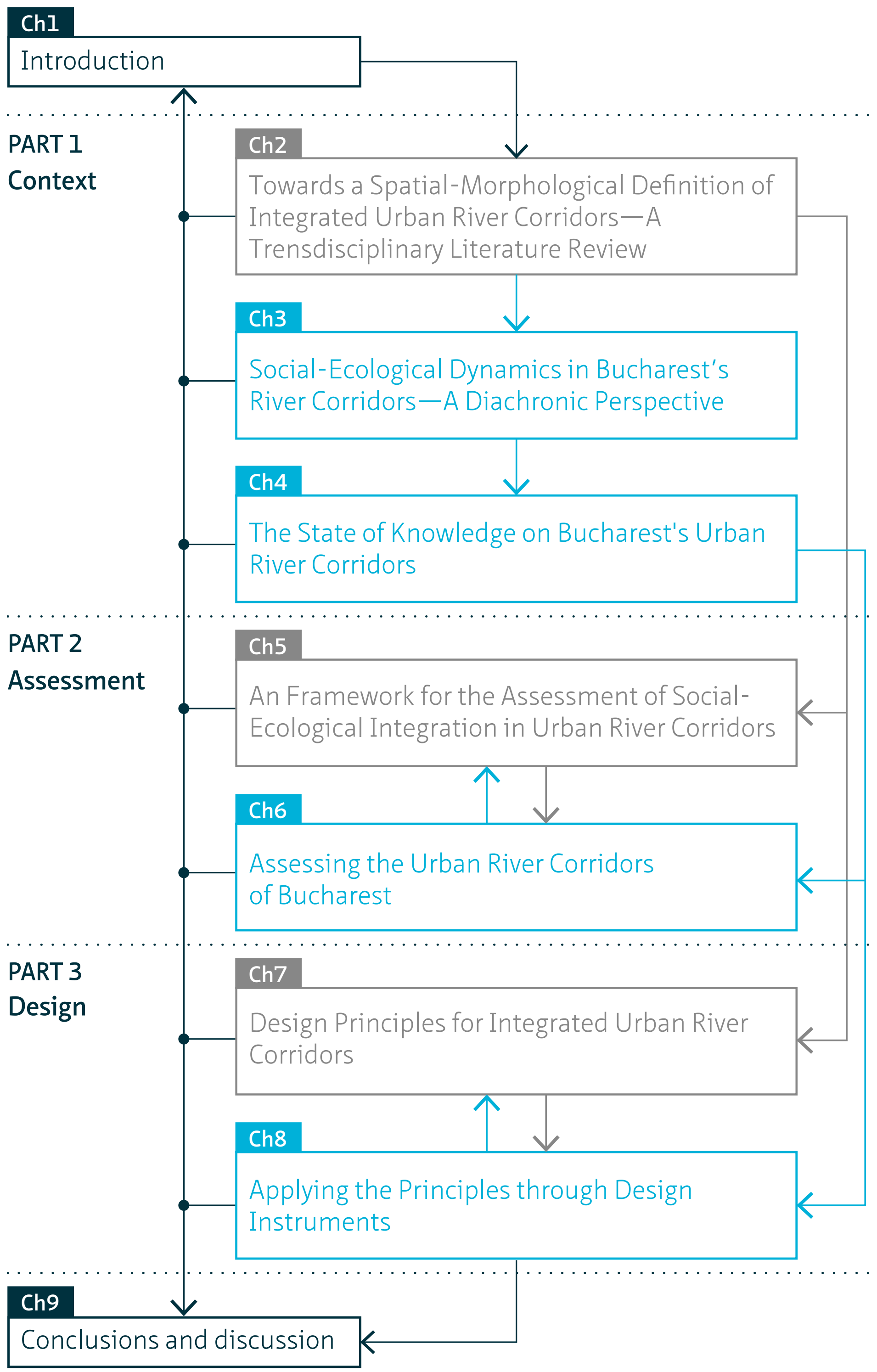

FIGURE 1.11 Visual outline of the thesis (theoretical chapters in grey, empirical chapters in light blue).

PART 1 Context

This part includes three chapters:

2 Towards a Spatial-Morphological Definition of Integrated Urban River Corridors—A Transdisciplinary Literature Review

§ 2.1 Introduction

This chapter presents a transdisciplinary literature review on urban rivers, in which key principles were identified under four domain families, referred to as *the environmental-ecological dimension*, *the social-economic dimension*, *the planning-governance dimension*, and *the spatial-morphological dimension*. The purpose of this chapter is to develop *a spatial-morphological definition of Urban River Corridors (URCs)* based on the translation of discipline-specific terms and definitions to urban planning and design. The literature review outlines the potentials and challenges of spatial integration between cities and their rivers and concludes with four key properties of URCs: *connectivity*, *open space amenity*, *integration* and *multiscalarity* (Section 2.2). Based on the principles and key properties described in Section 2.2, Section 2.3 elaborates and illustrates the spatial-morphological definition and a method of delineation for social-ecologically integrated URCs.

SUB-QUESTION AND OBJECTIVES:		
Sub-question 2:	**What are the spatial-morphological conditions for achieving social-ecological integration along urban rivers?**	
Objective 2.1:	Identify key properties of URCs.	Section 2.2
Objective 2.2:	Formulate a spatial-morphological definition of URCs.	Section 2.3
Objective 2.3:	Devise a method of spatial delineation of URCs.	

§ 2.2 Urban River Corridors—A Literature Review

A transdisciplinary literature review is an opportunity "to situate the inquirer in an ecology of ideas" (Montuori, 2013, p. 45), which would otherwise not be revealed. Such an inquiry is especially necessary in the study of a cross-cutting theme and common field of action like urban rivers. The following sections are meant to reveal, categorize and translate principles scattered across disciplines dealing with urban rivers and to synthesize them in a spatial-morphological definition of URCs.

§ 2.2.1 Urban rivers at the interface between city and nature

The relationship between the city and nature has been an increasingly important subject of research since the end of the 19th century. This trend was prompted by the negative environmental consequences of the Industrial Revolution, such as air and water pollution, deforestation, and landscape fragmentation. Contemporary to this phenomenon, Patrick Geddes (1915) was one of the first to draw the attention to the faults of the industrialising city by proposing a holistic vision, in which humans were inherent part of nature, and the city, the highest form of human evolutionary development, was understood as part of a region (Welter, 2002).

Geddes's was the first of a series of key moments of awareness in a century-long (and ongoing) discussion on environmental issues related to urban design and planning. The environmental discourse of the 1960s, represented by Rachel Carson (1962), Ian McHarg (1969), and Lewis Mumford (1968), followed by the process-oriented approach of Michael Hough (1984) and Ann Whiston Spirn (1984) have led to the emergence of an *environmentalist* approach in the fields of landscape architecture (Spirn, 2000), landscape ecology, including Sybrand Tjallingii's *Écopolis* (1995) and *Ecological Conditions Strategy* (1996), urbanism and architecture (Beatley, 2011), and landscape urbanism (Waldheim, 2006 , 2016).

At the same time, the years of exponential economic and population growth following WWII had started another wave of environmental awareness, in which *sustainability* had come to the forefront of global developmental concerns (Brundtland, 1987). The model proposed by Donella Meadows and her colleagues in their seminal book *Limits to Growth* (Meadows, Meadows, Randers, & William W. Behrens III, 1972) showed that, if trends of that time—population growth, industrialisation, pollution, food production and resource depletion—continued, the world would exceed its carrying capacity irreversibly by the year 2100.[13]

Arguably, a third wave of environmental awareness takes place today, this time under the watchword of *resilience*, in response to an increasing number of acute shocks and chronic stresses (da Silva & Moench, 2014), which are mainly caused by climate change, but also by the challenges of global population growth, resource depletion, and increasing levels of interconnectedness due to globalisation. Even after a century since Geddes (1915) put forward his evolutionary perspective and emphasised the interlinkages between man and nature on regional scale, the tension between city and nature is still present.

One of the places where this tension has increasingly become visible is along the rivers crossing urban areas (Tjallingii, 2015). In early human settlements, rivers provided the best environment for flood-based agriculture, transportation and strategic defence (Kostof, 1992). Later, as those settlements developed, wetland drainage further improved agriculture, channelization provided better conditions for boat traffic, and embanking and dredging allowed for flood control (Petts, Heathcote, & Martin, 2002). Cities found these conditions usually in low-plain areas, in the transporting or dispersing sections of the river system.[14] Low-lying locations have always been advantageous for settlements

13 In their 30-year update, the authors of Limits to Growth (Meadows et al., 2004) state that the new predictions are worse than the ones of the 1970s.

14 River systems are divided into three major parts: the collecting system (the network of upstream tributaries), the transporting system (the main channel), and the dispersing system (delta or estuary) (Hamblin & Christiansen, 2003).

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because their flat topography made expansion easier than in upstream locations and because the land was usually more fit for agricultural production. Yet the same locations are the most vulnerable to environmental disturbances, such as floods and draughts.

In Europe, three major trends have driven the search (in research and practice) for a resilient relationship between rivers and their urban surroundings (Prominski et al., 2017): the revival of waterside development (Samant & Brears, 2017); the high ecological standards set by the EU Water Framework Directive (see Section 2.2.4), and the need for flood protection measures driven by climate change. Accordingly, a new vision, expressed at least a decade earlier, promoted an "intimate link between community and nature", in which the waterfront could become "a desirable place to live and work" and "new developments and river corridors [...] can be arteries for transforming entire conurbations" (Petts et al., 2002, p. 3).

It is against the backdrop of this growing concern for social-ecological integration, in general, and the increasing tension between urbanisation and rivers, in particular, that the concept of URCs is elaborated in this thesis. URCs are at the same time artificial and natural, large- and small-scale, functional and experiential, ecological and social, to name just the extremes of a wide range of in-between variations of their multivalence. Landscape-related fields (landscape ecology, landscape architecture and landscape urbanism), engineering fields (hydrology, hydrogeology, hydraulic engineering, river ecology), and design-related fields (architecture and urban design, in addition to landscape architecture already mentioned above), are all directly concerned with the spatial relationship between city and river. Given this hybrid nature of URCs, the literature review presented in this section provides a transdisciplinary overview of the topic, building up gradually towards the domain of focus in this thesis, which is spatial morphology.

Hence, the author recognises—and this will be visible throughout the literature review—that very few perspectives presented below are purely limited to one discipline and instead resort to a certain degree of multidisciplinarity. Yet, as a categorisation is required for a systematic review, four domain families will be used to group current approaches found in literature into *environmental-ecological* (Section 2.2.2), *social-economic* (Section 2.2.3), *planning-governance* (Section 2.2.4), and *spatial-morphological* (Section 2.2.5). A synthesis of key concepts derived from these approaches will be given in Section 2.2.6.

With a few exceptions (e.g. Lerner & Holt, 2012),[15] the phrase 'urban river corridors' has been seldom used as such in literature. Other terms needed to be included in the review for a thorough scan of the subject matter. In this sense, the literature review is meant to (1) establish a common language between disciplines, to (2) build up a substantiated knowledge base of concepts, models and principles used in other disciplines, and, as a synthesis of that knowledge, to (3) provide a spatial-morphological definition of URCs. For this purpose, each of the four sections starts with a set of domain-specific definitions and concludes with a set of transferable principles.

15 As part of the EU-funded project Urban River Corridors and Sustainable Living Agendas (URSULA), Lerner & Holt (2012) use the phrase 'urban river corridor' as a central concept and spatial unit in urban river management.

§ 2.2.2 The environmental-ecological dimension

This dimension explores the system of the river as a natural infrastructure and the services that it provides to the city. It discusses approaches related to human impact on river morphology and ecology, urban river restoration, ecological and hydrological connectivity, as well as Green and Blue Infrastructure as a prominent concept in environmental rehabilitation. Table 2.1 offers a reference of key concepts described in this section.

TABLE 2.1 Definition of key terms required for the understanding of the environmental and ecological dimension of URCs.

TERM	DEFINITION	SOURCE
Catchment basin	"a main channel and all of the tributaries that flow into it [...] bounded by a divide (ridge), beyond which water is drained by another system."	Hamblin & Christiansen (2003, p. 299)
Ecosystem services	"the direct and indirect contributions of ecosystems to human well-being", categorized as provisioning, regulating, supporting and cultural ecosystem services.	Groot, Braat, & Costanza. (2017, p. 31); MEA (2005); Mader & Berghöfer (2011)
Ecological connectivity	In river ecology, connectivity is defined in three dimensions: lateral (interactions with the watershed, geomorphology, and material and species movement between water and land), longitudinal (migration of species and flows of materials up and down the stream), and vertical (e.g. exchanges between river and groundwater).	May (2006)
Floodplain	"A floodplain is the area affected by water that has extended beyond the normal banks of a stream, river, pond, or lake."	Vermont Agency of Natural Resources (2004)
Fluvial geomorphology	The study of "the shapes of river channels and how they change over time."	Everard & Quinn (2015)
Green and blue infrastructure	GBI aims to recreate a natural water cycle and to contribute to the amenity of the city by combining water management and green infrastructure in urban environments.	Perini & Sabbion (2017)
Hydrological connectivity	"water-mediated transfer of matter, energy and/or organisms within or between elements of the hydrologic cycle" on one temporal dimension and three spatial dimensions (longitudinal, lateral and vertical).	Pringle (2003, pp. 2685–2686)
River corridor	"The area that the stream or river needs to maintain physical/geomorphic equilibrium" and "the land area adjacent to a river that is required to accommodate the dimensions, slope, planform, and buffer of the naturally stable channel [...]"	Vermont Agency of Natural Resources (2004)
River restoration	"a large variety of ecological, physical, spatial and management measures and practices [...] aimed at restoring the natural state and functioning of the river system in support of biodiversity, recreation, flood management and landscape development."	ECRR (accessed 12-06-2016)
River rehabilitation	Different from restoration, rehabilitation is used to repair, not necessarily to return to a pre-existing condition.	Palmer et al. (2005)
River valley	An elongated lowland formed by flowing water.	Baschak & Brown (1995)
Urban stream	"A stream where a significant part of the contributing catchment consists of development where the combined area of roofs, roads and paved surfaces results in an impervious surface area characterising greater than 10% of the catchment."	Findlay & Taylor (2006, p. 313)

Anthropogenic pressures on fluvial geomorphology and ecology

Referred to as the 'urban stream syndrome' (Walsh et al., 2005), the negative effects of urbanisation on stream- and river ecosystems have been widely acknowledged (e.g. Gregory, 2006; Bernhardt and Palmer, 2007; Vietz et al., 2016). The extent of human impact on fluvial geomorphology, environment and ecology is visible in a number of co-occurring and aggravating symptoms, such as reduced

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biodiversity, increasing temperatures, decreasing water quality, altered flow and sedimentation regimes, and river channel degradation. In response to these symptoms, *river restoration and rehabilitation* have been increasingly employed environmental improvement strategies for urban rivers (e.g. the restoration of River Isar in Munich). River restoration, according to the European Centre for River Restoration (ECRR), "refers to a large variety of ecological, physical, spatial and management measures and practices [...] aimed at restoring the natural state and functioning of the river system in support of biodiversity, recreation, flood management and landscape development." As a marker of this trend, Figure 2.1 shows a sudden increase of the phrases 'river restoration' and 'river rehabilitation' in general literature since the 1990s.

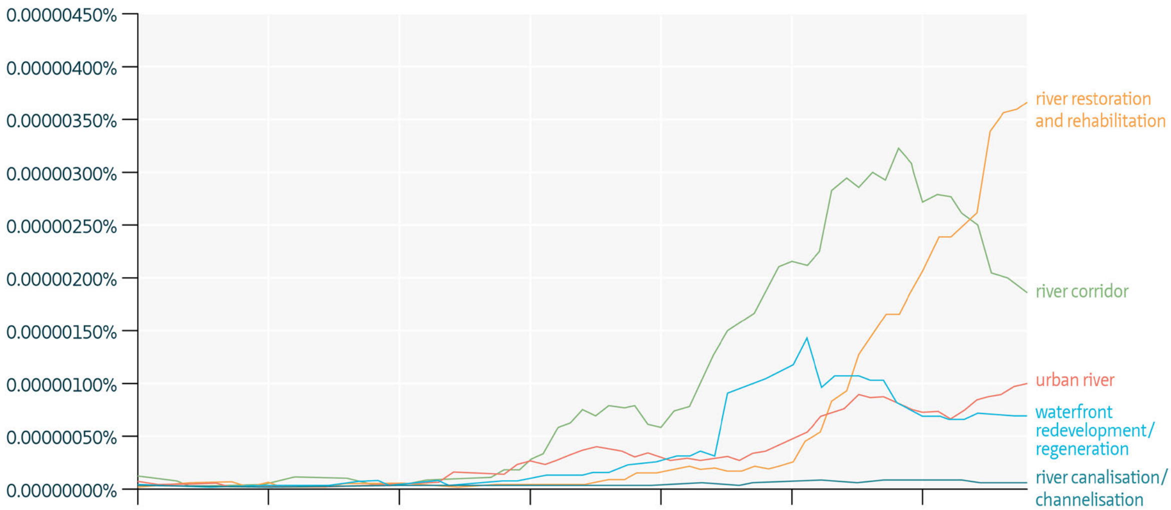

FIGURE 2.1 The use of key terms related to riverside urban transformation in general literature between 1940-2008. Source: Google ngram viewer (Accessed: 2 August 2017)

Even though river restoration has been increasingly popular all around the world, it still faces challenges, resistance and lacks integration with other development goals, such as compact and dense urban development. Vietz et al. (2016) identify five key challenges that need to be considered in current river restoration practices: *excess storm water runoff*, *insufficient riparian space*, *altered sediment regimes*, *legacy impacts*, and *social and institutional challenges*. Further, as a critique to the ineffectiveness of current channel-based approaches in river restoration such as channelization and channel reconstruction, Vietz et al. (2016) promote *catchment-scale approaches*, which are based on dynamic, complex, and self-sustaining streams, suggesting that only this way the causes, rather than the symptoms, of channel degradation will be addressed. However, as self-regulating streams require more space than channelized streams, they are more likely to be applicable to low density urban areas and towards medium- and long-term goals.

Wohl and Merritts (2007) investigate how human interventions throughout history affected the perception of what a natural river is and the way that perception influences strategies of river restoration. The authors suggest that historical or similar references need to be employed carefully in river restoration, as the majority of rivers worldwide (including those that seem to be natural) have been altered one way or another by humans. In order to avoid misled decisions (e.g. imposing meandering streams on a landscape where braided streams would be more appropriate), restorations need to be "firmly grounded in knowledge of how human activities altered a particular river" (Wohl &

Merritts, 2007, p. 872). It is more desirable to aim for rivers which are self-sustaining and integrated into the surrounding landscape than to try to recreate historical conditions. Even when possibilities river restoration are partial (which is the case most of the time for urban rivers), a better understanding of past dynamics is key to any design.

As pointed out by Wohl and Merritts (2007), 'natural' and 'stable' are two problematic concepts when applied to river form and process. How much human intervention is acceptable to a river to be still considered natural? Surrounding land use, even when it is unbuilt such as agriculture, can move away a river from its natural state. In addition, stability needs to be understood at the right (spatial and temporal) scale of reference. For instance, a river may be stable over a short period of time, but substantially change after a 100-year flood.

Linking ecology and hydrology

Agreement on terminology, conceptual frameworks, and experimental approaches between ecology and hydrology has still to be achieved for integrated catchment-scale approaches (Tetzlaff et al., 2007). A potentially integrating concept is *connectivity*, based on a view borrowed from landscape ecology in which the riverine ecosystem of the 'riverscape' and the catchment 'landscape' are in a close relation (Tetzlaff et al., 2007). Hydrologic connectivity, in an ecological sense, is defined by Pringle (2003, p. 2685) as "water-mediated transfer of matter, energy and/or organisms within or between elements of the hydrologic cycle". Like in ecology, hydrologic connectivity uses the conceptual framework of three spatial dimensions, together with the dimension of time, to understand human impacts on the river ecosystem—*longitudinal* (headwater-estuarine); *lateral* (riparian-floodplain); and *vertical* (riverine-groundwater) (Pringle, 2003). A joint understanding of ecological and hydrologic connectivity is especially important when considering the degree to which connectivity has been altered by human activities (Pringle, 2003), such as the disconnection from tributaries or groundwater through canalisation, or altered river flow through water abstraction.

Green and blue infrastructure

If river restoration, marked by ecological and hydrological connectivity, represent a more river-centred perspective, Green Infrastructure (GI) and Green and Blue Infrastructure (GBI) approaches are more urban-centred and have been increasingly employed in urban planning and design. The main argument is that even though sustainable urban form is compact and dense (Jabareen, 2006; Jenks & Jones, 2010), it also requires *Green Infrastructure (GI)*, i.e. an interconnected network of green spaces that supports ecosystem functions and delivers multiple benefits to humans (Benedict & McMahon, 2006). The multiple benefits of green infrastructure may be described through the lens of *ecosystem services* (ES) as *provisioning*, *regulating*, *supporting* and *cultural* (MEA, 2005; Mader & Berghöfer, 2011). In urban environments, GIs are prime providers of ecosystem services mainly in the regulating and cultural category. Regulating urban ecosystem services include micro- and meso-climate regulation, storm water control, while cultural ecosystem services are non-material services, such as recreation, aesthetic values and tourism. GI has different roles depending on the scale on which it is employed: on regional and national scale, it represents a multifunctional open space network, whereas at the local and site scale it has a role in storm water management (Rouse & Bunster-Ossa, 2013; cited by Perini & Sabbion, 2017).

Green and Blue Infrastructure (GBI) integrates GI and water management by emphasising the interlinkages between the network of green spaces and the water network (Henriquez & van

Timmeren, 2017). GBI is furthermore an integrative concept because it promotes multifunctionality and because it offers multiple environmental, ecological, social, and cultural benefits (Perini & Sabbion, 2017), which are characteristics lacking from grey infrastructure solutions. Important in relation to the concept of GBI is the recognition that blue (water) infrastructure should not be conceived as a linear system that drains rainwater and sewage waste through the city as fast as possible (Walsh et al., 2005), but as a spatial system defined on large scale as the *catchment*, and as the *valley* or *floodplain* at lower scales. Depending on the extent of urbanisation, the river valley as a surface may act like a 'sponge' when it is covered with vegetation, or as an 'umbrella' if it is impervious (Perini & Sabbion, 2017).

Flooding, both as a result of higher levels of river discharge (water from upstream) and of increased storm-water runoff (rainwater drained through urban space), is one of the main issues targeted by GBI. The shift from flood control to flood management (Zevenbergen et al., 2012) signals a growing tendency towards the adoption of flexible and adaptive approaches to water management in the urban environment. Also, emerging flood risk management approaches that tend to integrate GBI with urban planning include: integrated catchment management, integrated flood risk management, storm water Best Management Practices in the US and Canada, blue-green cities and Sustainable Urban Drainage Systems (SuDS) in the UK, water sensitive urban design (WSUD) in Australia, Low Impact Development (LID) in the US, Low Impact Urban Development and Design (LIUDD) in New Zealand, transition town planning, Integrated Water Resource Management (IWRM), water urbanism, and integrated urban water management (Perini & Sabbion, 2017).

GBIs can be grouped into *vegetated* and *non-vegetated* approaches. *Vegetated systems* are the most effective in providing ecosystem services, given their extensive use of natural processes for environmental purposes. In terms of landscape ecology, large interconnected patches and corridors are important for the internal (within the city) and external (with the surrounding landscape) connectivity of habitats and, as a result, for increased biodiversity (Forman, 2014). As a particular form of corridor-level solution, the "restoration of natural riparian systems and wetlands found in river and stream corridors is one of the best practices to implement the natural equilibrium of flow, sediment, movement, temperature, and biodiversity" (Perini & Sabbion, 2017, p. 49). Greenbelts and green structures (Tjallingii, 2006), greenways (e.g. F. L. Olmsted's Boston Emerald Necklace), or green streets, often employed in urban planning, are concepts that may incorporate vegetated GBI approaches. Examples of vegetated systems include vegetated biofilters, infiltration systems, bioretention systems, wetland ponds and green roofs (Perini & Sabbion, 2017). When there is no space for such vegetated solutions, which is the case especially in densely built central urban areas, *non-vegetated systems* can offer some solutions such as temporary water storage (e.g. water squares) or increased infiltration through pervious pavements. Vegetated and non-vegetated systems may be applied interchangeably at site scale, depending on site particularities, but corridor-scale approaches most often combine techniques from both systems. Both vegetated and non-vegetated GBI have a great contribution in terms of urban ecosystem services (EC, 2013). GBI can improve urban resilience at different spatial scales and it supports hydrologic connectivity at catchment scale.

As outlined above, GBI can provide a spatial framework to alleviate habitat fragmentation (Perini & Sabbion, 2017) and to guide sustainable urban development (Tzoulas et al., 2007). Increased interconnectedness of habitat patches and the surrounding matrix, together with habitat heterogeneity can be considered beneficial for the resilience of the corridor ecosystem. *Multiscalarity* is another important theme in both GI and GBI approaches (Benedict & McMahon, 2006; Perini & Sabbion, 2017; Rouse & Bunster-Ossa, 2013). According to Benedict and McMahon (2006), GI can be devised at all scales, from the individual parcel, through the local community, to national or supra-national level, respectively as green space design at parcel level, a system of green ways at neighbourhood level, and as a protection network of large natural areas on a regional and state level. Physical and functional connections across scales, according to Rouse and Bunster-Ossa (2013), are of increasing strategic importance for long-term environmental and ecological goals.

Environmental and ecological principles

The following principles emerge from the review of environmental and ecological aspects of URCs:

- **The physical configuration of the river valley** is important for understanding the extent of human pressure on fluvial geomorphology and for identifying potential spaces for improving river ecology.
- River restoration and rehabilitation require **sufficient riparian space** to allow for storm water storage and river dynamics. River restoration must be employed at the right scale: **a proper understanding of catchment-scale dynamics** is needed for effective channel-scale interventions. In urban areas, most of the time river restoration is partial, therefore **a proper understanding of past river dynamics** is essential.
- **GI** and **GBI** solutions are effective and proven approaches to **integrate natural processes in urban areas**, while providing urban ecosystem services. Vegetated and non-vegetated solutions in URCs can be used interchangeably or in combination.
- **A multi-scale approach** is essential to a systemic understanding of the river corridor. Besides channel-scale approaches, **catchment-scale** approaches to river dynamics are important to treat the causes rather than the symptoms of channel degradation. Multiscalarity allows for physical and functional connections across scales.
- **Connectivity is an integrative concept**. Ecological as well as hydrologic connectivity must be understood in three spatial dimensions: longitudinal, lateral and vertical. In addition, the temporal scale represents the fourth dimension of connectivity in river corridors.
- **Heterogeneous habitats** are considered to be **more resilient** than homogeneous ones.

§ 2.2.3 The social-economic dimension

Related to the cultural branch of ecosystem services offered by urban rivers, this section brings together approaches focusing on social and economic aspects of urban rivers. A selection of key concepts described in this section is included in Table 2.2.

TABLE 2.2 Definition of key terms for the understanding of the social and economic dimension of URCs.

TERM	DEFINITION	SOURCE
Open space amenity	Open space which is desirable or useful for the community, e.g. a park, sports area or promenade.	Stevens (2009)
Social connectivity of urban rivers	The way people, goods, ideas, and culture move along and across rivers.	Kondolf & Pinto (2017)
Waterfront	An urban area located near- and oriented towards the water.	Samant & Brears (2017)
Waterfront redevelopment/ regeneration	A waterside urban area transformed usually from a former land use, such as an industry or port, into a residential or mixed-use area, including spaces with public access.	Gordon (1996)

The waterfront as a social and economic attractor

In his book Aquatecture, Anthony Wylson (1986) uses the phrase 'urban river corridors' when referring to the space of the river as delineated by the architectural envelope of the waterfront. Although he acknowledged the importance of integrating the amenity value of the URC with neglected ecological aspects, Wylson did not elaborate on the spatial implications of such an integration. Still, he was one of the early discussants of waterfront regeneration emerging at that time (Figure 2.1), mainly investigating the architectural potentials of the waterfront.

In an international multiple-case study of four prominent urban waterfront redevelopment projects from the 1970s and 1980s,[16] Gordon (1996) concludes that waterfront redevelopment plans are successful when they lead to "improving image; adapting and reusing existing built form; improving public accessibility; integrating waterfronts with their urban surroundings and with the water; thinking small and planning in increments" (Stevens, 2009, p. 19). Drawing from the empirical base of his case study, Gordon (1996) posits that the negative image of isolation and decay of former harbour areas can be successfully improved through *historic preservation* and *better public access*. Accessibility can be achieved by overcoming physical and mental barriers inherited from former land uses. Continuous waterside promenades and connections to surrounding urban areas acting as access- and view corridors are measures that can improve both public access and image. In addition, Gordon concludes that the quality of the physical environment can be ensured by focusing on the *design of public infrastructure* as well as *public uses at grade* in adjacent buildings, *incremental implementation* of infrastructure, and *increased diversity*.

In Gordon's study, the waterfront is examined rather as a strategic location for urban redevelopment with a strong political and planning dimension, than a place of interaction between water and land. More recently, Samant and Brears (2017) give an overview of ecological approaches to waterfront redevelopment, with emphasis on social and environmental sustainability, in which they refer to the waterfront as the "delicate interface between land and water [as] integral to a city's wider network of open and green spaces" (Samant & Brears, 2017, p. 335), thus hinting at the importance of ecological interconnectedness with the social networks of surrounding urban areas.

Yet, even though current practices have been increasingly focusing on greening as a way to improve the environmental qualities of waterfronts and to diminish "the negative impacts of 'radically unnatural ecologies'" (Stevens, 2009, cited by Samant & Brears, 2017, p. 334), there are still challenges in safeguarding biodiversity in the face of rocketing economic attractiveness of waterside areas. In his critique of the artificiality and superficiality of post-modern waterfront redevelopment, Stevens (2009) points out four particularities of artificial waterfronts, as contrasted with a 'natural' relation between land and water. First, the taming of the waterfront implies a radical transformation of the edge between land and water, "socially constructed to accord with human ideals of visual attractiveness, health, and ease and safety of movement" (Stevens, 2009, p. 5). Second, he presents augmented waterfronts as an extreme type.[17] Third, he emphasises the importance of positioning the waterfront both in terms of spatial, functional and conceptual reintegration and as part of the citizens' mental map. In this sense, a*ccessibility* and *imageability* are notable yet conflicting properties, as

16 The four cases studied by Gordon (1996) were New York's Battery Park City (BPC), London Docklands, Toronto's Harbourfront and Charleston Navy Yard (CNY) of Boston.

17 Augmented waterfronts, i.e. reconstructions of a waterfronts in indoor spaces, are a particular type which are outside the scope of this thesis.

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"[t]he positioning of artificial waterfronts is a matter of conflict between social access and market strategy" (Stevens, 2009, p. 18). Finally, Stevens describes changing waterfronts, recognising, like Swyngedouw (2015) in his account of Lefebvre's 'second nature', the fact that "waterfronts are new nature, not a return to a prior condition" (Stevens, 2009, p. 18).

According to Stevens (2009), a particularly important social need that waterfront areas serve is the provision of *open space amenity*, a quality often overlooked in profit-driven waterside land redevelopment aiming for 'higher and better'. Having explored these particularities of artificial waterfronts, Stevens adds to Gordon's (1996) key factors of successful waterfront redevelopment the following three aspects: (1) beyond the natural context of the river, waterfront image should be understood as socially produced; (2) success often depends on *separation* and *protection* of a waterfront (e.g. quiet spaces for contemplation), as opposed to integration and accessibility; and (3) successful waterfront leisure depends on *materiality* and *human scale*, that is, comfort and sensory stimulation (Stevens, 2009).

Overall, the spatial quality of waterfront areas, as observed in current practices, seems to be a factor of growing importance for the economy of the city. However, the main qualities of waterfronts are related mainly to visual rather than wider sensorial interactions with the river space. As Samant and Brears (2017) point out, there is an increasing tendency of integrating waterfront development plans with urban water management plans, a tendency that requires changing planning and governance conditions.

Social connectivity of urban rivers

According to Kondolf and Pinto (2017), the social connectivity of urban rivers, or the way people, goods, ideas, and culture move along and across rivers, can be described in terms of *three-dimensional connectivity*, that is, through *longitudinal*, *lateral*, and *vertical* connectivity. Longitudinal connectivity characterises the activities that run along the river, such as navigation or riverside traffic corridors. The scale of this type of connectivity is large, up to the scale of the river catchment. Lateral connectivity refers, on one hand, to connections across the river and, on the other hand, to the way the river is connected transversally to the surrounding urban fabric through the street network. This type of connectivity can be observed on the scale of waterside urban districts and it has a key role in the connectivity of the urban river corridor as a whole. Vertical connectivity refers to the direct interaction between people and water, such as swimming, walking along the embankments, and the dynamic use of floodable areas. This is the smallest in scale of all three types of connectivity.

Attractiveness and imageability

In a study on visual attractiveness as key to city-river integration in urban planning, Batista e Silva et al. (2013) depart from the issue of segregation and disintegration as opposed to interdependence (or mutual benefits[18]) and integration. They state that a visual model, based on vision and design, is insufficiently employed at city and river-corridor scale, in contrast with current site-scale practices that are driven by marketing strategies meant to promote urban development. Visual attractiveness, in their opinion, can be used as a performance strategy. The difficulty of embracing large-scale landscape

18 The use of words interdependence or mutual benefits is arguable though; rivers can exist without cities.

policies is clearly related to the complexity and multi-dimensional nature of the landscape and it requires interdisciplinary teams and decision-making processes that are capable of a 'holistic vision'. In addition, the experiential use of the landscape is essential in understanding the users' opinions, perceptions and expectations. Having recognised these two needs, Batista e Silva et al. (2013) base their findings on a combined assessment framework involving (1) experts for fundamental and measurable viewpoints translated into descriptors and (2) residents from a case study area for qualitative data on perception, preferences and aesthetic values.[19] In reflection on their approach, Batista e Silva et al. stress the importance of local specificity in interpreting the "multidimensional world of aesthetical attractiveness" of URCs (Batista e Silva et al., 2013, p. 181).

Social and economic principles

The following themes emerge from social and economic approaches to city-river relationships:

- **Waterfronts are socially constructed**, meaning that total renaturalisation is neither possible, nor desired. On the other hand, purely profit-driven waterside development must not be attained either, as it might damage the riparian ecosystem and the hydrological performance of the site. A balance that is both economically feasible and ecologically responsible must be sought.
- **Three-dimensional** (i.e. longitudinal, lateral and vertical) **connectivity** is a frame that can be used to describe human and social activities in relation to the river.
- **Accessibility** or **public access** is one of the key features of a well-functioning waterfront. Access is given through routes towards- and promenades along the water. In addition, pockets of inaccessibility or invisibility may be desired by certain users. Such spaces, where nature and slow mobility recreation prevails, can contribute to a diverse user experience and spatial design.
- The spatial integration of **landmarks** in the **image** of the waterfront as seen along the river space or from one shore to another, as well as **visibility** towards and along the river space, play an important role in defining iconic places that contribute to the **identity** of the waterfront.
- **Waterside open space** is an important amenity. Waterfront redevelopment needs to integrate open spaces with built-up areas. These spaces can then be connected to the public space network of the city, thus consolidating the relationship of the city with the waterfront.
- **Human scale** is an important prerequisite for waterfront leisure. This requirement needs to be taken into consideration in the redesign of former land uses, which are often large industrial areas.

19 All measurement scales of both the expert viewpoints and the users' perception were standardised to a 0-100 cardinal scale.

§ 2.2.4 The planning-governance dimension

This section reviews approaches focusing on the integration of the urban system and the river system through planning on different scales, with a focus on the European system of environmental planning. Key terms used in this section are provided for reference in Table 2.3.

TABLE 2.3 Definition of key terms for the understanding of the planning and governance dimension of URCs.

TERM	DEFINITION	SOURCE
Integration Integrated planning	Integration is "an 'anchoring notion' of sustainable urban development." "An integrated plan for sustainable urban development comprises a system of interlinked actions which seeks to bring about a lasting improvement in the economic, physical, social and environmental conditions of a city or an area within the city."	Pieterse, (2004) quoted in Batista e Silva et al., (2013) JESSICA (Carbonaro, 2010)
Multiscalarity	The use of multiple scales to understand the context, focus and details of a complex situation.	Turner & Gardner (2015)
Multidisciplinarity	Drawing on multiple disciplines to understand and deal with complex problems which are outside the boundaries of one discipline. [To be understood together with trans- and inter-disciplinarity.]	Ramadier (2004)
River Basin District (RBD)	RBDs are the main river basin management units delineated by Member States, as required by the Water Framework Directive (WFD) of the European Union.	Perini & Sabbion (2017)
River Contracts	Flexible, mid- or long-term programs for integrated river management and water resources at catchment scale.	Ingaramo & Voghera (2016) Scaduto (2016)

European trends in environmental planning

Since the mid-twentieth century, legislation in environmental planning has increased with an accelerated pace and has been implemented at various spatial scales (Ndubisi, 2014), from top-down policies on international, national and regional level to local level plans, as seen in the recently escalating trend of bottom-up initiatives (Perini & Sabbion, 2017). Environmental planning in Europe is particularly top-down policy driven—i.e. it is regulated on international and Member State level—and it concentrates on "the preservation of air and water quality, conservation of resources and biodiversity, waste management, and adverse environmental impacts" (Perini & Sabbion, 2017, p. 163). With a long-term vision for 2050, the 7th Environmental Action Program (EAP) of the European Union[20] aims "to protect nature and strengthen ecological resilience, boost resource-efficient, low-carbon growth, and reduce threats to human health and wellbeing linked to pollution, chemical substances, and the impacts of climate change" (EC, 2014). Regulation 1293/2013 on the Programme for the Environment and Climate Action (LIFE) (EU, 2013c) and Decision 1386/2013/EU on the General Union Environment Action Programme (EU, 2013a) are provisions meant to arrest the degradation of ecosystems and the loss of biodiversity by 2020, including, in the case of Decision 1386/2013, the expansion of GI to overcome landscape fragmentation (Perini & Sabbion, 2017). In addition, the Birds Directive (EU, 2009) and Habitats Directive (EC, 1992) and the Prioritised Action Frameworks, integrated with the European Commission Communication on Green Infrastructure (2013), focus on enhancing natural capital and ecosystem resilience.

20 The 7th Environmental Action Program (EAP) of the European Union is the main guiding program for environmental policy until 2020.

Water-related policies

The main policies specifically dealing with water in Europe, namely Directive 2013/39/EU (EU, 2013b), amending the Water Framework Directive (WFD) 2000/60/EC (EU, 2000), the Directive on environmental quality standards in the field of water policy 2008/105/EC (EU, 2008), and the Directive on the Protection of Underground Waters 2006/118/EC state that good status needs to be attained for surface- and groundwater (EU, 2006).[21] One of the most important features of the WFD is that it adopts a *morphological*, *catchment-scale approach*,[22] as it requires plans at the scale of River Basin Districts (RBDs) in all EU Member States.

Flood risk, one of the main drivers of water-related environmental policy, is not covered by the WFD. Instead, it is the subject of the Flood Directive 2007/60/EC (EU, 2007) that emphasizes prevention, including "improvement of water retention as well as flooding" (European Parliament and Commission, 2012, cited by Perini & Sabbion, 2017). Large scale river rehabilitation projects, usually driven by the necessity of flood risk reduction, have been implemented in some European countries, such as Austria, Denmark, Germany and the Netherlands (Perini & Sabbion, 2017). For instance, Rotterdam Climate Proof, part of Rotterdam Climate Initiative, aims to reach a number of climate resilience targets by 2025, including flood resilience, better air quality and more green spaces (RCI, 2015).

With a wider scope, the EU Strategy on Adaptation to Climate Change is concerned with adaptation towards a climate proof and resilient Europe. The actions put forward by the Adaptation Strategy include flood resilience and ecosystem-based approaches drawn on the results of the European Commission Communication on Green Infrastructure (EC, 2013). Consisting of a proven set of measures, GBI is a priority for EU2020 targets, as it can "curb the negative effects of climate-related hazards, including storm surges, extreme precipitation, and floods" (EEA, 2012) and it can provide multiple environmental (biodiversity conservation and climate change adaptation) and social (e.g. water drainage and the provision of green spaces) benefits (EEA, 2015), as well as economic benefits, such as jobs in landscape management, recreation and tourism.

Seen from a global perspective, safeguarding surface- and groundwater supplies from contamination in the face of global population growth, mitigating conflicts in cross-border catchment management, especially in developing countries, are issues that have been declared matters of high priority in international programmes such as the United Nations' Agenda 21 (UNICED, 1992). Based on lessons learned from developed economies, Petts et al. (2002) highlight five important river functions that must be sustained through planning policies seeking to restore, maintain or revitalize "blue arteries": drainage and water supply; open space and ecological conditions; transport networks; recreational, leisure and tourist facilities; and a setting for and access to new development and heritage sites (Petts et al., 2002, p. 115).

21 This requirement refers to chemical and ecological aspects of surface water and chemical and quantitative aspects for groundwater.

22 This approach is morphological, because it is "based on hydrological boundaries rather than on administrative boundaries to better address ecological issues" (Quevauviller et al. (eds.), 2008, cited in Perini & Sabbion, 2017).

Local implementation

As required by the WFD, participatory planning—i.e. the active engagement of local communities, economic stakeholders, in dialogue with local administrations and institutions—has an important role to play in policies targeting river catchments. In order to meet this requirement, Member States need to transpose top-down environmental policy into local instruments. Several experiences of integrated water management have been devised in the last two decades, challenged especially by the "paradigm shift from government to governance of river basin districts" introduced by the WFD (Scaduto, 2016, p.19). As a particularly innovative instrument for the local implementation of the WFD, *River Contracts* (Ingaramo & Voghera, 2016; Scaduto, 2016) are flexible, mid- or long-term programs for integrated river management and water resources at catchment scale. In short, River Contracts (RC) are instruments meant to facilitate the communication between stakeholders and sectors and to build shared responsibility between public and private actors. Since the 1980s, RC experiences have been recorded in a number of European countries, namely in France, Belgium, Luxembourg, Spain, Switzerland, Italy, Netherlands, Germany, England, and Greece, but also outside Europe (Scaduto, 2016).

Another model, suggested by Lerner and Holt (2012) for the scale of the urban river corridor, is *partnership working* capable of "handling the complexity of issues and potentially competing interests in environmental management" (Lerner & Holt, 2012, p. 726). In this model, stakeholder groups join forces, pool knowledge and resources in a formal but voluntary way to analyse and deliver a strategy. According to Lerner and Holt, partnership working has been proven effective in catchment management, therefore it should work in urban river corridor management as well.

On the scale of the channel, one particular issue is the difficulty of reserving buffers and floodplains along urbanised rivers due to land tenure (Vietz et al., 2016). Instruments for negotiation, such as River Contracts mentioned above, comprising an inclusive participatory planning process are crucial in order to negotiate towards incentives and equitable solutions for well-functioning ecological and hydrologic buffers. Moreover, the balance between densification and open space amenity, as suggested by Gordon (1996), has to be well understood from an economic perspective in order to incentivise developers to capitalise on unbuilt space.

Planning and governance principles

The following themes emerge from planning and governance approaches to city-river relationships:

– **Multiscalar approaches** are essential for a proper understanding of the corridor system across scales and for a delineation of actions and policy plans to enhance integrated approaches. Two conclusions can be drawn: (1) plans and policies need to be prioritised correctly and implemented **at the right scales**, and (2) planning **on multiple scales** is important in order to link top-down policy to bottom-up needs and initiatives. The WFD's requirement for catchment-scale planning improves the understanding of the complex ecologic, hydrologic, social and institutional context of rivers, but poses challenges for implementation locally. Hence, there is a need for local instruments for participation and sharing responsibility between public and private actors.
– **Integration on all levels of planning and governance**, between different sectors with interest in catchment- or channel-scale development, or across multiple scales from community to region, to foster the spatial implementation of integrated plans, developed to remain highly context-specific.

– Resilience to climate change is a major theme in current environmental policy in Europe and worldwide. **Local solutions must integrate natural dynamics with local needs** in order to reach targets of resilience.

§ 2.2.5 The spatial-morphological dimension

This section reviews spatial-morphological approaches to URCs from the perspective of landscape ecology, spatial aspects of connectivity, and design. Key concepts used in this section are included in Table 2.4.

TABLE 2.4 Definition of key terms for the understanding of the spatial and morphological dimension of URCs.

TERM	DEFINITION	SOURCE
Land mosaics	A concept in landscape ecology, according to which the landscape can be classified in three types of components: corridors, patches, and matrix. The patterns formed by these components can be used to describe and assess ecologic processes.	Forman & Godron (1986); Forman (1995)
Riverfront	The space along the river delineated by the built front.	Batista e Silva et al. (2004; 2013)
Riverscape	Rivers seen as "linear, spatially continuous, heterogeneous habitat patches (Schlosser, 1991) that are intimately linked to their catchment landscapes (Stanford, 2006)"	Tetzlaff et al., (2007, p. 1386)

Land mosaics

Landscape ecology is a field concerned with pattern and process in the landscape to describe the relationship between ecosystems and their environment. 'Land mosaics' is a concept in landscape ecology, according to which the landscape can be classified in three types of components: *corridors* for species' movement, habitat *patches*, and an interconnected background *matrix* surrounding patches and corridors (Forman, 1995; Forman & Godron, 1986). According to this concept, the patterns formed by these components can be used to describe ecologic processes. Acknowledging the difficulty of communicating the concepts of land mosaics across planning and design disciplines, Dramstad, Olson and Forman (Dramstad et al., 1996) have developed a set of landscape ecology principles which explain typical relationships within and between the three components. Their concise but comprehensive set includes habitat distribution along stream and river corridors, as well as patterns of patches as stepping stones that can be easily applied to features of urban rivers, such as open space alternation along the river bank or the distribution of green areas along the corridor.

Like Dramstad et al., Manning (1997) puts forward a set of landscape design principles and guidelines for riverside areas. Manning is in favour of social-ecological integration with his first principle, according to which recreational and aesthetic values need to be combined with ecological values in any design. In his view, the elements of the landscape—such as topography, vegetation and climate—provide a basis for design which integrate ecology with human movement and activities. Diversity, especially in terms of *edge-complexity* (i.e. convolution and curvature), both on macro (corridor) and micro (river edge) scale, is key to creating the conditions for human-nature coexistence. *Structural gradients* between areas of extensive and intensive anthropic pressure, just like ecotones in ecology, must be preserved in order to maximise diversity. With examples, such as Glasgow, Paris, Ottawa, Köln and London, Manning illustrates his guidelines for the design of *contact zones* (edges), *circulation* (hierarchies of routes) and *crossings* (mainly bridges), as important landscape elements for integration.

Urban landscape ecology

Defined by Richard Forman as the study of "interaction of organisms, built structures and the physical environment where people are concentrated" (Forman, 2014, p. 27), urban ecology sets a promising frame for an integrative approach. Forman combines the formerly established theory of landscape ecology (Dramstad et al., 1996; Forman & Godron, 1986) and model of land mosaics (Forman, 1995) with his extensive study of urban regions (Forman, 2008) into urban ecology principles.[23]

As an update to the one dimensional urban-rural gradient model—similar to the urban-rural transect (Duany & Talen, 2002; Geddes, 1915; McHarg, 1969)—, Forman's land mosaic model provides a two-dimensional framework of classifying the surface of the urban region, metro area, city or neighbourhood[24] into *patches*, *corridors*, and *matrix* (Forman, 2014, pp. 98–99). This model effectively simplifies (without over-simplifying) the complex configuration of the urban environment.

Two particular types of urban land mosaics are especially relevant for riverside urban areas: *interwoven* and *corridor-centred mosaics*. Interwoven mosaics comprise "a group of landscape elements tied together by strong interactions" (Forman, 2014, p. 109). The presence of outer barriers, the area of influence of an internal organising force, or the spatial reach of internal activities determine the extent of interwoven mosaics. Due to the tight configuration of interwoven mosaics, flows are mainly perpendicular on the boundaries between patches. As urban rivers are corridors which tend to be organising forces in the areas that they cross, corridor-centred mosaics are of particular interest here. Key variables of such mosaics are *corridor width*, *connectivity*, *habitat quality*, and *straightness/convolution* (Forman, 2014, pp. 120–121).

The spatial configuration of urban green infrastructure has an important role in supporting ecological functions and in achieving social-ecological integration (Ahern, 2007). By applying Foreman's land mosaics model (1995) from landscape ecology, Ahern proposes a classification of the spatial elements of the urban landscape into *urban patches* (parks, sports fields, wetlands, etc.), *urban corridors* (rivers, canals, drainage ways, etc.), and *urban matrix* (residential neighbourhoods, industrial districts, etc.). In order to support ecological functions, GI must have a networked spatial configuration (Benedict & McMahon, 2006; EC, 2013). According to Ahern, key principles from landscape ecology relevant for a functional spatial configuration of GI are *connectivity*, i.e. "the degree to which the landscape facilitates or impedes the flow of energy, materials, nutrients, species, and people across a landscape" (Ahern, 2007, p.270)—as opposed to fragmentation—, *multiscalarity*, also mentioned by Perini and Sabbion (2017, p. 5) as the need to "establish physical and functional connections across scales to link sites and neighbourhoods to cities and regions", and the recognition of *pattern-process* as a "fundamental axiom of landscape ecology".

23 Perhaps this approach could be more appropriately called 'urban landscape ecology' as it has a particularly strong spatial dimension, compared to other urban ecology approaches focusing more on urban organism-environment relations.

24 A common (but not exclusive) set of scales proposed by Foreman is: megalopolis, urban region, metro area, city, residential area, neighbourhood, housing development, house plot, and vegetable garden (Foreman, 2014, p.81)

Spatial dimensions of ecological and social connectivity

As shown in Sections 2.2.2 and 2.2.3, *connectivity* is a term commonly used in research on urban rivers, but it has different, sometimes even conflicting, meanings in river ecology and urban waterfront planning (May, 2006). Landscape ecologists define connectivity, set against fragmentation, as "the strength of interactions across ecotones" (May, 2006, p. 478), where rivers are both corridors, i.e. connections between patches, and ecotones between water and land. In river ecology, connectivity is defined on three dimensions: *lateral* (interactions with the watershed, geomorphology, and material and species movement between water and land), *longitudinal* (migration of species and flows of materials up and down the stream), and *vertical* (e.g. exchanges between river and groundwater). Design approaches, on the other hand, focus on *accessibility* of the water shores to humans, *visual and conceptual connection* with the city, and the *attractiveness* of the riverfront, which often lead to interrupted ecological connectivity. In her attempt to respond to this conflict, May (2006, p.482) acknowledges that "humans are integral components of ecosystems" and posits that finding a common ground between ecological/hydrological connectivity and social connectivity requires 'cognitive connectivity'. Pedagogical restoration plans, riverfront museums, and 'eco-revelatory' design are three types of cognitive connectivity put forward by May as "educational and aesthetic interventions that allow urban dwellers to experience their place in the urban watershed in ways that do not jeopardize its ecological systems" (May, 2006, p. 478).

Urban and landscape design

The spatial configuration and morphology of urban river corridors is an important topic in urban and landscape design. In fact, riverside urban areas are among the places where these two design professions interact the most. Baschak and Brown (1995) devised an ecological framework for the planning, design, and management of urban greenways. The framework included an assessment of urban river corridors in four steps: (1) *making an inventory of landscape elements*, (2) *classifying the components of the corridor*, (3) *establishing a scalar framework* (site, local, and regional), and (4) a *quantitative ecological assessment of the landscape components*. The framework was then applied to the South Saskatchewan River Valley in Saskatoon, Canada, with the use of three criteria: *connections to species-rich areas*, *corridor to urban context relationship*, and *network structure and content*. The components of the corridor were inventoried and classified as patches (i.e. habitats) and corridors (i.e. migration routes). Then two assessment processes were used: (i) landscape element rating to assess the relative quality of landscape elements, and (ii) network assessment, a method used to measure the links in the landscape. When discussing issues of implementation, the authors addressed both the ecological goals of the corridor—the importance of retention of the remaining patches, followed by any necessary restoration—and the spatial limitations of the urban environment—as large habitats can hardly be accommodated in urban areas, the spatial configuration of the corridor offers more potentials than the size of landscape patches.

In a more recent study, Prominski et al. (2017) approach the topic of urban river restoration from the point of view of spatial design and planning of urban rivers. With their design and project catalogue, the authors build up a comprehensive knowledge body for riverside design strategies. Prominski et al. emphasise the need for *multifunctionality*, *interdisciplinarity*, and *process orientation*. Multifunctionality asks for a combination of ecological, hydrologic and human requirements. Interdisciplinarity is important to establish a common language between the main disciplines involved in river space design: hydraulic engineering, ecology, urban planning and landscape architecture. Finally, process orientation encourages a way of thinking and design that is 'evolutionary' and concerned with a better understanding of river dynamics, especially in the changing environmental conditions under climate change.

With their aims of "more space for water, more space for plants and animals, more space for people", Prominski et al. (2017, p. 15) adopt a social-ecologically integrative approach to urban design. Yet their approach is very much concentrated on the direct interface between water and land, with a focus on the flood limit and the limit of self-dynamic river channel development, and less on the structural and strategic relationship of the river with the surrounding urban fabric at other scales.

Strategies of integration

The Two Network Strategy put forward by Sybrand Tjallingii is "a conceptual guiding model for planning and design projects in the urban landscape,"[25] (Tjallingii, 2015, p. 59) in which the traffic network and the water network act as carrying structures, that is, frames for flexible urban development in face of unknown future activities (Tjallingii, 2005, 2015). This model combines a *'slow lane'* with a *'fast lane'*. The slow lane, where the carrier is the water network, is based on cooperation, non-profit activities, safety and quality, landscape and heritage, biodiversity, recreation, and local food production; whereas the fast lane, with the traffic network as its carrier, is competitive, efficient, productive, and profit-oriented. These two lanes are complementary and set the frame for a gradual, parallel and multifunctional spatial organisation of activities, linking ecology with social-economic processes. Typical applications of such an approach involve upgrading or downgrading parts of the two networks or multifunctional zoning. The mutual interdependencies between the water system and the urban system—with water and traffic networks as carrying structures—, the potential for social-ecological integration, and the openness to flexible infill are well represented in this model.

Tjallingii identifies three fields of integration between activities on the two carrying structures—the so-called *area*, *flow*, and *actor* perspectives. In his account of water flows in the urban water cycle, Sybrand Tjallingii (2012) points out two guiding principles relevant for water planning: 'closing the circle' and 'cascading'. For urban river waters,[26] 'cascading', that is, the sequential storage of water for as long as possible, is an important strategy as it helps to reduce storm water runoff and the chance of pollution due to overflow in mixed sewage systems. Moreover, in order to decrease the bottleneck effect of urban environments on river flow, floodplains should be free of buildings and, when this is not possible, like in the case of densely built up historic centres, bypasses may be built to relieve bottlenecks, such as in the Dutch 'Room for the River' program (Figure 7.14).

Spatial-morphologic principles

The following themes emerge from spatial and morphological dimensions of city-river relationships:

- **Three-dimensional connectivity**, approached from a spatial point of view translates into (1) continuity of the traffic network along the river, (2) transposability [or crossability] of the river by different mobility flows and pedestrian access to the river front, and (3) vertical interaction by providing areas or points of access to the river, such as beaches or waterside walkways.

25 Defined as "more concrete tools for making concrete plans" (Tjallingii, 2012, p.103), guiding models can instrumentalise guiding principles. Such a guiding model is *The Two Network Strategy* of Tjallingii (2005, 2015).

26 Rain water is one of the five water flows defined by Tjallingii along with rainwater, groundwater, drinking water, and wastewater.

- **The Two Network Strategy** (Tjallingii, 2005, 2015) is a guiding model to combine a 'fast lane' and a 'slow lane.' In this model, water is a structuring element or carrying structure for sustainable urban development by the slow lane.
- **Corridor-centred mosaics** are of particular interest as urban rivers are corridors, which tend to be organising forces in the areas that they cross. Key variables of such mosaics are corridor width, connectivity, habitat quality, and straightness/convolution. (Forman, 2014, pp.120-121) Based on these variables, the qualities of the corridor can be assessed.
- **Interwoven mosaics** comprise "a group of landscape elements tied together by strong interactions" (Forman, 2014, p.109). The presence of outer barriers, the area of influence of an internal organising force, or the spatial reach of internal activities determine the extent of interwoven mosaics. Due to the tight configuration of interwoven mosaics, flows are mainly perpendicular on the boundaries between patches.
- **Spatial configuration** of land mosaics in urban areas is more important for ecological functions than the size of ecological patches.
- **Interconnectedness** of background matrix, patches as stepping stones and corridors, as defined in land mosaics, enhances ecological functions.
- **Diversity**, especially **in terms of edge-complexity** (i.e. convolution and curvature) both **on macro (corridor) and micro (river edge) scale**, is key to creating the conditions for human-nature coexistence.
- **Diversity** can be found **in structural gradients between areas of extensive and intensive anthropic pressure**. Structural gradients, just like ecotones in ecology, must be preserved in order to maximise diversity.
- **Accessibility** of the URC (can be achieved) through continuous access along the waterfront and improved accessibility to and across the river.
- **A good provision of public facilities and mix of uses** can partially determine and enhance accessibility to the waterfront.

§ 2.2.6 Key properties of URCs—a synthesis

In a synthesis of the transdisciplinary principles outlined in the Sections 2.2.2-2.2.5, four key properties of urban rivers can be identified: *connectivity*, *open space amenity*, *integration* and *multiscalarity*. Knowing these properties and the principles behind them is an important prerequisite for the spatial understanding, design and planning of URCs.

Connectivity

The presence of connectivity in all four domain families as well as the integrative potential of three-dimensional connectivity expressed in literature make this a key property of URCs (Table 2.5). Connectivity is used to describe processes, movement and interactions within and between the spaces of the URC. The space of the river includes movement of water and species, whereas the urban space includes the movement of the people. This compound space of movement in the river space, can be described and assessed, on the one hand, in terms of space available for the water dynamics, the spatial configuration of habitat patches as stepping stones along the corridor, and, on the other hand, in terms of accessibility along-, across- and to the river, crossability, or visibility, for social connectivity. Table 2.5 summarises ecological, hydrologic, social and spatial connectivity, as derived from literature, on three dimensions: longitudinal, lateral, and vertical.

In response to the need for an integrated multidimensional connectivity (of social and ecological systems), the principle of *Interconnectedness* will be proposed as a key principle of URCs (see Chapter 7).

TABLE 2.5 A synthesis of integrated three-dimensional connectivity.

	LONGITUDINAL	LATERAL	VERTICAL	SOURCE
Ecological	Migration of species and flows of materials up and down the stream	Interactions with the watershed, geomorphology, and material and species movement between water and land	Exchanges between river and groundwater	May (2006)
Hydrologic	Headwater-estuarine flows	Riparian-floodplain interaction	Riverine-groundwater relation	Tetzlaff et al. (2007)
Social	Activities that run along the river, such as navigation or riverside traffic corridors, ranging from fast to slow movement	Visual and mobility connections (accessibility) (1) across the river and (2) transversally to and from the surrounding urban fabric.	The direct interaction between people and water, such as swimming, walking along embankments and dynamic use of floodable areas	Kondolf and Pinto (2017); Gordon (1996)
Spatial	Continuous access along riverbanks for both people and ecosystem agents	Transposability of the river and accessibility from the surrounding urban fabric	Channel section configuration to allow access to and from water	Gordon (1996)

Open space amenity

Both the river and the city require open space, as shown in all four domain families. In the environmental-ecological dimension, the spatial configuration of habitat patches and corridors, and the space available for flooding and water storage are essential. From a social-economic perspective, waterside public spaces supported by a diversity of adjacent public amenities are important for a well-functioning space in the waterfront. Although from a planning-governance perspective the necessity of open space is not explicitly stated, the provision of open space as part of urban development is part of the targets of local planning instruments. From a spatial-morphological point of view, various spatial configurations are brought together from the field of landscape ecology, landscape architecture, urban design and hydraulic engineering. Overall, the spaces available in the river corridor determine its capacity to absorb, i.e. to accommodate and to provide desirable spatial conditions to both natural and urban dynamics. The spatial components of river space and public space identified under the property of open space amenity are summarised in Table 2.6.

In response to the need for open space amenity, this thesis will propose the principle of *Absorptive Capacity* (see Chapter 7).

TABLE 2.6 A synthesis of spatial components of URCs identified in literature under the theme of open space amenity.

	SPATIAL COMPONENTS OF THE URBAN RIVER CORRIDOR	SOURCE
River space (ecological and water space)	• Wetlands and floodable areas for water storage capacity • Water space defined by cross section (flow capacity), length and configuration (sinuosity) • Ecotones as spaces of ecological transition and interaction between land and water • Green corridors and patches along the corridor to accommodate ecological processes	e.g. Prominski et al. (2017)
Public space	• Promenades as public spaces designed for the river • Embankments designed to allow access to water • A diverse set of amenities at grade to support the public space of the river • Parks and green spaces to provide shade and a pleasant setting for recreational and leisure activities • Places of belvedere to improve the visibility of and in the river space	Stevens (2009); Gordon (1996)

Integration

Integration is "an 'anchoring notion' of sustainable urban development" " (Pieterse, 2004, cited in Batista e Silva et al., 2013). In each of the four dimensions presented above the need for integration was expressed, either as a reaction to anthropic pressures in the case of river ecology or driven by the need of improving the environmental qualities and resilience of the city. Multifunctionality, inherent in solutions such as GI and GBI, and multi- or interdisciplinarity as proposed in most of the studies presented above, are necessary for the integrated planning of URCs. To quote the Joint European Support for Sustainable Investment in City Areas, "an integrated plan for sustainable urban development comprises a system of interlinked actions which seeks to bring about a lasting improvement in the economic, physical, social and environmental conditions of a city or an area within the city" (Jessica BROCHURE, cited in Carbonaro, 2010, p. 7).

Social-Ecological Integration is a principle of URCs proposed in this thesis that represents the spatial juxtaposition of the social system determined by the urban fabric, and the ecological system structured by the river valley (see Chapter 7).

Multiscalarity

Another key property addressed in all the four domain families is multiscalarity. A key conclusion of the environmental-ecological perspective is that the river needs to be understood in its entirety on the catchment scale (Vietz et al., 2016). Only this way, channel-scale approaches will be properly understood. From a social-economic perspective human scale has to be considered in conjunction with the scale of waterfront development (Samant & Brears, 2017), and the scale of the river space crossing the whole city. The planning-governance dimension also reveals a multi-scalar framework ranging from the EU policy framework, through River Basin Districts, catchments, cities, corridors, neighbourhoods, down to the level of the parcel (Perini & Sabbion, 2017). A set of scales defined in urban landscape ecology and urban design represents the scalar framework of the spatial-morphological perspective. These scales cover a wide spectrum: megalopolis, urban region, metro area, city, major land use type, neighbourhood, block, building, and site, which are juxtaposed with the spatial scales of the river represented by the catchment, corridor, channel, and river section. All the above are nominal, spatially defined scales. The context-focus-detail scalar framework used in landscape ecology (Turner & Gardner, 2015) is a different approach, as it is relative to the problem at hand: depending on the extent and level of detail of the area in focus, the context and detail are defined accordingly. Table 2.7 summarises the scalar ranges described in literature.

Interscalarity, i.e. interactions and interdependencies across scales, will be introduced as a principle that must be sought for social-ecologically integrated URCs (see Chapter 7).

TABLE 2.7 A synthesis of multiscalar approaches to URCs identified in literature.

THE FOUR DIMENSIONS OF THE LITERATURE REVIEW	URBAN RIVER SCALE LEVELS SPECTRUM AND INTERRELATIONS	SOURCE
Environmental and ecological	• Catchment scale is comprehensive for the URC in its entirety. • Channel-scale is properly approached if related to the Catchment scale.	e.g. Vietz et al. (2016)
Social and economic	• Human scale, waterfront scale and the scale of the river space at city level need to be considered together.	Kondolf & Pinto (2017) Gordon (1996)
Planning and governance	• Multi scalar framework: EU level, River Basin District, catchment, city, corridor, neighbourhood, parcel.	European Community (2000)
Spatial and morphologic	• Urban scales (megalopolis, urban region, metro area, city, major land use type, neighbourhood, block, building, site) juxtaposed with the river scales (catchment, corridor, channel, and river section).	(e.g. Forman, 2014; Prominski et al., 2017)

§ 2.3 Spatial definition

Urban River Corridors (URCs) are social-ecological systems (SESs), meaning that social and ecological systems are equally considered in their spatial definition. Accordingly, URCs are defined here from a spatial-morphological perspective as spatial structures that integrate river corridors with the surrounding urban fabric. In conclusion of the multi-domain review elaborated in Section 2.2, the relationship between the river and the urban fabric must be described in terms of a reciprocal spatial configuration[27] (Figure 2.2) stemming from four key properties of riverside urban areas: *connectivity*, *open space amenity*, *integration* and *multiscalarity*.

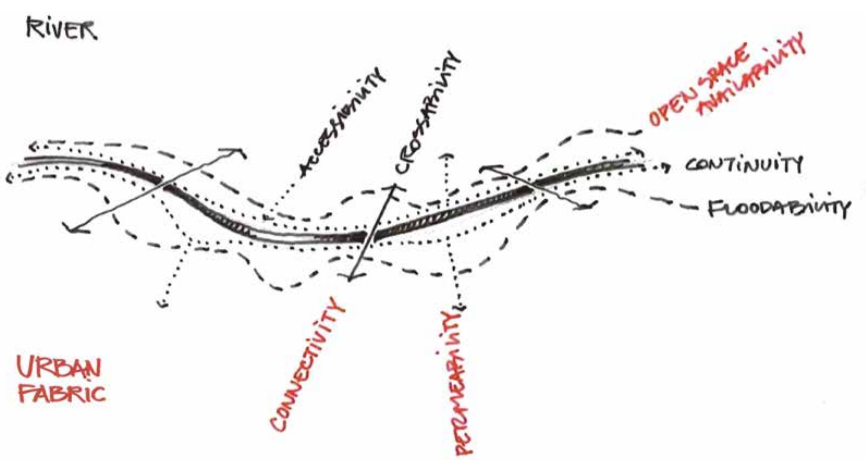
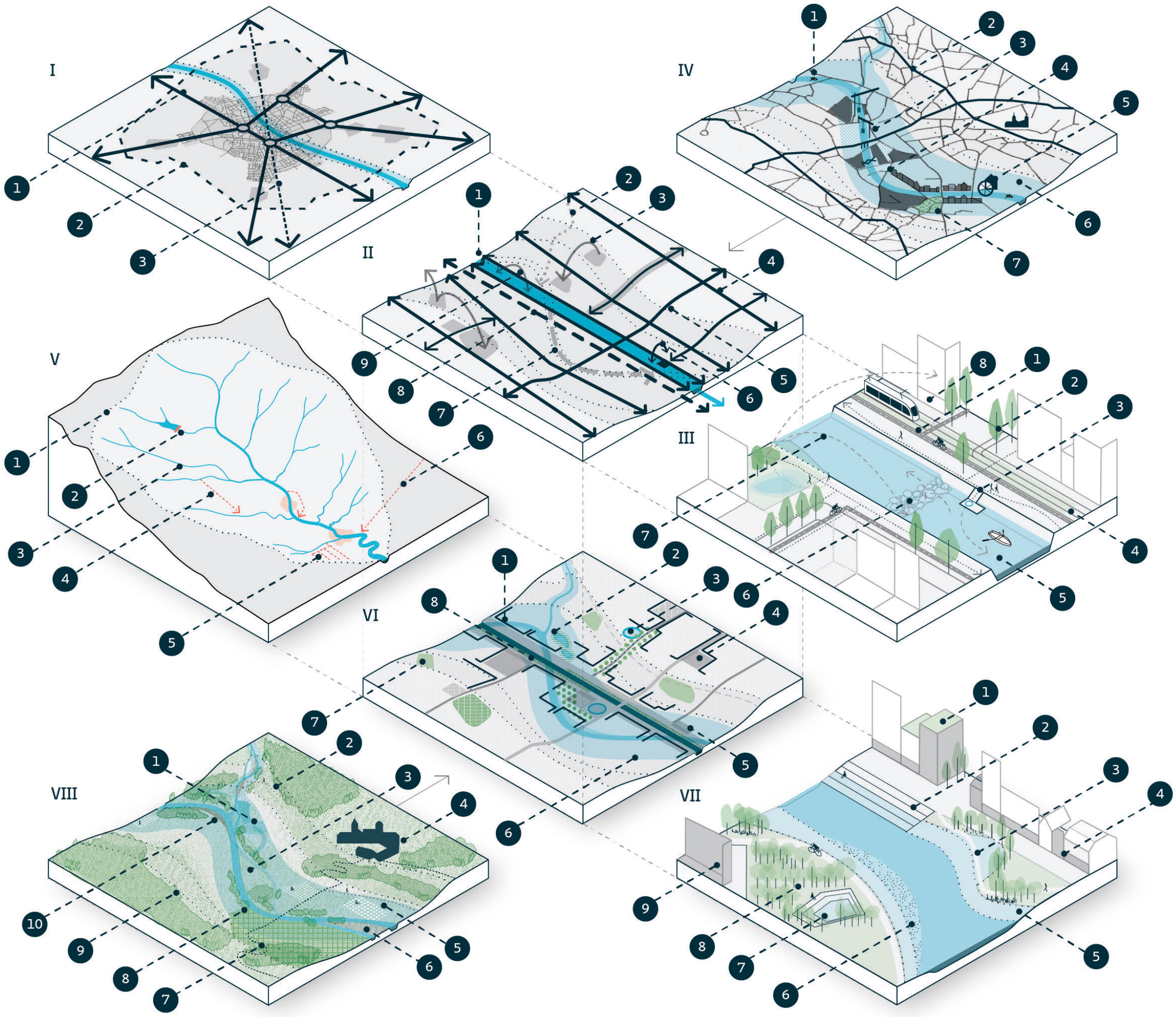


FIGURE 2.2 Urban River Corridors are coupled systems. Their qualities must be understood as mutually beneficial for the river valley and the urban fabric. For instance, accessibility of the waterfront can be expressed also in terms of permeability of the surrounding urban fabric.

27 A reciprocal spatial configuration entails a view in which any property of the URC is defined as a mutual relationship between a property of the river and a property of the urban fabric (e.g. accessibility of the river – permeability of the urban fabric).



I Metropolitan area

1 Major metropolitan network
2 Metropolitan area
3 Rail

II URC segment scale: connectivity

1 Roads in the river space
2 Natural drainage lines
3 Ecological connections in the river corridor
4 LoC (Major roads along valley edge)
5 Transversal road connections
6 LaC (lateral connectivity) in the river space
7 Bypass, river system restoration
8 Public transport lines in the river space
9 LoC (longitudinal connectivity) in the river bed

III River space: connectivity

1 LoC (slow mobility + public transport)
2 LaC (roads and trees)
3 VC vertical connectivity (water access point)
4 Public transport lines
5 LoC in the river (navigation)
6 LoC in the river bed (fish leader)
7 LaC and LoC, ecological connections in the river space
8 Accessible ground floors (public, semi-public functions)

IV Urban fabric before river rationalisation

1 Riverside path
2 Valley route
3 Wells in the valley
4 Organic urban fabric in floodable area
5 Water mills in the river space
6 Floodplain
7 Semi public and private gardens and backyards in the river space

V Catchment area

1 Watershed
2 Dam
3 Tributaries
4 Bypass channel
5 Irrigation systems
6 Inter-basin transfer channel

LoC= Longitudinal Connectivity
LaC= Lateral Connectivity
VC= Vertical Connectivity

VI URC segment scale: open space

1 Waterfront
2 Water storage spaces natural solutions
3 Water square
4 Open spaces in the river corridor
5 Open spaces in the river space
6 Former flood plain
7 Green spaces in the river corridor
8 River space

VII River space: open space

1 Private or semi-public green space (green roof)
2 Floodable public spaces on the river bank
3 Integrated natural and recreational public spaces
4 Groundfloor public functions
5 VC, ecological gradient
6 Beach, restored river dynamics
7 GBI, water storage design solutions
8 Pervious surface in the river space
9 Landmarks in the river space

VIII Natural river dynamics

1 Oxbow lake
2 Routes along topography
3 Braided stream
4 Settlement outside the valley
5 Agriculture, rationalisations in the riverspace
6 Sedimentation areas (beaches)
7 LaC main road transversal to the valley
8 Riparian vegetation
9 Vegetation on the valley edge (forests)

FIGURE 2.3 Illustration of the spatial-morphological definition of URCs.

A spatial-morphological definition of URCs, as illustrated in Figure 2.3, entails integrated knowledge of three-dimensional connectivity, open space amenity in the river space, and consideration of a scalar spectrum specific to URCs. Three-dimensional connectivity describes connections on longitudinal, lateral, and vertical dimensions. Open space amenity represents the provision of open spaces (public or private, green or paved), in balance with built density, to ensure environmental and public space quality. The spectrum of scales (Figure 2.4) specific to URCs comprises the *catchment scale* (bounding the river system), the *metropolitan scale* (overall urban structure and landscape), the *urban river corridor*, *corridor segment* and *river space scales* defined below (Figure 2.5) and the *site scale*.

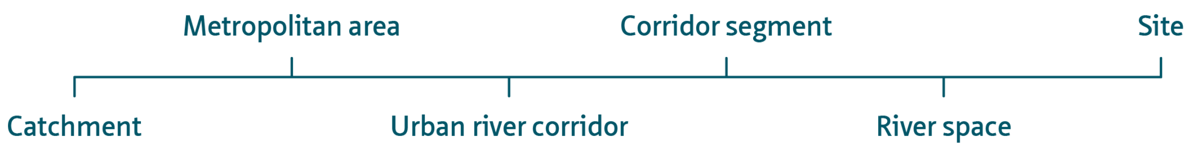


FIGURE 2.4 The spectrum of scales specific to URCs.

The river is not a line, but an area shaped by river dynamics. Hence, it must be defined from a spatial point of view. Even when the natural dynamics of the river are suppressed (e.g. through canalization), the valley is a fundamental spatial condition that needs to be embedded in the configuration and development of the urban fabric. Accordingly, the delineation of the URC,[28] that is, its outer boundary, the corridor segments and the river space, is defined as follows (Figure 2.5):

1. The edges of the valley are determined, for instance, from a digital elevation model, using a method of river corridor delineation (e.g. Vermont Agency of Natural Resources, 2004).
2. The main roads parallel, next to, and outside the river valley are identified as the outer boundaries of the URC. The ends of the corridor are determined by municipal or metropolitan administrative boundaries.[29]
3. The outer boundary is extended with a walkshed (i.e. the area accessible within a walking distance of e.g. 500 m from a given location) calculated from both edges of the river.
4. After the outer boundary of the URC is delineated, corridor segments (CSs) are determined by dividing the URC along major transversal traffic lines. This way, spatially continuous morphological units (i.e. uninterrupted by traffic barriers) are identified along the URC.[30]
5. The river space, defined as "the direct contact area between the river and the first line of buildings, including these buildings" (Batista e Silva et al., 2004, p. 17).

28 Each city developed a specific spatial relationship with its river. Therefore, this method of delineation is not purely quantitative, as it requires a judgement of the morphological particularities of the site in question. This is especially the case for corridor segment delineation, where variations in distance between major crossings may lead to unbalanced subdivision. Although uncommon, if two consecutive major crossing are too close to each other (the case of narrow rivers), then adjacent segments can be merged. If they are too far from each other (the case of wide rivers), then the URC can be further subdivided.

29 The ends of the URC are determined in such a way that connectivity with the surrounding (non-urbanised) landscape is ensured.

30 Observing the case studied in this thesis in Chapters 3 and 4, it can be assumed that urban areas between two major crossings tend to have distinct morphological characteristics.

TOC

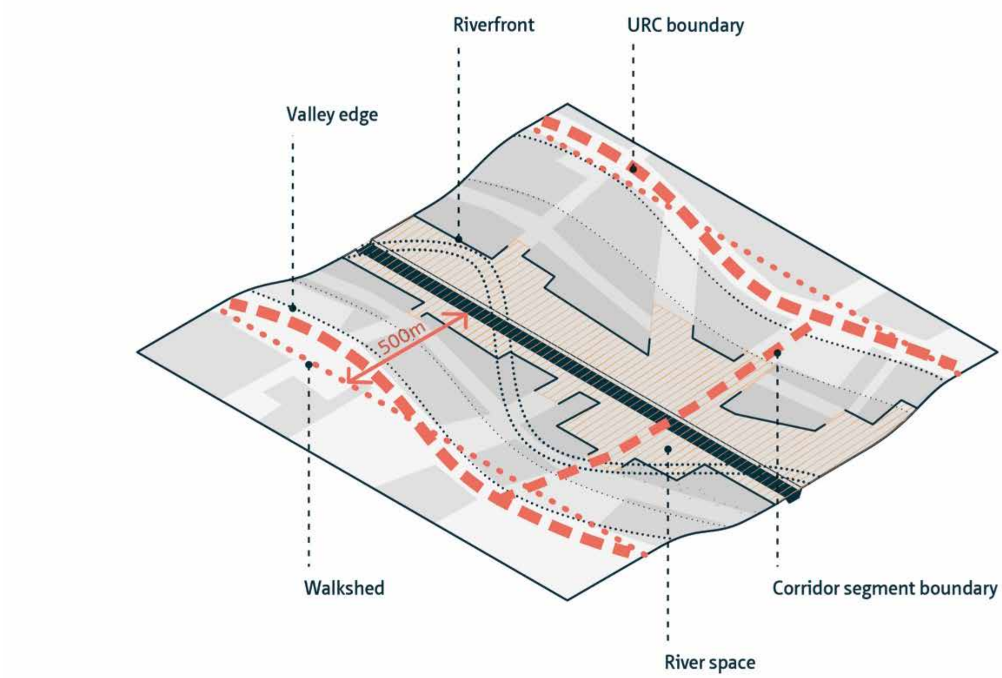


FIGURE 2.5 Proposed method for the spatial delineation of the URC, its segments and the river space.

§ 2.4 Conclusion

This chapter presented a literature review of different domain-specific approaches to urban rivers. A frame of reference of four domain families was used to structure the literature review and to summarise key principles from different fields of knowledge. First, *environmental-ecological* approaches (Section 2.2.2), such as river restoration and green and blue infrastructure (GBI), were described. Second, from a *social-economic* perspective (Section 2.2.3), key challenges and features of waterfront regeneration were outlined. The *planning-governance* dimension (Section 2.2.4) gave an overview of current planning and policy practices addressing urban rivers, from the scale of EU regulations to catchment- and community-scale river management. Finally, the *spatial-morphological* perspective (Section 2.2.5) gave a detailed overview of landscape ecology principles, landscape and urban design practices, and strategies of integration applicable to urban rivers.

As a result of this transdisciplinary literature review, four *key properties of URCs* were identified (Section 2.2.6): *connectivity*, *open space amenity*, *integration*, and *multiscalarity*. Connectivity was described as an integrative concept in ecology, hydrology and urban space design (Kondolf & Pinto, 2017; May, 2006). Open space amenity was promoted as a key element in waterfront development (Gordon, 1996; Stevens, 2009), in green infrastructure (GI) planning (Ahern, 2007; Benedict & McMahon, 2006) and in green and blue infrastructure (GBI) solutions (Perini & Sabbion, 2017). Integration was described in terms of possible models and principles of combining the networks and spaces of URCs (Manning, 1997; Tjallingii, 2005, 2015). Finally, the property of multiscalarity was based on a synthesis of scales that were used in descriptions of urban rivers in literature (Vietz et al., 2016).

Built on these four properties, the *spatial-morphological definition* of URCs gave a visual summary of the transdisciplinary knowledge on urban rivers (Figure 2.3) and developed a method of spatial delineation for the URC and its subdivisions, the corridor segment and the river space (Figure 2.5). This spatial-morphological definition of URCs will constitute a frame of reference throughout the whole thesis. It will be used to structure the assessment framework developed in Chapter 5 and to formulate the design principles in Chapter 7 and the design instruments in Chapter 8. The next two chapters will confront this spatial-morphological definition with an empirical case—Bucharest and its two URCs—from a historical perspective (Chapter 3) and from a multi-domain perspective (Chapter 4).

3 Social-Ecological Dynamics in Bucharest's River Corridors—A Diachronic Perspective

§ 3.1 Introduction

The properties identified in Chapter 2 are illustrated in this chapter with the case that will be studied throughout the thesis: Bucharest and its two river corridors, Dâmbovița and Colentina. As defined in Chapter 2, Urban River Corridors (URCs) are the result of a process of constant interaction between natural and urban dynamics. Hence, the following pages will reveal the geographical and historical traces of the changing relationship between urban development and river dynamics in Bucharest. The search for conflicts and synergies underlying this exploration is intended to construct an understanding of the urban environment as a system in dynamic equilibrium, in which the natural and the artificial co-exist and establish a reciprocal relationship.

After a brief introduction of the geographic context of Bucharest in Section 3.2, Section 3.3 provides a historical account centred on the development of the city in relation with the two rivers, as portrayed in written and cartographic sources. Given (1) the chaotic development of Bucharest after 1989, (2) the scarcity of literature on post-communist urban transformations, and (3) the fact that the rivers haven't been actively transformed during the years of transition, the current state of the URCs of Bucharest will be approached separately and with a different methodology in Chapter 4. This chapter concludes (Section 3.4) with a reflection on conflicts and synergies found in the dynamic relationship between Bucharest and its two rivers across time, as a basis for understanding the current state of social-ecological integration in Bucharest's URCs.

SUB-QUESTION AND OBJECTIVES:		
Sub-question 3:	How has the relationship between Bucharest and its rivers evolved through time?	
Objective 3.1:	Describe the geographic context of Bucharest's URCs.	Section 3.2
Objective 3.2:	Describe the spatial-temporal dynamics of Bucharest's URCs.	Section 3.3

§ 3.2 Geographic context: hydrography and fluvial geomorphology

Not surprisingly, the geographic context has had a defining role in the development of Bucharest into a centre of national and regional importance. Here as in other cities, the presence of water and the physical configuration of geographic space have been defining conditions for settlement and growth. A hydrographic and geomorphologic description can, therefore, shed light on the *substratum*—that is, the natural base formed by long-term processes, as presented in the Dutch *Layers Approach* (De Hoog, Sijmons & Verschuuren, 1998, cited in van Schaick & Klaasen, 2011)—of a river-crossed city. The substratum can be considered relatively stable on the short term, as it tends to have a very slow rate of change (100-500 years). Therefore, it is presented here separately from the 150-year urban history of Bucharest explored in Section 3.3, which focuses on the faster dynamics of what in the Layers Approach would be called the *occupation* (25-50 years) and *networks* (50-100 years) layers (Figure 3.1).

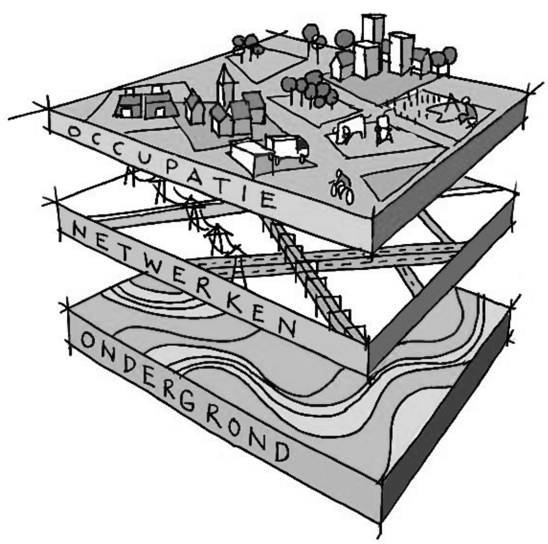


FIGURE 3.1 The Dutch *Layers Approach*. Illustration based on van Schaick and Klaasen's review of the Dutch model (2011). Source: De Hoog, Sijmons & Verschuuren, 1998, cited in van Schaick & Klaasen, 2011.

Thus, for a proper description of Bucharest's rivers, it is important first to understand their wider hydrographic context at the catchment scale. As shown in Figure 3.2a, the Romanian capital is located within the lower section of the catchment area of River Argeș, one of the main tributaries of River Danube on the territory of Romania.[31] River Argeș crosses the Romanian Plain on a northwest-southeast direction from its headwaters in the Carpathian Mountains to its confluence with the Danube. Its largest tributary River Dâmbovița has a similar trajectory,[32] flowing from the mountains (1800 m) to its confluence with River Argeș (27 m) (Cocoș, 2006; Zaharia, Ioana-Toroimac, Cocoș, Ghiță, & Mailat, 2016). In its lower course, River Dâmbovița crosses the city of Bucharest diametrically on a distance of 24 km, with elevations between 90-60 m (Figure 3.2b). One of the main tributaries of Dâmbovița is River Colentina crossing the north of Bucharest.

31 Romania is located within the lower segment of the Danube River Basin (DRB) with 97,4% of its total surface and it has the highest share (29%) of the river basin out of the 19 countries crossed by Europe's second largest river (ICPDR, 2006).

32 This hydrographic type is called a Wallacho-Carpathian (Dinu, 1994) or Carpatho-Wallachian river system (Cocoș, 2006).

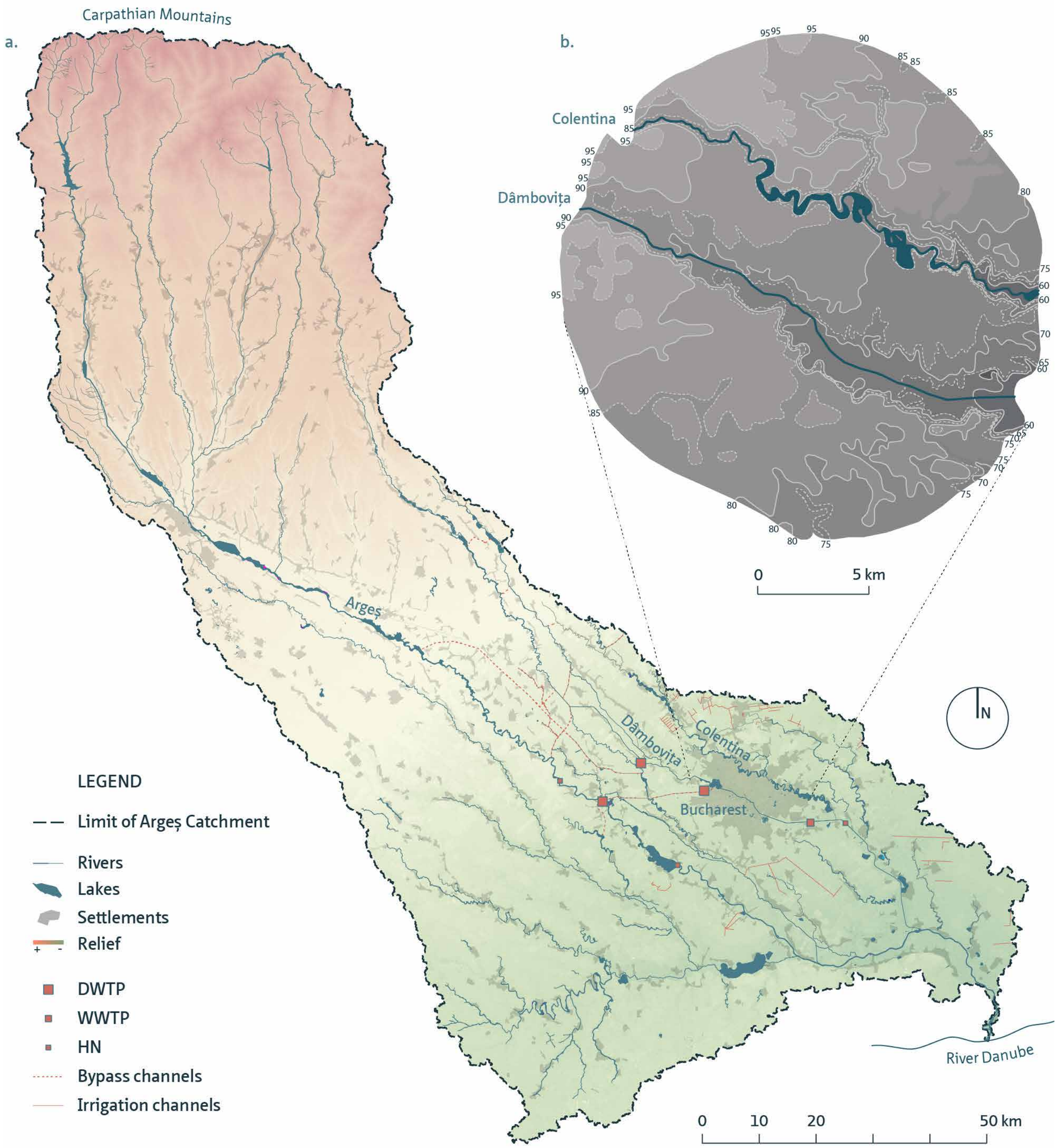


FIGURE 3.2 The hydrographic context of Bucharest: (a) at the scale of Argeș Catchment Basin; and (b) at the scale of Bucharest crossed by River Dâmbovița and River Colentina, as depicted in an illustration of the relief inside the rail ring by Cincinat Sfințescu (1931). Data sources: (a) OpenStreetMap and SRTM DEM underlay; (b) traced after Sfințescu,1931.

River Dâmbovița, like River Argeș, is an *allochthonous* river, meaning that it originates in a different geographic region—in this case, in the mountains—, while River Colentina, similar to River Sabar in the same region, is an *autochthonous* river, that is, its source and mouth are in the same geographic region—in this case, in the plain (Zaharia et al., 2016). River flow originates both from surface water (rain or snow) and from groundwater. In case of allochthonous river Dâmbovița, most flow is gained from rainfall (32.4%) and snow (26.6%) from upstream in the Carpathian and sub-Carpathian regions, with an additional 41% from groundwater (Cocoș, 2006). Autochthonous rivers in the Bucharest region, such as Colentina and Sabar, have a more reduced flow, but, as it will be explained in the following sections, those rivers receive a large amount of water from artificial sources, especially through derivations from neighbouring streams.

From a geomorphologic point of view, the two rivers are also different. As described by Cincinat Sfințescu (1931), Dâmbovița has a divagating channel, while Colentina has a more stable channel. This difference is still visible in the features of the landscape developed along the two streams. Before regularisation and canalisation, Dâmbovița had a wide and dynamic valley with several tributaries, side-channels, wetlands, islands, and hills, while Colentina has a narrower valley. Both rivers have a reduced slope (1,2 m/km for Dâmbovița and 1,1 m/km for Colentina, according to Cocoș, 2006) and thus a reduced velocity, which in natural conditions leads to floods.

Given its location in a plain geographic region, the main topographic features of Bucharest are the valleys of the two rivers (Comănescu, Nedelea, & Stănoiu, 2017). Dâmbovița's valley is between 300m and 2km wide (Sfințescu, 1931, p. 15) and it is asymmetrical, with a high right bank and a lower, less steep left bank. Colentina's valley, also asymmetrical, has been extensively transformed by the construction of the lakes. In the Bucharest region, Colentina has a more sinuous course than Dâmbovița (Cocoș, 2006) and it has meadows on both banks with widths ranging from 100 m to 1,5 km. Table 3.1 summarises the general morphometric features of the two rivers.

TABLE 3.1 Morphometric features of Dâmbovița and Colentina

RIVER	L_t (km)	L_B (km)	A_s (m)	A_m (m)	S (m/km)	S_B* (m/km)	A (km^2)	SI*	SI_B*
Dâmbovița	286	24.2	1,800	27	6	1.2	2,824	1.27	1.56
Colentina	101	29.4	179	52	1	1.1	643	1.50	1.56

*Lt, total length; LB, length in the Bucharest city area; As, headwaters elevation; Am, river mouth elevation; S, slope gradient; SB, slope gradient in Bucharest city area; A, catchment area; SI, sinuosity index; SIB, sinuosity index in Bucharest city are. (Sources: Zaharia et al., 2016; *Cocoș, 2006).*

As we will see in the next section, this geographic context represented important spatial conditions for the development of Bucharest. While the city was growing, the river system was transformed very fast, mainly out of a need to alleviate conflicts with natural river dynamics, such as floods or disease, but also to maximise the supply of water for various uses. At the same time, the morphology of the city too has adapted to the topography of- and around the two river valleys. This interplay between mitigating and adapting to the substratum needs a closer historical look.

TOC

§ 3.3 A synoptic history of Bucharest's river corridors

A history always has a certain degree or form of subjectivity, either through the chosen narrative or the emphasis on a topic of particular interest. The linear nature of a historical narrative implies the assumption of a thread meant to make sense, in a step-wise manner, of an otherwise complex course of events. The thread presented here links together a succession of events, projects, visions, or technical descriptions considered to be necessary for the understanding of the URCs of Bucharest before any description (Chapter 4) and assessment of their current state (Part 2) or suggestion for their future transformation (Part 3) can be made.

This endeavour is complicated when the subject has been partially charted by historians, when a consensus has not been reached, or when the studied subject or phenomenon is examined at the wrong spatial and/or temporal scale.[33] Such a difficult topic is the urban morphological history of Bucharest, in general, and its URCs, in particular. To the author's understanding, there are at least three reasons why this history is incomplete and, hence, needs to be further explored. First, for decades already the topic of urban rivers in Bucharest has not received sufficient attention in research. Second, there is a lack of trans-disciplinary research on a topic which is inherently cutting across disciplines. Third, Bucharest lacks a full-fledged body of knowledge on urban morphology,[34] especially taking into consideration the urban areas which were most recently transformed, such as the civic centre built in the last years of Communism, abandoned or regenerating former industrial areas in the centre, or the morphology of interstitial and leftover spaces so widely distributed in the heterogeneous urban fabric of Bucharest.

The history presented here is not original in its parts. It is, however, in its spatial-temporal scope and in its emphasis on the subject matter: the spatial-morphological description of the social-ecological relationship between Bucharest and its rivers. It builds on and brings together important sources, such as Vintilă Mihăilescu's influential work on the urban geography of Bucharest from mid-nineteenth century until 1977 (Mihăilescu, 2003), Georgescu et al.'s (1966) detailed historical account of the transformation of the two rivers, Nicolae Lascu's (2011) study on the modernisation of Bucharest through boulevards until WWII, early urbanist Cincinat Sfințescu's vision for the rivers of Bucharest (1931; Udrea, Popescu, Calotă, & Păun Constantinescu, 2015), the work of engineer Nicolae Caranfil and his colleagues (1936) on the transformation of River Colentina in the 1930s, and Dana Harhoiu's (1997) depiction and interpretation of Bucharest's pre-modern, modern and recent urban morphological transformations. In addition, more recent studies (e.g. Avădanei, 2012; Stematiu and Teodorescu, 2012; Zaharia et al., 2016) were consulted to outline the recent history of the two URCs.

The historical account starts with the middle of the 19th century, considered the beginning of Bucharest's urban history (Mihăilescu, 2003) around the time when it was established as the capital of the Romanian Principalities, and also the time when the first actions were taken for the transformation of Dâmbovița (Section 3.3.1). The narrative is built chronologically, thus the main stages of development of River Dâmbovița and River Colentina will be presented as they occurred in

33 Although established works, such as Georgescu, Cebuc, & Daiche's (1966) extensive account of the river transformations undertaken in the 19th and 20th centuries, and Mihăilescu's (2003) monographic study of Bucharest's geographic transformations have been influential, the social-ecological dynamics remain implicit.

34 There is, however, literature on specific aspects of urban transformation in Bucharest, such as Nicolae Lascu's (2011) study of the boulevards of Bucharest or Harhoiu's (1997) investigation of the morphogenesis of city centre and the disruptive transformations of the Civic Centre built under Communism.

relation to the development of the city (Sections 3.3.1-3.3.3). Finally, a summary of human impacts on the river system in the presented history concludes the narrative (Section 3.3.4).

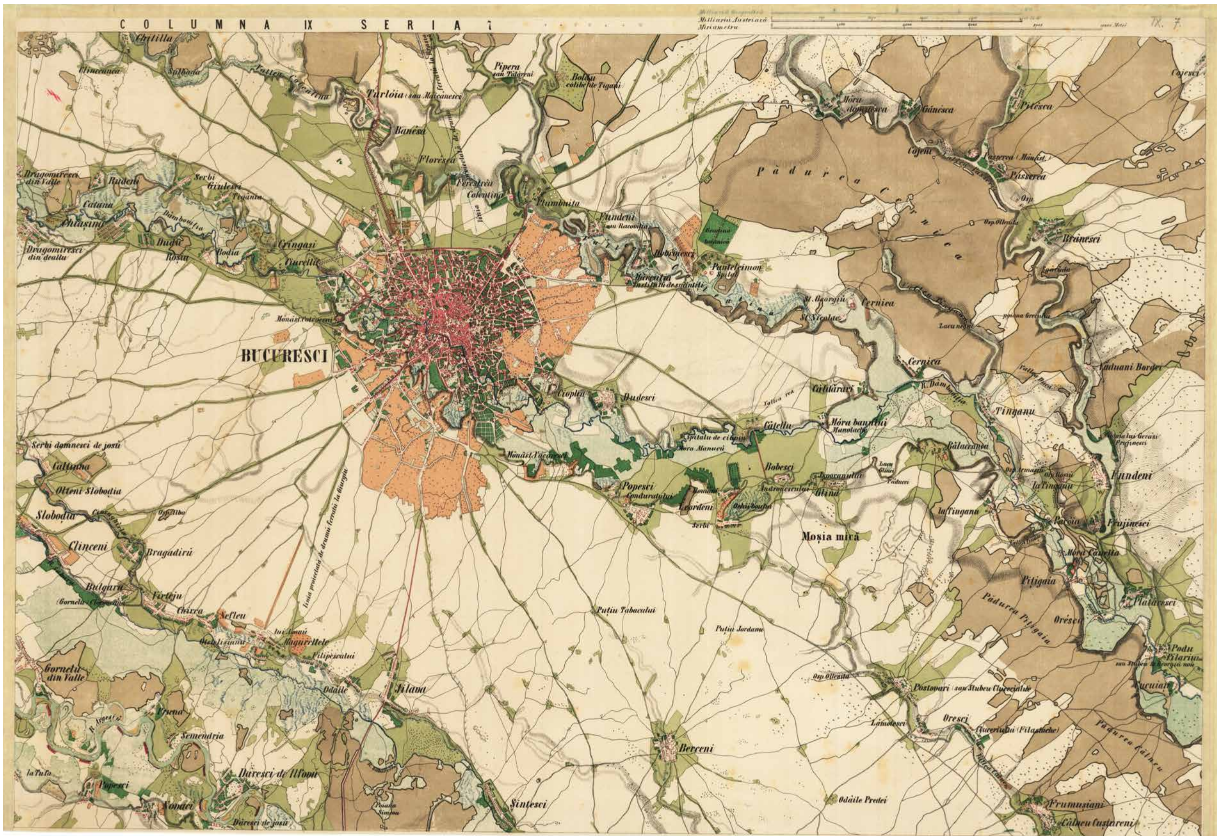


FIGURE 3.3 Fragment from the Szathmári's Map of Southern Romania (1864) showing the regional context of Bucharest in the middle of the 19th century. Source: Szathmári, 1864, map sheet No. 77, in Bartos-Elekes, Z. (2015). The Habsburg mapping of Moldavia and Walachia. Retrieved from https://icaci.org/files/documents/ICC_proceedings/ICC2015/papers/18/fullpaper/T18-696_1428396969.pdf

§ 3.3.1 Dâmbovița—from a dynamic valley to a canal

The city of Bucharest, first documented in 1459, originated along a meandering river called Dâmbovița[35] in the Wallachian Plain, also known as the Romanian Plain. This geographic location was especially suitable for an urban centre as it was located halfway on a straight trading route (Mihăilescu, 2003) and military outpost (Harhoiu, 1997) between the Carpathian Mountains and River Danube, and because the soil and subsoil conditions of this part of the Wallachian Plain were

35 The exact location of the city core was between the bottlenecks created by two hills—Mihai Vodă and Radu Vodă—in the river valley (Sfințescu, 1931).

exceptionally good[36] (Sfințescu, 1931). Initially the city was located—just like most settlements in the same region—on the left bank of the river (Figure 3.3), because aquifers as well as gravel and sand for extraction[37] were more accessible through the thin layer of loess which covered the Vlăsiei Plain, a sub-unit of the Wallachian Plain lying north of Dâmbovița (Figure 3.4). The right bank was urbanised later, but its picturesque hills and steep cornice provided a good location for many important buildings such as monasteries, churches and military facilities from early times.[38] In fact, before rectification and canalisation works carried out at the end of the 19th century, Dâmbovița was a dynamic sinuous river which changed its course several times forming a landscape of islands ("ostroave"), secondary channels, floodplain lakes ("zătoane"), wetlands, tributaries and a valley topography marked by hills ("grădiști") and steep cornices.

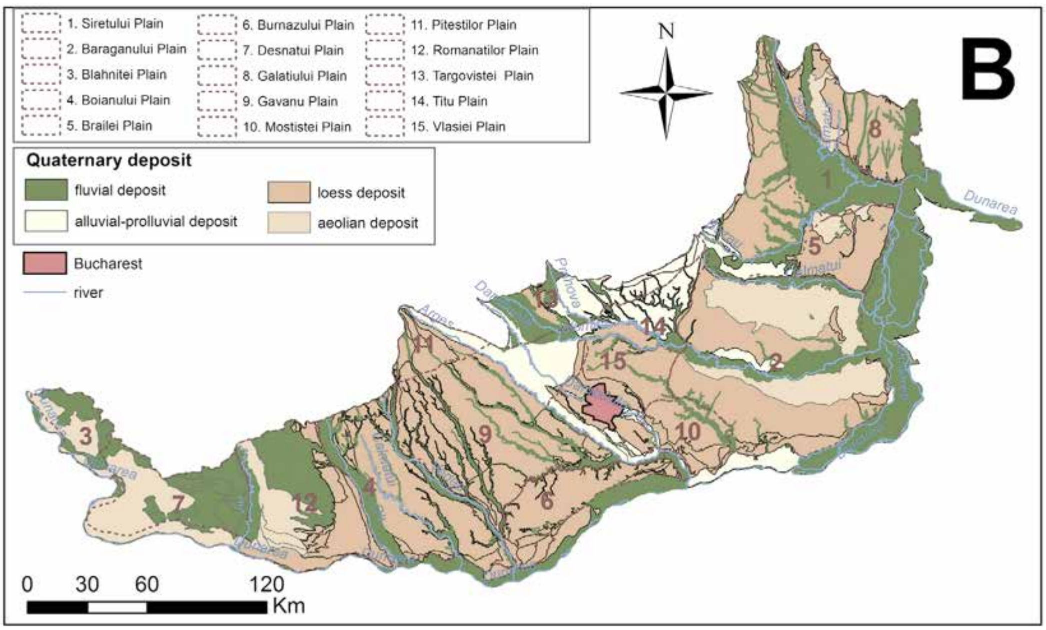


FIGURE 3.4 The Romanian Plain and its subdivisions. Source: Comănescu, Nedelea & Stănoiu, 2017.

River Dâmbovița itself has always been seen as a problem which the city needed to overcome (Georgescu et al., 1966; Lascu, 2011). The increasing frequency of floods in the 18th and 19th centuries[39] was caused mainly by the strangling of the river course with a growing number of man-made structures such as watermills and bridges. Before the extensive canalization of the river in the 1880s, several attempts had been made to tame the river and to adjust it to its urban functions. The first measures of flood prevention date back to 1774 when the Wallachian voivode Alexander Ypsilantis ordered the construction of a bypass channel upstream from Bucharest in order to divert

36 The thin loess top layer was easily penetrable by the roots of the trees, so that forests could easily develop and the clay layers kept aquifers closer to the surface (Sfințescu, 1931).

37 Almost all extraction pits of the city are located north of Dâmbovița, especially in Crângași and Ciurel (Sfințescu, 1931).

38 Notable examples are Mitropolia located on a hill with the same name housing the national seat of the Orthodox Church, Mihai Vodă Monastery and the Arsenal of the Army located on another hill in the centre of the city.

39 According to Georgescu et al. (1966) major floods were recorded in 1774, 1834, 1851, 1860, 1862, 1864, and most of all in 1865.

excess water to River Argeș in case of high flow. Later in 1803 waste disposal into the river was prohibited, the riverbed was cleaned and deepened in 1815, it was periodically dredged, river walls were anchored to stop erosion, local adjustments were made to the river course, and successive attempts were made to demolishing the mills (Georgescu et al., 1966).

Watermills for cereals were built from very early times by the monasteries located on the hills next to the river. As the city developed, the number of mills increased so much that the river weirs required for their operation became the main cause of flooding in the city. Bridges with several in-channel supports represented an important obstacle to river flow as well. Recognising these threats, the *Organic Regulation*[40] adopted in 1831 prompted the demolition of all mills within the city, the widening of the riverbed and the setback of buildings located near the river. Furthermore, the great flood of 1865 motivated the government under Alexandru Ioan Cuza to issue the *Law for the demolishment of mills*, to remove all bridges with supports in the riverbed, and to consider the rectification of the course of Dâmbovița (Georgescu et al., 1966). The abolishment of mills was made especially difficult by the users of the river, namely the tanners and the owners of the mills and river baths. Yet, after repeated attempts[41] to implement these measures in the following years, the *Law for the canalisation of Dâmbovița* was approved in 1878 and the *Project for the rectification and canalisation of Dâmbovița* of engineer Grigore Cerchez (Figure 3.5) was voted by the Communal Council of Bucharest in 1879.

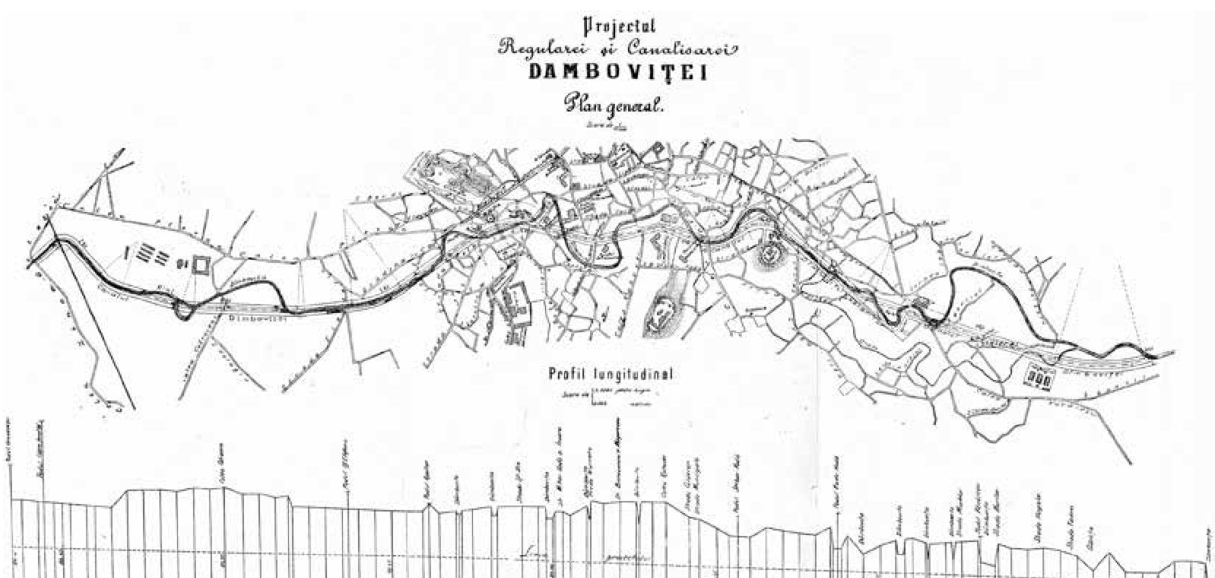


FIGURE 3.5 The project for the regularisation and canalisation of River Dâmbovița (1879) by Grigore Cerchez. Source: Georgescu et al., 1966.

40 The *Organic Regulation* (called Regulamentul Organic in Romanian) was a quasi-constitutional act adopted in 1831 in Wallachia and in 1832 in Moldavia. In urban planning, the act was concerned with the "beautification and straightening" of the city.

41 Such attempts were carried out downstream from the city in 1868 (Georgescu et al., 1966).

The project of Cerchez included the deepening of the riverbed with 6 meters, two steps—one at Grozăvești and one at Vitan—and a flow capacity between 8-22 m^3/s aimed at levelling the slope, the removal of sharp bends and secondary channels, a regulated trapezoidal drainage profile, the transformation of the banks with masonry work, a 20-meter unbuilt space on both sides of the river, four new bridges, and a riverbed deck made of wood on wooden beams and piles. The works of regularisation were carried out between 1880-1886 by French contractor Alexandre Boisquerin (Georgescu et al., 1966). As a result of the rectification and canalisation, 192 properties on the right bank and 182 on the left bank are demolished, and the tributaries of Dâmbovița were cut off (Georgescu et al., 1966). The extent of the transformations is depicted in Figure 3.6.

FIGURE 3.6 Dâmbovița before (A, 18th/17th c.) and after (B; C, 1927) regularisation and canalisation. Source: Comănescu, Nedelea & Stănoiu, 2017.

Even after canalisation, floods—with the largest one in 1893[42]—occur due to heavy rainfall and the bottlenecks created by bridges, so the works were extended to the Grozăvești-Ciurel section in 1898[43] to prevent further such events (Georgescu et al., 1966). Except the extensive dredging operations carried out between 1930-1932 (Georgescu et al., 1966), and further rectification upstream from Ciurel Dam in 1942 (Stematiu & Teodorescu, 2012), the river remains relatively unchanged until the last phase of transformation in the 1980s.

The urban landscape: from private backyards to a public waterfront

Despite the modernisation efforts triggered by the Organic Regulation in 1831 and its recognition as a regional centre, Bucharest was still perceived as a large village at the middle of the nineteenth century (Mihăilescu, 2003). A possible explanation for its rural image, usually depicted by travellers visiting the city, is the fact that the urban fabric had a loose structure inherited from the 16th century, when civil fortifications were forbidden by the Ottoman rulers (Harhoiu, 1997).

42 The flow of River Dâmbovița increased to 125 m^3/s during the flood of 1893.

43 The weir in the Grozăvești area was demolished, and another one was built at Ciurel.

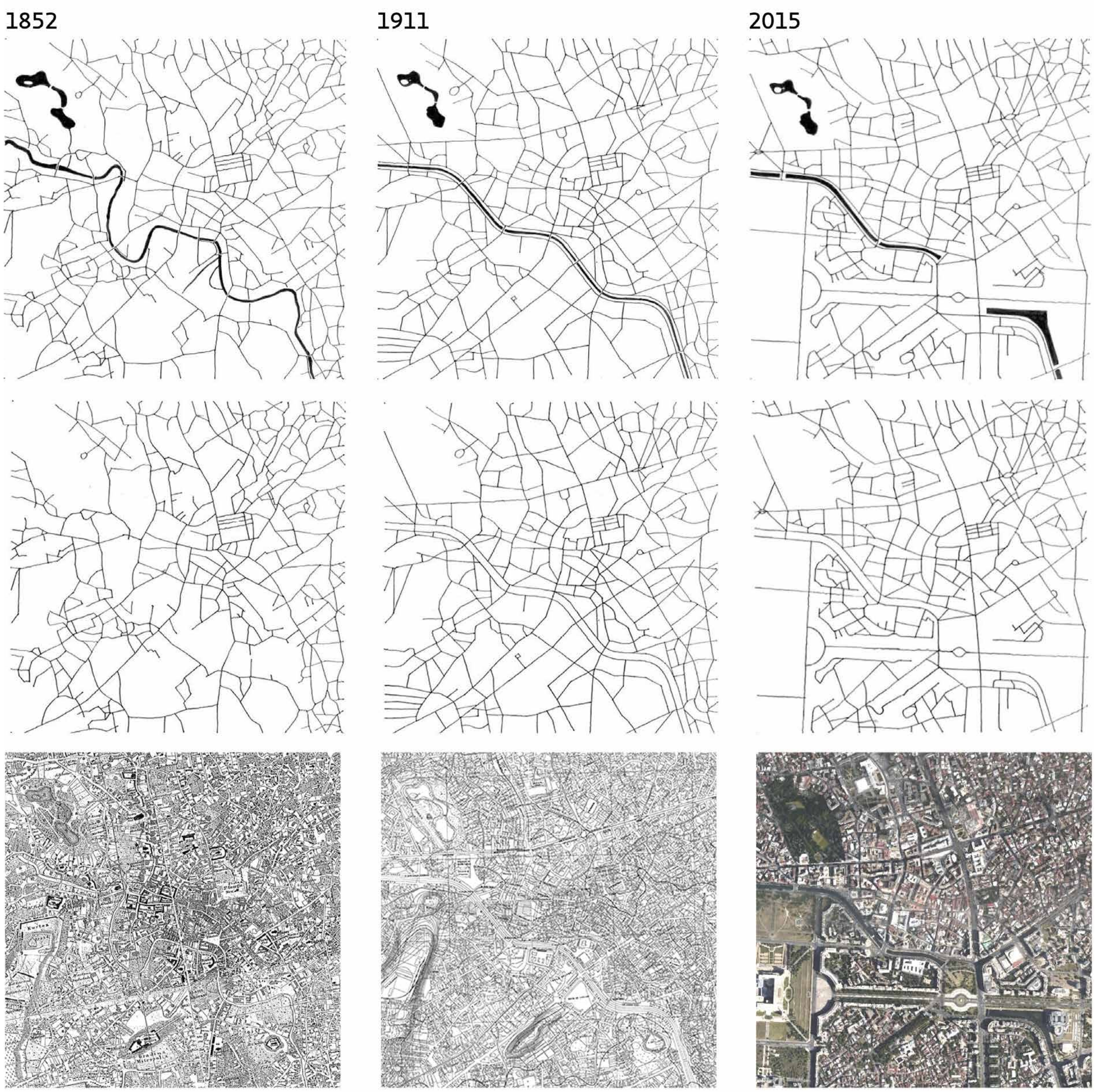


FIGURE 3.7 The transformation of the urban fabric in the centre of Bucharest form the natural state (left) of Dâmbovița, through canalization (centre) and to its current state (right). Two major transformations can be observed: (1) the urban fabric became more fragmented and the river valley more constrained; and (2) the number of crossings decreased from 11 to 7 to 4, the latter being exclusively used by car traffic. Basemaps: Borroczyn map (1852, left), cadastral map (1911, middle), Google satellite map (2015, right).

Yet the policy of "Westernisation" put forward by the administration during the first two decades of the twentieth century is very visible. The city had a double face during that period: modernised along the main arteries and old across the rest of the urban fabric (Mihăilescu, 2003). The regularisation of Dâmbovița played an important role in changing the image of the Romanian capital. The river was upgraded from a stream in the backyard into a city-wide infrastructure, just like a boulevard (Lascu, 2011). This modernisation symbolised a change in mentality, in which the new waterfront (the 'Splai' in Romanian) became a public space.

The new waterfront, with its wide and long perspectives became an attractive place for public institutions. In 1895, the Palace of Justice, built in French Renaissance style, opens on the right bank of Dâmbovița (Georgescu et al., 1966). The new corridor crossing the city became attractive for various infrastructure projects, such as Sfințescu's unbuilt proposal for a rail line from 1921 (Udrea et al.2015). In order to solve the problem of traffic in the centre, in 1934-36 the river was covered at what is today known as the Union Square. As a result of the extensive transformation of the urban areas along the river, very few parts of the former urban riverfront remained in place. The extent of the spatial transformations in this area is shown in Figure 3.7.

§ 3.3.2 Colentina—from a pestilential river to a pearl of lakes

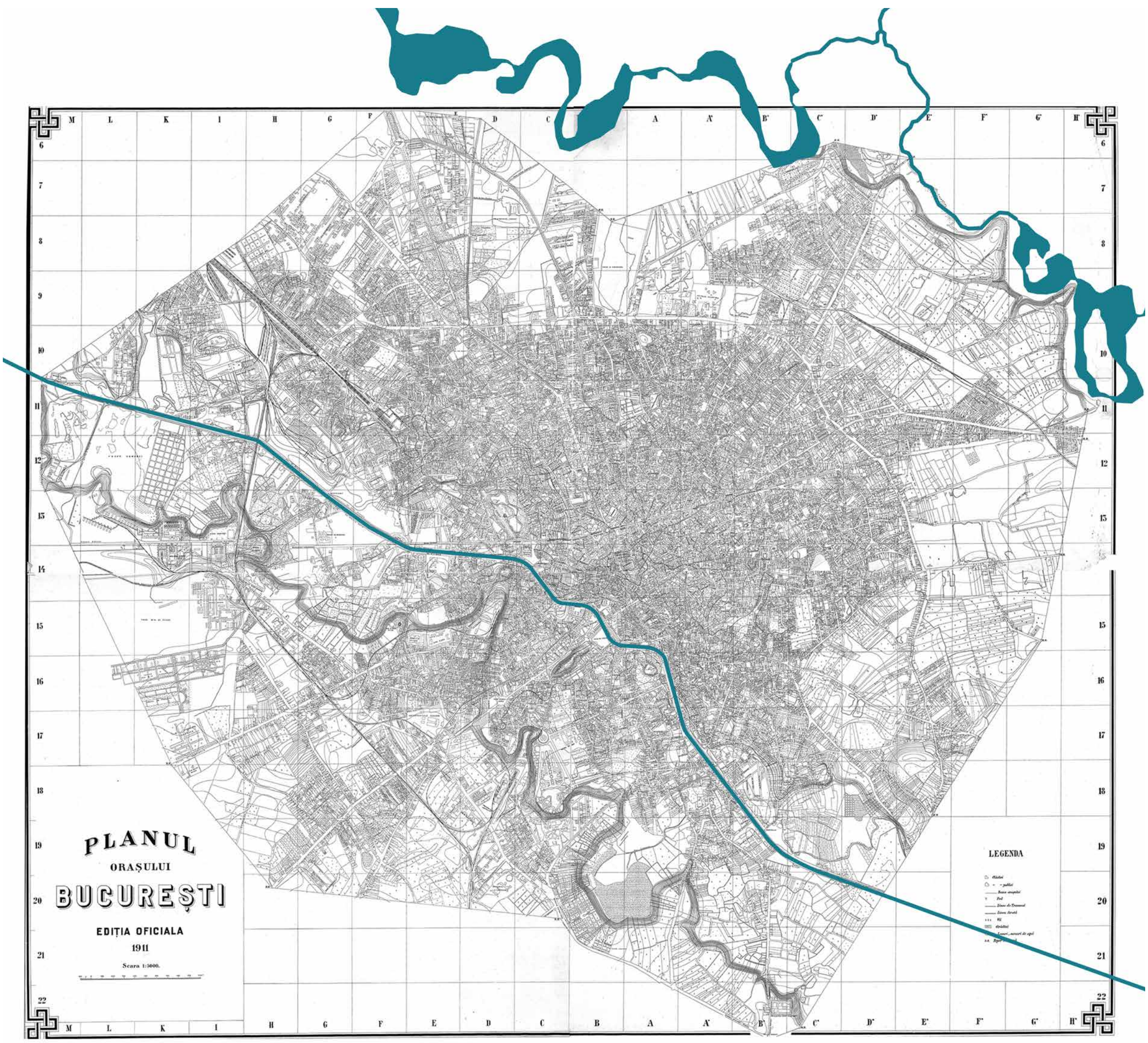


FIGURE 3.8 The administrative area of Bucharest in 1911 and, highlighted with blue, canalised River Dâmbovița crossing the city centre, and the valley of River Colentina visible in the northeast. Source: Serviciul Geografic al Armatei on Wikimedia Commons.

As the city expanded to the north at the turn of the twentieth century, it gradually encapsulated River Colentina and the neighbouring villages in its periphery[44] (Figure 3.8). The valley of Colentina, however, was not yet fit for urban living. The population growth and the lack of a sewage network made it a very problematic location. The stagnating water of the barely flowing river had an unpleasant smell and favoured the breeding of malaria-spreading mosquitos. The quality of water was further deteriorated by industrial and domestic wastewater discharge and by the use of the swamps as waste pits (Georgescu et al., 1966). Moreover, the population—mainly comprising informal Roma communities—was living in precarious conditions around and inside the pits (Băncescu & Calciu, 2014; Caranfil et al., 1936).

Although concerns for sanitation had been expressed before WWI,[45] the issue was only addressed by the city in the late 1920s. In response to the aforementioned problems, but also in the view of new opportunities that the transformation of River Colentina could bring, the program put forward by Bucharest Communal Works (B.C.W.)[46] was meant to increase the water flow, to transform the marshland into a salubrious and picturesque landscape, to increase the size of the National Park (part of today's Park Herăstrău), to create a large water surface which would bring environmental benefits to the city, and to open a navigable link between the rivers Argeș, Dâmbovița, Colentina and Danube (Caranfil et al., 1936).

Studies led by Cincinat Sfințescu started in 1926 by the House of Public Works of Bucharest and resulted in three possible solutions for transformation.[47] The chosen solution included a bypass channel from River Ialomița located upstream and designated to supplement the flow required for a series of lakes envisioned along River Colentina. The technical proposal by engineer Nicolae Caranfil, head of B.C.W., was accepted by the mayor Dem I. Dobrescu and ratified by the General Council in 1932. In a speech at the Polytechnic Society on 25 February 1936, Caranfil gives the example of Dâmbovița, a canal without hope, to contrast with the great natural potential of the project for the lakes. According to him, the city of Bucharest dried out a landscape which once was "an oasis of green, water and humidity". "We drained and assassinated Dâmbovița, there's nothing else we can do with it," he said (Caranfil et al., 1936, p. 13). Having partially executed the plan for the sanitation and reclamation of River Colentina, Caranfil has proven the success of the project and announced the next phases of implementation.

The green belt

Equally important, but less sustained in the subsequent years, was the idea of a green belt as a way to contain urban growth. The concept was introduced at the beginning of the twentieth century and then elaborated by Cincinat Sfințescu's study for the general urban plan of Bucharest[48] (Figure 3.9).

44 According to Mihăilescu (2003), archaeological findings show that in the Palaeolithic hunters and fishermen preferred to take shelter in the valley of Colentina, rather than in the valley of Dâmbovița which was more exposed to floods. It can be argued that with the emergence of agriculture in the Neolithic, the fertile lands of Dâmbovița's marshy valley became in time more attractive for settlers.

45 The need for transformation of River Colentina was signaled in 1912 by a landslide on lake Herăstrău (Caranfil et al., 1936).

46 Uzinele Comunale București (U.C.B.) in Romanian.

47 According to the first solution, all lakes would have been dried and the river would have been transformed into a streamlet. As Bucharest needed more water, this solution was not accepted. Instead, a second solution was chosen, one in which water was diverted upstream from River Ialomița to supplement the flow in Colentina. The third solution was a combination between the first two.

48 One of the novelties of the plan was the adoption of the Garden City theory by Cincinat Sfințescu (Udrea, 2015).

According to this concept, Colentina represented a natural barrier to growth in the north of the capital, which could be included in a possible green belt for Bucharest. As shown in Figure 3.9, the proposed belt intersects the green corridors of the two rivers. Dâmbovița too was part of the proposed belt, but, as it crossed the centre of the city, it was rather a green structure connecting the city externally than a continuous green corridor. Although the corridor of Colentina and the partial green structure of Dâmbovița are still discernible on the current plan of Bucharest, the spaces of the rest of the belt were built over as the city expanded.[49]

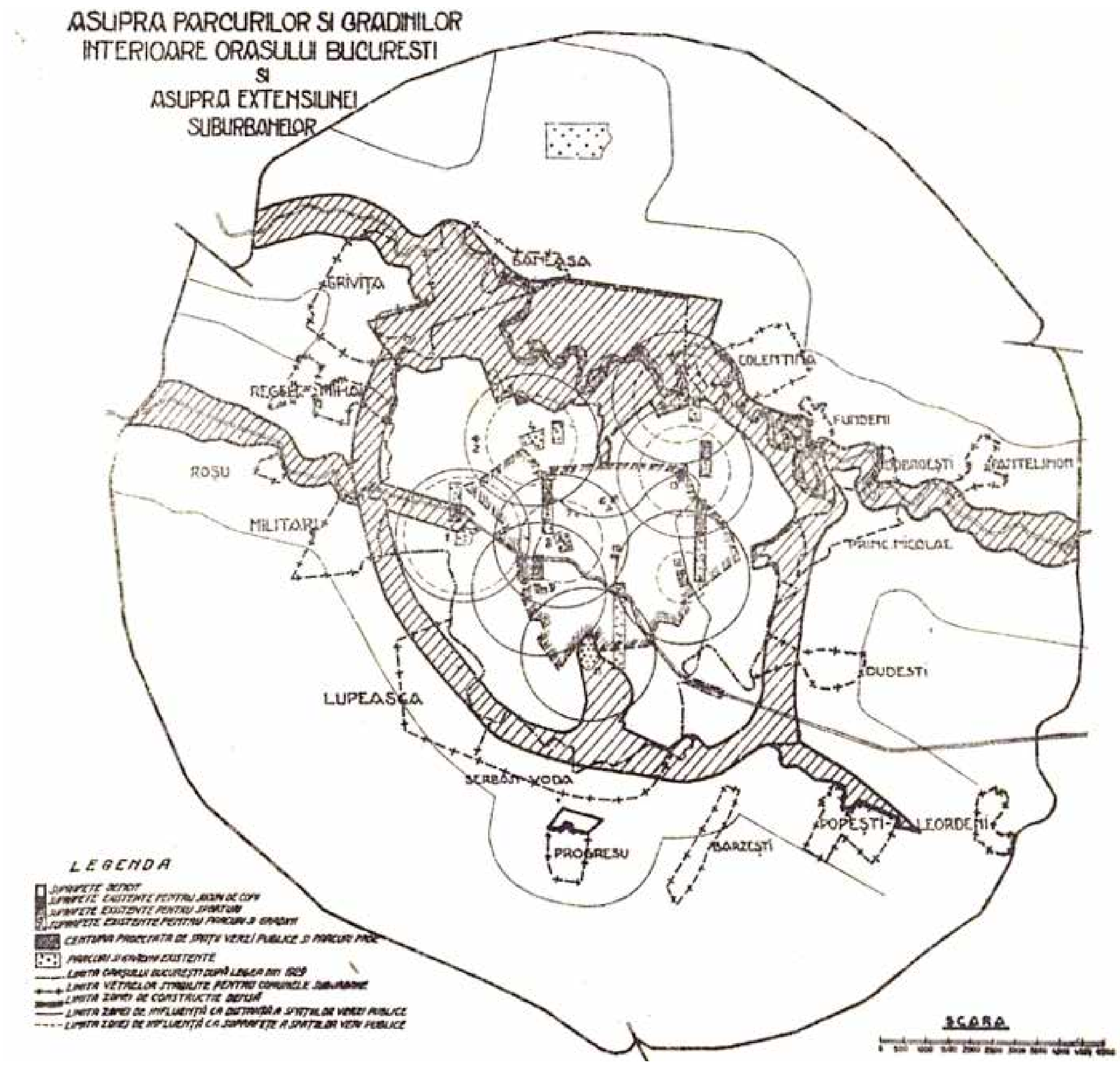


FIGURE 3.9 The proposal for Bucharest's green belt. Source: Sfințescu, 1931.

49 It may be argued that the idea of the green belt, artificial in its design, was not successful as it was less compatible with the urban structure than the natural green corridors of the two rivers.

Sewage and water supply

As the city crossed the ridge line between Dâmbovița and Colentina, the general project for water supply (1906) and for sewage (1913) concentrated along Dâmbovița was outdated, so the sewage network needed to be extended to urban areas along Colentina as well (Caranfil et al., 1936). At the same time, the growing population of Bucharest needed drinking and wastewater treatment. A treatment plant was already built at the end of the 19th century at Arcuda, upstream on Dâmbovița near Bucharest, but as the flow was limited to max. $8m^3/s$ at the beginning of the 20th century due to flood risk, waste water treatment plants were needed. Also, for the sewage network of the areas in the N, NW (draining to Colentina), E, and SE waste water treatment plants were required. A solution for the low flow of Colentina would be a diversion canal bringing water from Ialomița.

§ 3.3.3 The two rivers under Communism—continuity and disruption

The years of Communism (1947-1989) deserve to be presented separately, as both rivers went through a second phase of transformation during this period. The change of regime from Monarchy to the Socialist Republic marks an important point in the urban history of Bucharest. After WWII, the city witnessed an unprecedented growth from nearly 900.000 inhabitants in 1948 to over 1.8 million in 1977[50] (Mihăilescu, 2003). In response to this trend, new plans of systematisation started in the 1950s were meant to implement a radical social and spatial transformations sought by the communist regime. The plans included large works along major transport arteries, completely new neighbourhoods with increased densities, but also the transformation of the two streams to ensure water supply, flood protection and recreation. The new approach was characterised by continuity, in the case of Colentina, and disruption, in the case of Dâmbovița.

Interrupted by WWII, the project of the lakes on River Colentina was resumed during Communism with the completion of Lake Chitila (1980), Lake Străulești (1971), Lake Grivița (1972), Lake Plumbuita (1978), Lake Fundeni (1979), Lake Dobroești, Lake Pantelimon I (1972), Lake Pantelimon II (1970), Lake Cernica (1960), and a second derivation channel from River Ilfov. With the exception of the navigable link, all the technical ambitions of the initial project were realised during this period. This may be considered one of the most successful infrastructure projects carried out by the regime, because it recognised the social and spatial benefit of a project started in the previous regime and completed it. Photographs from that period depict the lakes as the main recreational destinations of the city: vast green areas and lakes with beaches were full of Bucharestians seeking to 'recharge their batteries' in the weekend after a week of hard work (Figure 3.10).

50 This number is comparable to the current population of Bucharest: 1.859 mil. in 2014 (UNdata)

FIGURE 3.10 Beaches on the lakes of Colentina during the years of Communism. Source: Tudora & Stan, 2015.

The canalization of River Dâmbovița between 1985-1988 was among the major infrastructural projects put forward by the communist regime (Stematiu & Teodorescu, 2012). This last phase changed Dâmbovița's course within Bucharest into a technical device made of two superimposed water courses (Figure 3.11): a surface concrete canal with clear water released from Lake Morii and a culvert for draining wastewater collected from the sewage system to the treatment plant at Glina (Stematiu & Teodorescu, 2012). The main purpose of this intervention was the improvement of the flood protection system of Bucharest. Consequently, Dâmbovița lost its vegetated banks and became completely artificial (Figure 3.11).

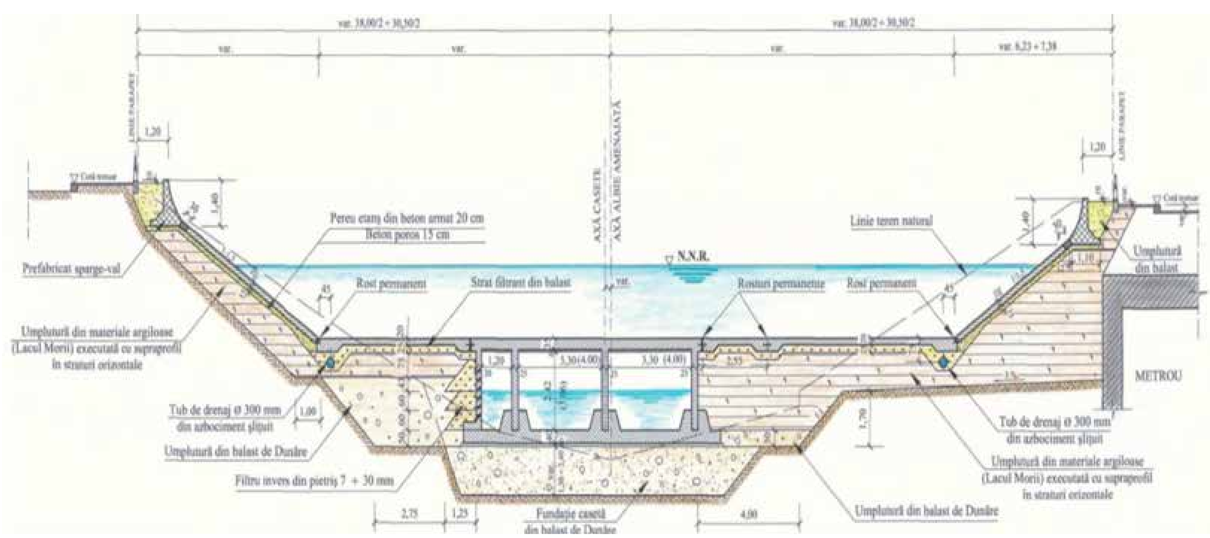


FIGURE 3.11 The new cross section of Dâmbovița. Source: Stematiu & Teodorescu, 2012.

The disruption was further amplified by what many consider to be the most destructive urban intervention in Bucharest. A country-wide program of new "civic centres" was initiated during Communism (Harhoiu, 1997), the largest of which, as could be expected, was built in Bucharest during the last years of Communism with the additional function of holding the nation's seat of power in the House of People (Figure 3.12). It is widely agreed that the construction of Bucharest's Civic Centre had an unprecedented disruptive effect on the urban fabric (Cavalcanti, 1997; Harhoiu, 1997; Ioan, 2007). Positioned across Dâmbovița, the new urban axis disregarded the topography of the valley—except for the Palace, the crown piece of the plan, being located on Arsenal Hill—and became a barrier as well as a space out of scale (Figure 3.13). If the project of the lakes can be characterised as historically continuous, the project of the Civic Centre had the total opposite effect on Dâmbovița: it created a radical spatial and temporal discontinuity.

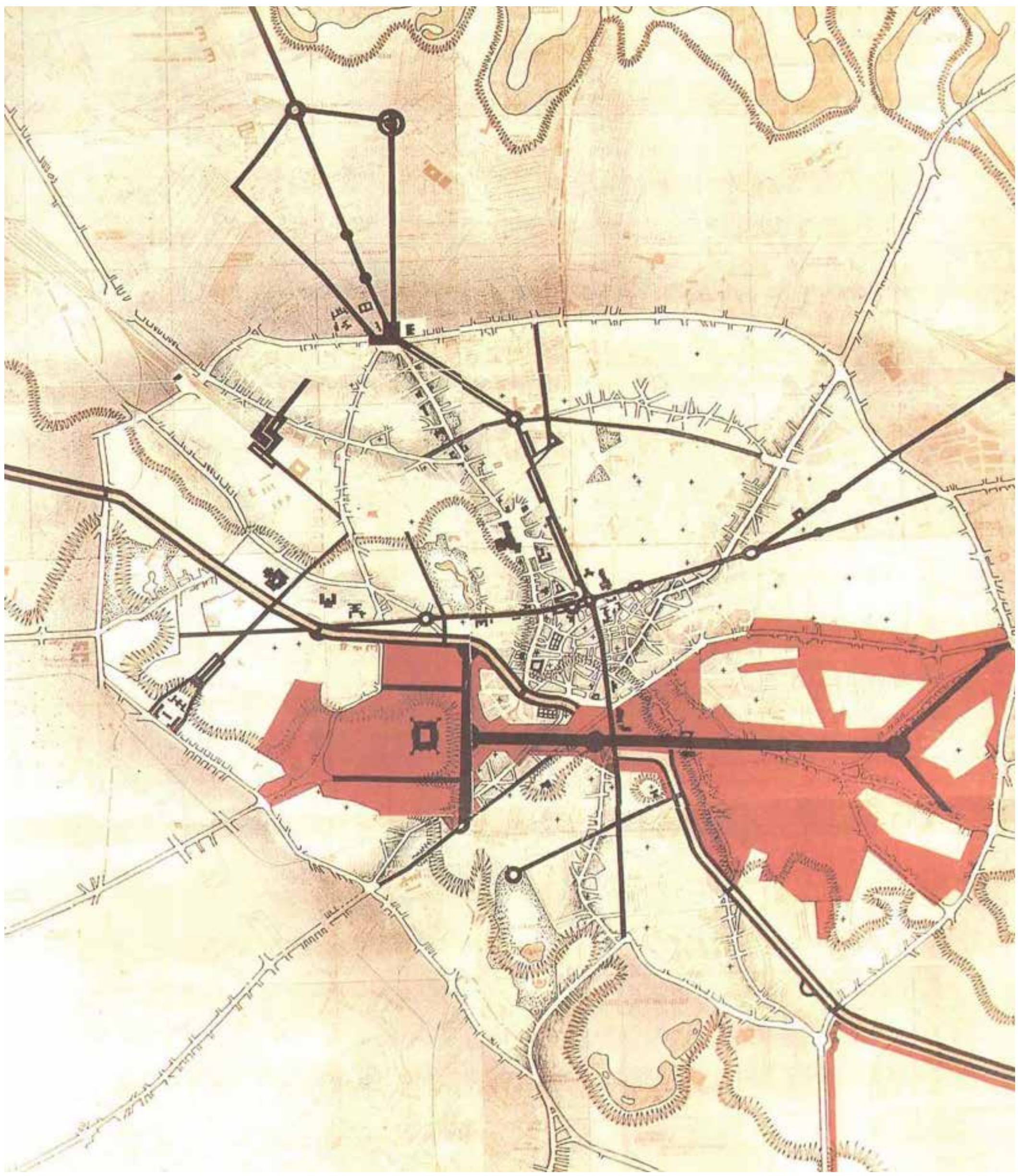


FIGURE 3.12 The plan of Bucharest's centre showing the extent of demolitions for the new Civic Centre. Source: Harhoiu, 1997.

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FIGURE 3.13 Photo of the monumental axis of the new Civic Centre.
Source: fotografieaeriana.eu.

Another project continued during Communism deserves special attention: the project for a navigable link to the Danube. Even though navigation on Dâmbovița and Colentina could not be realised inside the city, the project for navigation was not abandoned. In the period 1980-1990, the complex transformation of Argeș and Dâmbovița downstream from Bucharest, including two ports—one on each river—were planned (Figure 3.14). Although a large part of the plan was executed, works were abandoned in 1990 (Avădanei, 2012).

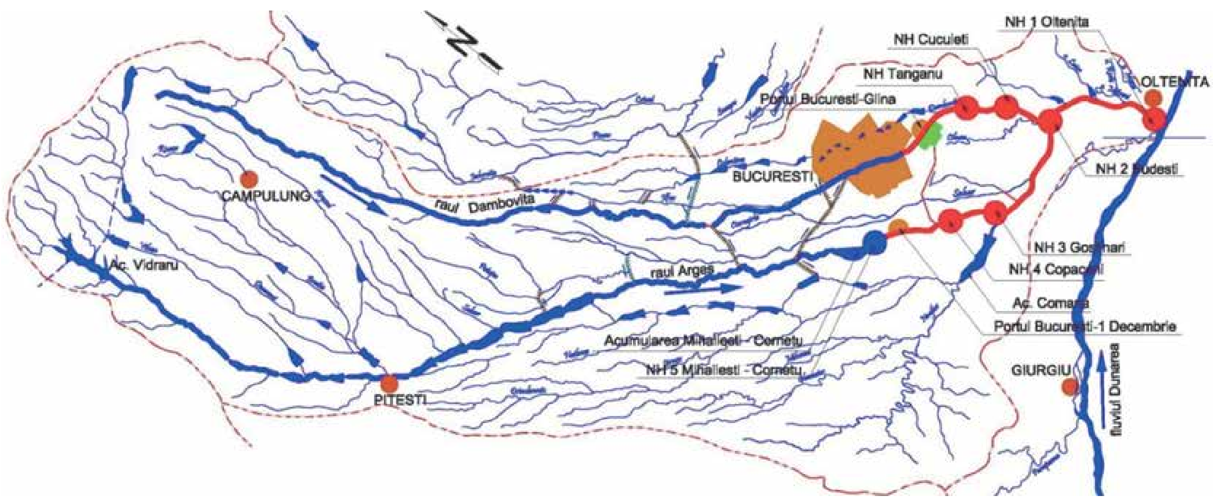

FIGURE 3.14 The transformation of the lower course of rivers Argeș and Dâmbovița. Source: Avădanei, 2012.

According to Georgescu et al. (1966), the canalisation of Dâmbovița at the end of the 19th century and the transformation of River Colentina into a pearl of lakes are arguably among the greatest public works ever done in Bucharest with such a generative role in urban development. Lascu (2011), in a similar way, considers Dâmbovița's first phase of rectification and canalisation, along with the boulevards of Bucharest built in the same period, among the most important urban transformations undertaken in the Romanian capital. During Communism, the greatness of these projects was acknowledged and amplified, although very differently: Colentina was completed and it became a continuous green-blue corridor, whereas Dâmbovița was further changed into a functional concrete conduit draining water through the city.

§ 3.3.4 Human-induced changes in the river system

As a consequence of the transformations presented above, the hydrological regime of the river system in the Bucharest area has been influenced to such an extent that it cannot be considered natural anymore (Cocoș, 2006). Human pressures on the river system are mainly represented by engineering works—dams, reservoirs, channelization and flow regulation works, inter-basin transfers, and water intakes—, water abstraction, and wastewater discharge meant to fulfil a number of aquatic ecosystem services, such as water supply, flood defence, sewage collection and recreation (Zaharia et al., 2016). As a result of this variety of human interventions, Argeș River Basin has a complex water management scheme (Figure 3.15).

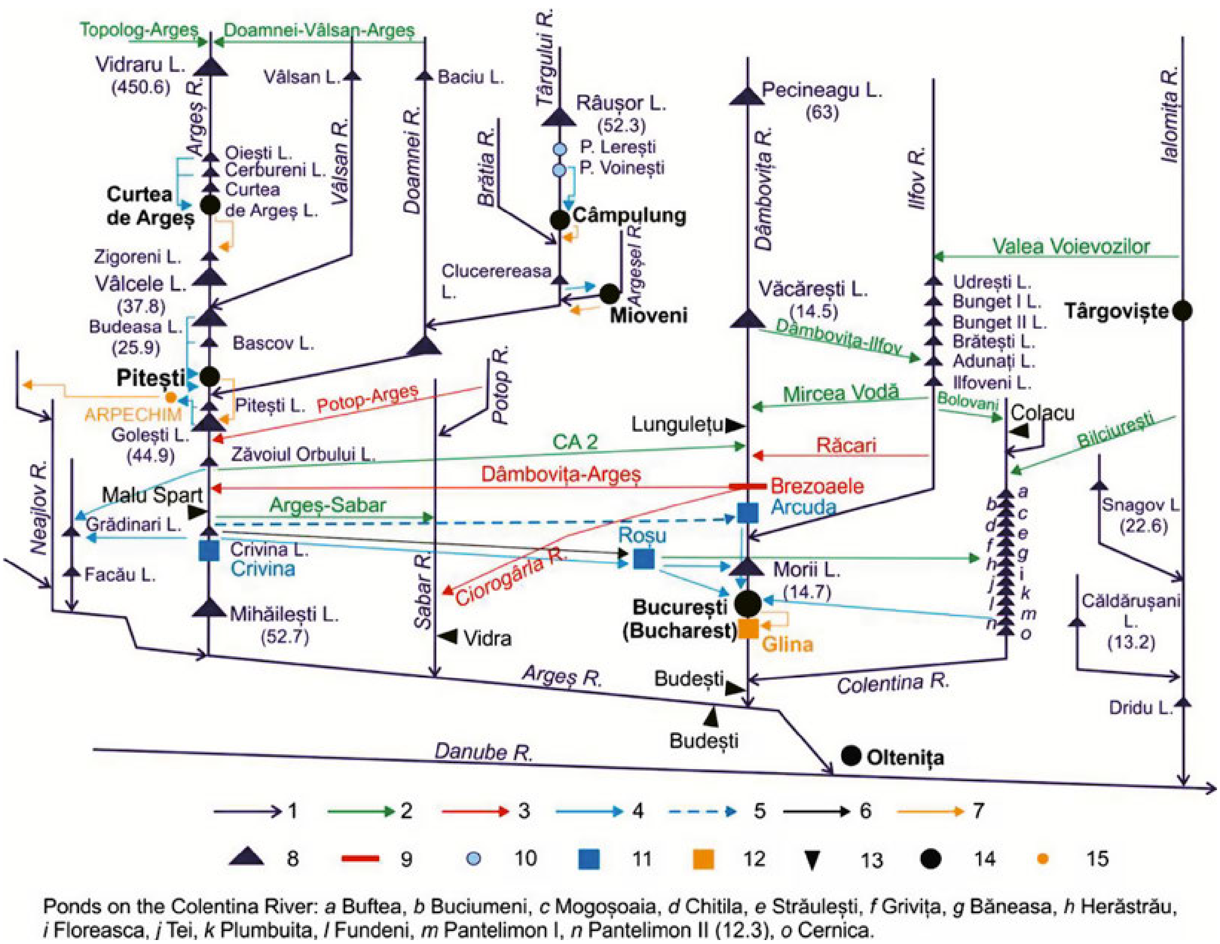

FIGURE 3.15 The management scheme of Argeș River Basin. Source: Zaharia et al., 2016.

Seen at a larger scale, the flood protection system of Bucharest has three lines of defence (Figure 3.16). The first line of defence consists of accumulation lake Văcărești and a polder upstream on Dâmbovița, followed, in the second line, by a hydrotechnical node at Brezoaiele 30 km downstream from the Văcărești accumulation, and the derivation canal Dâmbovița-Argeș. The third line of defence is located on River Dâmbovița and on River Colentina. On Dâmbovița, it is represented by the natural polder Dragomirești, polder Giulești, and the dike enclosing Lake Morii. On Colentina, the water level is regulated upstream from Lake Buftea and by the lakes of Colentina themselves.

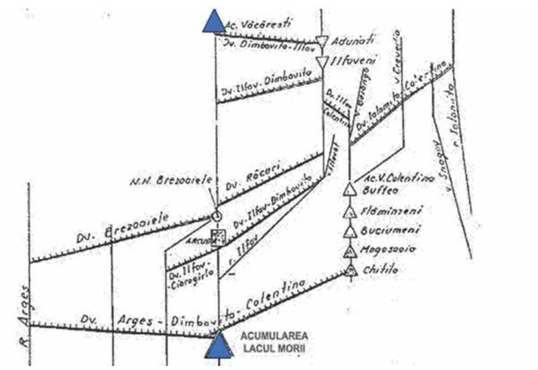

FIGURE 3.16 Synoptic scheme of the flood protection system of Bucharest. Source: Stematiu & Teodorescu, 2012.

Under the complex transformations of the river system in the Bucharest region, according to Cocoș (2006), Dâmbovița and Colentina exhibit different mean monthly and seasonal flow distributions. River Dâmbovița has an increased flow during periods with low discharge and a decreased flow during times of high discharge, while river Colentina, receives water from neighbouring systems and thus its mean monthly flow is high during periods of high flow, and low during dryer periods (Figure 3.17). In terms of maximum flow, the highest values were recorded in 1979 for Dâmbovița (546 m^3/s) and in 1978 for Colentina (57,9 m^3/s). Based on values of monthly maximum flows recorder between 1970-1997, it is estimated that Dâmbovița could reach a maximum flow of 1260 m^3/s every 1000 years, 750 m^3/s every 100 years, and 290 m^3/s every 10 years. During periods of minimum flow, water is gained from the ground. Recorded values—for the altered hydrological regime—are between 1,23 m^3/s in January and 4,94 m^3/s in May for Dâmbovița, and between 0,0006 m^3/s in September and 0,036 m^3/s in June for Colentina (Cocoș, 2006). Minimum flow is influenced by the transformations and use of the streams in two ways: regularisation enabled by the existence of accumulation lakes has an increasing effect; water abstraction for irrigation as well as domestic and industrial use have a decreasing effect.

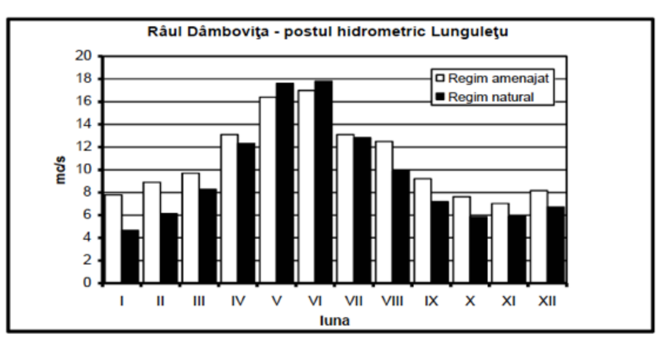

FIGURE 3.17 Variation of mean monthly flow on Dâmbovița in natural (black) and regulated (white) regime. Source: Cocoș, 2006.

In a review of water quality of the rivers in the Bucharest region based on ecological state as defined by the Water Framework Directive (WFD),[51] Zaharia et al. (2016) position the global water quality of Dâmbovița in class III-V (moderate to bad quality) and Colentina's in class IV (poor quality). The main source of water pollution in the region is Bucharest. The largest amount of storm water and waste water are released through the culverted drain of Dâmbovița downstream of Bucharest at the current wastewater treatment plant Glina, which at the moment can only partially purify the city's output. On Colentina, measurements show the presence of heavy metals and some pathogenic germs, i.e. contamination with human and animal faeces, mainly from upstream peripheral locations or small settlements disconnected from the sewage network (Stănescu, 2011).

§ 3.4 Discussion

Looking back at history, the social-ecological relationship between the city and its two rivers, Dâmbovița and Colentina, went through a series of radical transformations. As shown in this chapter, both rivers were seen, in their natural state, as obstacles to urban development and, in their eventual engineered form, as major functional infrastructures aiding the modernisation of the city.

Against the backdrop of the accelerated population growth and urban expansion started in the middle of the 19th century, taming the rivers was indeed an urgency: floods had to be stopped, disease had to be driven out, waste water had to be drained through the city in efficient conduits as fast as possible and with as little friction as possible. Today, however, there is no apparent urgency, as it was for the early Bucharestians facing those threats. Seemingly, the 130-year transformation of the hydraulic system in the lower part of River Argeș catchment has been managing water very efficiently. Bucharest is seemingly in control of its rivers. But is it really? Or should it be? Moreover, is it 'in control' that it should be?

These questions are not meant to disregard the feats of engineering accomplished by some of the most talented Romanian engineers of the 19th and 20th century, but to draw attention to the fact that any engineering work that, regardless of its brilliance, poses resistance to natural processes, eventually becomes obsolete. As shown in Chapter 2, river corridors in their natural state are dynamic systems in which land and water constantly interact. This interaction, visible in river morphodynamics, has both ecological and social implications. Fluvial geomorphologic processes—chiefly sedimentation and erosion—create beneficial conditions for biodiversity, but also have the power to shape landscapes which are safe and meaningful for people. For instance, the hills on the right bank of Dâmbovița, depicted over history as the most "picturesque" part of the city's landscape, are the result of such dynamics. In a similar way, the riparian landscape is negotiated between natural and social dynamics. The green corridor of River Colentina was transformed from a dangerous, pestilential periphery to the main recreational green space of the city.

51 The Water Framework Directive (WFD) defines five water quality classes, taking into consideration biological, physicochemical, hydromorphologic and microbiological factors (Zaharia et al., 2016): class I—very good quality; class II—good quality; class III—moderate quality; class IV—poor quality; class V—bad quality.

Today, global environmental issues are different than the ones from just a century ago, when river taming operations were at their highest all over the world. Given the exacerbated effects of climate change, increased interconnectedness on multiple scales, and the growing number of urbanites bearing the environmental weight of their coexistence, addressing the issue of water must go beyond mere reactions to disruptions, shocks, disasters. A proactive approach is more than predicting urban or natural dynamics, such as population growth and floods underlying engineering approaches. It implies the acceptance of uncertainty and building resilience to absorb those dynamics, a characteristic inherent in the social-ecological definition of URCs as presented in Chapter 2. Overall, the planning of the lower catchment of River Argeș before 1989 had been mainly focused on taming and exploiting the river system. With the exception of the 1930s project for the lakes of Colentina, the history hardly shows any clear pathways towards a more sustainable social-ecological relationship between the two rivers and Bucharest.

The concept of the *river corridor* is only implicit in the history presented here. The river and its valley were seen form a water management or urban planning perspective, with little regard for their ecological dimension. The paradigm of the city as a complex adaptive system, in which the social system of the urbs and the ecological system are understood together and in a dynamic equilibrium, stands in contrast to the way the two streams of Bucharest and the systems they are part of were designed. As explored in this chapter and further clarified in Chapter 4, the example of Bucharest is an excellent illustration of the latent, invisible, and chronic nature of the problematique around over-engineered urban rivers. Understanding the synergies and conflicts between the river as a rational infrastructure meant to service the city—like Dâmbovița and Colentina—and the river as an ecological system will be the analytical and design assignment for the rest of this thesis.

4 The State of Knowledge on the Urban River Corridors of Bucharest

§ 4.1 Introduction

The focus of this chapter is on the current state[52] of Bucharest's river corridors, in addition to the history described in Chapter 3 and in the context of the uncharted period of post-communist transition. Chapter 4 starts by looking at the particularities of post-communist transition in Central and Eastern European (CEE) cities as described in literature (Section 4.2) in order to contextualise and describe the most recent transformations and the current state of URCs Dâmbovița and Colentina. Given the scarcity of literature on the subject matter, the approach in this chapter is not historical, but based on the interviews of 22 experts dealing with the current issues of the two urban river corridors. After the description of the methods of data collection and analysis in Section 4.3, this chapter reports on problems and potentials of the two rivers in relation to the spatial development of Bucharest identified by the experts (Section 4.4). The chapter concludes with a discussion of similarities and differences between two rivers and with an assignment for the assessment and design presented in Part 2 and Part 3 of the thesis.

SUB-QUESTION AND OBJECTIVES:		
Sub-question 4:	What is the current state of knowledge on Bucharest's URCs?	
Objective 4.1:	Summarise the spatial effects of post-socialist transformations on URCs in Central and Eastern Europe.	Section 4.2
Objective 4.2:	Identify the current problems and potentials of Bucharest's URCs related to urban development.	Section 4.4

§ 4.2 The urban river corridors of Bucharest under post-communist transition

In addition to facing the global challenges of large cities, Bucharest is a representative case for Central and Eastern European (CEE) post-socialist cities which have undergone extensive institutional, social, and economic transformations for nearly three decades since the Revolution of 1989. Subsequent to the historical narrative presented in Chapter 3, this last episode of Bucharest's urban history is still

52 The current state is considered between the time of data collection (2016) and the time of writing the thesis (2018).

being revealed in an ongoing process known as 'post-communist transition'.[53] In a wider geographic context, post-communist transition exhibits urban dynamics specific to cities in former Communist countries of CEE. In brief, post-communist transition in CEE countries is considered a period of "paradigm shifts and revolutionary changes", "described by the swing of the pendulum from the far left to the far right", in which "the laissez-faire model of social development was quickly embraced as an antidote to the totalitarian past" (Stanilov, 2007, pp. 5–7). It is characterised by extensive privatisation of public property,[54] commercialisation, deindustrialisation, and by a dramatic shift in lifestyle brought by capitalism, democratisation and 'Europeanisation' (Munteanu & Servillo, 2014).

Under these dynamics, managing spatial development has proven to be a complex and challenging task for local administrations, which were reformed during the early years of transition. At that time, spatial planning had a diminished importance due to more urgent political and economic matters (Sýkora & Bouzarovski, 2012)[55] and because of the anti-planning attitude of the population fuelled by a general belief that planning is an instrument of Communism (Munteanu & Servillo, 2014). One of the consequences of the dismissal of spatial planning was that there is little knowledge on the relationship between post-socialist transition and urban form[56] (Stanilov, 2007). The post-socialist city has specific spatial characteristics which are different from its capitalist counterpart. These characteristics are partly inherited from the socialist period—less urbanisation, less diversity, and a distinct spatial structure (Szelenyi, 1996, cited in Hirt, 2013)—, partly developed during transition—spatial fragmentation due to the loss of state ownership of urban land, the dominance of market forces, and the lack of central planning (Hirt, 2013). Overall, the spatial transformations of CEE cities seem to have a direction opposite of sustainable development (Stanilov, 2007) and, after almost three decades of transition, the need for a long-term vision is acknowledged not just by citizens, but also by businesses and local administrations.

In Romania, post-communist transition is manifested in socio-spatial changes such as deindustrialisation, urban shrinkage and deepening social disparities, along with a process of massive and chaotic suburbanisation (Dumitrache, Zamfir, Nae, Simion, & Stoica, 2016), visible in 'ad-hoc' urban landscape changes and infrastructure 'catch-up' (Nae & Turnock, 2011). According to Dumitrache et al. (2016), this form of suburbanisation, considered the broadest phenomenon of post-socialist urban change in Romania, was influenced by "legislative ambiguity and institutional instability" (Dumitrache et al., 2016, p. 48), on one hand, and by increased foreign direct investment followed by a strengthened banking-financial system allowing for mortgage loans and a growing real estate market, on the other.

The spatial impact of this complex phenomenon of urban transformation is the most visible in the capital of Romania, which concentrates today 9% of the country's population and about one quarter of the national GDP. From a city which had very low to no peripheral growth during Communism, Bucharest has sprawled rapidly outside its administrative boundaries after 1989 (Dumitrache et

53 Although some authors refer to 'post-socialism' when talking about the phenomenon across CEE, the term 'post-communism' is more accurate in the case of Romania.

54 Privatisation was carried out either by means of restitution of properties nationalised during Communism or by the transfer of state property to the private sector, as in the case of most former industrial areas which were transformed into mixed-use developments.

55 According to Sýkora and Bouzarovski (2012), the complex process of post-communist transition can be divided in three consecutive phases representing institutional, social, and urban transformations. In this sequence, according to them, transition can reach the phase of urban transformation only after institutional reforms and social transformations have been achieved.

56 This fact is also confirmed by Augustin Ioan (2006) in the case of Romania.

al., 2016). Kucsicsa and Grigorescu (2018) demonstrate that sprawl, especially after 2002, was influenced mainly by transportation networks and the proximity of built-up areas, and less by the presence of natural features, an observation which seems to be consistent with the real-estate boom of the early 2000s and with the Western, car-based and materialist lifestyle valued by the Bucharestians at that time.

In an overview of the recent spatial changes in Bucharest, Angelica Stan (2015) concludes that the years of transition, considered to be relatively homogeneous in a wider historical context (Pascariu, 2012), can be subdivided into three distinct periods of morphological transformation. In the first period (1990-2000), characterised by a mix of "reformist enthusiasm" and "communist inertia" (Munteanu & Servillo, 2014), spatial development in Bucharest is dominated by a large program of privatisation of industries and agricultural land. The environmental impact of the new direction of urbanisation is acknowledged and the first studies—including the Zonal Urban Plans (ZUPs) for the two river corridors—are made in preparation of the new GUP to be released in 1999.

Having reached a relatively stable economic and political state after the first decade of transition and facing the prospect of EU accession in 2007, the country had experienced an economic boom during the second period (2001-2007). Unfortunately, the lack of firm urban regulations led to a process of piecemeal urban transformations, an "urban 'hysteria' evident in the construction of shopping malls, business centres and luxury apartments" (Nae & Turnock, 2011, p. 217), in strong contrast with an acute social housing shortage. This phenomenon is the most visible in the expansion of the city to the north over the Colentina lakes. Even though the new General Urban Plan (GUP) (Figure 4.1) was approved in 1999 and legally backed by Law 350/2001 (Parlamentul României, 2001), it could be easily overruled by ZUPs, derogative instruments allowing for extensive alterations of the GUP by market forces.

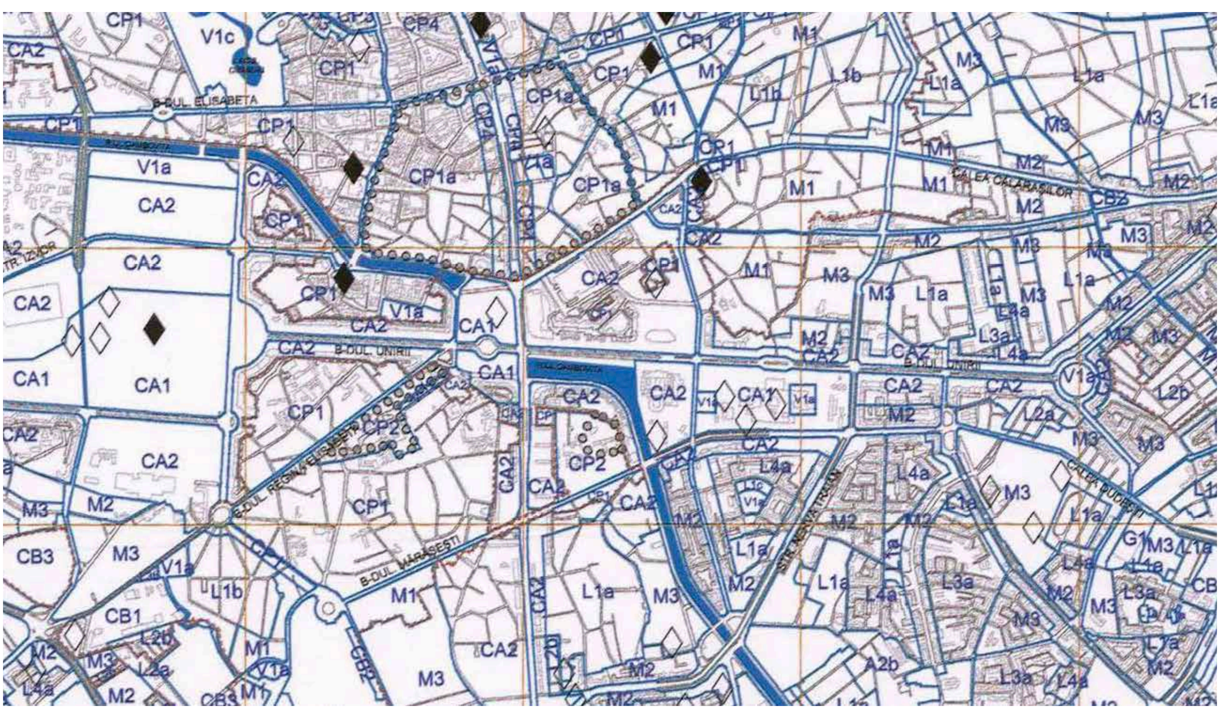

FIGURE 4.1 Detail from the General Urban Plan (GUP) in the centre of Bucharest. Dâmbovița does not have a separate territorial reference unit (TRU). Source: Municipality of Bucharest. Retreived from: http://www.pmb.ro/servicii/urbanism/pug/pug.php (Accessed: 28 January, 2018).

It is as late as the third period (2008-2014), strongly marked by the efforts to overcome the 2008 economic crisis, when the regulatory framework and spatial planning started to show signs of improvement. A change in Law 350 for Spatial Planning and Urbanism (Parlamentul României, 2001) led to considerable reduction of ZUP derogations and work on a new GUP started in 2011.[57] Furthermore, encouraged by the new EU development framework and by EU funding, planning has steered more in the direction of integrated and strategic approaches.[58] The main strategic document prepared during this period (2011-2012) is the 'Bucharest Strategic Concept 2035' (BSC2035, known as CSB2035 in Romanian).[59] Another important field of improvement, compared to the previous years of transition, was in environmental planning, including the adoption of the several EU directives, such as the Water Framework Directive (European Community, 2000), the Habitat Directive (EC, 1992) and the Birds Directive (EU, 2009).

All in all, the years of transition present a shift in spatial and temporal scales: from the gigantic urban projects of Ceaușescu to the piecemeal urban development of 'derogative-' or 'private urbanism'; from collective living to individual housing; from large to very few infrastructure projects being implemented very slowly. As a reaction to the phenomenon of 'private urbanism', the need for a new GUP in which "a derogative PUZ will have to be argued as being in the best interest of the city" (Nae & Turnock, 2011, p. 217) has become evident.

Thus far, environmental and ecological issues, in general, and the topic of urban rivers, in particular, are far from having received the desired attention within the discourse of post-communist transformations outlined above. The urban environment is described mainly in terms of urban systems. For instance, in the three main categories—urban management, urban patterns and urban impacts—used by Stanilov (2007, p.9) to summarise the positive and negative characteristics of post-socialist urban transformations in CEE cities, the environmental-ecological dimension is weakly represented by two negative characteristics under urban impacts: loss of open space and increased congestion, air, and noise pollution.

Indeed, as mentioned in the previous chapter, the last years have shown a growing concern, especially in the environmental sciences, hydrology and geomorphology, about the rivers of Bucharest. However, most studies are still rather descriptive than forward-looking. Also, even though some comprehensive urban studies had been made on the two river corridors by 1999-2000 (Figure 4.2), the derogatory urbanism of the subsequent years, characterised by real-estate speculation and lack of public interest, pushed those plans to the bottom of the planning agenda until they became outdated. As a result, today the two river corridors seem to be in an uncertain state of development, degrading, and with an unclear future. So how did the recent social-economic dynamics, as well as planning and governance practices influence the spatial development of the two rivers of Bucharest? And, in turn, what role (if any) did they play in the post-communist urban transformation of Bucharest? Understanding this reciprocal impact is key to future transformations of the two rivers. Masked by many uncertainties, and poorly recorded in literature, the actual state of knowledge on planning the two river corridors can only be understood by asking the experts dealing with the two river corridors.

57 After several extensions, the new GUP of Bucharest is still under development.

58 Similar transformations have taken place in other EU-member CEE countries. See, for instance, the account of institutional changes in Poland by Dąbrowski (2008).

59 Although the GUP of 1999 contained some strategic elements, BSC 2035 is the only city-wide strategic document created since 1989.

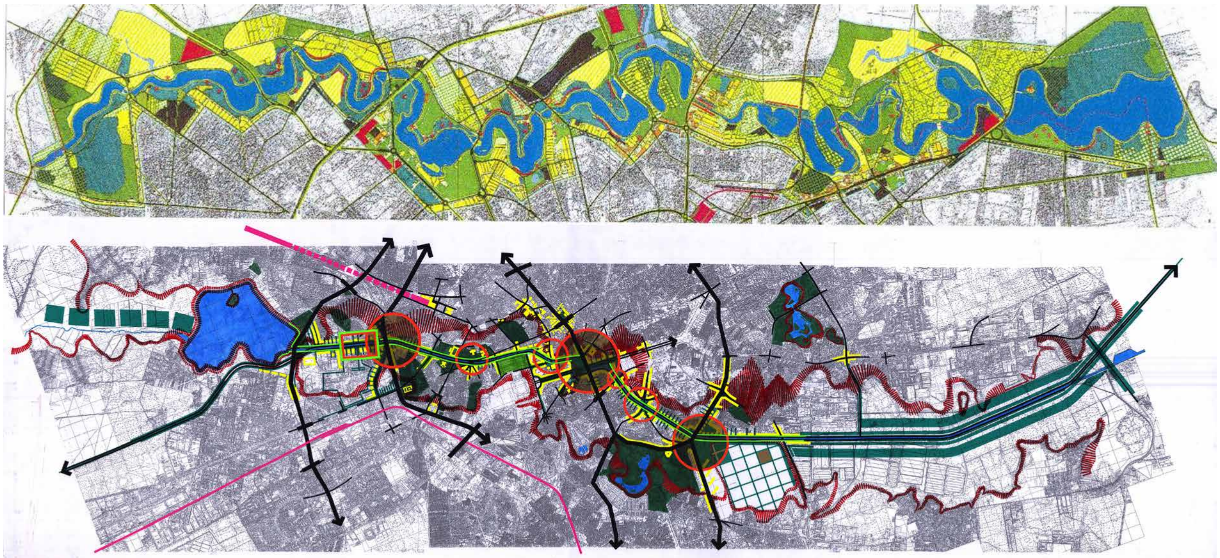

FIGURE 4.2 Two comprehensive studies carried out as ZUPs complementary to the GUP: (top) 'Dâmbovița structuring axis' ('Dâmbovița axă structurantă' in Romanian; Filipeanu et al., 2000) and (bottom) 'ZUP for the lake area on River Colentina' ('PUZ zona lacurilor râului Colentina' in Romanian; Fulicea, 1999).

§ 4.3 Methods

The methods adopted in this chapter are part of the multi-method and mixed methods approach presented in the overall research design of the thesis (see Section 1.6). In the multi-method framework, the analyses of the current state of Bucharest's URCs are based on two different data sources: (1) on primary data in the form of the questionnaires and the expert interviews presented in this chapter; and (2) on (secondary) geographic data presented in Chapter 6. The method of data collection and analysis is mixed as it combines both quantitative and qualitative elements. Figure 4.3 illustrates the data collection and analysis process, which is explained further in this section.

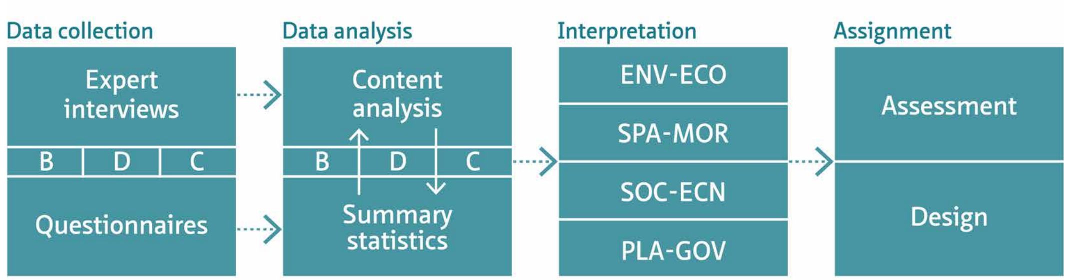

FIGURE 4.3 Diagram of the data collection and analysis process.

§ 4.3.1 Data collection

Given the lack of comprehensive studies on contemporary planning with the two rivers in Bucharest, the choice for primary data collection was necessary for an accurate and grounded overview of the subject matter. As the first step of the data collection process, a set of *22 semi-structured expert interviews* were conducted in April-May 2016 in Bucharest. To maximise the accuracy and elaborateness of the responses, the interviews were conducted in Romanian. The interview guide (Appendix A) was divided in two parts: a questionnaire comprising multiple open-ended questions (e.g. "What are the three most important problems of Bucharest in terms of urban development?") as well as closed-ended questions with 5-point attitudinal scales;[60] and a semi-structured part allowing for more flexibility in the responses. The questionnaire in the first part, administered during the interview, recorded the experts' opinions on the general problems and potentials of Bucharest, Dâmbovița, and Colentina, whereas the second addressed the four major angles from which the data was later analysed: spatial-morphological, social-economic, environmental-ecological, and planning-governance. The interviews were concurrently translated and transcribed, and coded in preparation to the qualitative data analysis (see Appendix C for an example of a transcribed and coded interview).

Sampling

For the qualitative data collection procedure, a combined *expert* and *snowball sampling* design (Bryman, 2016; Kumar, 2014) was used in order to gain a deep access to the network of professionals connected to the topic. First, expert sampling was used to determine the respondents for the semi-structured expert interviews. The expert status was ascribed by the researcher according to one or more of the following criteria: professional or research experience in the topic, variety of domains across the sample, and representativeness of both the private and public sector (Table 4.1). Second, as part of the interview schedule, snowball sampling was used, that is, the interviewees were asked to recommend other experts or people whom they consider to be knowledgeable and able to provide further insight on the topic (see Appendix B for a list of all interviewees and their expertise). From an initial set of invitations and with the additional recommendations received with snowball sampling, a total of 22 experts were interviewed.

TABLE 4.1 Disciplines and domains represented in the sample of experts.

DISCIPLINE	Count
Urban planning	7
Architecture	6
Urban design	4
Landscape architecture	3
Architectural history	1
Architectural journalism	1
Environmental sciences	1
Hydrology	1
Anthropology	1
Urban sociology	1

DOMAIN	Count
Academy	17
Administration	2
Planning and/or design practice	10
Civil society	2

60 The values of the Likert scale were: strongly disagree = 1; disagree = 2; neutral = 3; agree = 4; strongly agree = 5.

Quality criteria

The data collection instrument follows the principles of *credibility*, *transferability*, *dependability* and *confirmability* (Lincoln & Guba, 1985 and Trochim & Donnely, 2007 as cited in Bryman, 2016).[61] Credibility was achieved on three levels: (1) by confirming the correctness of the findings with the respondents; (2) by asking another researcher to code one of the interview transcripts to confirm the initial coding; and, as part of the overall methodology of the thesis, (3) by means of the multi-method approach (i.e. triangulation) in which the results of the qualitative data analysis are confronted with the results of the analyses performed in Chapter 6. Although transferability and dependability of the research instrument adopted in this chapter is difficult to achieve due to its qualitative nature (Kumar, 2014), this limitation was tackled with a thorough description and a detailed record of the techniques and procedures. Finally, confirmability, meant to ensure that the biases of the researcher were minimised during the process, was achieved by recording the process in a reflexive journal.

§ 4.3.2 Data analysis

The data obtained from the interviews in the form of filled-in questionnaires and transcripts was subjected to *summary statistics* and *qualitative content analysis* respectively (Table 4.2).

TABLE 4.2 Methods of analysis associated with the questionnaire and interview guide.

PART	NO.	DESCRIPTION	QUESTION TYPE	METHOD OF ANALYSIS
Questionnaire				
Part I	Q1-Q2	Problems and potentials of Bucharest	Open categorical question	Content analysis
	Q3	The two rivers in relation to Bucharest	Closed interval scale question	Summary statistics
Part II	Q4-Q5	Problems and potentials of Dâmbovița and Colentina	Open categorical question	Content analysis
	Q6	Functions of Dâmbovița and Colentina	Open categorical question	Summary statistics
Part III	Q7-Q10	Thematic questions about Dâmbovița and Colentina	Closed interval scale question	Summary statistics
Interview guide				
Part IV	Q11	Question in the SPA-MOR category	Open question	Content analysis
	Q12	Question in the SOC-ECN category	Open question	Content analysis
	Q13	Question in the ENV-ECO category	Open question	Content analysis
Part V	Q14-Q16	Questions in the PLA-GOV category	Open question	Content analysis
Part VI	Q17-Q19	Personal experience and references	Open question	-

The closed interval scale questions of the questionnaire (Q3, Q7-Q10) were quantified and summarised in diverging stacked 100% bar charts with a vertical baseline separating negative and neutral (1-3) from positive responses (4-5). The responses to the open categorical questions of the questionnaire addressing current functions of the rivers (Q6), as well as problems and potentials of

61 According to Bryman, these four principles are typical to qualitative social research and parallel internal validity, external validity, reliability and objectivity, respectively, in quantitative research.

Bucharest (Q1-Q2) and of the two rivers (Q4-Q5) were not summarised separately, but instead were coded and embedded in the content analysis, together with the open questions of the interview guide (Part IV and Part V). The responses to the questions of Part VI were not included in the analysis, as they were meant to record the personal experience of the interviewees with the two rivers (Q17) and to obtain further recommendations of other experts (Q18) and literature on the topic (Q19) from the interviewees.

The qualitative data analysis (QDA) of the interview transcripts was carried out in the computer-assisted qualitative data analysis software (CAQDAS) *Atlas.ti* (Friese, 2011, 2014) using a combined deductive-inductive approach (Bryman, 2016), meaning that some code categories were predefined while some have emerged from the data. The categories of the coding system represent (1) the themes built in the interview guide—functions (FCT), potentials (POT), problems (PRB), and projects (PRJ)—and (2) the themes that have appeared to be important during the data analysis—meaningful places (PLC) and proposals (PRP). As shown in Table 4.3, problems (PRB) and potentials (POT), for all three subjects (Bucharest, Dâmbovița and Colentina), represented the main categories in the coding process under which the four domain families (ENV-ECO, SPA-MOR, SOC-ECN and PLA-GOV) were also included as predefined sub-categories. These subcategories are used to group codes and to answer research questions in a deductive approach, such as "What are the environmental and ecological problems of River Colentina?". The categories PLC, PRP, and PRJ were not subdivided further and were summarised visually on a geographic support.

TABLE 4.3 The hierarchy of groups and code naming convention used in the content analysis.

<table>
<tr><th colspan="2">SUBJECT</th><th colspan="2">GROUP</th><th colspan="2">SUB-GROUP</th><th>CODE</th></tr>
<tr><td rowspan="12">B_
D_
C_</td><td rowspan="12">Bucharest
Dâmbovița
Colentina</td><td>FCT_</td><td>function</td><td colspan="2">-</td><td rowspan="12">See
code list</td></tr>
<tr><td>PLC_</td><td>place</td><td colspan="2">-</td></tr>
<tr><td rowspan="4">POT_</td><td rowspan="4">potential</td><td>ENV-ECO_</td><td>environmental / ecological</td></tr>
<tr><td>PLA-GOV_</td><td>planning- / governance-related</td></tr>
<tr><td>SOC-ECN_</td><td>social-economic</td></tr>
<tr><td>SPA-MOR_</td><td>spatial-morphological</td></tr>
<tr><td rowspan="4">PRB_</td><td rowspan="4">problem</td><td>ENV-ECO_</td><td>environmental / ecological</td></tr>
<tr><td>PLA-GOV_</td><td>planning- / governance-related</td></tr>
<tr><td>SOC-ECN_</td><td>social-economic</td></tr>
<tr><td>SPA-MOR_</td><td>spatial-morphological</td></tr>
<tr><td>PRJ_</td><td>project</td><td colspan="2">-</td></tr>
<tr><td>PRP_</td><td>proposal</td><td colspan="2">-</td></tr>
</table>

Within the framework of these categories, the Straussian coding approach (Strauss & Corbin, 1990 as cited in Bryman, 2016)—a three-step process consisting of open, axial and selective coding—was adopted.[62] A *problem-potential analysis* (PPA) approach targeting the codes in the PRB and POT categories, was proposed as a framework for further categorisation. The PPA is meant to give a detailed account of the problematique by looking at both positive and negative views on different or sometimes the same aspects of the two river corridors. In this case, the codes are further grouped

62 In qualitative data analysis, codes represent concepts assigned to segments of data. In the case of the expert interviews the segments of data are quotations selected in the interview transcripts.

under predominant themes, regardless of their membership in the four predefined domain families, and represent the core concepts derived from the QDA. This way the problem-potentials of the three subjects are seen in a wider, transdisciplinary way.

Even though elements of grounded theory were used in the QDA, the study may not qualify as such as it does not claim to formulate a theory. Instead, it is meant to establish a grounded knowledge base—that is, a set of core concepts around which the current state of the two river corridors are described—, required for the formulation of an assignment for further analysis and design.

§ 4.4 Results

The following sections report on the results from the analysis of the questionnaires and provide a synthesis of the problems and potentials of River Dâmbovița and River Colentina, as they emerged from the content analysis of the expert interviews. In line with the PPA, pairwise correspondences between problems and potentials were found and used to present the results of the content analysis organised under separate sections dedicated to the three subjects of analysis—Bucharest (covered briefly in Section 4.4.1), Dâmbovița (Section 4.4.2) and Colentina (Section 4.4.3). To illustrate the conclusions of the analysis and to bring the reader closer to the voice of the interviewees, the most representative quotations are included under the corresponding themes emerging from the data. This summary only includes code categories; a detailed list of codes used under these categories can be found in Appendix D.

§ 4.4.1 Bucharest

"the problem number zero is **the total inexistence of urban policies**." (Interviewee 19)

"In Romania, we went out of the frying pan into the fire. **If before we had 97% and so state property, now it's the other way around.**" (Interviewee 6)

"**the capital**, which is the representative, political, administrative city […] is in conflict with, or it **dominates the discourse of development at the expense of the human scale city**" (Interviewee 16)

"it's strange to play the card of a radial-concentric city when it has two large water secants. […] **Why radial-concentric?!** It seems like a cacophony" (Interviewee 6)

"**the ecological side is perceived here from a 'hipster' perspective [i.e. superficially], in the sense that we protect for the sake of protection and it isn't a value that brings income**. This is a major mistake. In a global world, in which this is clearly a trend, Romania, instead of looking over the fence and regarding its traditional culture as a handicap, has now the opportunity to settle this trend in a legitimate way and to say: 'I have a contribution to make.'" (Interviewee 16)

Although less space was allocated to the subject of Bucharest in the interview schedule (1 part out of 6, see Appendix A), Bucharest received the same amount of attention as the two rivers, with 366 (35%) out of the total number of quotations processed in the content analysis. This is due to the fact that, in addition to general problems of Bucharest related to urban development, most issues specific to the two rivers could be traced back to the larger narrative of post-communist transition including the whole city. More than with the two rivers, the experts had the tendency to highlight problems (73% of the quotations) rather than potentials. The most noted problems were the lack of strategic planning, dysfunctional administration, poor interaction with surrounding territories, weak legislation

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for urban development, lack of a competent planning authority, and the extensive privatisation of the city. When prompted for potentials, the interviewees mentioned human capital, spatial diversity, favourable geostrategic position in the Balkan region, economic attractiveness, and the two rivers as potential green corridors penetrating the city. One interviewee even mentioned the conflict between the high-level structuring potential of the rivers and the radial-concentric model adopted by the city.

§ 4.4.2 Dâmbovița

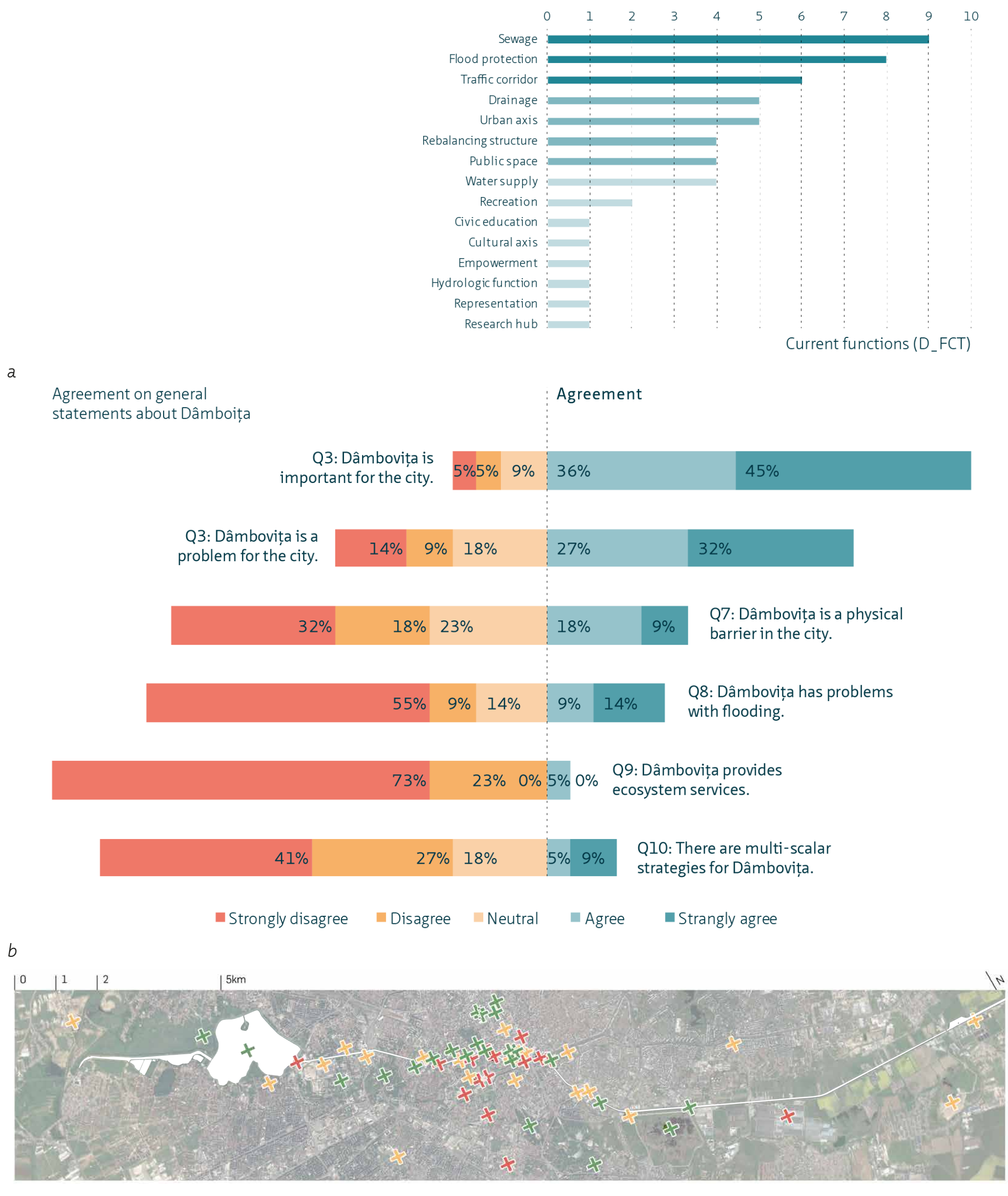

FIGURE 4.4 (a) The current functions of Dâmbovița (D_FCT) according to the experts. (b) Agreement on general statements about River Dâmbovița. (c) Map of meaningful places on River Dâmbovița mentioned by the experts (green = positive remark; red = negative remark; yellow = mention).

According to the experts, River Dâmbovița functions as an important technical infrastructure for sewage, flood protection, traffic and rainwater drainage (Figure 4.4a). Also, as it crosses the centre, it is considered to be important, but mostly for its potential as a central location, as it does not deliver environmental and ecological functions anymore (Figure 4.4b). As shown in Figure 4.4c, the meaningful places mentioned by the experts are clustered around the central part of Dâmbovița (see example in Figure 4.6).

Overview of problems and potentials

With 69% of the quotations focusing on problems (Figure 4.5, left), Dâmbovița was presented as highly problematic during the interviews. In the analysis correspondences were sought between the core concepts related to problems—'canalisation', 'physical barrier', 'a non-place', 'decay', 'out of scale', 'lack of integrated planning', and 'crampedness'—and the ones describing potentials—'axis of urban development', 'latent spatial capacity', 'a space of identity', 'the invisible valley', and 'economic attractor'. In order to equalise the number of categories for the purposes of the problem-potential analysis, the categories 'decay' and 'out of scale' were included under the category 'lack of integrated planning' and the category 'economic attractor' was embedded in 'axis of urban development'.

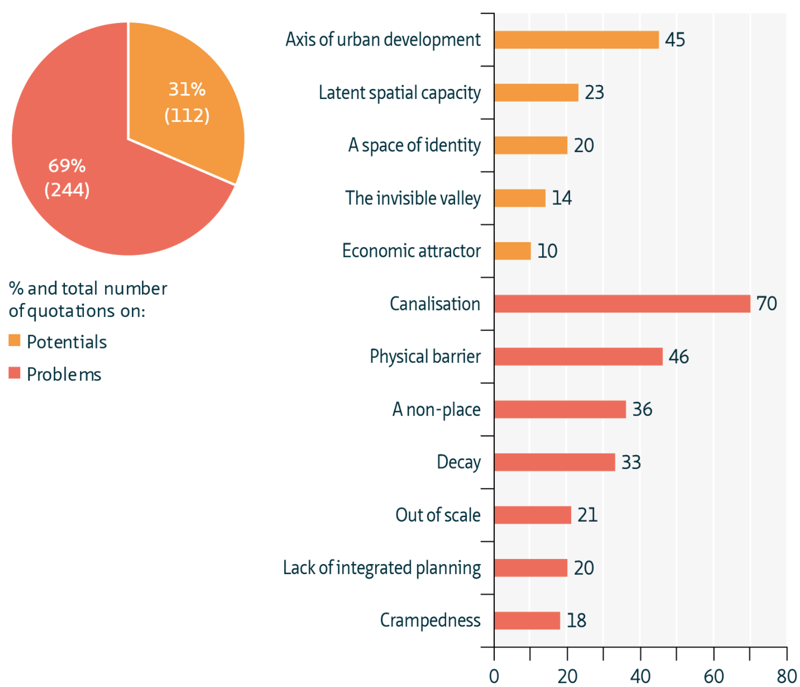

FIGURE 4.5 Summary of the content analysis of problems (red) and potentials (orange) of River Dâmbovița.

FIGURE 4.6 Iconic perspective along the central segment of River Dâmbovița. Photo credit: Alexandru Mexi.

Canalisation / the invisible valley

"There's a major problem that contains all the rest: **it is a canal**. [...] It is not a river. All the rest derives from this." (Interviewee 19)

"[Dâmbovița was designed as a] secant cutting the city, without understanding **what is the river basin, the river plain, what is the relief** and all these elements which often intersect paradoxically with the urban fabric. [...] the valley is not that strong, but it exists, it can be felt." (Interviewee 7)

"Water [...] is **[sealed off] in a concrete pipe**. And this is a problem, because there are many rivers that cannot flow into Dâmbovița, but around it, like Bucureștioara. [...] From a hydrological point of view, Dâmbovița is a disaster. Dâmbovița does not offer anything." (Interviewee 9)

"[W]e can try to **re-naturalize** it, which is a possible practice—Seoul is an example—, but which, in case of Dâmbovița, can hardly be done, because the main canal is underground." (Interviewee 15)

"Every time when I come from the Timpuri Noi metro station, I come on the sidewalk next to Dâmbovița. It is cool, especially in Spring. In Spring, you see ducks with ducklings! **It's alive**. I am sure that they come from Văcărești." (Interviewee 17)

"[In history,] foreign travelers used to climb some hill and see a sea of greenery with the golden cupolas of the churches and maybe the upper level of a nobleman's palace. How is this now?" (Interviewee 2)

"**there is a valley** of Dâmbovița and, you want it or not, the roads go naturally towards it. I realized that there is a valley when I moved in the South [...] and I was coming to [...] the North by bike. I was going straight, and then a I speed up with the bike in the valley, then straight again and suddenly I had to climb a hill [...] on the bike the feeling is very strong. Every time you want to go from somewhere in the South to somewhere in the North, you feel this difference." (Interviewee 17)

FIGURE 4.7 Canalised (left) and cramped (right) River Dâmbovița. Source: mariciu.ro (left); b365.ro (right).

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Canalisation is notably the most important problem mentioned by the experts during the interviews. According to them, the canalisation of Dâmbovița, especially in the last phase when its banks were concreted during Communism, destroyed the natural qualities of the river and transformed it into an artificial structure (Figure 4.7). Once the canal was built and floods had been tamed, geomorphology could be ignored. Still, as signalled by some of the experts, there is a flood risk due to the poor condition of the technical infrastructure, especially at dam Ciurel where the water flow from Lake Morii to Dâmbovița is controlled. A breach in the dam would expose the city to a flood that could reach 3 meters in some central areas. The lack of ecosystem services was pointed out as an important environmental consequence of canalisation.

Linked to the problem of canalisation is the potential of the invisible valley. Within this category, the interviewees mentioned geomorphology, especially with reference to the pronounced topography of the right valley edge, as well as the ecological and micro-climatic potentials of the open spaces along the river. Two types of spaces with ecological potential were identified in the response of the experts: the spaces which were reclaimed by nature due to abandonment or isolation; and the relatively continuous chain of parks and green spaces on the right valley edge which could constitute an ecological corridor. From an environmental perspective, one of the experts pointed out that, if designed and operated properly, Dâmbovița could be an important element for mitigating urban overheating. This could be one of the main ecosystem services that the river could provide to surrounding urban areas.

Physical barrier / a gathering space

"Dâmbovița is **clearly a barrier** and it requires improvements in connectivity. [...] from a barrier, an element that cuts, it can become an element that generates development around it." (Interviewee 16)

"There were more bridges in the past. True, they looked differently and the whole area was completely different, [...] but the fact that there's an **insufficient number of bridges** also contributes to the poor visibility, accessibility and presence [of the river]." (Interviewee 2)

"First of all, [...] the 'artificialization' of Dâmbovița and the limited number of bridges and secondly [...] the construction of the Boulevard Victory of Socialism (currently Boulevard of Union) cut the city in two. [...] Through re-naturalisation, with the recreation of a relationship, the construction of spaces connected to water, it would be possible to coagulate [the] two areas of the city." (Interviewee 7)

"Dâmbovița [...] **unites and separates** two areas that even in the collective mental are considered to be very different from each other. This is a very serious problem for many years from now on and maybe definitive for Bucharest." (Interviewee 13)

"Dâmbovița isn't a water stream anymore that itself represent a potential for the city, but **Dâmbovița as an axis**, water together with its surroundings, as an urban axis that represents a direction, an ordering axis, along which there are services, elements of interest for the city, which as a whole would play a role in the life of the city." (Interviewee 4)

"Dâmbovița could be a pedestrian path that is different, because it has elements of interests, it has a scale that makes the communication between banks possible, meaning that it is not an isolating element, but **an element that gathers**. So its principal advantage is that it crosses the heart of the city." (Interviewee 11)

The river is perceived as a physical barrier for various reasons. Above all, interviewees mentioned the fact that River Dâmbovița is a space of cars, as it is bordered on both sides by car traffic. The street called Splai (Romanian for "embankment"), crossing the whole city diametrically from ring road to ring road, is designed in such a way that riverside pedestrian spaces and sidewalks are dysfunctional, inaccessible, under-dimensioned, and of a poor material quality (Figure 4.7). The experts also mentioned reduced crossability, i.e. the fact that there is an insufficient number of crossings. In addition, inaccessibility was mentioned as a major problem of Dâmbovița, as it is disconnected from the pedestrian network of the city. The barrier caused by the car-based design of the river profile resulted in a disconnected riverside urban fabric and poor physical contact with water.

Yet, according to the majority of the experts, river Dâmbovița has the potential to become an axis of urban development, which could bring coherence to a fragmented urban space. This potential is mainly enabled by the river's central position in the city by its historical importance as a primary generating structure. Such an axis could become a connecting structure, both as a North-South balancing structure on the city scale and among local communities positioned along its trajectory.

Crampedness / high spatial capacity

"Dâmbovița was a victim, since its canalization until today, of urban interventions that used the river as a chance of relieving certain problems, but which never saw the river itself as an important potential. As a result, **Dâmbovița is squeezed by an underground collecting canal, by the metro line, by the traffic lanes**, etc." (Interviewee 12)

"***It feels cramped***, and this is a big problem, but I think that, at the same time, in many places where it feels cramped **it could be un-cramped, because there's unused building stock or abandoned land**. So, this could be a potential." (Interviewee 17)

Another problematic morphological aspect of the river is caused by its central position in the city. As it crosses the centre, Dâmbovița is surrounded by densely built-up areas. The crampedness caused by this condition was mentioned by several interviewees as one of the main limitations to spatial development along the river. The crampedness of central riverside urban areas, together with the inaccessibility of the banks and the fact that it is small, results in poor visibility of the river too.

Regarding its spatial configuration, the reduced dimensions of the river profile make it suitable for human-scale/pedestrian activities in potentially the largest public space of the city, while the diametrical span of its trajectory is considered to be highly suitable for a slow mobility route. Riverside open spaces, such as the public space in front of the National Library (Figure 4.8) or the Văcărești Natural Park, and abandoned structures, such as the platforms of the former docks or the dikes of Lake Văcărești, are considered to be important resources for the future spatial development of Dâmbovița.

FIGURE 4.8 River Dâmbovița during an event at the National Library, one of the few used public spaces. Photo credit: Cristian Vasile, IGU.ro.

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A 'non-place' / a space of identity

"The Old Centre roars, it is full. Go and walk on the riverside in the area of the Old Center, where Smârdan reaches Dâmbovița. **There's nothing!**" (Interviewee 17)

"I realized this absolutely evident thing: the fact that **it is a 'non-place'**, a perfect non-place." (Interviewee 19)

"Dâmbovița is **the largest unused and ignored public space of the city**." (Interviewee 17)

"**Dâmbovița is of maximum priority**, both [1] because of its trajectory crossing the center of the city, the need for intervention, and the potential of open spaces that can be converted or valorized on its trajectory; and [2] because it is still an important element of identity for the citizens, even though they don't exactly know how to relate to this river." (Interviewee 12)

Several experts consider Dâmbovița a 'non-place', because it is almost completely absent from the life of the city and from the mental map of its inhabitants. Hence, unattractiveness, lack of social activities, lack of public space and lack of resident population were mentioned as problems too. On the other hand, many experts considered that Dâmbovița is potentially one of the most important elements of identity of the city. Its identity is given especially by the historical value of the riverside urban development, the 'genius loci', as stated by one of the interviewees. As a particular feature, the sequentiality of different urban spaces along the periphery-centre-periphery transect provided by its trajectory, such as the educational clusters in the NW and SE sections and the old city in the central section, was considered to be very important. By capitalising on its identity and sequentiality, Dâmbovița could become an important touristic route and economic attractor, a place for innovation, education, green economies or commercial activities related to tourism and recreation.

Lack of integrated planning

"Dâmbovița was the object of certain studies in the last 25 years, but **in most cases the studies had the 'myopia' to build as if there were no preceding studies.**" (Interviewee 12)

"Besides this problem of continuing the complex transformation—this phrase is very important, because it refers not only to the pitching of the canal and regularization, but also to use and valorisation of surrounding areas—, **the problem of the area crossed by Dâmbovița and the surroundings is not taken into account at this moment at the scale of the city.**" (Interviewee 13)

In terms of planning and governance, the main problem identified by the interviewees is the lack of integrated (or "complex", as one of the experts called it) planning. The fragmented administration, the lack of collaboration with neighbouring municipalities, the lack of a general vision, and the lack of a multi-scalar strategy for the river lead to fragmented responsibility, discontinuity between plans, and lack of coordination in the city governance structure and, consequently, to difficulties in corridor-wide decision-making processes. The Integrated Urban Development Plan for the Central Area (IUDP) (Figure 4.9), Dâmbovița Smart River (Figure 4.10), and Bucharest Strategic Concept 2035 were the strategic plans mostly mentioned by the interviewees. Linked to the issue of planning is the decay visible in the abandonment of riverside built structures or stagnating development, the poor condition of the technical infrastructure, poor water quality of the surface water due to upstream exposure to pollutants, and lack of control over the development of the corridor in the peripheral areas at the ends. Moreover, issues of scales were noticed by some respondents: riverside urban areas out of scale, the small size of the canalised river, the embankments dimensioned for car traffic. Although no potentials were explicitly stated under these issues, strategic planning would integrate all the potentials form the other categories outlined above.

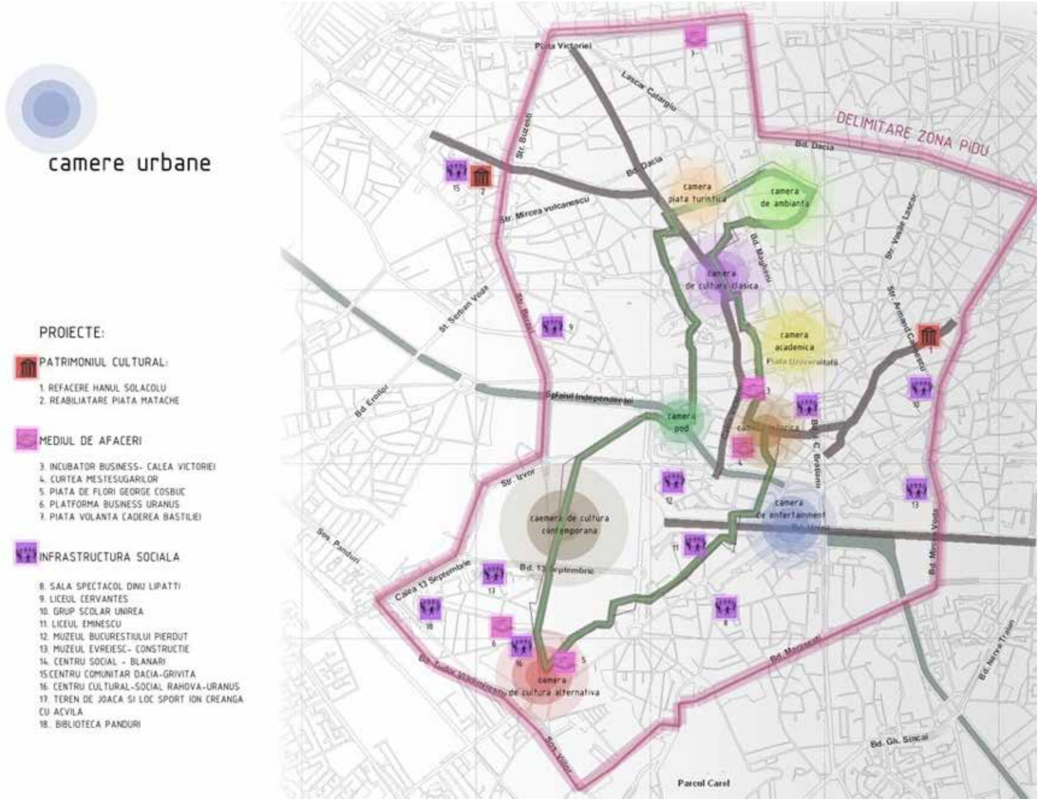
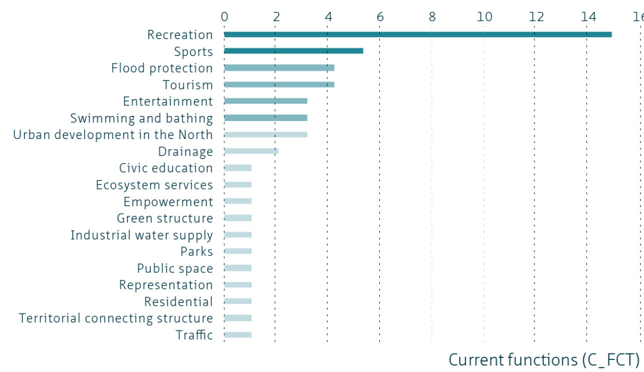


FIGURE 4.9 The Integrated Urban Development Plan for the Central Area proposes public space routes crossing the river. Besides two bridges and the transformation of a small central segment, the plan does not develop Dâmbovița longitudinally. Source: Synergetic Corporation et al. Retreived from http://www.centralbucuresti.ro (Accessed: 1 August 2018).

FIGURE 4.10 Dâmbovița Smart River, a bottom-up project on River Dâmbovița. Source: Dâmbovița Smart River. Retreived from https://expertforum.ro/smart-river/ (Accessed: 1 August 2018).

§ 4.4.3 Colentina

According to the experts, River Colentina functions as the most important recreational space of the city (Figure 4.11a), as it has a stronger ecological function than Dâmbovița (Figure 4.11b). However, almost all recreational activities are concentrated in the central section of the corridor (Figure 4.11c).



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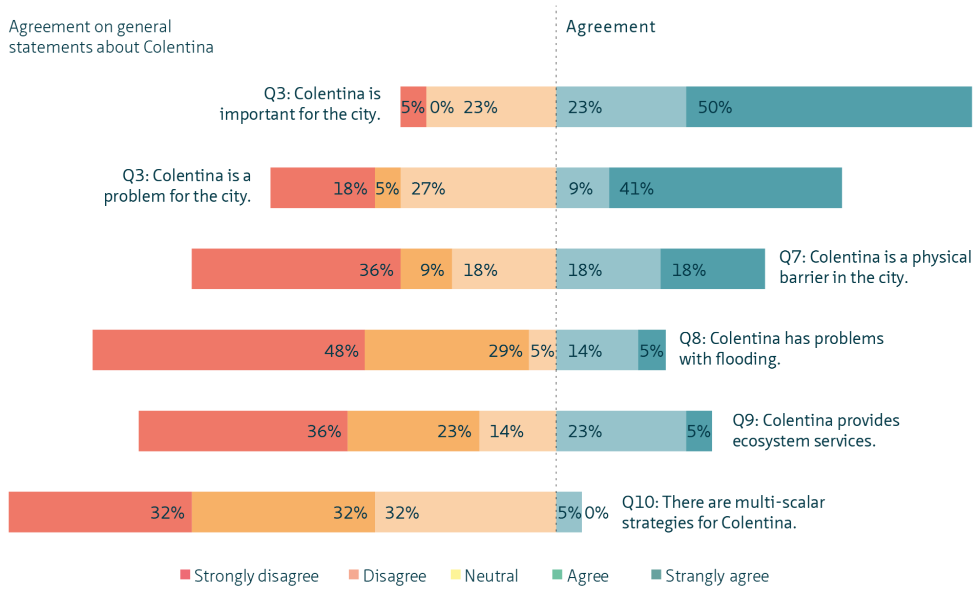

b

c

FIGURE 4.11 (a) The current functions of Colentina (C_FCT) according to the experts. (b) Agreement on general statements about River Colentina. (c) Map of meaningful places on River Colentina mentioned by the experts (green = positive remark; red = negative remark; yellow = mention).

Overview of problems and potentials

Problems and potentials of River Colentina were overall more balanced (Figure 4.12, left). When compared to Dâmbovița, the river in the north appears as slightly less a problem (50% compared to 59% in case of Dâmbovița), but also less important (73% compared to 81% in case of Dâmbovița) for the city (Figure 4.11b). Problem-potential correspondences were found between the following concepts: the problem of 'a fragmented territory' and the potential 'axis of urban development', 'artificial nature' and 'green blue corridor', 'social exclusion' and 'recreation'. As with Dâmbovița, planning issues, represented here by the concept of 'derogative planning', are presented separately.

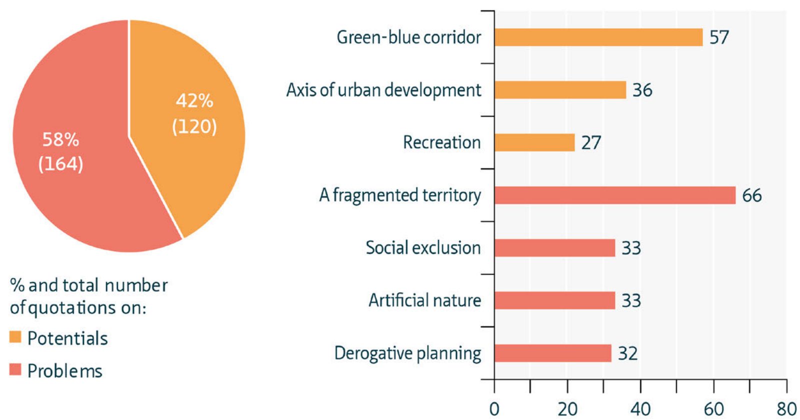

FIGURE 4.12 Summary of the content analysis of problems (red) and potentials (orange) of River Colentina.

A fragmented territory / axis of urban development

"There are more problems here which are interconnected and which are related to (go figure) the post-communist period. **The main problem is privatisation**. In what sense? The parks and green spaces around this chain of lakes became the object of real-estate speculation. As a result, a large part of it was taken out from the public domain [...] Just like with Dâmbovița—which is a canal, not a river—, everything derives from here." (Interviewee 19)

"[...] **the public beaches disappeared**. This is one of the largest losses, both from a social and economic point of view. The privatisation of the sports facilities was a disaster. People still go, but [...] everything that remained on Colentina is informal." (Interviewee 9)

"If you consider this a large public space, **it is more and more fragmented**, and there are less and less possibilities of having a coherent action over the whole structure." (Interviewee 5)

"It seems to me that Colentina is ignored in most part by the urban fabric. **Besides the central lakes—Herăstrău, Floreasca and that's it—, the rest is completely ignored.**" (Interviewee 9)

"[There] is the problem of **lack of longitudinal continuity**, and the very **uneven distribution of transversal penetrations**, uneven in terms of both position and quality." (Interviewee 18)

"There's this rare capacity for an element that is territorial and urban at the same time [...] I would call it **a multi-scalar structure**. This is a potential that Bucharest doesn't have anywhere else—with the exception of the ring of forts, but which does not have the same strength." (Interviewee 5)

"it is a structuring of **sports, recreation, leisure**, but also of agriculture and landscape. [...] Interrelation, collaboration, because this means, apropos of the social side, also collaboration between entities. We always tell students that birds don't see administrative limits." (Interviewee 8)

As illustrated in Figure 4.12, the fragmentation caused by the privatisation of the lake shores was the problem of Colentina most frequently mentioned by the experts. After '89, lakeside properties have been gradually occupied by private owners in a piecemeal fashion, as part of an uncontrolled urban

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development process and real estate speculation in the North of Bucharest, permitted by weak urban regulations and an unclear functional profile. This process resulted in spatial and social fragmentation, a discontinuous service area, poor accessibility to the lake shores, and poor contact with water (Figure 4.13).

Even though it is not as centrally located as Dâmbovița, Colentina could also become an axis of urban development, which would strengthen local urban centres in the north of the capital. This axis could act as a balancing structure between the city and neighbouring municipalities and between the different social groups of riverside communities. At the same time, the high spatial diversity of riverside neighbourhoods was considered to be an important feature to maintain for future development. The fact that it could be used as a multi-scalar structure was also identified by the experts as an important potential.

FIGURE 4.13 Inaccessible (foreground) and fragmented (background) lake shores on River Colentina. Photo credit: Claudiu Forgaci.

Artificial nature / green-blue corridor

"**I would be curious if on some mental maps of Bucharest there is Dâmbovița. In any case, Dâmbovița may be there, but Colentina, for sure not.** [...] [Interviewer: Maybe lake Herăstrău...] Yes, an enclave, a lake, that is there, it doesn't come from anywhere, it is filled by the fire department." (Interviewee 19)

"There you have the feeling that you are in a mall. [...] I think that the lakes in the North (Herăstrău and Floreasca) come with **an ideology of consumption**, of amusement, of fun. [...] If you look at Pantelimon, Fundeni, you will see there, without an urban development strategy and in a chaotic way, **real estate speculation**. [...] But it isn't a type of speculation that would contribute to sustainability, to the use of the lake by the community. It is more like a view from the living room, and the fake promise that you can jog there (it's full of weed in large parts)." (Interviewee 1)

"**You cannot explore the neighbourhood and you cannot have a healthy relationship with people who live nearby.** No. You have your own apartment with a lake view, you can even go to the pontoon, but that's it. These are the only places that are asphalted; the rest is all mud. This is because everything is privatised there, very expensive." (Interviewee 17)

"The boom of development with apartments (that is, very dense development) on the lake shores began some time around 2005-2006, when we were getting close to 2007, when it felt like the market was getting very strong and **the extraordinary reserve for this kind of development offered by the sports areas was discovered.**" (Interviewee 7)

"The main problem is **the proximity of the rural residential**. [...] The closer you are (anthropically) to the aquatic zone, the higher the vulnerability of the water body is. On top of this are the processes of washing from precipitations. The closer (especially) the traffic networks are, the higher it is the risk of bringing pollutants from traffic and what is on the asphalt (break residues, etc.) into the water as suspended particles." (Interviewee 3)

"Without the lakes in the North **the green lung of Bucharest** would not exist." (Interviewee 11)

"Colentina is **the greatest ecological resource of the city** by far, undoubtedly." (Interviewee 9)

"Colentina was thought from the very beginning as a succession of lakes accompanied by parks. And even at that time they thought about the fact that **these parks should be connected**. [...] If the connectivity of this green corridor is achieved, it is incredible what could be in that area." (Interviewee 3)

"[Colentina] could be **one of the important anchoring threads, stronger than Dâmbovița, in my opinion, for a future regional park system**." (Interviewee 18)

The artificial character of River Colentina is one of the main themes observed in problems pointed out by the experts. Regarding the environmental characteristics of Colentina, flood risk was indicated as a problem in some segments of the corridor. Moreover, in case of extreme events, the municipalities which are located upstream from Bucharest might be flooded. According to the environmental scientist, the reduced water flow allowed through the flood defence system has an inverse influence on the UHI effect, as it stores heat and increases the temperature instead of reducing it during the hot season (Figure 4.14). Another environmental problem is poor water quality, partially caused by the illegal discharges of informal and rural communities from peripheral sections of the corridor, as pointed out by some experts.

As planned in the 1930s, the 'emerald necklace' along river Colentina, together with the continuous strip of green spaces on its shores could constitute a green-blue corridor for the city, in which ecology and biodiversity could develop. This potential was mentioned by several interviewees. Environmental aspects were also pointed out as potentials by the experts. Most of all ecosystem services, micro-climate regulation was considered to be the most important. With a sufficient water exchange rate, the large water surface of the lakes could have a considerable air cooling effect in the North of the Capital. Colentina was also considered a green lung, given its capacity of cleaning the air of Bucharest with its large volume of vegetation.

FIGURE 4.14 Artificial edge and low water on Lake Herăstrău. Photo credit: Claudiu Forgaci.

Social exclusion / recreation

"[T]here are villas, buildings of the nouveau riche, and this is, of course, because they are **more attractive spaces [for ...] a kind of real-estate investment**." (Interviewee 19)

"**There are the good spots on Colentina**, which are the parks—Herăstrău and a few more—**and there are points of total rupture**." (Interviewee 5)

"The idea is to keep people there for half a day, to keep them there with the family, to offer them more possibilities to benefit from this space. But the dynamics in fact are of **masked privatisation of parks and public spaces of the park**, in the sense that some areas are cut off, transformed into services with theoretically public access, but extremely costly, so they target certain categories of the population." (Interviewee 7)

"[Colentina] **is a place for recreation**, but for a whole day, not like on Dâmbovița, where you would have a coffee for two hours and then you would move on." (Interviewee 17)

"Together, **[the lakes] could be complementary**, could have a better distribution of leisure services." (Interviewee 16)

"**I wish there was a possibility to do again recreational sports activities on Colentina.** [...] cycling routes, promenades, why not horse tracks—we know what happens in the Netherlands, for instance—, their introduction in a system that can be crossed from one end to another and which would offer recreational sports activities that would increase the health of the population after all. [...] This is an extremely important thing, because in Bucharest there are major problems related to the lack of physical activity. [And that's] because there's no space for physical activities." (Interviewee 7)

"it should practically be **the sponge that absorbs all the energy that the inhabitant of Bucharest dissipates while being in a hurry**, while taking the car and running away to the mountain or to the sea. Obviously, in a weekend there's no time for this, as 80% of the time would be spent in traffic. Maybe not 80%, but an enormous amount of time, during which he or she could have done the same thing on the lake shore, here in the city." (Interviewee 14)

Colentina is presented as a space of contrasts between: the rich and the poor, rural and urban, gated and unsafe areas, central and peripheral conditions. Also, the spaces open to the public are clustered almost exclusively in the central segment of the river, namely in Park Herăstrău, while other lakes are hardly visited (Figure 4.15), leading to a striking imbalance in the distribution of visitors. The social imbalances created by these contrasts are among the main problems of the river, visible also in the fragmented spatial configuration described in the previous section.

On the other hand, according to the experts, river Colentina is potentially the most important recreation space in Bucharest, especially for weekend tourism. In addition, the natural character of the area creates a high-quality setting for residential development. For all the inhabitants of the city, Colentina could become a great sports area. Its value as a cultural landscape could also be capitalised on. Under these conditions, Colentina could potentially be an economic attractor, especially for smart investments in green economy.

FIGURE 4.15 View from the green lake shore towards the collective housing neighbourhoods in Fundeni. Photo credit: Claudiu Forgaci.

Derogative planning

"I have a theory: the simplest urban regulation that is applied in Romania is the 'three As': anything, anywhere, anyhow. With all the regret, this is what everybody says. Beyond the sweet-sour aspect of it, the situation is very bad. So, from my professional point of view, **the urban fabric around Colentina has an uncertain future**." (Interviewee 13)

"In case of Colentina, I would say that the relationship was very soft and landscape related, concerned with the integration of built-up areas in the geographic context with a non-antagonistic attitude. This was lost as soon as **it was allowed to build too close or to build too much**." (Interviewee 15)

"**[Colentina] is a peri-urban, metropolitan, inter-community issue.** The discussion shouldn't even be otherwise, then in a partnership, association structure, in which Bucharest would be a partner along with all the others that have a relationship with the natural element, from Buftea to at least Cernica." (Interviewee 4)

"There was the idea, when the GUP was drawn up in 2000, that, in order to spread the beneficial effect of the water surface and green space on a radius that is as large as possible, in the proximity of Colentina **there should be a very low building coverage (POT) and floor area ratio (CUT)**. This had two consequences. Those who complied with the regulations were those people who had money, thus making the rich people live even better. On the other hand, there was a consequent, perseverant, insistent effort to break this barrier, (also) by the rich who wanted to sell the place to others at a [high] price. There was a very high pressure to increase the density in an attractive place and often for residences of a condominium type, or individual villas on their own plot, with the condition that the villa is as big as possible and the plot as small as possible. I think that the majority was in the second category in the dispute with the municipality." (Interviewee 11)

"there's no visible intention or project to think the lakes or the parks as a whole." (Interviewee 19)

"I think **the largest project for Bucharest should be on the lakes of Colentina**. Just look at the map from above, you see that there's a pearl of lakes. Dâmbovița, practically does not exist." (Interviewee 22)

"In my opinion, the pearl of lakes does not have a potential for growth besides the fact that it could improve the quality of a residential area." (Interviewee 16)

The spatial transformation of River Colentina is one of the best examples of sprawling suburbanisation and 'derogative-' or 'private urbanism' in Romania. As shown in the responses of the experts, there are at least three main conditions which led to this phenomenon. First, property restitutions and privatisation of agricultural and industrial land freed up lakeside locations to a quickly growing real-estate market. Second, the weak urban regulations and permissive planning instruments—chiefly

ZUPs—could not control this new form of urbanisation. And third, the boundary condition of the lakes between Bucharest and neighbouring municipalities was not sustained by inter-communal collaboration. Moreover, the administration's lack of interest for the lakes, the lack of a corridor-wide vision, and the lack of strategies has engendered the deterioration of riverside structures, such as the former sports and bathing facilities, and undesigned banks.

§ 4.5 Discussion

Having learned how the two rivers are seen by the experts, at least three questions remain to be answered. How do these results add to the knowledge on the post-communist transformation of the two rivers? What do the results mean for URCs as defined in this thesis? And how can this knowledge be used in design?

In the previous two sections the two rivers were examined separately. Here, similarities and differences will be discussed and related to the four domain families used in the thesis (Table 4.4): environmental-ecologic (ENV-ECO), spatial-morphological (SPA-MOR), social-economic (SOC-ECN), and planning-governance (PLA-GOV). Although the analysis sheds light on several issues which have not been explicitly discussed in literature, some gaps, inconsistencies, partial explanations and disagreements remain. The discussion in this section includes those aspects.

TABLE 4.4 The main themes emerged from the QDA in relation to the four domain families.

	PROBLEMS		POTENTIALS	
	Dâmbovița	Colentina	Dâmbovița	Colentina
ENV-ECO	Canalisation	Artificial nature	Geomorphology	Green-blue corridor
SPA-MOR	Physical barrier	Fragmentation	Axis of urban development	
	Crampedness	-	Spatial reserve	-
SOC-ECN	A non-place	Social exclusion	Spatial identity	Recreation
PLA-GOV	Lack of strategic planning		-	-

The environmental-ecological dimension

An important issue observed in the analysis is the absence of in-depth knowledge on environmental issues and ecology. Several experts gave partial responses and reported limited knowledge on this topic. The ones more familiar in their expertise with the topic complained that “green space is still seen in a functionalist way” (Interviewee 14), as an imposed requirement of unbuilt square meters “where money is lost in the city” (Interviewee 9). This is consistent with the fact that environmental policies were adopted in a later stage of post-socialist transition, after EU accession, and that the value of open space and ecosystem services has hardly been acknowledged yet.

Even with this partial knowledge, the analysis gives a consistent result regarding the main problems and potentials of the two rivers. Although the two rivers are different in shape and some functions, the canalisation of Dâmbovița and the artificial nature of Colentina, two core concepts emerged from the analysis, are the product of similar processes of artificialisation. The presence of the valley, as well as the continuity of a green corridor—the parks along the lakes of Colentina and the parks along the left valley edge in the case of Dâmbovița—seem to represent key prerequisites for a green-blue corridor.

The spatial-morphological dimension

By the systematic cancellation of the natural qualities of Dâmbovița through canalisation, the urban and ecological spatial capacity of the river was ignored. In the logic of URCs, crampedness and canalisation are symptomatic of the same phenomenon: the treatment of the urban river space as an efficient conduit of different longitudinal flows at the expense of the transversality of the river valley and the spatial permeability of riverside public space. Although the problem of 'physical barrier' was mentioned several times, there seems to be disagreement whether Dâmbovița is or not a barrier. As one of the interviewees stated, "the problem that Dâmbovița would cut the city in two is false" (Interviewee 6), whereas others firmly state that "Dâmbovița is clearly a barrier and it requires improvements in connectivity" (Interviewee 16). The fragmentation of the urban spaces along river Colentina is very different from the crampedness of Dâmbovița. In fact, it is the reverse. On Colentina, on the longitudinal flows are not merged, but separated and located away from the river. Transversal connections are more dominant than on Dâmbovița.

The potential of both rivers of becoming axes of urban development is agreed upon by most experts. However, the type of development along the two corridors is different. Colentina is seen as a succession of smaller centralities along a large recreational and residential corridor, whereas Dâmbovița promises to become a highly mixed central location attracting businesses taking advantage of the latent spatial capacity available along its trajectory.

The social-economic dimension

It may be argued that what actually makes a difference, is not the shape but the location of the two rivers in relation to the city. The argument of location was brought up in the case of both rivers: the peripheral condition of Colentina and the central, diametric position of Dâmbovița are defining for their role in the functioning of the city.

On the other hand, Dâmbovița as a non-place and the socially exclusive character of Colentina are not so different as they may seem. Both are the victims of a peripheral condition. While on Colentina rural-urban transition areas combined with sprawling and infrastructure 'catch-up' can be observed, in the centre of Bucharest Dâmbovița is lifeless as it is disconnected by car traffic from the rest of the city. The social-economic phenomena described in the interviews seem to fit well in the wider social-economic patterns described in Section 4.2.

The planning-governance dimension

The lack of integrated planning on Dâmbovița and the unleashed derogative urbanism occurring on Colentina are symptoms of the same general issues, which were highlighted as the main problems of Bucharest: the lack of vision and strategies, the lack of collaboration between disciplines and between administrative units, and weak regulations combined with strong property rights and extensive privatisation. The three dimensions described above are conditioned, as stated by Sýkora and Bouzarovski (2011), by planning and governance.

One aspect that remained almost entirely implicit is that of scales and multiscalarity. Question 10 of the questionnaire ("Is there a comprehensive multi-scalar plan/strategy for Dâmbovița/ Colentina?")

addressed the topic and the responses for both rivers were almost entirely on the negative side of the scale (86% for Dâmbovița and 95% for Colentina), but the responses were hardly elaborated. This indicates a lacking practice of strategic planning and the need for planning and design instruments addressing problems in a multi-scalar framework.

§ 4.6 Assignment

As suggested in Section 4.3, the objective of the qualitative data analyses reported in this chapter was not theory development, but to build a reliable knowledge base for assessment and design. Thus, the first part of the thesis concludes with an assignment, which takes into account the spatial definition of URCs (Chapter 2), as well as the historical development (Chapter 3) and current profile (Chapter 4) of Bucharest's river corridors. As opinions on issues related to problems and potentials in connectivity and spatial capacity seem to be limited to the perceptions and experience of the experts, further assessment is required to answer the following questions: How are the two URCs connected with the city? How much and what kind of spaces can be found in the two URCs and how are they spatially distributed? To what extent do current open spaces and connections in the two URCs support social-ecological integration? What are the scales of action/relevance of the two URCs? Part 2 of this thesis will address these questions by further analysing and assessing the actual and potential spatial conditions found in the URCs of Bucharest, as a basis for further design explorations carried out in Part 3.

PART 2 Assessment

This part includes two chapters:

5 A Framework for the Assessment of Social-Ecological Integration in Urban River Corridors

§ 5.1 Introduction

This chapter develops a framework for the assessment of social-ecological integration in URCs. As the first chapter of Part 2, it makes the transition from the general principles and key properties of URCs presented in the transdisciplinary literature review of Chapter 2 to an assessment framework that can be used to verify the spatial-morphological definition of URCs in a real-world context. After an introduction on challenges and opportunities for sustainability assessment in Section 5.2, Section 5.3 provides an overview of current approaches to urban river assessment in the fields of urban planning and design, landscape architecture and landscape ecology. Building on these approaches and structured by the key properties of URCs introduced in Chapter 2, Section 5.4 assembles *a system of indicators* and devises *a method of assessment* of social-ecological integration on corridor segment scale and corridor scale. Finally, Section 5.5 discusses some considerations of assessment quality, such as weighing, validity, calibration and wider applicability.

SUB-QUESTION AND OBJECTIVES:		
Sub-question 5:	**How can the social-ecological integration of URCs be spatially assessed?**	
Objective 5.1:	Review current approaches to the assessment of urban rivers.	Section 5.3
Objective 5.2:	Build an assessment framework for social-ecological integration in URCs.	Section 5.4

§ 5.2 Challenges and opportunities for assessment

In Chapter 1, the link between urban resilience and social-ecological integration was made in two respects. First, it was proposed that URCs are urban spaces where the potential for social-ecological integration is the highest. Second, given its explicit transdisciplinary nature, social-ecological integration was presented as a fit concept for operationalising urban resilience. Based on combined knowledge from spatial morphology and landscape ecology, the spatial-morphological definition and holistic nature of the concept make it suitable for the construction of an assessment framework using spatial indicators of social and ecological systems. To make the transition from the description of URCs given in Part 1 to the analytical approach of this second part, challenges and opportunities of assessment in planning for sustainability need to be highlighted.

§ 5.2.1 Assessment in planning for sustainability

Within the process of urban planning, indicators can be used to explain the current state of a spatial system in relation to a reference state, to assess the impact of particular actions on the current state in relation to a reference state, to predict future conditions under various scenarios, or to monitor processes of change (Briassoulis, 2001). For the purposes of planning and design, this thesis' emphasis will be put on ex-ante evaluation—i.e. on explanation, impact assessment and prediction—, which presents a recognised need in sustainable urban development (Gil & Duarte, 2013).

According to Briassoulis (2001), indicators of sustainable development have a short history that started in the mid-1980s, more in the ecological and environmental than in the social dimension. Although some integrated indicators had appeared, the general approach remained mono-disciplinary. In the early 1990s, social indicators were improved and multi-disciplinary approaches to the study of the economy-environment-society emerged. More recently, inter- and transdisciplinary approaches replaced multidisciplinary practices and the targets of sustainable development became more about choosing development paths than reaching a terminal state. Today, social-ecological integration appears to be an important requirement for urban sustainability. Criteria for measuring sustainability include "key variables to describe urban and environmental systems and their interrelationships", "measurable objectives and criteria to assess these interrelationships", feedback mechanisms at both individual and institutional levels (Alberti, 1996, pp. 381–382), as well as knowledge of 'where' (context), 'when' (timeframe), 'who' (actors), 'what' (goals), 'why' (problems), and 'how' ("deliberate decision making, the design of courses of action, means and implementation") are interrelated planning decisions made (Briassoulis, 2001).

§ 5.2.2 From properties to indicators of URCs

The literature review of Chapter 2 presented a set of themes under four domain families representing the environmental-ecological, social-economic, planning-governance, and spatial-morphological knowledge on urban rivers. As shown in Table 5.1, those themes were used to summarise the main branches of knowledge on URCs, their core principles, and to formulate a spatial-morphological definition comprising four key properties of URCs: *connectivity*, *open space amenity*, *integration* and *multiscalarity*. The translation of the spatial-morphological definition to a real-world context raises a few challenges. How to evaluate whether and how those properties are in place? And how can they be translated into indicators of social-ecological integration? This chapter addresses these challenges first by identifying current approaches to spatial assessment of urban rivers and, building on those approaches, by proposing a system of indicators and an assessment framework for social-ecological integration.

TABLE 5.1 Summary of the main themes presented in Chapter 2 and their relation with the four properties of URCs.

THEMES	Properties									
	Connectivity			Open sp. amenity			Integration			Multiscalarity
	Lon.	Lat.	Vert.	Div.	Qual.	Comp.	Soc.	Ecol.	Soc.-ecol.	
The environmental-ecological dimension										
River restoration					x	x	x	x	x	catchment + channel
Linking ecology and hydrology	x	x	x					x		catchment + valley + channel
Green and blue infrastructure				x	x	x	x	x	x	region + city + neighbourhood + site
The social-economic dimension										
The waterfront							x		x	city + riverfront
Social connectivity	x	x	x							watershed + neighbourhood + site
The aesthetic value					x				x	city + corridor + site
The planning-governance dimension										
Legal and regulatory framework										continent + country + region + catchment
Planning instruments					x	x				catchment + corridor + channel + community
The spatial-morphological dimension										
Landscape ecology	x	x		x		x				matrix + corridor + patches
Landscape design and planning	x	x							x	corridor + river space + site
Assessment of urban river corridors					x	x	x	x	x	corridor + river space

§ 5.3 Spatial metrics of urban rivers in current approaches

In the spatial-morphological dimension, a number of attempts to quantifying urban rivers are selected and described below: *landscape metrics*, *landscape design principles*, *urban form resilience, integrated spatial quality*, and *ecosystem services*. This section is not a literature review; the sources cited here were selected either as an introduction to a certain approach of assessment or as an example of a river case study.

Landscape metrics

"Determining the causes, consequences, and functional importance of spatial heterogeneity" (Turner & Gardner, 2015, p. 97), i.e. quantifying the variability of landscape patterns described as patches, corridors and matrix, is a core concern in landscape ecology. Developed to that end, landscape metrics are "algorithms that quantify specific spatial characteristics of patches, classes of patches, or entire landscape mosaics", which fall into two categories: *landscape composition*, looking at non-spatial attributes of the landscape (e.g. proportional abundance, richness, evenness, diversity); and *landscape configuration*, which require spatial information (e.g. edge length and edge density, contagion, patch size distribution and density, patch shape complexity, core area) (Gustafson, 1998; MacGarigal, 2015). Additional categories of metrics are *fractals*, used, for instance, to measure shape complexity; *measures of landscape texture* used for continuous rather than categorical landscape data; and *connectivity*, used in nearest-neighbour approaches or as a graph-based alternative to the cell-based approaches described above (e.g. area of largest component on landscape level, and degree centrality on patch-level) (Turner & Gardner, 2015).

In a study on the impact of urbanisation patterns on aquatic (river) ecosystems, Alberti et al. (2007) propose four categories of landscape metrics: *land use intensity*, *landscape composition*, *landscape configuration*, and *connectivity*. Land use intensity measures are *percentage of land use class*, *population or housing density*, *road density*, *road intersection density*. Landscape measures of composition include *percentage of land cover occupied by a certain patch type* and *the number of land cover classes in a landscape expressed through a diversity index* such as SHDI. Typical measures of land configuration are *mean patch size (MPS)*, *contagion (C)*, *aggregation index (AI)*, and *percentage-of-like-adjacency (PLADJ)*. Landscape metrics can further be combined with measures of *connectivity of the impervious surfaces*. Alberti et al. (2007, p. 359) recognise that “metrics are scale-dependent […] or are relevant to processes operating only at specific spatial scales” and perform their analysis across *five nested scales*: local riparian zone; 100m, 200m, 300m riparian widths; and basin scale.

Landscape metrics are used either with vector-based digital categorical maps of land-use and land-cover data or with grid-based (raster) data (Turner & Gardner, 2015). Although raster data has been commonly used for landscape pattern analysis, vector data, such as the Corine Land Cover (CLC) dataset (Büttner, Soukup, & Kosztra, 2014; Büttner et al., 2004; EEA, 2006), and the more detailed Urban Atlas dataset (Copernicus Land Monitoring Service, 2016; EU, 2011), can be equally suitable for analysis. With “reliable, inter-comparable, high-resolution land use maps for 305 Large Urban Zones”, Urban Atlas (UA) data[63] is of particular interest for more detailed urban-scale analysis. Recognising this potential, Prastacos et al. (2017) devised a methodology for estimating spatial metrics by using UA data to quantify and analyse the aggregation/dispersion/proximity patterns of land uses in urban areas.

Landscape design principles

Design principles developed through a long-term, incremental process of trial and error are another potential basis for developing spatial indicators. For instance, Manning (1997) gives a detailed list of principles for social-ecological design in river landscapes. He emphasises a number of spatial properties that must be addressed in river landscape design: *margins or ecotones as transition areas*, *edge complexity*, *visibility*, *accessibility*, *diversity*, *hierarchy of riverside routes*, *natural river dynamics*, *the relationship between river width and crossability*, the *movement along, towards, and across*, and the social *attractiveness of crossings*. All these properties are qualified in the way they are incorporated in design principles. For example, a principle could state that the hierarchy of riverside routes should include minor routes on the water edge and major routes collecting those minor routes away from and parallel to the water. With a proper definition (e.g. how are routes classified as minor/major?), target values can be derived (e.g. what is the optimal spatial relationship/distance between the water edge and minor/major routes?) and an indicator can be formulated.

Baschak and Brown (1995) build on landscape ecology principles to develop an ecological assessment framework for the planning, design and management of urban river greenways. Their framework uses an inventory of landscape elements classified as patches, corridors and matrix in a hierarchy of *at least three scales (i.e. site, local, regional)* established in terms of contextual criteria, species diversity, spatial relationships and management units. Their assessment process is carried out in two steps: (1) a landscape element rating, used to evaluate the relative quality of landscape elements; and (2) a network assessment, used to measure the (existing and potential) links in the landscape. The study of Baschak and Brown identifies three main criteria influencing the spatial structure of a corridor

63 Urban Atlas is developed by the European Environment Agency (EEA) and it is a freely available dataset with land use/cover information for the years 2006 and 2012 for most Large Urban Zones in Europe with a population above 100.000.

network: (1) *connections to species-rich areas*, especially in urban areas where source pools are scarce; (2) *corridor to urban context relationship*, e.g. the 10-15m edge effect (Forman & Godron, 1986) of the surrounding matrix significantly impacts especially narrow corridors and small patches; and (3) *the network structure and content*, e.g. "various spatial distribution models of islands and corridors use riparian corridors" (Baschak & Brown, 1995, p. 215) as backbones connecting patches of various sizes. Baschak and Brown conclude that, given the scarcity of open spaces in an urban environment—that is, the potential for large habitat patches—, optimal shapes, configurations and minimum widths of corridors are more important than habitat size.

The tight interaction between the fields of landscape ecology and landscape design is visible in both Manning's (1997) and Baschak and Brown's (1995) studies. Yet, even though the necessity of formulating landscape ecology principles for landscape design and planning has already been recognised (Dramstad et al., 1996), their application to urban environments, i.e. in urban design and planning, remains a research frontier and a practical challenge. One way to address this challenge, in addition to formulating metrics from landscape principles, is to consider urban design principles in formulating metrics for URCs.

Urban form resilience

Davis and Uffer (2013) formulate a set of physical, environmental, social and economic indicators of urban form resilience. Indicators in the physical category include *density* (of population and of built form) as a measure of intensity of development and *adaptability* (of the street layout and of building types), both referring to how extra open (i.e. unbuilt) space can improve resilience. Environmental indicators of urban form resilience are *accessibility* or permeability "from near and far places" and *green space coverage*, that is "publically accessible green open space for recreation and the promotion of urban biodiversity" (p.15). Social indicators of resilient urban form are *diversity of land use* and *diversity of tenure*. Finally, the economic dimension includes indicators related to *property values* over time and in a wider urban context.

Most of these have been identified as key indicators of urban form complexity. According to Boeing (2017, p. 3), "urban design and planning can foster diversity, connectedness, complexity, resilience, and robustness – elements of a healthy complex adaptive system." Boeing (2017) gives an overview of various measures of urban form complexity, from common measures of network analysis, *fractal structure*, *diversity*, and *information entropy* to *resilience*, *robustness*, and *adaptiveness* employed at a higher level of abstraction. Out of these, the most common measures of urban spatial complexity are *diversity* and *connectedness*. For a precise measurement and analysis of urban diversity, a distinct definition of the category and scale—i.e. the answer to the question 'diversity of what and on what scale'—is required (Sayyar & Marcus, 2011). The complexity of a network is indicated by its structure, "in particular density, resilience, and connectedness" (Boeing, 2017, p. 10). Network measures are divided into metric and topological. Street connectivity metrics depend on the way study areas are drawn; topological measures, on the other hand, "may more robustly indicate the connectedness and configuration of the network" (Boeing, 2017, p. 10).

Integrated spatial quality

Khan et al. (2014) describes *integrative spatial quality* as a concept "across scales, beyond shape and, more importantly, across and beyond disciplines" and builds his definition on Sternberg's (2000) four principles: *good form*, i.e. proportions and interrelation between parts and the whole; *legibility* with reference to Lynch's (1960) sensuous qualities; *vitality* referring to mixed use, fine grain, high density, permeability; and *meaning*, or identity, local culture, history.

Batista e Silva et al. (Batista e Silva, Saraiva, Ramos, Silva, et al., 2004; Batista e Silva et al., 2013; Batista e Silva, Serdoura, & Pinto, 2006) have developed an assessment framework for the classification of the aesthetic value of urban rivers. Although they focus on a qualitative aspect—aesthetic value—, their work is arguably one of the most extensive and integrative corridor-scale assessment frameworks of urban rivers to date. Visual attractiveness, in their opinion, can be used as a performance strategy recognising the complexity and multi-dimensional nature of the landscape and the need for interdisciplinarity and a 'holistic vision'. In addition, the experiential use of the landscape is essential in understanding the users' opinions, perceptions and expectations. Having recognised these two needs, the study presented by Batista e Silva et al. (Batista e Silva, Saraiva, Ramos, Silva, et al., 2004; Batista e Silva et al., 2013) combines two assessment methods: an expert panel providing technical expertise and a set of interviews administered to the users of riverside areas for aspects such as perception, preferences, and aesthetic values. In analysing the outcomes of the expert panel session, a general framework was established, with the use of the three worlds of Habermas (1984): the material world (River), the personal world (People), and the social world (City). Within these three categories, expert viewpoints were structured in two levels of specification: fundamental (families of concerns) and elementary viewpoints (measurable aspects). For each elementary viewpoint, descriptors were used. For the category People, a sample of one hundred twenty-nine residents from a case study area was selected and interviewed about public perception of the attractiveness of the river corridor. All measurement scales of both the expert viewpoints and the users' perception were standardised to a common 0-100 cardinal scale. Reflecting on the approach put forward by them, Batista e Silva et al. stress the importance of local specificity in interpreting the "multidimensional world of aesthetical attractiveness" (Batista e Silva et al., 2013, p. 181) of urban river corridors assessed and quantified in this way.

Ecosystem services

In the definition of the city as a social-ecological system (SES) "the flow from the ecosystem towards society is generated through the supply of [Ecosystem Services]" (Schneiders & Müller, 2017, p. 35). ES are related to *biodiversity*, which "determines the self-regulating capacity of the system and the attitudes of biodiversity dynamics, such as resilience or adaptability" (Schneiders & Müller, 2017, p. 35). Biodiversity can be described on four organisational levels—gene, species, ecosystem, and landscape—and from four perspectives—*composition*, *diversity of functions*, *structural diversity*, and *stock*. In the light of mainstream uses of ecosystem services (ES) based on excessive demand and high levels of human control, nature-based solutions imply a more balanced use of ES (Burkhard & Maes, 2017). As pointed out by Perini and Sabbion (2017), Green and Blue Infrastructure (GBI) are one of the main sources of ecosystem sources inside urban areas; understanding, quantifying, planning and monitoring their performance therefore is considered to be essential. In an overview of mapping ecosystem services (Burkhard & Maes, 2017), current practices of quantifying ES are outlined, such as landscape metrics on the organisational level of the landscape. Most of these indicators of ES are related to measurements of provisioning, regulating and supporting services. Urbanised areas require a detailed assessment of cultural services as well.

§ 5.4 Assessment framework

The overview of spatial metrics given in Section 5.3 provides the base for the construction of the indicator system used in the assessment framework for social-ecological integration in URCs. The indicator system can be related, on the one hand, to the specific objectives of the thesis and, on the other hand, to the spatial-morphological definition of URCs. The relation to the overall objectives of the thesis, the indicator system is represented in Figure 5.1 as a hierarchical structure (based on Gil & Duarte, 2013), in which urban resilience is the top-level theme of the study, social-ecological integration in URCs is the issue of focus. Furthermore, spatial indicators and target values are defined and organised according to criteria specific to URCs, i.e. the key properties of URCs introduced in Section 2.2.6—*connectivity*, *open space amenity*, *integration* and *multiscalarity*—are used here as building blocks of the assessment framework. The property 'open space amenity' was renamed to the more neutral 'spatial capacity', for a better representation of the indicators of both social and ecological kind.

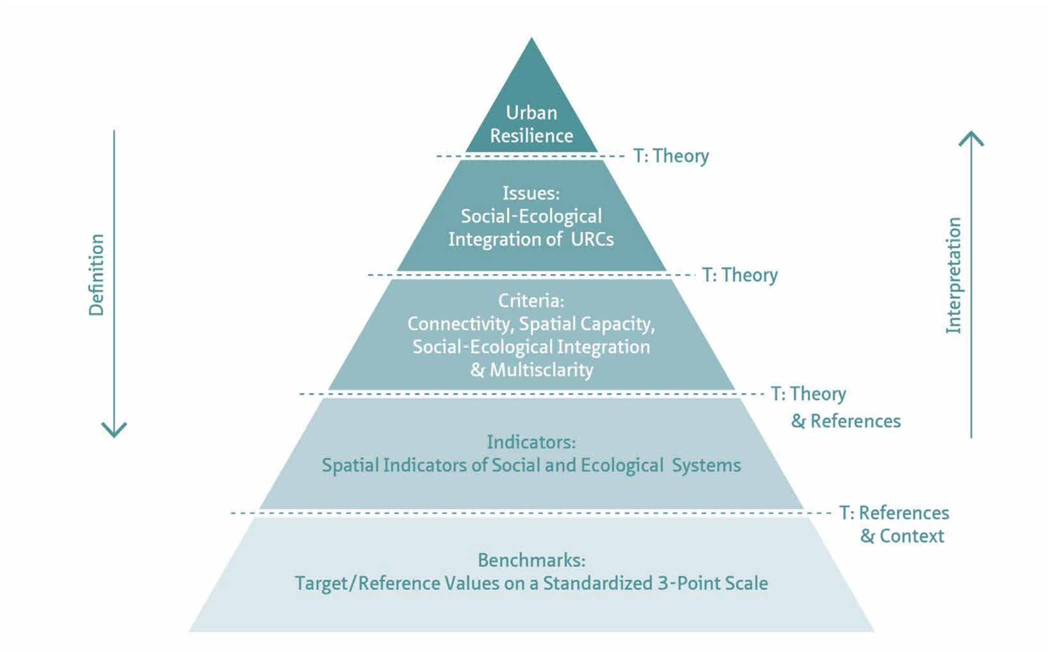

FIGURE 5.1 The structure of the indicator system used for the assessment, represented on Gil and Duarte's (2013) hierarchical levels of sustainable urban development tools. The transitions between different stages of definition and interpretation are also included in the diagram. Based on: Gil & Duarte, 2013.

As shown in Figure 5.2, *connectivity* and *spatial capacity* represent the main categories comprising the spatial indicators of URCs. Corresponding to the spatial-morphological definition of URCs, both categories are subdivided in meaningful sub-categories: *longitudinal*, *lateral* and *vertical connectivity*, and *spatial diversity*, *quality* and *composition*, respectively. In addition, all indicators in these categories are grouped into social and ecological indicators. This way, social-ecological integration can be assessed by confronting the results in corresponding categories of the social and ecological dimension (e.g. social longitudinal with ecological longitudinal connectivity). Multiscalarity is attained by translating scales of constraints—catchment and metropolitan—and scales of components—river space and site to the scales of focus for assessment, i.e. corridor (URC) and corridor segment scale.

The indicators of connectivity and spatial capacity described in the following two sections are defined on a standardised three-point scale, in which values are represented as *[1] low*, *[2] medium*, and *[3] high*. Reference values were either adapted from the source of the indicator or were determined from maximum and minimum plausible values of the assessment conducted in Chapter 6. When more than one method of assessment for an indicator was found, subdivisions were provided (e.g. B.1.1.1a and B.1.1.1b). Subdivisions were also provided for the actual and potential situation (e.g. A.2.1.1).

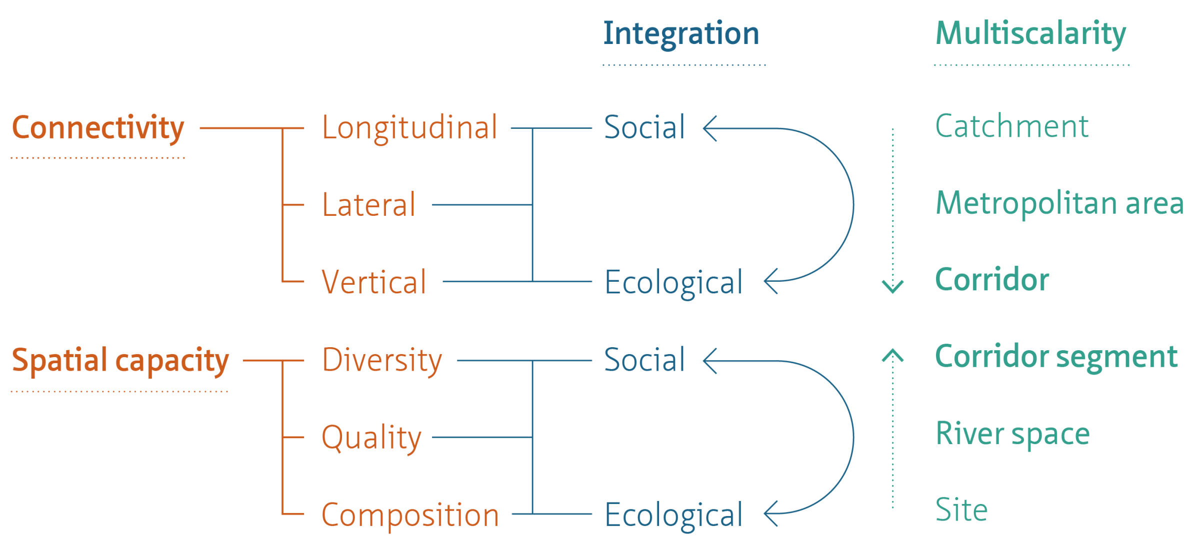

FIGURE 5.2 Diagram of the assessment framework built on the four properties of URCs: *connectivity*, *spatial capacity*, and their subdivisions as the categories used to structure the indicator system (in orange), social and ecological categories confronted under *integration* (in blue), and the spectrum of scales focused on the corridor and corridor segment under the property of *multiscalarity* (in green).

§ 5.4.1 Indicators of connectivity

Three-dimensional, i.e. *longitudinal*, *lateral*, and *vertical*, *connectivity* is used to structure the subcategories of both the social (A.1) and ecological (A.2) dimension. Indicators of this category, summarised in Table 5.2, are based on landscape/urban design principles, landscape metrics and measures of urban form.

Longitudinal connectivity (A.1.1 and A.2.1)

"new forms of local longitudinal connectivity are regaining importance, such as the ability to continuously walk along river banks by introducing footpaths along the river's banks and the ability to pass continuously in canoe or kayak facilitated by removal or retrofitting of outdated dams and other such obstacles to navigation" (Kondolf & Pinto, 2017, p. 14).

Longitudinal connectivity includes all indicators measuring the space for movement and flows along the URC. On the social dimension, infrastructure for movement with different speeds—ranging from high (vehicular) to low (sidewalks)—are taken into consideration (A.1.1.1-A.1.1.4). On the ecological dimension, longitudinal connectivity is assessed based on longitudinal continuities of water and green space in the corridor and stepping stones of ecological patches (A.2.1.1-A.2.1.3).

Lateral connectivity (A.1.2 and A.2.2)

"a river is something too wide to be jumped over, and therefore a significant interruption to progress or land use, yet not so wide that its other side is perceived as unconnected or unattainable." (Manning, 1997, p.68)

"every river has two edges, continuous and parallel, near enough to be seen yet far enough apart to be tantalizing. To the attraction of the water itself, and of the side we are on, is added the magic of the other side: a constant magnet. To reach it we must cross the water somewhere, and the point where we cross will be special in its own right, generating other events and often an entire network of human uses." (Manning, 1997, p.69)

"Crossing-points are where things happen, where people meet, wait and watch; paint and sketch; enjoy the water and the sight of others enjoying it; or spread out to explore from this convenient access point. In other words, they are contact-zones in their own right, and must be treated as such." (Manning, 1997, pp.86-7)

Under the sub-category lateral connectivity, indicators measuring the space for movement across, to, and from the URC are included. The social dimension of this sub-category measures accessibility to-/from- and across the river (A.1.2.1-A.1.2.3), as well as the transversal distribution of speeds of movement (A.1.2.4). The ecological dimension looks at transversal spaces for the connectivity of water and plant and animal species along corridors, in terms of soil and drainage conditions, and lateral migration of the river channel (A.2.2.1-A.2.2.3).

Vertical connectivity (A.1.3 and A.2.3)

"Vertical connectivity, from the upper street level; onto embankments, terraces; and eventually down to the water level and into the water itself, has been practically lost from western cities. When constraints such as the available bank width, flood management issues, or water quality are not an obstacle, reestablishing this most elusive connection across the different levels becomes possible" (Kondolf & Pinto, 2017, p. 14).

Vertical connectivity, the most local of all three categories, comprises indicators of connectivity with, into and through water. From a social point of view, direct contact and different uses of water are assessed (A.1.3.1-A.1.3.3), while ecological indicators examine transition areas between land and water, water and groundwater, as well as air and water (A.2.3.1-A.2.3.3).

TABLE 5.2 Indicators of social and ecological connectivity.

ID	Indicator and source*	Definition
A	CONNECTIVITY	
A.1	Social	
A.1.1	Longitudinal	
A.1.1.1a	Slow mobility routes - continuity	The presence and continuity of slow mobility routes along the river: [1] absent; [2] discontinuous; [3] continuous.
A.1.1.1b	Slow mobility routes - %	Percentage of waterside slow mobility routes out of the total length of riverbanks per corridor segment. Values: [1] below 50%; [2] medium 50-75%; [3] above 75%.
A.1.1.1c	Slow mobility routes - location	Location of riverside slow mobility routes: [1] absent; [2] on one bank or partial; [3] on both banks.
A.1.1.2a	Pedestrian network - continuity	The presence and continuity of riverside walkways: [1] absent; [2] discontinuous; [3] continuous.
A.1.1.2b	Pedestrian network - %	Percentage of walkways out of the total length of riverbanks per corridor segment. Values: [1] below 50%; [2] medium 50-75%; [3] above 75%.
A.1.1.2c	Pedestrian network - location	Location of walkways: [1] absent; [2] on one bank or partial; [3] on both banks.
A.1.1.3a	Major roads - continuity	The presence of major roads along the corridor in parallel with the river: [1] absent; [2] discontinuous; [3] continuous.
A.1.1.3b	Major roads - location	Location of major roads: [1] on both sides of the river; [2] on one side of the river or partially on both sides; or [3] detached from the river.
A.1.1.4a	Navigability – continuity (adapted from Kondolf & Pinto, 2016; Batista e Silva et al., 2004)	The possibility for navigation along the channel determined by obstacles in water: [1] not possible (e.g. presence of weirs); [2] reduced continuity (e.g. presence of sluices); and [3] navigable.
A.1.1.4b	Navigability – use (adapted from Kondolf & Pinto, 2016; Batista e Silva et al., 2004)	The section of the channel and the presence of obstacles to movement on water determine the suitability for: [1] cargo transport (regional scale), [2] passenger transport (city scale), or [3] recreational (corridor and river segment scale).
A.1.2	Lateral	
A.1.2.1a	Accessibility - network	Percentage of the total length of riverside segments classified into low, medium and high local integration (R500m), compared to local integration (R500m) of the road network of the whole city. Values: [1] low, when medium and high values of local integration are below city low values; [2] medium, when medium values are higher than city values, and high values are lower than city values; [3] high, when high values are higher than city values.
A.1.2.1b	Accessibility - residents	The percentage of the total inhabited area (the area of the corridor, excluding the river space) in the corridor which is accessible by pedestrians (500 m). A service area of 500 m is calculated from the river, i.e. from all riverside road and path intersections. Values: [1] below 50%; [2] between 50%-75%; [3] above 75%.
A.1.2.1c	Accessibility - visitors (public transport) (adapted from Batista e Silva et al., 2004, pp.63,66)	Accessibility of the river space by pedestrians from public transport stops (bus, tram, metro) per corridor and river segment. This indicator shows the percentage of the total river length accessible by public transport in a 500m distance. Values: [1] below 50%; [2] medium 50%-75%; [3] above 75%.
A.1.2.2a	Level of disruption - % (adapted from Batista e Silva et al., 2004, pp.63,67)	The percentage of riverbanks occupied by disruptive (road or rail) traffic per river corridor and river segment: [1] more than 75%; [2] between 50-75%; [3] less than 50%.
A.1.2.2b	Level of disruption - classified river length	The length of the river is divided and classified in [1] river sections disrupted on both banks, [2] disrupted on one bank or [3] undisrupted by car or rail traffic.
A.1.2.3a	Crossability - linear density of crossings (adapted from Batista e Silva et al., 2004, pp.63-4)	Linear density of pedestrian/bike bridges (number of crossings/km) (Batista e Silva et al., 2004; 2006; 2013) and change through time. This variable indicates to what extent the river is perceived as a barrier to transversal movement. The scale is determined based on the minimum plausible and maximum plausible number of pedestrian bridges per river segment. Batista e Silva et al. use a max. plausible value of 4 bridges/km. Values: [1] 0-1 bridge/km; [2] 2-3 bridges/km; [3] ≥4 bridges/km.
A.1.2.3b	Crossability – river width (adapted from Kondolf & Pinto, 2017, p.190)	Crossability is measured in function of the width of the river: [1] rarely bridged above 400m; [2] hard to bridge between 50-400m; or [3] easily bridged below 50m.
A.1.2.4	Transversal gradient of speeds of movement (based on Tjallingii, 2005; 2015)	Transversal disposition of speeds of movement: [1] fast lane along the river, slow lane outside the river space; [2] fast and slow lane along the river; [3] slow lane along the river, fast lane outside the river space.

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TABLE 5.2 Indicators of social and ecological connectivity.

ID	Indicator and source*	Definition
A.1.3	**Vertical**	
A.1.3.1a	Contact with water – points (based on Kondolf & Pinto, 2016)	The percentage of river banks where physical contact with water (e.g. stairs, beaches) is possible. Values: [1] below 50%; [2] medium 50-75%; [3] above 75%.
A.1.3.1b	Contact with water – typology (adapted from Batista e Silva et al., 2006, p.11)	Points or areas of contact classified as: [1] punctual; [2] linear and short (<50m); [3] linear and long (>50m).
A.1.3.2	Contact with water – constructions (based on Kondolf & Pinto, 2016)	The presence of buildings or structures providing public amenities in relation with water: [1] absent; [2] facilities in the proximity of water; [3] facilities providing interaction with water.
A.1.3.3	Contact with water – swimming (based on Kondolf & Pinto, 2016)	The presence of swimming facilities in a river segment: [1] absent; [2] isolated swimming facilities; [3] swimming possible in the river.
A.2	**Ecological**	
A.2.1	**Longitudinal**	
A.2.1.1a	Landscape connectivity – existing (based on Anderson et al., 2009; Zetterberg et al., 2010)	Number of connected components in the corridor formed by vegetated patches in the corridor. Values: [1] disconnected; [2] fragments; [3] connected.
A.2.1.1b	Landscape connectivity – potential (based on Anderson & Bodin, 2009; Zetterberg et al., 2010)	Number of connected components in the corridor formed by existing (vegetated) and potential (non-vegetated open spaces) ecological patches in the corridor. Values: [1] disconnected; [2] fragments; [3] connected.
A.2.1.2a	Stepping stone redundancy – existing (based on Dramstad et al., 1996, Anderson & Bodin, 2009; Zetterberg et al., 2010)	Betweenness (stepping stones) values of the patches in the network of vegetated open spaces classified as [1] low, [2] medium, and [3] high.
A.2.1.2b	Stepping stone redundancy – potential (based on Dramstad et al., 1996, Anderson & Bodin, 2009; Zetterberg et al., 2010)	Betweenness (stepping stones) values of the patches in the network of existing (vegetated) and potential (non-vegetated) open spaces classified as [1] low, [2] medium, and [3] high.
A.2.1.3	Continuity of riverside vegetation	The vegetation between points of discontinuity (road crossings, walls, etc.) is classified as: [1] absent; [2] intermittent; or [3] continuous.
A2.2	**Lateral**	
A.2.2.1	Presence of transversal corridors	The percentage of vegetation on transversal roads, from the river to the URC edge are mapped and classified into: [1] absent, vegetated road segments ≤33%; [2] intermittent, >33% and ≤66%; or [3] continuous, >66%.
A.2.2.2	Connectivity of the impervious area (adapted from Alberti et al., 2007)	
A.2.2.3	Sinuosity (adapted from Batista e Silva et al., 2004; based on Manning, 1997)	Sinuosity can be determined by dividing channel length with down-valley length. Values: [1] almost straight between 1,00-1,05; [2] sinuous between 1,05-1,50, and [3] meandering above 1,50.
A.2.3	**Vertical**	
A.2.3.1	Presence of ecotones (based on May, 2006)	Percentage of the total length of ecotones out of the total length of river edges. Values: [1] low for values below 25%; [2] medium for values greater than 25% but lower than 50%; and [3] high for values higher than 50%.
A.2.3.2	Surface and groundwater interaction (based on Pringle, 2003)	The interaction between surface- and groundwater, i.e. vertical hydrologic connectivity, is classified according to the permeability of the riverbed: [1] no connectivity (concrete channel); [2] partial connectivity (partially channelized or sealed riverbed); [3] total connectivity (natural river bed).
A.2.3.3	Open water surface	The total area of water uncovered by bridges. Values: [1] <50% uncovered; [2] uncovered between 50%-75%; [3] uncovered above 75%.

** Indicators for which a source is not specified were proposed in this thesis.*

§ 5.4.2 Indicators of spatial capacity

Both the social and the ecological dimension of the category *spatial capacity* is divided in three sub-categories: (1) *spatial diversity*, (2) *spatial quality* and (3) *spatial composition*. These sub-categories are less clearly delineated than the sub-categories of connectivity, as they combine different epistemologies of both qualitative and quantitative nature and because they are not independent. For instance, landscape heterogeneity, here included under diversity, is also indicated by landscape composition, another sub-category, and by landscape configuration, which is covered under indicators of connectivity. Another example is spatial quality, which may refer both to spatial diversity and to aspects related to legibility from a human perspective. Yet, for the same reasons, the classification can be considered meaningful in the sense that it exhibits synergies. Indicators in this category are summarised in Table 5.3.

Spatial diversity (B.1.1 and B.2.1)

Diversity (or heterogeneity) is an important spatial property in both landscape ecology and spatial morphology. In landscape ecology, heterogeneity is "the quality or state of consisting of dissimilar elements, as with mixed habitats or cover types occurring on a landscape; opposite of homogeneity, in which elements are the same" (Turner & Gardner, 2015, p. 3), often measured with a diversity index such as SHDI (B.2.1.4). In urban areas, it may refer to the relative proportion of different land uses (B.1.1.1). Indicators of ecological diversity include biodiversity (B.2.1.1), storm water storage diversity (B.2.1.2), presence of riparian vegetation (B.2.1.3), and SHDI (B.2.1.4).

Spatial quality (B.1.2 and B.2.2)

Spatial quality (or environmental quality) is approached through the lens of integrative spatial quality proposed by Khan et al. (2014). According to Khan et al., understanding integrative spatial quality requires a relational and transdisciplinary perspective. Social indicators in this category include visibility (B.1.2.1), presence of landmarks and quality of the built environment (B.1.2.2-B.1.2.5) and attractiveness of existing activities accommodated in riverside public space (B.1.2.6). Ecological indicators refer to the degree to which natural processes, including river dynamics and geomorphological processes are accommodated in space (B.2.2.1-B.2.2.3).

Spatial composition (B.1.3 and B.2.3)

"more space for water, more space for plants and animals, more space for people." (Prominski et al., 2017, p.15)

"what and how much is present of each habitat or cover type" (Turner & Gardner, 2015, p.3).

In landscape ecology, spatial composition is defined as "what and how much is present of each habitat or cover type" (Turner & Gardner, 2015, p. 3). Together with spatial configuration, it is an important measure of landscape heterogeneity (Gustafson, 1998). Indicators in this category are concerned with areal properties of the urban fabric and artificial spaces (B.1.3.1-B.1.3.3), as well as open and green spaces (B.2.3.1-B.2.3.2).

TABLE 5.3 Indicators of social and ecological spatial capacity.

ID	Indicator and source*	Definition
B	**SPATIAL CAPACITY**	
B.1	**Social**	
B.1.1	**Spatial diversity**	
B.1.1.1a	Diversity of land uses – richness (adapted from Prastacos et al., 2017)	Patch richness density (PRD), representing the number of different land use classes per 100 hectares within the study area, is used as a measure of land use diversity. Values: [1] PRD < 0,25; [2] 0,25 ≤ PRD < 0,75; [3] PRD ≥ 0,75.
B.1.1.1b	Diversity of land uses – dominance (based on O'Neill et al., 1988)	Dominance represents the relative abundance of a land use class. Values (normalised): [1] ≤0,33; [2] >0,33 and ≤0,66; [3] >0,66.
B.1.1.1c	Diversity of land uses – dominant activities in riverfront (adapted from Batista e Silva et al., 2004, pp.59-61)	Percentage of different types of activities such as dwelling, services, commerce, and industries in the river space. Values: [1] not urbanised or predominantly non-urban; [2] partially urban with low diversity of urban activities; [3] predominantly urban with diversity of urban activities.
B.1.2	**Spatial quality**	
B.1.2.1a	Visual permeability - % visible river space	Percentage of visible open space within the river space. Values: [1] low visibility, when lower than 25%, [2] medium visibility between 25% and 75%, and [3] high visibility above 75%.
B.1.2.1b	Visual permeability – linear density of visual intersections (adapted from Batista e Silva et al., 2004, pp.48-49)	The visibility of the river space from the surrounding urban fabric is measured by the linear density of visual intersections between transversal visual axes and the river. Values: [1] 0-3 intersections/km; [2] 4-6 intersections/km; [3] 7-10 intersections/km. The maximum plausible and the corresponding categories may differ depending on specific URC or corridor segment conditions.
B.1.2.1c	Visual permeability - average length of transversal visual axes (adapted from Batista e Silva et al., 2004, pp.48-49)	Average length of visual axes with the river in a corridor segment, i.e. length of visual axes per number of visual axes intersecting the river. The maximum plausible (M) is determined for each corridor segment. Values: [1] ≤M/3; [2] >M/3 and ≤2M/3; [3] >2M/3.
B.1.2.1d	Visual permeability - no. of belvederes (adapted from Batista e Silva et al., 2004, pp.48-49)	Number of belvederes (no. of belvederes/area of river corridor (km2). The maximum plausible number of belvederes (M) is determined in a site analysis. Values: [1] ≤M/3; [2] >M/3 and ≤2M/3; [3] >2M/3.
B.1.2.2	Density of landmarks	Number of landmarks per area of river corridor. Maximum/target (M) is determined by a landscape analysis. Values: [1] ≤M/3; [2] >M/3 and ≤2M/3; [3] >2M/3.
B.1.2.3	Built space quality (adapted from Batista e Silva et al., 2004, pp.51-53)	Built space quality according to local building quality classification: [1] good quality; [2] medium quality; [3] bad quality.
B.1.2.4	Public utility of riverfront (adapted from Batista e Silva et al., 2004, p.53)	Predominance of attractive riverside public space (incl. green space). Values are given by the predominance of: [1] private space, public space not designated for pedestrian use (streets and parking); [2] unattractive public space; [3] attractive public space.
B.1.2.5	Cultural heritage (CH) - public interest of present CH values (adapted from Batista e Silva et al., 2004, pp.56-57)	"The amount of classified CH units in the river corridor with officially recognized public interest." (Batista e Silva et al., 2004, p.57) Maximum/target (M) is determined by a site analysis. Values: [1] ≤M/3; [2] >M/3 and ≤2M/3; [3] >2M/3.
B.1.2.6	Pollution (adapted from Batista e Silva et al., 2004, p.69)	Pollution classified according to local measurements of water quality: [1] poor; [2] fair; [3] good.
B.1.2.7	Attractiveness of existing activities (adapted from Batista e Silva et al., 2004, p.62)	The attractiveness of areas in a riverfront "is influenced by their distinctiveness, which makes them different from other common places in the city playing a different or specific role in the daily life of the city." Values: [1] low; [2] medium; [3] high.

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TABLE 5.3 Indicators of social and ecological spatial capacity.

ID	Indicator and source*	Definition
B.1.3	**Spatial composition**	
B.1.3.1	Intensity of construction (adapted from Batista e Silva et al., 2004, pp.55-56)	Gross floor area of construction per net surface of the river front. The maximum plausible intensity of construction (M) is determined in a site analysis. Values: [1] ≤M/3; [2] >M/3 and ≤2M/3; [3] >2M/3.
B.1.3.2a	Waterfront constitutedness - composition	Waterfront constitutedness is indicated by the percentage of the total length of built fronts projected on the river edges out of the total length of the river edges, corrected with a coefficient of fragmentation (standard deviation from maximum potential constitutedness). Values are standardized and classified as: [1] value ≤ 50%; [2] 50% < value ≤ 75%; [3] value > 75%.
B.1.3.2b	Waterfront constitutedness - configuration	Waterfront constitutedness is indicated by the perimeter-area ratio of the river space in a corridor segment. Values are determined according to the standard deviation from maximum possible constitutedness as: [1] fragmented; [2] partially constituted; [3] constituted.
B.1.3.3	Coverage - % parking spaces	Parking space coverage is indicated by the percentage of the total area of parking spaces out of the total area of open spaces in the corridor segment and it is classified as: [1] low, below 10%; [2] medium, between 10%-20%; [3] high, above 20%. The maximum plausible and the corresponding categories may differ depending on specific URC or corridor segment conditions.
B.2	**Ecological**	
B.2.1	**Spatial Diversity**	
B.2.1.1	Biodiversity	Species-rich areas in the corridor are mapped and classified as follows: [1] low, when no such area is present, [2] medium, when they are present in the proximity of the river, or [3] high, when species-rich areas are in direct contact with the river, i.e. they constitute part of the riparian space.
B.2.1.2	Storm water storage diversity	Different types of storm water storage solutions, classified as: [1] absent or neglected, grey infrastructure accommodating mainly drainage; [2] storage through grey infrastructure and pervious surfaces; [3] storage through pervious surfaces and a variety of green and blue infrastructure solutions, in addition to grey infrastructure.
B.2.1.3	Presence of different types of vegetation species (adapted from Batista e Silva et al., 2004, p.42)	Riparian vegetation classified as: [1] absent or herbaceous vegetation; [2] scarce trees in one or both margins; [3] well developed and continuous riparian vegetation in both margins.
B.2.1.4	Shannon diversity index (SHDI) (based on Alberti et al., 2007)	"The number of land cover classes in the landscape, [calculated as the] minus the sum, across all patch types, of the proportional abundance of each patch type multiplied by that proportion." (Alberti et al., 2007, p. 352). Values (normalised): [1] ≤0,33; [2] >0,33 and ≤0,66; [3] >0,66.
B.2.2	**Spatial quality**	
B.2.2.1	Flood vulnerability - % (adapted from Batista e Silva et al., 2004, pp.45-46)	Percentage of the total area of the corridor within the area of a 100-year flood. Values: [1] low; [2] medium; [3] high. As stated by Batista e Silva et al. (2004), adequate risk cartography is required for the assessment; values for the three classes are determined accordingly.
B.2.2.2	Bank erosion or landslide risk - % (adapted from Batista e Silva et al., 2004, p.46)	Percentage of the total length of river banks with potential erosion or landslides. Values: [1] low; [2] medium; [3] high. As stated by Batista e Silva et al. (2004), adequate risk cartography is required for the assessment; values for the three classes are determined accordingly.
B.2.2.3	Respect of natural dynamics (adapted from Batista e Silva et al., 2004, p.34)	Degree of disturbance of the river channel classified as: [1] highly disturbed (very artificial, channelized, concrete bed and banks), [2] moderately disturbed (artificial, channelized or concrete bed or banks), or [3] undisturbed (close to natural conditions).
B.2.3	**Spatial composition**	
B.2.3.1a	Coverage - % open space	The percentage of the total area of open spaces in a corridor segment out of the total area of the corridor segment. Open spaces are all unbuilt spaces, excluding the area occupied by road infrastructure and water. Values: [1] below 50%; [2] medium 50-75%; [3] above 75%.
B.2.3.1b	Coverage - % green space (based on Davis & Uffer, 2013)	Green space coverage is indicated by the percentage of the total area of green spaces out of the total area of the corridor segment and it is classified as: [1] low, below 20%; [2] medium, between 20%-40%; [3] high, above 40%.
B.2.3.1c	Coverage - % total impervious area (based on Alberti et al., 2007)	Percent total impervious area (%TIA) is classified as: [1] high imperviousness, below 20%; [2] medium imperviousness, between 20%-40%; [3] low imperviousness, above 40%. The maximum plausible and the corresponding categories are determined according to specific URC or corridor segment conditions.
B.2.3.2	Width of riparian vegetation (adapted from Batista e Silva et al., 2004, pp.42-43)	The riparian vegetation is classified as: [1] absent or narrow, value between 0-12m; [2] medium, value between 12-20m; [3] large, value >20m.

** Indicators for which a source is not specified were proposed in this thesis.*

§ 5.4.3 Scalar framework

As explained in the spatial definition of URCs presented in Section 2.3, the scalar framework of the analyses uses a three-level hierarchy of scales: *scale of context*, *scale of focus* and *scale of detail* (Turner & Gardner, 2015). The assessment is carried out at the scale of focus: the URC and the corridor segment, delineated spatially according to the method described in Section 2.3. Within this framework, any spatial implication of the larger scales of context (the catchment or the urban hinterland) or of scales of detailed interventions (in the river space or the individual project) must be first translated to the scale of the corridor segment before it can be subjected to assessment.

§ 5.4.4 Social-ecological integration assessment

The assessment of social-ecological integration is made by confronting the social and ecological dimensions of each sub-category described above on the scale of the river corridor segment. Each indicator is assessed on a standardised three-point scale. Although the indicator system proposed here can be used in various ways, in this method the selection of at least one representative indicator per sub-category is required for a complete assessment. The results per sub-category are summarised with minimum values in a *mirorred assessment chart*, as presented in Figure 5.3. In this mirrored assessment chart, the level of social-ecological integration is given by the lowest score of the social or the ecological dimension for each sub-category. When scores are different in the two dimensions, areas of strategic intervention are identified with a '+'. In terms of planning and design decision, these areas represent *the minimum desirable goal* that needs to be attained for social-ecological integration. The results of each corridor segment are summarised and compared in radar charts (see Figure 6.7 in the next chapter) and an assessment of the whole corridor is made by highlighting segments of high and low social-ecological integration, as well as areas of strategic corridor-scale intervention (e.g. actions that can be replicated across corridor segments where similar potentials for social-ecological integration are observed).

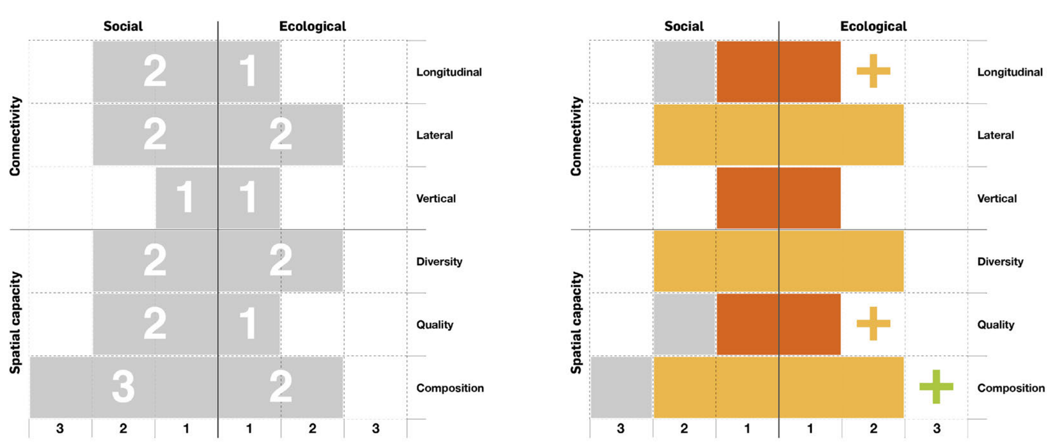

FIGURE 5.3 Example of a mirrored assessment chart, summarizing social-ecological integration assessment on the scale of a corridor segment. Fields with '+' mark areas of intervention towards the minimum desirable goal.

§ 5.5 Discussion

This assessment framework provides a general estimation of social-ecological integration in URCs. That is, its main purpose is to inform early stages of decision-making, to guide more targeted analyses and to provide an evidence base for urban design and planning. Yet, if the target is a fully fledged assessment of social-ecological integration in a real-world context, then some limitations of the indicator system and the assessment method developed in this chapter must be considered.

The quality of an indicator system is subject to issues of weighing, validity, calibration and comparability across cases. The system of indicators presented in this chapter puts an equal weight on each indicator, even though some indicators might have a higher impact on the sub-category that they are part of than others. Also, redundancies and synergies between indicators could not be fully identified. For improvements to these issues to be made, the indicator system needs to be tested, validated, and calibrated on different URCs. A reliable method of weighing based on local conditions (e.g. making use of the opinions of local experts or the public) can improve the accuracy of the assessment. Validation with different URCs can also improve the scientific underpinning, output and usefulness of the indicators. Given the extensive use of relative values in the indicator system introduced in this chapter (e.g. maximum and minimum plausible values), and thus the lack of comparability across cases, applications on different URCs can be used to calibrate benchmarks and hence increase the wider applicability of the indicator system.

The method of assessment, i.e. the aggregation of the indicators to the six sub-categories and the use of the mirrored assessment chart to confront indicators of corresponding social and ecological sub-categories, may lead to under-evaluation of the actual situation. However, the use of potential values (i.e. the fields marked with a '+' in the mirrored assessment chart) provide knowledge of strategic areas of intervention towards a minimum desirable goal, which balances the minimum aggregation method. Furthermore, as the assessment framework is part of a larger planning or design process, other external constraints and unidentified potentials can be considered in the unmarked fields of the assessment chart. These constraints and potentials will be further discussed in the application on the URCs of Bucharest presented in Chapter 6.

Regarding the wider implications of this assessment framework, a few questions and avenues for exploration are left open. How can the knowledge gained from assessment inform design and planning for social-ecological resilience? Or, how does corridor-scale social-ecological integration contribute to city-scale resilience? To what extent can the design process lead to discoveries that are not pointed out in the assessment? The following chapters will set out to tackle these challenges.

§ 5.6 Conclusion

This chapter translated the spatial-morphological definition of URCs formulated in Chapter 2 into *an assessment framework*, that is, *a system of indicators* and *a method of assessing social-ecological integration in URCs*. Informed by an overview of current approaches to urban river assessment in urban planning and design, landscape architecture and landscape ecology, and structured by the four properties of URCs, the assessment framework comprises a system of *social and ecological indicators of connectivity* (with the sub-categories of lateral, longitudinal and vertical connectivity) *and spatial capacity* (with the sub-categories of spatial diversity, spatial quality, and spatial composition). The method of t*he mirrored assessment chart* confronts social and ecological indicators of corresponding sub-categories (e.g. ecological spatial diversity and social spatial diversity) on corridor segment scale and on the scale of the URC. As a planning or design decision tool, this method of assessment highlights key areas of intervention for a *minimum desirable goal* of social-ecological integration. In the next chapter, the two URCs of Bucharest are used to demonstrate the application of the assessment framework.

6 Assessing the Urban River Corridors of Bucharest

§ 6.1 Introduction

With the aim of demonstrating the application of the assessment framework developed in Chapter 5 on a real-world case, this chapter presents a full assessment of URC Dâmbovița and a demonstration of wider applicability on URC Colentina. Based on problems and potentials derived from the expert interviews presented in Chapter 4, a case-specific subset is selected from the indicator system for both URCs of Bucharest. Before the assessment, Section 6.2 presents the units of assessment, that is, the corridor segments of URC Dâmbovița delineated according to the method introduced in Section 2.3, explains the reasoning behind the selection of indicators, and provides some specifications related to data and implementation. Section 6.3 presents the results of the assessment carried out on URC Dâmbovița in three steps: measurements of all indicators are summarised under the sub-categories of connectivity (longitudinal, lateral and vertical) and spatial capacity (diversity, quality and composition) and potential synergies between indicators are highlighted (Sections 6.3.1 and 6.3.2); a mirrored assessment chart is used as a method for segment-scale assessment of social-ecological integration; corridor-scale assessment is used to compare segment-scale results and to identify typologies of potential social-ecological integration (Section 6.3.3). Section 6.4 illustrates the wider application of the assessment framework on URC Colentina. The chapter ends with a discussion on challenges and opportunities that arise from the assessment process (Section 6.5), and a set of recommendations for design (Section 6.6).

SUB-QUESTION AND OBJECTIVES:		
Sub-question 6:	**To what extent are the URCs of Bucharest social-ecologically integrated?**	
Objective 6.1:	Assess social-ecological integration in URC Dâmbovița.	Section 6.3
Objective 6.2:	Demonstrate the wider application of the assessment framework on URC Colentina.	Section 6.4

§ 6.2 Assessment methodology

As it will be demonstrated in Section 6.3 on URC Dâmbovița and further illustrated with URC Colentina in Section 6.4, a complete assessment process consists of the delineation of the study area and the units of assessment, selection of indicators according to a number of criteria, and segment- and corridor-scale assessment.

§ 6.2.1 Study area and assessment units

The study area (the URC) and the assessment units (CSs) are determined according to the method of delineation presented in Section 2.3. The outer boundaries of the URC are delineated by major transport routes parallel to- and outside the river valley. Corridor segments (CSs) are delineated with major transversal roads and are defined as distinct morphological units with relatively high potential accessibility towards the river. URC Delineated according to this method, URC Dâmbovița consists of 9 corridor segments (Figure 6.1). CSs are chosen as the spatial units of analysis as they offer a sufficiently detailed area of analysis while remaining representative modules of the overall corridor. The two end segments CS01 and CS09 are considerably larger than CS02-CS08 in the middle of the corridor. They were maintained as such due to their less dense and peripheral position and more continuous spatial morphology. A possible subdivision can amend this subdivision in the future if the express road in CS01 and the median ring in CS09 are built.

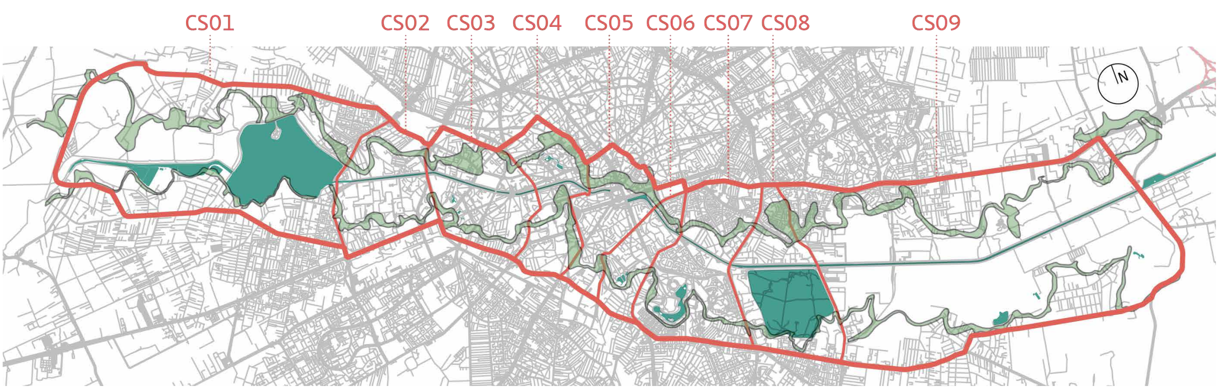

FIGURE 6.1 The delineation of URC Dâmbovița and its segments.

§ 6.2.2 Selection of indicators

The indicator list presented in Chapter 5 can be selectively adapted to specific cases. A complete assessment using all indicators might not be necessary, nor feasible. A selection of a representative subset of indicators is used in this chapter to demonstrate the assessment process on the case of URC Dâmbovița and URC Colentina in Bucharest. The selection of indicators for both corridors was made (see the selection of indicators for URC Dâmbovița in Table 6.1) based on the following criteria:

- *Representativeness* is achieved by selecting at least one indicator from each sub-category of the indicator system. This balanced distribution of indicators is important for a complete assessment of social-ecological integration.
- The selection of indicators within each sub-category is *case-/application-specific*. Case-specificity is achieved in this assessment by selecting indicators corresponding to major local issues, as identified by the local experts in Chapter 4. Application-specificity is related to case-specificity and it is determined by the objectives of the assessment. For instance, if description of the current situation is the main objective, indicators of the actual situation are preferred. If the assessment is used for

planning decisions—i.e., how can the social-ecological integration of the URC be improved?—, then indicators of potentials must be included in the selection. In this case, indicators of both the actual and, as much as possible, the potential situation were included in the selection.

- In addition, the use of certain indicators may be constrained by *data availability*. Within the constraints of the first two criteria (representativeness and case-/application-specificity), the indicators for which data is readily available are selected.
- *Implementation constraints* can be also a criterion for selection. Indicators for which implementation knowledge is lacking—e.g. the use of a new software or method of analysis—can be avoided.

§ 6.2.3 Data and implementation

This assessment uses open geographic data, namely OpenStreetMap (OSM), Urban Atlas (UA) data, and SRTM DEM data.[64] Due to its thorough global coverage (relatively complete especially in urban areas) and high update rate, OSM was chosen as the main data source for this assessment. In addition, UA data were used for more detailed and consistent land cover and land use information, where a complete partition of space was needed for the calculation of some indicators. In response to the requirements of context specificity and data availability stated above, OSM and UA data for the city of Bucharest were considered suitable for the purposes of this assessment.

For in-depth analyses, subsequent to and informed by this assessment, more detailed and authoritative geographic data can be used (e.g. building and parcel data from municipal sources). In addition, the assessment framework can be supplemented with other types of data, such as biophysical data from remote sensing, socio-economic data, environmental data, climate data, or primary data collected through site surveys.

Whenever data-related recommendations could be made, or limitations were observed during analysis, they were included in the description of the indicator in question. The assessment made use of GIS software—*ArcGIS* and *QGIS*—as well as indicator-specific tools, such as the *Space Syntax Toolkit* for *QGIS*, *Fluvial Corridor* and *MatrixGreen* for *ArcGIS* to generate geographic data, to perform spatial and network analyses and to integrate different types of data. A detailed description of the tools used for each indicator, including specific recommendations, can be found in Appendix E.

64 OpenStreetMap (OSM) is the most comprehensive source of volunteered geographic information (VGI) on a global scale. Urban Atlas (UA) is a dataset developed by the European Environment Agency (EEA) for land use/cover applications in urban areas. The UA dataset contains most Large Urban Zones (LUZs)—cities with a population over 100.000—of the EU for the reference years 2006 and 2012. 30-meter resolution Digital Elevation Models (DEM) from the Shuttle Radar Topography Mission (SRTM) data are freely available from NASA.

	PROBLEMS	POTENTIALS	SELECTED INDICATORS
Connectivity			
Longitudinal			
Social	It is currently a thoroughfare crossing the city diametrically. Transversal crossings (mostly car bridges) are obstacles to longitudinal pedestrian movement.	It could be a slow mobility corridor crossing the city.	**A.1.1.1a Slow mobility routes - continuitiy** **A.1.1.1b Slow mobility routes - %** A.1.1.1c Slow mobility routes - location
Ecological	It does not function as a green corridor. A large part of the river flow is underground; the weirs are barriers to fish movement; river dynamics (e.g. sedimentation) are absent.	Although detached from the river, the parks on the right valley edge represent an important green structure.	**A.2.1.1a Landscape connectivity - connected components** A.2.1.1b Landscape connectivity - stepping stones
Lateral			
Social	Riverside walkways are difficult to access and, according to some experts, the river is hard to cross.	It could become a balancing structure bringing local communities and inhabitants of the whole city together.	**A.1.2.1a Accessibility - network** A.1.2.1b Accessibility - residents **A.1.2.1c Accessibility - visitors** **A.1.2.3a Crossability - linear density of crossings** **A.1.2.3b Crossability - river width**
Ecological	Tributaries and lateral corridors have been disconnected from the river due to canalisation.	The morphology of the river and the valley can be used to understand and restore the qualities of the river.	**A.2.2.1 Presence of transversal corridors** **A.2.2.3 Sinuosity**
Vertical			
Social	Besides the occasional use of the river for fishing, there is almost no physical contact with water.	Some points such as abandoned weirs or service ramps could become access points to the river.	**A.1.3.1a Contact with water - points** A.1.3.1b Contact with water - typology A.1.3.2 Contact with water - constructions A.1.3.3 Contact with water - swimming
Ecological	The design of the river as a sealed concrete canal does not allow for interaction with groundwater, nor for gradients or ecotones on the riverbank.	The spontaneous riverbank vegetation in certain river segments could be extended to the water.	**A.2.3.1 Presence of ecotones**
Spatial capacity			
Diversity			
Social	The functional and spatial diversity of the river is not capitalised on. It is perceived as a fragmented rather than a diverse urban space.	Dâmbovița could become an axis of urban development. Its sequentiality, i.e. the succession of urban areas with different characteristics along its trajectory, is an important part of its identity.	**B.1.1.1a Diversity of land uses - richness** B.1.1.1b Diversity of land uses - dominance B.1.1.2 Attractiveness of existing activities
Ecological	The quality of water and the delivery of ecosystem services are poor.	Large natural areas like Lake Văcărești, are important sources of biodiversity.	**B.2.1.1 Biodiversity—presence of species-rich areas**
Quality			
Social	It is unattractive, hardly visible, it lacks public spaces, and it is considered a 'non-place'.	It could become the largest public space of the city.	**B.1.2.1a Visual permeability - % of visible river space** B.1.2.1b / B.1.2.1c / B.1.2.1d
Ecological	The quality of water and the delivery of ecosystem services are poor.		**B.2.2.4 Respect of natural dynamics**
Composition			
Social	The river space is cramped in the central part of the river and fragmented in peripheral segments. In both cases, the riverside urban fabric hardly interacts with the river.	Riverside abandoned urban structures or fragmented spaces, such as brownfields and former industrial buildings, could accommodate new projects and public spaces.	**B.1.3.2a Waterfront constitutedness - configuration** B.1.3.2b Waterfront constitutedness - composition
Ecological	There is a latent flood risk due to canalisation, but it is mitigated on a regional level and there is no spatial reserve for flooding, i.e. a floodplain, inside the city.	Open spaces, currently unused or used as parking spaces (mostly impervious), present an important potential for increasing the spatial capacity of the river.	**B.2.3.1a Coverage - % open space** B.2.3.1b Coverage - % green space B.2.3.1c Coverage - % total impervious area

TABLE 6.1 Indicators selected for URC Dâmbovița, according to the criteria of representativeness and case-specificity, i.e. corresponding to the main problems and potentials identified by local experts (see Chapter 4 for a detailed analysis of the experts' opinions and Appendix E for a full list of problems and potentials, from which the summary in this table was made). A subset (marked with blue) was selected according to the criteria of data availability and implementation constraints.

§ 6.3 Corridor segment analysis

A complete assessment was carried out on the nine segments of URC Dâmbovița with the indicators highlighted in Table 6.1. In what follows, the results are summarised under the six sub-categories of the indicator system (Sections 6.3.1 and 6.3.2) and the assessment of social-ecological integration is demonstrated on corridor-segment-scale (CS03) and URC-scale (Section 6.3.3). The results for all indicators used in the assessment are included in Appendix E.

§ 6.3.1 Connectivity

Issues related to connectivity on River Dâmbovița have been pointed out already in Chapters 3 and 4. Most of those issues were related to the way people move along, to, across and in URC Dâmbovița. Connectivity was described as a problem whenever it creates barriers through fast vehicular movement along the river, and as a potential when it facilitates pedestrian access to and slow movement along the river. The assessment of three-dimensional connectivity presented here responds to those observations and adds to them a more explicit ecological view. Each indicator was measured on the scale of a corridor segment for all segments of the URC. Figure 6.2 gives an example of an indicator used for the assessment of connectivity.

Longitudinal connectivity

Most local experts have agreed that, on one hand, Dâmbovița is a traffic corridor dedicated to fast vehicular movement and that, on the other hand, it could become a major slow mobility route of the city (Table 6.1). Assuming that bike paths are markers of consolidated slow mobility routes, their presence and continuity (see indicators A.1.1.1b and A.1.1.1a, respectively, in Appendix E) were chosen as a measure of actual longitudinal connectivity in the social category. Although longitudinal vehicular traffic is relatively well accommodated along River Dâmbovița, the analysis shows that the actual longitudinal connectivity of slow mobility routes is low. Looking at the percentage of slow mobility routes, it is visible that bike paths are only present in river segments CS03 (55% of the total length of riverbanks), CS04 (98%) and CS05 (36%) located in the centre of the city, leaving riverside paths in the other river segments completely disconnected from the bike path network. As a result, actual longitudinal connectivity of slow mobility routes on the scale of the corridor is considered to be low. However, given the continuity of riverside roads, the potential for a continuous corridor route is high.

On the ecological dimension, actual and potential longitudinal connectivity is measured at the scale of the corridor. Landscape connectivity metrics show that, even though the network of green patches crossing the city is not continuous, there is a high potential to achieve continuity—i.e. one connected component crossing the city along the corridor—by including non-vegetated open spaces in the network (see indicator A.2.1.1a in Appendix E).

Lateral connectivity

According to several experts, an important problem of River Dâmbovița is that riverside walkways are difficult to access by pedestrians; on the other hand, some experts state that it could potentially become a balancing structure bringing local communities together (Table 6.1). Network analysis carried out with indicator A.1.2.1a shows that the local accessibility of riverside paths—i.e. the possibility to access the river within a 500m walking distance—is high in central river segments CS04 and CS05, and that it gradually decreases through medium values in CS02, CS03, CS06 and CS07 to low values in the peripheral segments CS01, CS08 and CS09. Accessibility from public transport stops (A.1.2.1c), indicating the potential access to the river for visitors is high (above 75%) in most segments (Figure 6.2). Exceptions are CS07 with a medium value (64%) and the peripheral segments CS01 (4%) and CS09 (48%) with low values. Crossability was recorded with mostly medium values for the linear density of bridges (2-3 bridges/km) in the actual situation (A.1.2.3a Crossability – linear density of bridges) and with mostly high potential values given by the narrow cross section (below 50m) of the river (A.1.2.3b Crossability – river width).

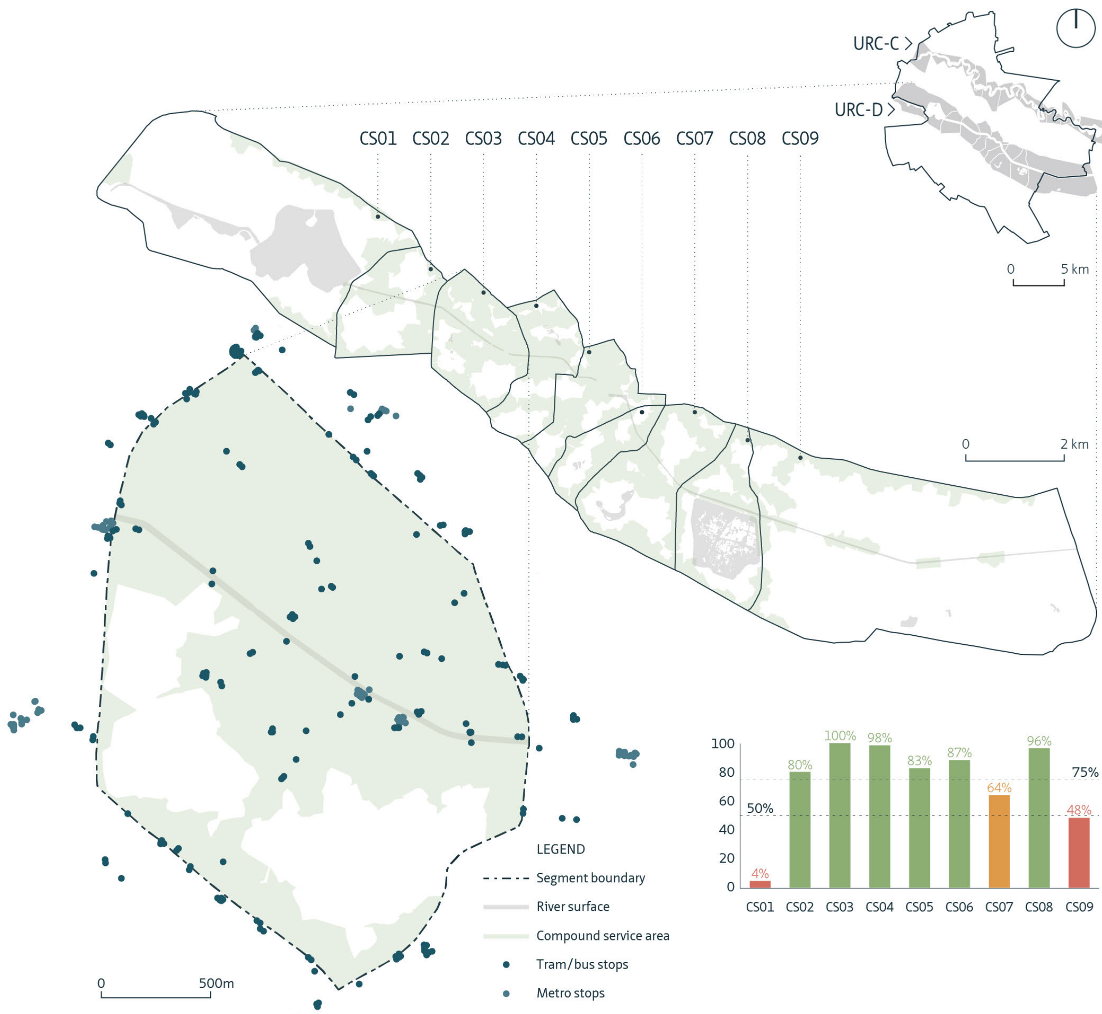

FIGURE 6.2 Accessibility from public transport stops (A.1.2.1c Accessibility – visitors), as an example of a connectivity indicator applied on URC Dâmbovița and detailed on corridor segment CS03.

Regarding ecological connectivity on the lateral dimension, the disconnection of tributaries and lateral corridors were mentioned, as well as the hidden potential of the river valley to restore the qualities of the corridor (Table 6.1). The presence of transversal corridors (A.2.2.1), indicating the ecological side of lateral connectivity, gave less regular results than lateral connectivity indicators related to people's

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movement. Here ecological lateral connectivity varies between low and medium values and it is mainly provided by the succession of green patches along roads intersecting the river. The smallest value was recorded in CS06 (11%) and the highest in CS09 (80%).

Vertical connectivity

It was repeatedly pointed out during the interviews that the canalised profile of the river offers no possibility for physical interaction with water, such as bathing and boating (Table 6.1). From the point of view of hydrological and ecological vertical connectivity, the sealed profile of the river does not allow for interaction between the river and ground water, nor does it provide the conditions for ecological transition zones between terrestrial and aquatic ecosystems. Vertical connectivity, assessed by the number of contact points with water (A.1.3.1a) and the presence of ecotones (A.2.3.1), obtained the minimum score (less than 2 contact points per km) for most corridor segments on the social side, and for all corridor segments on the ecological side (total absence of ecotones), as both human and ecological contact is obstructed by the canalised design of the river. The only exception is CS05, where a number of five balconies and a floating platform were recently added on the widest segment of the river in front of the National Library. This river segment in particular was mentioned by the experts as one of the most attractive public spaces along the river and the only place where events on water take place.

Although existing technical structures, such as the piers, ramps or stairs counted along River Dâmbovița as contact points, can be used to improve the contact with water, more points of access, such as the new structures added in CS05, are needed for an increased score. Also, a less sealed and more gradual river section, combined with existing and new points of access, can improve the potential of both social and ecological vertical connectivity.

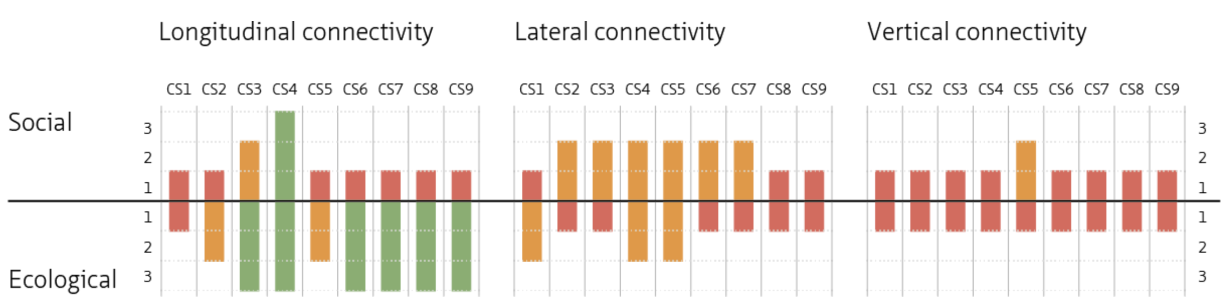

FIGURE 6.3 Summary of three-dimensional connectivity assessment.

As shown in Figure 6.3, the actual three-dimensional connectivity of URC Dâmbovița is low, mainly on the vertical dimension. However, as pointed out above, a number of spatial potentials for improved connectivity can be observed on all three dimensions:

– The continuity of the traffic corridor along and on both sides of the river creates the conditions for improved longitudinal social connectivity. Longitudinal ecological connectivity can also be improved by transforming non-vegetated open spaces into ecological patches acting as stepping stones for species movement.

- The high potential crossability of the river, as well as the relatively high local accessibility of riverside paths in the overall street network of the city, allows for a potential increase of lateral connectivity in URC Dâmbovița especially in corridor segments CS04 and CS05 (see Table 6.2).
- Although both social and ecological connectivity scored low on the vertical dimension, riverbanks redesigned with a more gradual transition between land and water and a more permeable ground can considerably improve vertical connectivity.

§ 6.3.2 Spatial capacity

The lack of riverside public space and green space, as well as the confinement of a large part of river in an underground culvert, were mentioned by several experts as a major problem of River Dâmbovița. Another issue stated by most experts is that the river is highly unattractive, although the sequentiality of different spatial identities along its trajectory and its central position could potentially make it the largest public space of the city. Assessment of spatial capacity addresses these issues with indicators of spatial diversity, spatial quality, and spatial abundance (see example in Figure 6.4).

Spatial diversity—mixed use and landscape heterogeneity

According to some local experts, the potential for functional and spatial diversity of River Dâmbovița is unused; instead, it is currently perceived as a fragmented urban space. If this potential is exploited, several experts stated, River Dâmbovița could become the largest public space of the city (Table 6.1). Analysis shows that the diversity of land uses (B.1.1.1a) in the social dimension is medium for most corridor segments. From an ecological perspective, biodiversity (B.2.1.1) scored low in all river segments (no species-rich areas), except CS08 where Văcărești Natural Park is located and in the two end segments which are directly connected to the landscape surrounding the city.

Although diversity can be improved locally by mixed use interventions and landscaping that combines different habitat types, sustainable diversity is highly dependent on connectivity. Improvements in longitudinal, lateral and vertical connectivity (indicated by A.1.1.1, A.2.1.1, A1.2.1, A.2.2.1, A.1.3.1 and A.2.3.1) can have a positive impact on increasing potential functional diversity and biodiversity. Similarly, improved spatial quality (e.g. indicated by B.2.2.4 Visual permeability) and spatial abundance (e.g. indicated by B.2.3.1 Coverage) can encourage diversity.

Spatial quality—attractiveness and respect of natural dynamics

Many of the interviewed experts considered URC Dâmbovița a 'non-place', that is, a place where people do not go or do not know of. They also pointed out the potential of the river space to become an element of spatial identity for the whole city (Table 6.1). In terms of visual permeability (B.1.2.1a, Figure 6.4), the river space of Dâmbovița scored medium values (i.e. more than 25% of the river space is visible) in all corridor segments, except CS01, which scored high (above 75%). On the ecological dimension, however, the whole corridor scored low (highly disturbed), as the river currently does not accommodate natural dynamics, such as sedimentation and erosion (B.2.2.4 Respect of natural dynamics).

Apart from augmenting the current visibility of River Dâmbovița, shown by the indicator of visual permeability, attractiveness requires increased spatial diversity (see indicators B.1.1.1 and B.2.1.1) and spatial capacity (e.g. B.2.3.1 Coverage). Moreover, indicators of connectivity (e.g. A.1.2.1

Accessibility or A.2.2.3 Sinuosity), can provide further insights on the potential attractiveness of riverside urban spaces.

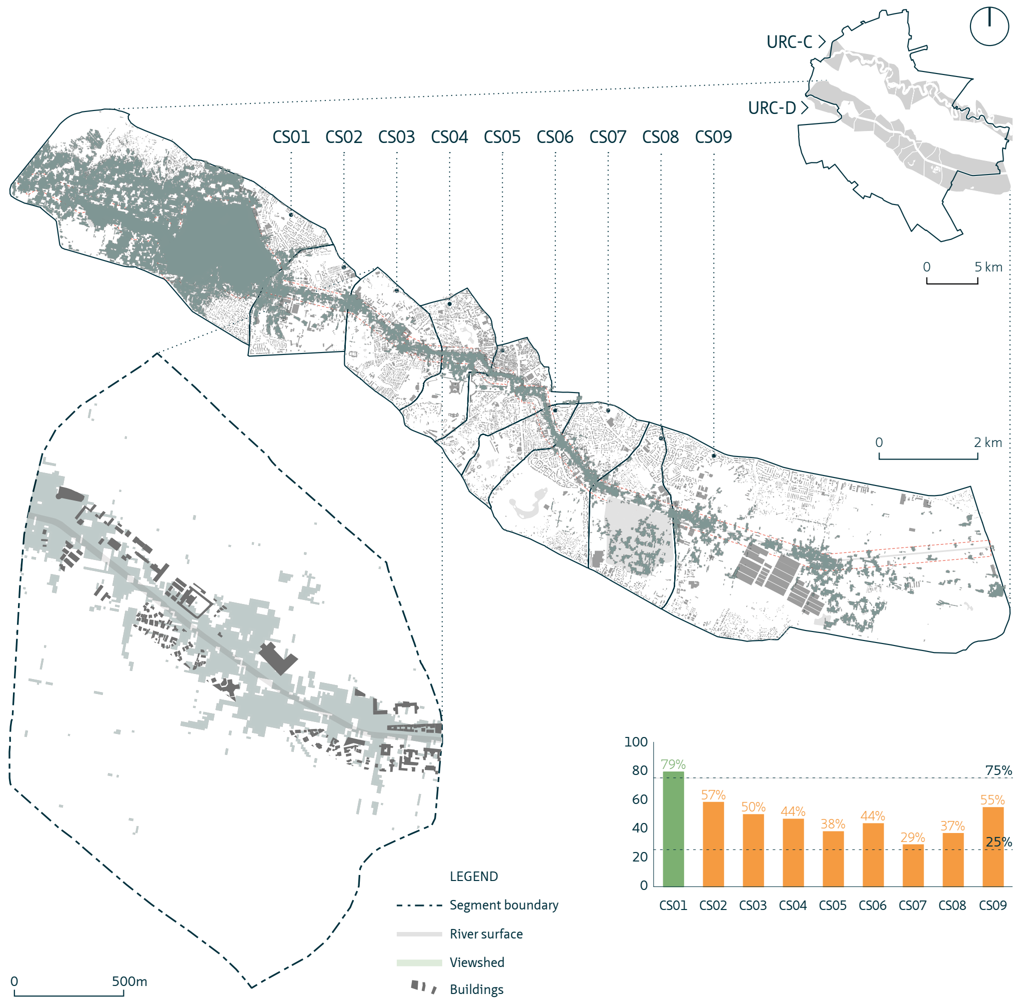

FIGURE 6.4 Visual permeability - % of visible river space (B.1.2.1a), as an example of a spatial capacity indicator applied on URC Dâmbovița and detailed on corridor segment CS03.

Spatial composition—intensity and abundance

A general observation across the expert interviews (Table 6.1) was that the urban space along River Dâmbovița is cramped due to the built density, especially in central segments. Similarly, the space of the river is confined to an underground culvert and a surface canal that constrain the lateral movement of water and the ecological development of the riparian space. Yet, as mentioned by some interviewees, underused structures and open spaces could be used to accommodate new public spaces and ecological space.

Analysis of the spatial configuration of the waterfront (B.1.3.2a), chosen for the assessment of spatial capacity on the social dimension, showed that the central corridor segments CS03-CS07 have a consolidated waterfront, followed by the neighbouring segments CS02 and CS08 with medium values

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and the end segments CS01 and CS09 with low values. Open space coverage (B.2.3.1a), the indicator selected in the ecological dimension, gave medium (CS01, CS03-CS06) and high (CS02, CS07-CS09) values.

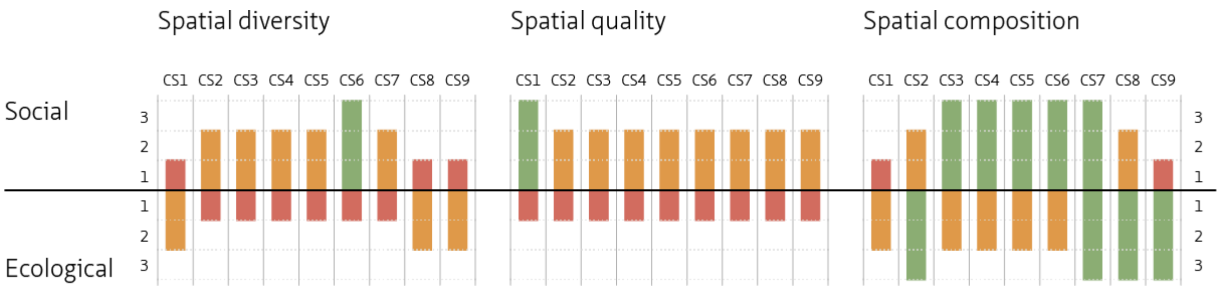

FIGURE 6.5 Summary of spatial capacity assessment.

Overall, as summarised in Figure 6.5, indicators of spatial capacity on the social side gave considerably higher values than the ones on the ecological side. The strong urban character and central location of URC Dâmbovița affords a higher spatial diversity on the social dimension than on the ecological dimension. For the same reason, social spatial quality is higher, with at least one point on the assessment scale, than ecological spatial quality. Even though crampedness is signalled as a key issue if River Dâmbovița, there is unused spatial capacity available along the entire corridor. In this case, abundance alternates on the two dimensions, with high social capacity in central segments and high ecological capacity in end segments.

Ecological spatial capacity scored especially low in central segments due to low biodiversity and a high level of disturbance of natural dynamics. In terms of spatial composition, ecological values were considerably higher, as the indicator of open space coverage (B.2.3.1a) took into consideration open spaces found in the whole corridor segment, regardless of their ecological value.

§ 6.3.3 Social-ecological integration

In the assessment of connectivity and spatial capacity, some indications have been given regarding combinations of indicators of connectivity and spatial capacity for attaining potentials of either ecological or social kind. Yet, as the final goal of the framework is the assessment of social-ecological integration, the results were aggregated and re-arranged into social and ecological categories (Table 6.2). To that end, minimum values were used for the aggregation of individual indicators to the level of the six sub-categories of the indicator system. These aggregated values, equally distributed in the social and ecological categories, were used for the assessment of social-ecological integration on segment scale and on corridor scale.

TABLE 6.2 The results of the assessment carried out with the indicators of connectivity and spatial capacity on the standardized three-point scale and aggregated values (the minimum value in each category) used for the assessment of social-ecological integration. The complete results with absolute values for each indicator can be found in Appendix E.

Corridor segment	CONNECTIVITY											SPATIAL CAPACITY					
	Social							Ecological				Social			Ecological		
	A.1.1.1a	A.1.1.1b	A.1.2.1a	A.1.2.1c	A.1.2.3a	A.1.2.3b	A.1.3.1a	A.2.1.1a	A.2.2.1	A.2.2.3	A.2.3.1	B.1.1.1a	B.1.2.1a	B.1.3.2a	B.2.1.1a	B.2.2.4	B.2.3.1a
CS01	1	1	1	1	1	1	1	1	2	2	1	1	3	1	2	1	2
CS02	1	1	2	3	2	3	1	2	1	1	1	2	2	2	1	1	3
CS03	2	2	2	3	2	3	1	3	2	1	1	2	2	3	1	1	2
CS04	3	3	3	3	2	3	1	3	2	2	1	2	2	3	1	1	2
CS05	2	1	3	3	2	3	2	2	2	2	1	2	2	3	1	1	2
CS06	1	1	2	3	2	3	1	3	1	1	1	3	2	3	1	1	2
CS07	1	1	2	2	2	3	1	3	1	1	1	2	2	3	1	1	3
CS08	1	1	1	3	2	3	1	3	2	1	1	1	2	2	2	1	3
CS09	1	1	1	1	1	3	1	3	3	1	1	1	2	1	2	1	3

Corridor segment	AGGREGATION METHOD: MINIMUM											
	Social						Ecological					
	A.1.1	A.1.2	A.1.3	B.1.1	B.1.2	B.1.3	A.2.1	A.2.2	A.2.3	B.2.1	B.2.2	B.2.3
CS01	1	1	1	1	3	1	1	2	1	2	1	2
CS02	1	2	1	2	2	2	2	1	1	1	1	3
CS03	2	2	1	2	2	3	3	1	1	1	1	2
CS04	3	2	1	2	2	3	3	2	1	1	1	2
CS05	1	2	2	2	2	3	2	2	1	1	1	2
CS06	1	2	1	3	2	3	3	1	1	1	1	2
CS07	1	2	1	2	2	3	3	1	1	1	1	3
CS08	1	1	1	1	2	2	3	1	1	2	1	3
CS09	1	1	1	1	2	1	3	1	1	2	1	3

Segment-scale assessment

The first stage of the assessment of social-ecological integration is carried out on the scale of a corridor segment, where the social and ecological categories of both connectivity and spatial capacity are confronted in a mirrored assessment chart. The assessment chart, illustrated in Figure 6.6 for corridor segment CS03, is applied as follows:

- The lowest values are mirrored, i.e. the minimum value from each of the six sub-categories are assigned as the mirrored scores of social-ecological integration;
- When the scores on the two sides are asymmetric, fields which can potentially balance and increase the score in that category are marked with a '+';
- Further improvements made to any of the other scores are subject to negotiation and prioritisation between social and ecological goals determined by factors that were not included in the assessment.

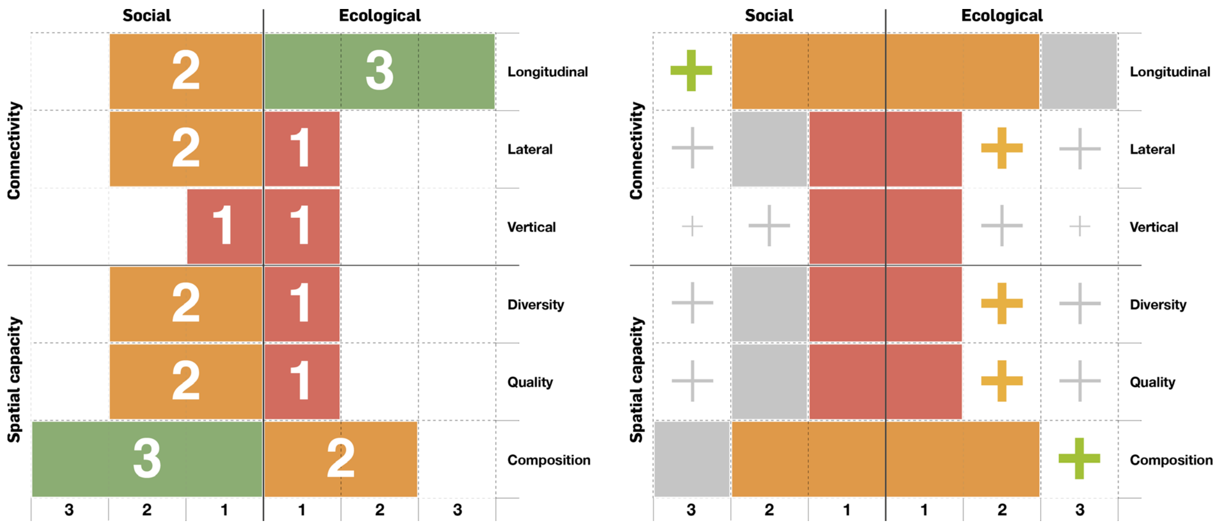

FIGURE 6.6 The assessment of social-ecological integration for segment CS03: category-level assessment (left); social-ecological integration assessment (right). Potentials for integration are marked with a coloured '+' or a grey '+', representing potentials above the minimum desirable goal.

In this assessment, the balance between the two sides of the chart is a *minimum desirable goal*. Accordingly, if CS03 shown in Figure 6.6 has an actual mirrored score of 8 (out of a maximum possible of 18), it can be potentially increased to 13 if improvements are made in the fields marked with a coloured '+'. However, this is a guiding score and the minimum desirable goal can be exceeded, so potentials for social-ecological integration may be found in other fields as well, marked in Figure 6.6 with a grey '+'. For instance, as mentioned above, the transformation of the concrete banks of the river into a soft edge may increase both social and ecological vertical connectivity. Also, an intervention marked as potential in the social-ecological integration assessment chart might not be possible to be carried out due to planning, financial or ownership constraints, which are outside the scope of this assessment. Hence, the results given by this method of assessment must be complemented with an overview of planning constraints, on the one hand, and with urban and landscape design explorations that may shed light on uncharted possibilities, on the other.

Corridor-scale assessment

When put together, the results of all segments can be compared (Figure 6.7) and an actual and potential social-ecological integration profile for URC Dâmbovița can be formulated. As shown in Figure 6.7, most river segments concentrate high values along the axes of spatial capacity. Especially in central segments, improvement of ecological spatial capacity can increase social-ecological integration. Connectivity values are less prominent, with little potential for improvement in central segments and slightly higher potentials in peripheral segments. In terms of total score, CS06 has the highest actual and potential integration, followed by central segments CS03, CS04 and CS07 with identical profiles and CS06, and gradually decreasing towards the end segments CS08, CS09, CS02 and CS01.

FIGURE 6.7 Comparison of the actual (grey fill) and potential (dotted outline) social-ecological integration of the nine corridor segments and the emerging typology of potential social-ecological integration.

The segment profiles illustrated in Figure 6.7 can be used as a visual aid for planning and design decisions (e.g. in a decision support system). The gap between the actual and potential profiles can provide a quick overview of where action is needed for achieving the minimum desirable goal. Imbalances between the social and ecological side, as well as differences between connectivity and spatial capacity (values on the two diagonals of the diagram) can be easily identified.

In Figure 6.7, similar potential social-ecological integration profiles emerge from the mirrored segment-scale assessment. While the profile of CS01 is different, the rest of the corridor segments are either similar or recurring. Except for a difference in vertical connectivity, CS02 and CS05 have a similar profile. The profile with the highest occurrence is found in CS03, CS04, CS07 and, with a slight difference in the social side of spatial diversity, in CS06. In a similar way, CS08 and CS09 are only distinct from CS03, CS04 and CS07 by a lower potential lateral connectivity. Such a comparative assessment, even though illustrative in this case, can inform planning and design decisions aiming for increased social-ecological integration on corridors scale. Although the actual scores are distinctive for each corridor segment, and therefore can mainly inform segment-scale decisions, the mirrored scores can help in devising actions that can be replicated in segments of the same type along the URC.

§ 6.4 URC Colentina—wider application

In addition to the assessment of URC Dâmbovița, URC Colentina is presented here to illustrate the application of the assessment framework to another URC. As most indicators are relative to the URC that they measure, a full inter-corridor assessment cannot be attained. Also, the validation—i.e. a systematic comparison with another case in order to establish wider applicability—or the calibration—i.e. the adjustment of reference or target values in the light of measurements taken on a different case—are outside the scope of this thesis. Instead, two indicators are given as examples from the selection made for URC Colentina (Table 6.3): one that is the same as in the case of URC Dâmbovița (A.1.2.1a Accessibility - network) and one that is specific to URC Colentina (B.2.3.1b Coverage - % of green space). In addition, these two indicators were chosen in such a way that, on the one hand, the categories of both connectivity and spatial capacity are represented, and, on the other hand, one is of social and the other is of ecological kind.

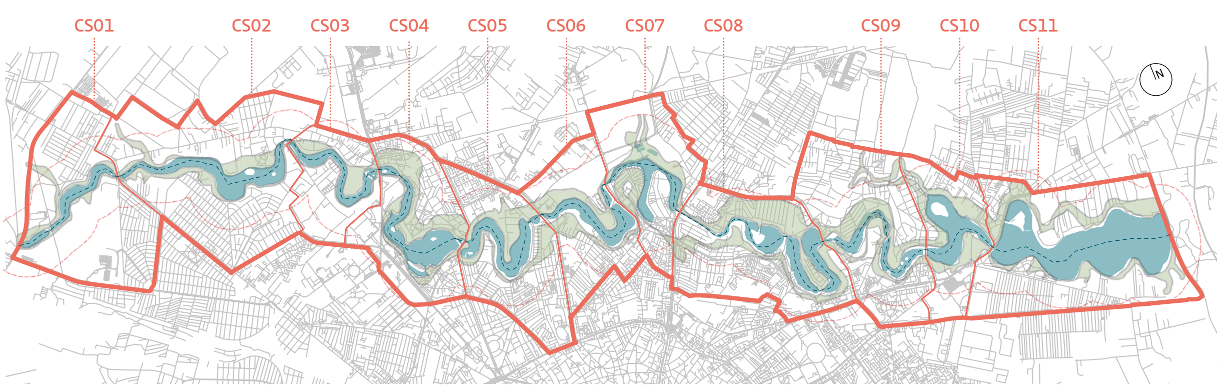

FIGURE 6.8 The delineation of URC Colentina and its segments.

Delineated according to the method presented in Chapter 2, URC Colentina comprises 11 corridor segments (Figure 6.8). The boundary of URC Colentina determined this way is less regular than the boundary of URC Dâmbovița. This is due to the fact that, given its peripheral location, River Colentina is surrounded by a more heterogeneous and less consolidated urban fabric than River Dâmbovița, and that it is mainly crossed, rather than followed in parallel, by major traffic corridors. Another notable difference from URC Dâmbovița is that the succession of artificial lakes and recreational corridor of River Colentina, as conceived initially in the 1930s (see Section 3.3.2), extend beyond the administrative boundaries of Bucharest. However, for the purposes of this demonstration and to keep the assessment within the urban area, the segments surrounding Lakes Buftea, Mogoșoaia and Chitila (upstream from CS01) and Lake Cernica (downstream from CS11), located outside the administrative boundaries of Bucharest, were not included in the delineation.

	PROBLEMS	POTENTIALS	SELECTED INDICATORS
Connectivity			
Longitudinal			
Social	The privatisation of the lakeshores led to a discontinuous service area and spatial fragmentation along the corridor.	It could become an axis of urban development and a continuous lakeside public space.	A.1.1.2a Pedestrian network – continuity A.1.1.2b Pedestrian network – % A.1.1.2c Pedestrian network – location
Ecological	Water flow is reduced.	It could become a green corridor.	A.2.1.1a Landscape connectivity - existing A.2.1.1b Landscape connectivity – potential
Lateral			
Social	It is perceived as a physical barrier and the lakeshores are inaccessible.	It could become a balancing structure for local communities and intercommunal collaboration.	**A.1.2.1a Accessibility – network** A.1.2.1b Accessibility – residents A.1.2.1c Accessibility – visitors A.1.2.3a Crossability - count A.1.2.3b Crossability – linear density of crossings
Ecological		It can benefit from a good connectivity with the surrounding landscape.	A.2.2.1 Presence of transversal corridors
Vertical			
Social	Banks are undesigned and riverside structures are deteriorated.	The water surface offers more possibilities for use, such as swimming.	A.1.3.1a Contact with water – points of contact A.1.3.1a Contact with water – typology A.1.3.2 Contact with water – swimming
Ecological	There is a lack of gradients between land and aquatic ecosystems.		A.2.3.1 Presence of ecotones
Spatial capacity			
Diversity			
Social	Extreme social contrasts	It could become an axis of urban development / an economic attractor / sports / diversity	B.1.1.1a Diversity of uses – richness B.1.1.1b Diversity of uses – dominance
Ecological	Spontaneous vegetation	It is and could be enforced as an important source of ecology and biodiversity.	B.2.1.1 Biodiversity – presence of species-rich areas
Quality			
Social	Spatial fragmentation	Flood risk	B.1.2.1a Visual permeability - % visible river space
Ecological	Artificial nature		B.2.2.4 Respect of natural dynamics
Composition			
Social	Public space for consumption	Space for recreation	B.1.3.1 Intensity of construction
Ecological	Artificial nature	Abundance of open space / green lung / microclimate regulation	B.2.3.1a Coverage - % open space **B.2.3.1b Coverage - % green space** B.2.3.1c Coverage - % TIA

TABLE 6.3 Indicators selected for URC Colentina, corresponding to the main problems and potentials identified by local experts (see Chapter 4 for a detailed analysis of the experts' opinions and Appendix D for a full list of problems and potentials incorporated in this table). Indicators highlighted with green are used for demonstration in this section.

Network accessibility (A.1.2.1a) of the paths along the lakes of URC Colentina is predominantly low, with the exception of CS04, where Lake and Park Herăstrău represent the most attractive location along the corridor, and CS07, where the historical neighbourhood and Monastery of Plumbuita are located. These findings can be correlated with the observation by most experts that Park Herăstrău concentrates most recreational activities in the corridor (Section 4.4.3), and with the location of Plumbuita (one of the riverside historical villages encapsulated by the city) along one of the generative radials of the city (Section 3.3.2). The network accessibility profile of URC Colentina shown in Figure 6.9 (bottom right) is less regular than in the case of URC Dâmbovița (see Appendix E). This difference may be ascribed to the more peripheral location of URC Colentina. While URC Dâmbovița concentrates longitudinal flows running through the centre, and thus having a more distributed accessibility profile, the lakes are rather crossed laterally by traffic radials connecting the city centre with territories in the north, creating points of high accessibility at the junction between the radials and the riverside path network. Indicator A.1.2.1a of lateral connectivity gives significant results and clearly shows the difference between the two URCs (see values for URC Dâmbovița in Table 6.2).

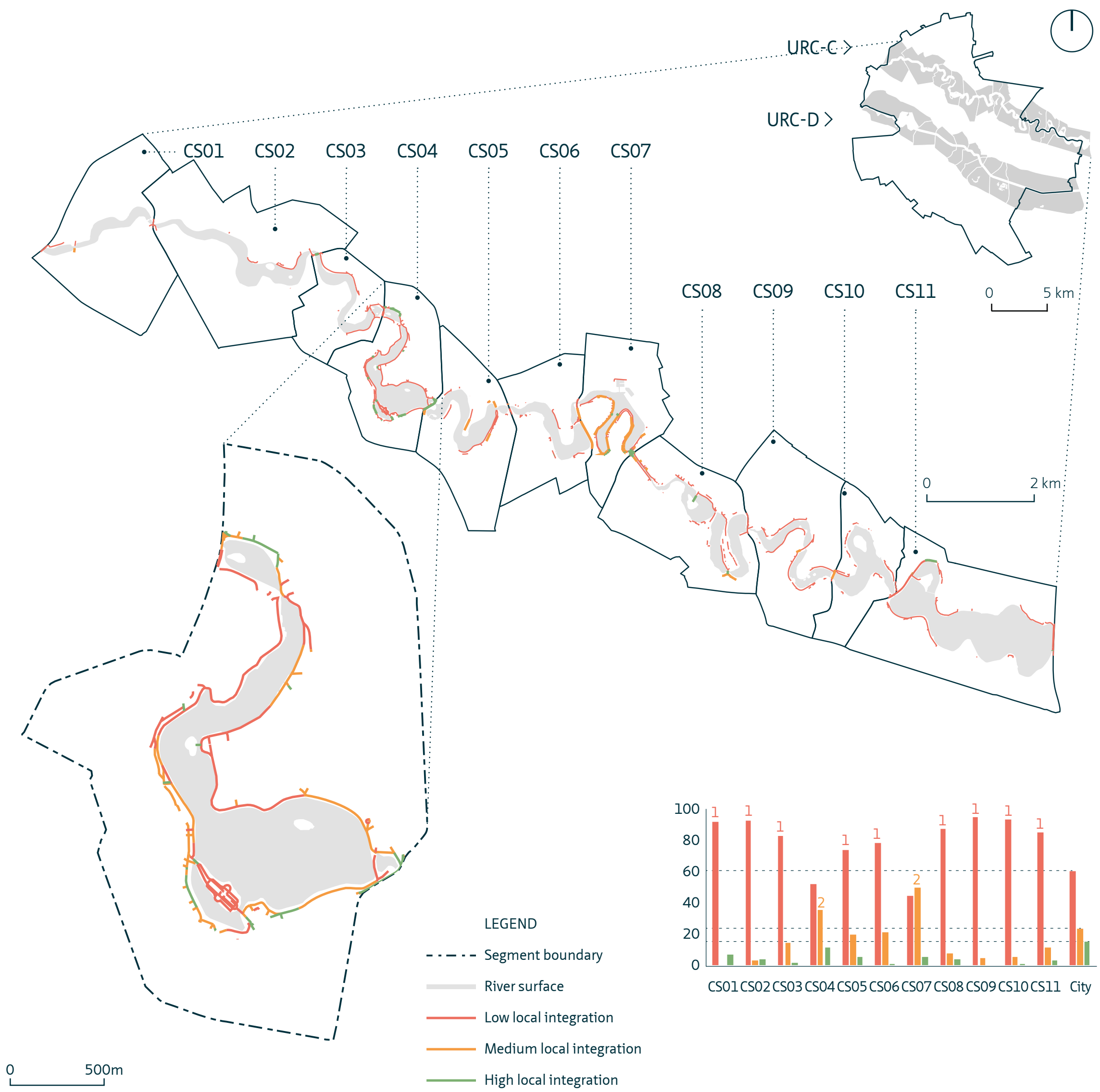

FIGURE 6.9 Network accessibility (A.1.2.1a) along URC Colentina with a detail of CS04, in which Lake and Park Herăstrău are located.

To further shed light on potentials that can be found in the path networks running along the river, indicators of the pedestrian network on the longitudinal dimension (A.1.1.2a-c), as well as indicators of contact with water (A.1.3.1a-c) on the vertical dimension, can be combined with the results given by this indicator. Furthermore, the presence of transversal corridors (A.2.2.1) can determine potentials for social-ecological integration through lateral connectivity.

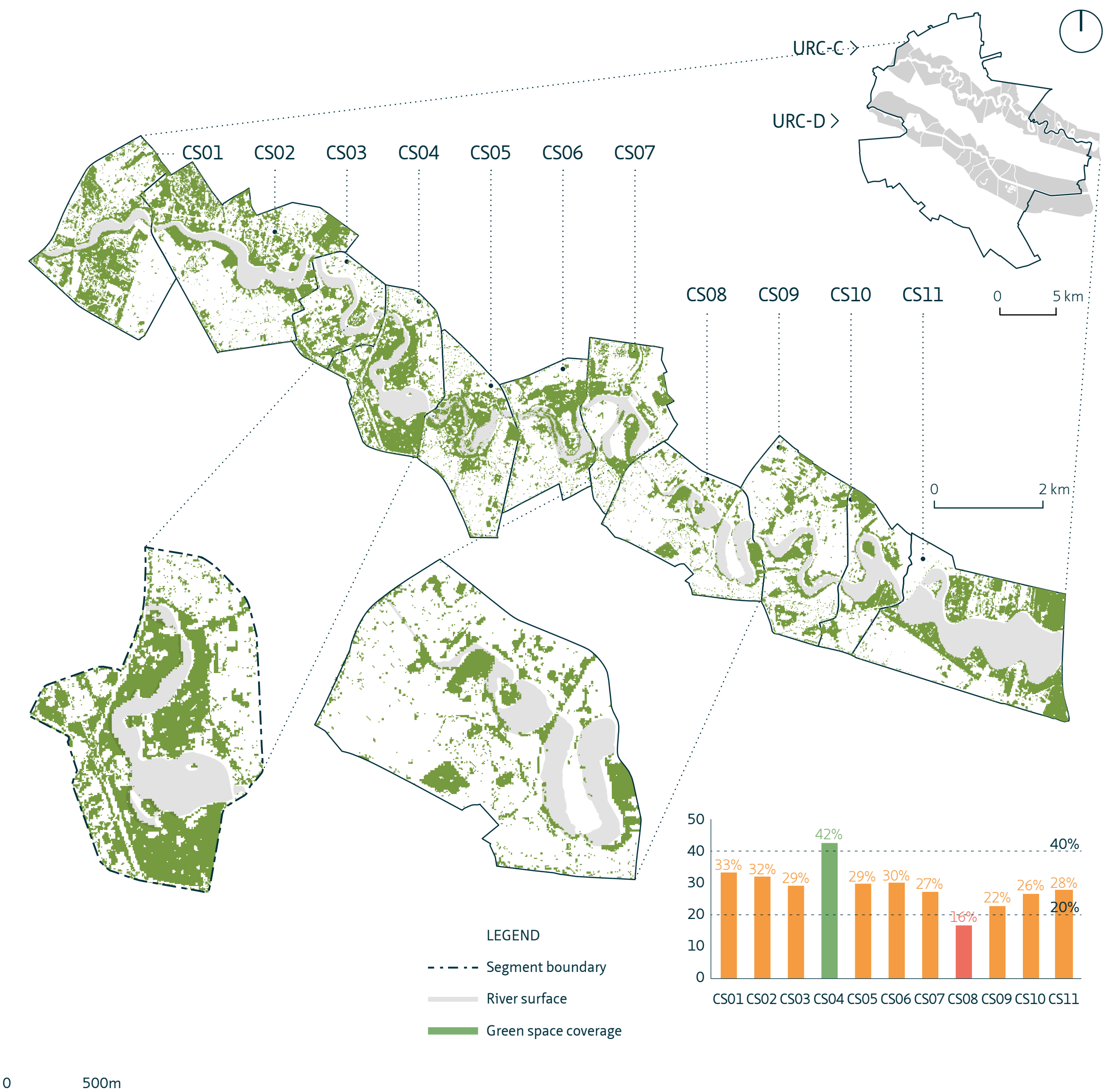

FIGURE 6.10 Green space coverage (B.2.3.1b) along URC Colentina, with a detail of corridor segment CS04, in which Lake and Park Herăstrău are located (highest coverage in the URC), and CS08, the corridor segment of Lake Fundeni (lowest coverage).

Pointed out by most experts in Chapter 4 is the distinctive potential of URC Colentina to become a green corridor. Accordingly, green space coverage (B.2.3.1b), used here for the illustration of ecological spatial capacity, is an indicator of spatial composition that is specific to URC Colentina. As shown in

Figure 6.10, results indicate medium coverage in most corridor segments, except CS04 with a high score (42% of the total area of the segment) and CS08 with a low score (16%). Like in the case of network accessibility, Park Herăstrău has a high score, as it was designated and has remained one of the largest parks of the city ever since the transformation of River Colentina started in the 1930s.

Further knowledge of biodiversity (B.2.1.1) and respect of natural dynamics (B.2.2.4) can help in identifying potentials of ecological spatial capacity in URC Colentina. Also, results from the other indicators of coverage (B.2.3.1a and B.2.3.1c) can provide insights on potentials for increased green space coverage in non-vegetated urban spaces, such as brownfields and convertible impervious spaces.

§ 6.5 Discussion

Apart from the results, a critical reflection on the process of the assessment is necessary to identify the strengths and weaknesses of the methodology and to frame the quality of the results. Moreover, assessment must be positioned in the overall planning and design process in order to identify conflicts or synergies with other ways of approaching social-ecological integration, such as the design explorations presented in Part 3 of this thesis.

One of the critical aspects of this assessment framework is the way social and ecological indicators are aggregated. It may be argued that mirroring, as shown in Figure 6.6, might not produce meaningful results, as the selections of indicators from the two sides might not be comparable or related. Also, using the minimum value for aggregation might lead to under-evaluation. These challenges were met with the balanced logic of the *minimum desirable goal*, that is, the inclusion of both the actual and potential situation in the assessment. That is, the aggregation method using minimum values in the first step (aggregation of indicator results into social and ecological sub-categories) and in the second step (mirrored minimum values) is balanced by the identification of potential areas of intervention. This balanced logic, similar to the problem-potential approach used in the analysis of expert interviews carried out in Chapter 4, is also useful in identifying similarities between corridor segments in the third step of the assessment on corridor scale.

Although inter-corridor (comparative) assessment could not be attained in this research, as it would require further validation and calibration with other URCs, the similarities in potential corridor segment profiles identified in the corridor-scale assessment may be developed into a generalizable method of assessment. If similar potential social-ecological integration profiles can be observed and correlated across different URCs, a cross-case typology may be developed.

The equal weighing and aggregation of the indicators in the six sub-categories of connectivity and spatial capacity also raises questions regarding the validity of the results. The purpose of this chapter was to illustrate the use of the assessment framework, rather than to provide advice for planning. Hence, for real-world application, this assessment framework needs to be calibrated, i.e. case-specific weights, benchmarks and parameters must be developed with empirical evidence. Nevertheless, given the complexity of factors influencing the current state of URCs, as seen in Chapter 4, the assessment framework put forward in this chapter can provide useful insights into potentials in early stages of the planning and design process.

Finally, a considerable issue is that the method of social-ecological assessment presented here is not spatially explicit. The potentials for social-ecological integration are virtual, based on the mirroring logic of the minimum desirable goal. Whether the potentials highlighted here are possible, depends on spatial conditions in the URC. Therefore, spatial synergies must be sought in the design and planning process to further identify potentials for integration.

§ 6.6 Conclusion

Throughout this chapter, the framework for the assessment of social-ecological integration in URCs introduced in Chapter 5 was applied on the URCs of Bucharest. For both URCs, a number of indicators were selected based on a set of criteria: *representativeness*, according to which each sub-category of the assessment framework is represented by at least one indicator; *case-specificity*, attained by using the statements on problems and potentials given by local experts in Chapter 4; *application-specificity*, by including indicators of potential, in order to inform subsequent planning and design decisions; as well as *data availability* and *implementation constraints*.

A full assessment was carried out on URC Dâmbovița and results of the actual situation and potentials for improvement were summarized for all indicators of connectivity and spatial capacity. *Segment-scale assessment* combined the results from the assessment of connectivity and spatial capacity in a *mirrored assessment chart*. With this method, a general assessment of the current state of social-ecological integration and potentials for improvement could be identified. In a subsequent step, *corridor-scale assessment* compared the segment-scale results and identified similar *profiles of potential social-ecological integration* that can inform planning and design actions that are replicable or have an impact on the whole corridor.

Finally, URC Colentina was used to illustrate the application of the assessment framework on a different case. One indicator (A.1.2.1 Accessibility - network) was selected to show variations of the same indicator across the two cases and another (B.2.3.1b Coverage - % green space) was presented as a case-specific indicator to illustrate the adaptability of the indicator system to specific URC conditions.

As an assessment carried out this way may not provide a complete picture of the spatial problems and potentials found in a particular URC, it must be combined with knowledge on planning constraints and design explorations. Based on these challenges and the results of the assessment, but also informed by the projects, meaningful places, and proposals collected from the interviews in Chapter 4, a number of design questions become apparent: How can the artificial nature of the two rivers be overcome? How can the connectivity of the two rivers be improved? How can the development dynamics of the two rivers be accommodated spatially? How can the open spaces and connections of the social and ecological systems of Bucharest be spatially integrated? How can the scalar qualities of the two URCs be improved? Part 3 of the thesis will attempt to respond to these questions, and, as a result, to advance the current state of knowledge described in Chapter 4 and supplemented with the assessment in this chapter with future possibilities of development in the two URCs.

PART 3 Design

This part includes two chapters:

7 Design Principles for Integrated Urban River Corridors

§ 7.1 Introduction

Distilled from practical experience and refined by theory, a principle is a "fundamental truth or proposition that serves as the foundation for a system of belief or behaviour or for a chain of reasoning" (Principle, n.d.). As such, principles are essential for guiding thought or action and for facilitating the transfer of knowledge across disciplines. Because they involve a judgement of what or how something *should be*, they are employed here to shift the descriptive/analytical perspective of the previous two parts of the thesis to a normative one. This shift is needed as urban design is, in substance (and in addition to its use of description), a normative activity that often makes use of principles to transfer knowledge of a given urban phenomenon to the design process. To that end, this chapter sets out to translate the four properties of URCs introduced in Chapter 2, namely *connectivity*, *open space amenity*, *integration*, and *multiscalarity*, into corresponding design principles: *Interconnectedness*, *Absorptive Capacity*, *Social-Ecological Integration*, and *Interscalarity*.

The main body of the chapter is organised in three sections. Prior to the introduction of the principles, Section 7.2 establishes the disciplinary context in which design is referred to, starting from sustainable urbanism, through green-, landscape- and ecological urbanism, to the more recent approach of *social-ecological urbanism*, all of which have in common an emerging ecological rationality enriching the traditional spatial and social discourse of urban design. In Section 7.3, each principle is defined and founded on concepts from urban and landscape design theory. In addition, Boxes 7.1-7.4 illustrate the development of the principles with four river projects, which were carried out by the author as *design explorations* in parallel to the research process. Finally, Section 7.4 discusses challenges and opportunities arising from the use of the design principles.

SUB-QUESTION AND OBJECTIVES:		
Sub-question 7:	**How can the design of URCs be guided towards social-ecological integration?**	
Objective 7.1:	Formulate design principles of social-ecologically integrated URCs.	Section 7.3
Objective 7.2:	Explore URCs through design.	Boxes 7.1-7.4

§ 7.2 Social-ecological urban design

As indicated in Section 1.1, urban design is an activity that is situated in place and time and whose underlying values are directed by socio-cultural and environmental dynamics. That being so, before any attempt to formulate urban design principles, one must understand urban design as an integrative activity (Sternberg, 2000) and urbanism as a field of knowledge that is contingent on changing urban conditions (e.g. Lynch, 2007).

Urban design is commonly defined as "the process of making better places for people than would otherwise be produced [and it is] primarily concerned with shaping urban space as a means to make, or re-make, the 'public' places that people can use and enjoy" (Carmona, Heath, Oc, & Steve, 2010, p. 3). Rather than "an exclusive professional territory", it is considered to be "the interface between architecture, landscape architecture and town planning, drawing on the design tradition of architecture and landscape architecture, and the environmental management and social science tradition of contemporary planning" (Carmona et al., 2010, p. 4). Although urban design is an integrative practice (Khan et al., 2014; Sternberg, 2000) combining the morphological, perceptual, social, visual, functional, and temporal dimensions of the design process (Carmona et al., 2010), the ecological dimension is still poorly represented in urban design (Pickett, Cadenasso, & McGrath, 2013).

The current urban condition, characterised by escalating environmental challenges, growing social inequalities and increased interconnectedness, has prompted repeated attempts to redefine urbanism and its fundamental orientations. Those attempts include: *sustainable urbanism* (Burton, Jenks, & Williams, 2004, 2013; Farr, 2007; Jenks & Jones, 2010), concerned with compact and dense forms of urban development, integrated transportation and land use, sustainable neighbourhood-scale development, environmental benefits of human-nature linkages, and building- and district-level energy efficiency; *green urbanism* (Beatley, 2000) as a more resource-efficient and community-based practice; *landscape urbanism* (Waldheim, 2006, 2016), in which the emphasis is shifted from the built environment to the larger landscape; *ecological urbanism* (Mostafavi & Doherty, 2010) combining social inclusiveness and environmental sensitivity in a holistic approach; and, more recently, *social-ecological urbanism* (Barthel et al., 2013; Erixon Aalto et al., 2018), putting further emphasis on adaptation and resilience by integrating ecosystem services in urban planning and design and by seeking synergies between the ecological and social systems. These different interpretations of urbanism represent the evolution and emergence of an underlying *ecological rationality* (Viganò, 2013), which complements traditional urbanism's core interest in the physiognomy of the city with a systemic and integrated understanding of space occupied by both people and ecosystems.

Informed by social-ecological systems and social-ecological resilience theory (discussed in Section 1.3.1), social-ecological urbanism provides a conceptual framework which can potentially lead to a more integrative urban design practice (e.g. Barthel et al., 2013; Erixon Aalto, Marcus, & Torsvall, 2018). In addition, the spatial-morphological approach (Section 1.3.3) is built upon an elemental understanding of urban space that is useful for a social-ecological description of urban space. Hillier (2007), one of the principal proponents of this elemental spatial approach, refers to *occupied space*, i.e. the (built or un-built) space of activities that are mainly static or where movement is localised within the occupied space, in contrast to the *space for movement*, which is shaped by movement between occupied spaces or in and out of an occupied space. In a spatial-morphological approach, the focus is on the space of movement, which comprises the space of vehicular movement and the space of pedestrian movement, i.e. *public space*. The 18th c. Nolli map (Figure 7.1) is a classic example of a figure-ground representation in which public space, including outdoor and indoor spaces, is revealed.

This map is especially representative for the space of pedestrian movement, as it predates the appearance of routes designed for fast vehicular movement and, thus, it is completely shaped by and accessible to pedestrian movement.

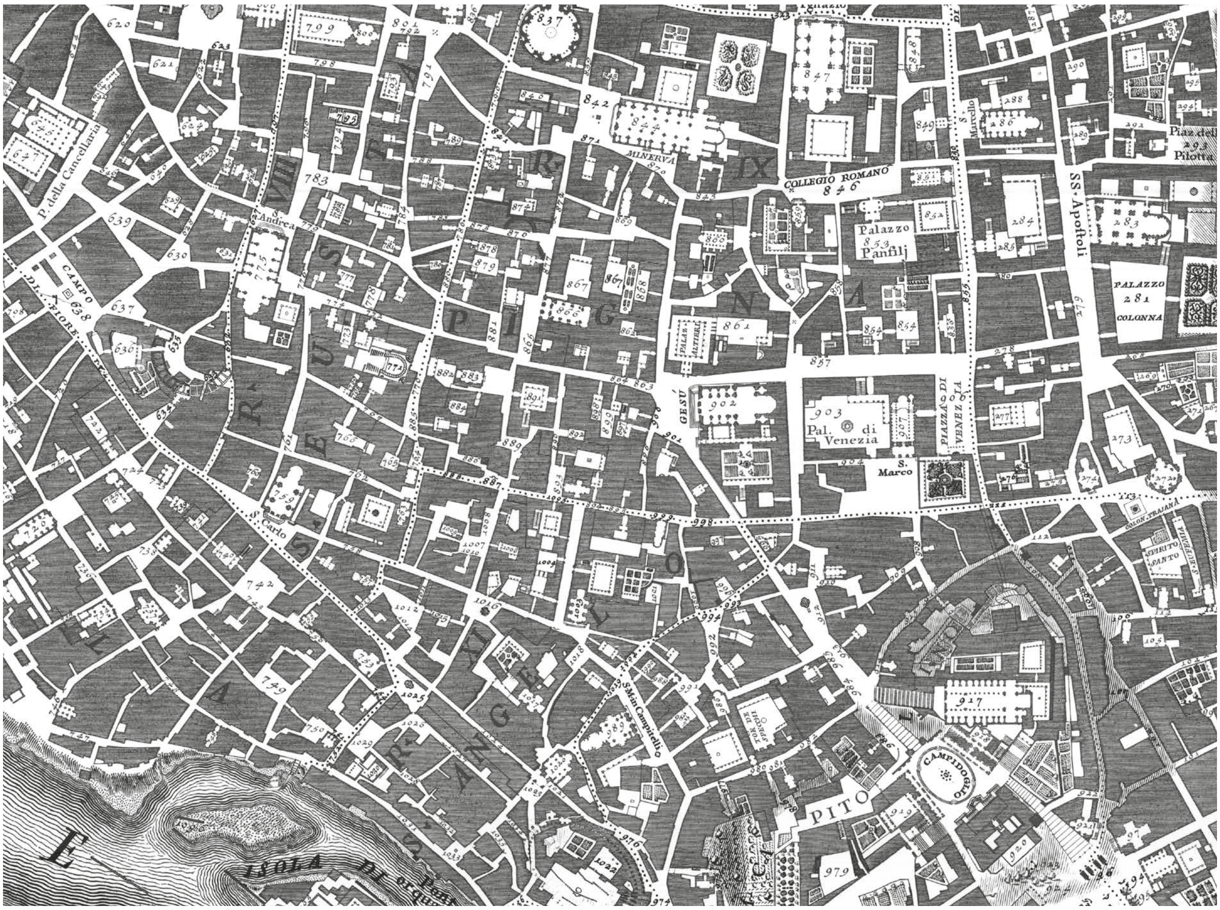

FIGURE 7.1 Public space, as depicted in a detail of the 1748 map of Rome made by Giambattista Nolli. Source: Wikimedia Commons.

Although hardly visible in the Nolli map, another space of movement exists in the city, *ecological space*, as described in landscape ecology.[65] As shown in Figure 7.2, ecological space overlaps public space (e.g. parks, public gardens, rows of trees), occupied space (e.g. private gardens, green roofs), but also undefined spaces (see Section 7.3.2 for a detailed definition). The loose superposition between the space of movement, including public space and ecological space, is the ground upon which social-ecological urbanism operates. By not being ingrained in categorical descriptions of urban space, the inclusive description of the spatial-morphological approach provides an open ground for the understanding of and design for social-ecological integration.

65 Although a solely spatial definition of ecosystems is partial, as ecological space in ecology "is more defined by function than by physical dimension or magnitude" (Hayward, 2013, p.2), it is nevertheless useful in transferring knowledge of ecology to urban and landscape design (e.g. Dramstad et al., 1996).

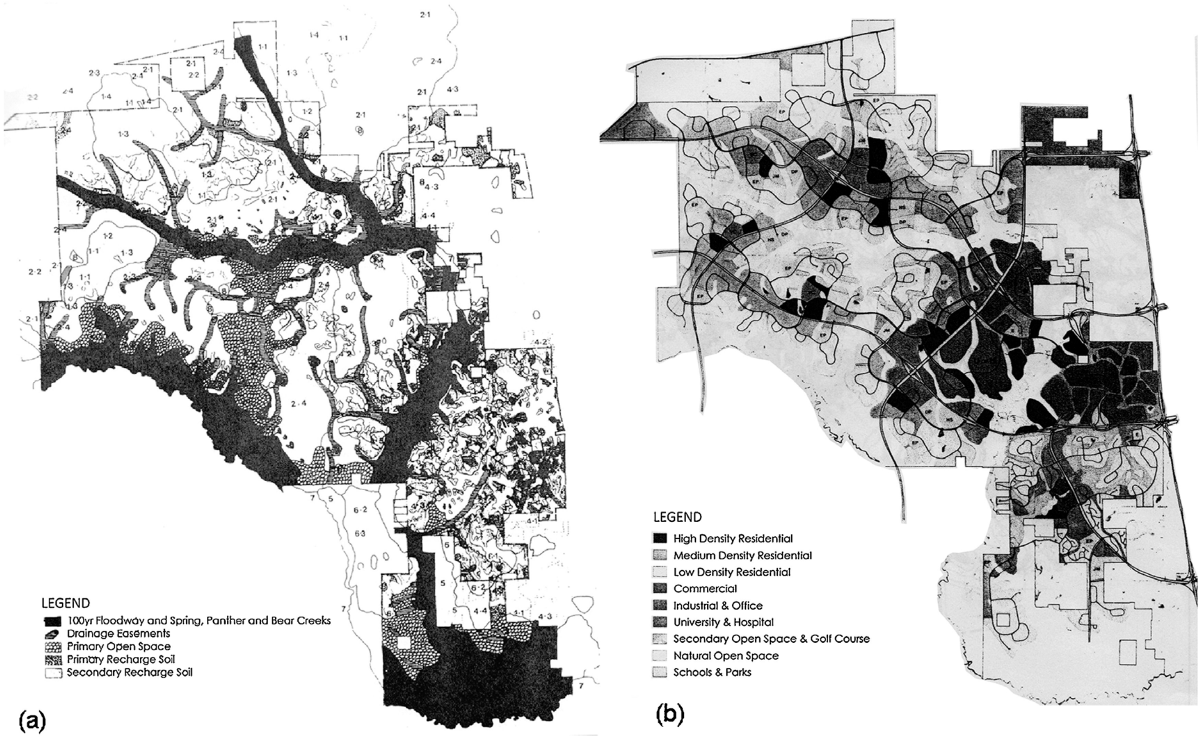

FIGURE 7.2 Ecological space, as shown in The Woodlands, Texas, USA, an ecologically designed community development plan based on Ian McHarg's design-with-nature concept. Source: Wallace et al., 1974, cited in Yang, Li, & Li, 2013.

§ 7.3 Principles of urban river corridor design

A brief review of general urban design principles, summarised in Table 7.1, shows a possible alignment with the URC properties identified in Chapter 2, and hints to their potential translation into URC design principles. As shown in Table 7.1 under the theme of connectivity, urban design is concerned with improving the spatial conditions for walking, cycling, public transport and vehicular traffic (in this order of priority) (Llewelyn-Davies & Alan Baxter & Associates, 2007), increased spatial permeability (Bentley, Alcock, Murrain, McGlynn, & Smith, 1985) and access to key destinations (Llewelyn-Davies & Alan Baxter & Associates, 2007). Open space amenity is related to urban design issues such as spatial redundancy (Hassler & Kohler, 2014), diversity and mix of uses (Bentley et al., 1985), and local identity (DETR & CABE, 2000). The combination of dense urban form with the provision of green infrastructure (Benedict & McMahon, 2006), as well as a recent interest in design for ecosystem services through green and blue infrastructure (GBI) solutions (e.g. Perini & Sabbion, 2017), are two examples of principles that contribute to integration. Finally, multiscalarity is a general principle in urban design, an activity which typically bridges spatial and temporal scales (Carmona et al., 2010). While urban design focuses on the scale of the neighbourhood (Farr, 2007) or public space (Tibbalds, 2007), landscape design addresses a wider range of scales from regional green infrastructure networks to localised site-scale interventions (Baschak & Brown, 1995).

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TABLE 7.1 Summary of principles found in urban and landscape design literature that are related to the four key properties of URCs identified in Chapter 2. Principles that are specific to river- or waterside urban design, already described in Section 2.2, are included in a distinct category under each property.

URC PROPERTY	URBAN AND LANDSCAPE DESIGN PRINCIPLES
Connectivity	**Ensure connections suitable for walking, cycling, public transport and cars**, in this order of priority. (Llewelyn-Davies & Alan Baxter & Associates, 2007)
	Increase the spatial permeability of the urban environment to maximise ease of movement and choice of access through it available to users. (Bentley et al., 1985; DETR & CABE, 2000)
	Provide access to key amenities and facilities, such as parks and schools, **within walking distance**. (Llewelyn-Davies & Alan Baxter & Associates, 2007)
	Design in the URC
	Accommodate temporary flow fluctuations, that is, the vertical and lateral movement of water, **and long-term morphodynamic processes** of sedimentation, erosion and channel migration **in the design of the river space**. (Prominski et al., 2017)
Open space amenity	**Design for diversity/mix/variety/hybridity** of uses, users, building types, and public spaces (e.g. Bentley et al., 1985)
	Provide spatial and functional redundancy to account for flexible and unpredictable development dynamics (e.g. Hassler & Kohler, 2014)
	Ensure continuity of street frontages and the enclosure of open space by development to differentiate public and private space. (DETR & CABE, 2000)
	Consider the porosity of urban space, that is, a distributed and balanced configuration of open spaces in relation to built-up space. (Ellin, 2006; Viganò, 2009a)
	Consider the identity and character of the place when designing for vibrant and liveable public spaces. (DETR & CABE, 2000)
	Design in the URC
	Adapt and reuse existing built form and increase public access in the waterfront to increase spatial quality and to overcome physical and mental barriers inherited from former (industrial) land uses. (Gordon, 1996)
	Provide **open space amenity** in waterfront development. (Stevens, 2009)
Integration	**Achieve density and compactness, while preserving open spaces**, which have an integral role in the provision of green infrastructure. (Beatley, 2000; Benedict & McMahon, 2006) **Integrate nature in the urban environment** for a positive psychological impact on people. (Kaplan & Kaplan, 1989)
	Design with landscape elements, such as topography, vegetation and climate, to integrate ecology and human activities. (Manning, 1997)
	Use hybridity and connectivity as means to establish a symbiotic relationship between people and nature, and between buildings and landscape. (Ellin, 2006)
	Integrate green infrastructure (GI) to maximise the combined social and ecological benefits of urban green spaces. (Ahern, 2007; Kambites & Owen, 2006)
	Design in the URC
	Integrate the waterfront with the city's networks of public and green spaces (Samant & Brears, 2017).
	Integrate waterfront development plans with urban water management plans (Samant & Brears, 2017).
	Integrate vegetated and non-vegetated green-blue infrastructure (GBI) solutions to improve environmental (e.g. micro- and meso-climate regulation), social (e.g. recreation) and ecological (e.g. biodiversity) conditions in the city. (Perini & Sabbion, 2017)
	Protect streams and wetlands, and store, clean, and recycle storm water runoff (by employing, for instance, principles of water-sensitive urban design) for both ecological and social uses. (Hoyer, Dickhaut, Kronawitter, & Weber, 2011)
	Preserve structural gradients between areas of extensive and intensive anthropic pressure, just like ecotones in ecology, in order to maximise diversity. (Manning, 1997)
	Design river crossings as points of high accessibility and intense (physical and visual) interaction between the city and water, while "allowing circulation along the river to continue uninterrupted." (Manning, 1997, p. 81)

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TABLE 7.1 Summary of principles found in urban and landscape design literature that are related to the four key properties of URCs identified in Chapter 2. Principles that are specific to river- or waterside urban design, already described in Section 2.2, are included in a distinct category under each property.

URC PROPERTY	URBAN AND LANDSCAPE DESIGN PRINCIPLES
Multiscalarity	**Consider three categories of scales in urban design**: (1) the region: metropolis, city and town; (2) the neighbourhood, the district and the corridor; and (3) the block, the street and the building. (CNU & Talen, 2013)
	Design at and across multiple scales, that is, considering scales below and above, in order to deal with "places as vertically integrated 'wholes'". (e.g. Carmona, Heath, Oc, & Steve, 2010, p. 6)
	Plan for human habitability at regional scale. (MacKaye, 1940)
	Nurture the neighbourhood scale by providing local facilities, mixed use and walkability. (Farr, 2007)
	Design on human scale: "concentrate on attractive, intricate places related to the scale of people walking, not driving" (Tibbalds, 2007, p. 9)
	Understand past urban dynamics to build lasting environments (Tibbalds, 1992)
	Design for change to build flexibility to future demographic, economic and lifestyle changes. (Llewelyn-Davies & Alan Baxter & Associates, 2007)
	Design in the URC
	Consider a hierarchy of site (a single habitat or community), **local** (a series of habitats or communities) **and region** (a large geographic region) in the landscape design of urban river corridors. (Baschak & Brown, 1995)
	Understand the river at catchment scale regardless of the scale of intervention. (Ingaramo & Voghera, 2016)

Along general urban design principles, Table 7.1 includes design principles specific to river- or waterside urban transformation. These principles, described in more detail in Section 2.2, extend urban design goals with considerations of river restoration and hydrological connectivity addressed in river space design (Prominski et al., 2017), perceptual and economic aspects in waterfront redevelopment (Gordon, 1996; Stevens, 2009), potentials of integration offered by green and blue infrastructure (GBI) solutions (Perini & Sabbion, 2017) and by key landscape interventions (Manning, 1997), considerations of scalar hierarchies in landscape design (Baschak & Brown, 1995), and the influence of catchment-scale conditions on urban and landscape design (Ingaramo & Voghera, 2016). Overall, however, the urban design principles summarised in Table 7.1 do not offer a comprehensive set of guidelines that are directly applicable to the design of URCs as defined in Chapter 2. The following sections put the four groups of principles presented in Table 7.1 under closer scrutiny and aim to distil a set of urban design principles addressing the goals of social-ecologically integrated URCs.

§ 7.3.1 Configuring connections

In Section 2.2.6, connectivity was defined as a key property of URCs that can offer an integrated three-dimensional—that is, longitudinal, lateral and vertical—description of how people, plants and animals,[66] and water move along, towards/across, and within urban rivers. As part of the assessment framework developed in Chapter 5, this three-dimensional framework was used to devise and categorise indicators of connectivity (e.g. the accessibility of the river space indicated by the percentage of riverside paths that can be reached by pedestrians from public transport stops within a 500 m walking distance) and, as such, to provide an evidence base for planning and design decisions.

66 In a representation of urban space as a complex social-ecological system (SES), two types of behavioral entities are considered: 'people' as social actors, and 'plants and animals' as ecosystem agents (Rounsevell, Robinson, & Murray-Rust, 2012).

In addition to information obtained from assessment, design principles can offer workable guidelines for the design of connectivity elements in URCs. By and large, urban design principles (Table 7.1) address the topic of connectivity by prioritising connections for slow mobility and public transport over individual vehicular transport, by emphasizing the permeability of the urban fabric and by improving access to key amenities and facilities. Urban river design principles, such as the one mentioned in Table 7.1, offer extensive guidelines for the design of the edge between urban space and water, with emphasis on lateral and vertical connectivity in the river space. However, neither of these sets of principles address the design of connectivity in the URC, and therefore this subject requires a further analysis of the particularities of URC networks.

The networks of URCs

In dealing with the spatial interaction of social and ecological systems at large, one must understand the underlying networks of the urban environment in question, including their elements at multiple scales and their spatial configuration, i.e. the way those elements are assembled. There are a number of interpretations in the descriptions of spatial networks in the urban environment, out of which notable examples include: the network models of urban space as a representation of inherent hierarchies of pedestrian movement offered by Space Syntax theory (Hillier & Hanson, 1989), metaphors of traffic networks determined by slow and fast movement (the 'sponge' and 'pipes' of Viganò, Fabian, & Secchi, 2016), the integration of the traffic- and water networks in the guiding model of the Strategy of the Two Networks of Sybrand Tjallingii (2005, 2015), and descriptions of the ecological network in terms of corridors, stepping stones (Forman, 1995) and gradients (de Jong, de Vries, Tjallingii, Duijvestein, & Sijmons, 2015).

Notable examples of *traffic network* descriptions in urbanism are Hillier's (2012) dominant 'foreground' network characterised by route continuity and the more localised 'background' network characterised by shorter lines and less continuity, Read's (2013) 'supergrid' of major urban streets contrasted with the regular grid of urban blocks, and Marshall's (2005) description of road hierarchy ranging from 'primary distributors' to 'access roads'. One aspect that these descriptions have in common is the concept of 'hierarchy' applied to the description of urban form, according to which traffic is distributed "through a hierarchy of routes closely matched to traffic volume and purpose, with free-flow movement at one end (e.g. a dedicated expressway) and local access at the other, and with each level linked dendritically to the next" (Carmona et al., 2010, p. 87). More recent and higher-level hierarchies were imposed on the traditional street network at the outset of personal car mobility, to separate and accommodate different speeds of vehicular movement in the city.[67] As a major consequence of this transformation, the connectivity of the street network and the freedom of pedestrian movement were diminished, especially on higher levels of the hierarchy, where unhindered vehicular movement had to be ensured. Realising that road network hierarchies conceived this way "segregate and fragment urban areas into enclaves", Carmona et al. (2010, p. 90) among others[68] suggest that more interconnected road networks, as a quality of traditional urban space incrementally shaped by pedestrian movement, are necessary for integrated urban design.

67 The concept of street network hierarchy was first explicated by Ludwig Hilberseimer in 1927, in his book Groszstadt Arhitektur (translated to English in Hilberseimer, 2012). According to Hilberseimer, road hierarchy was needed to ensure the safety for children, at the same time improving traffic flow, ensuring the penetration of landscape and settlement and securing against disasters and crises.

68 Similarly, several urban design studies have demonstrated the effectiveness of redundant road configurations. Examples include the so-called semi-lattices of Alexander (1965) and the grids of Martin, (1972).

This does not mean that there is no hierarchy inherent in the way people move in urban space. An interconnected road network configuration does not exclude hierarchy. As shown in Space Syntax theory, pedestrian movement can be correlated with the spatial configuration of the road network (Hillier & Hanson, 1989). Upon analysis of network characteristics such as integration and choice,[69] hierarchies inherent in the configuration of the urban fabric may be revealed. However, such hierarchies do not create barriers to pedestrian movement. Instead, they represent routes crystallised through time, which still guide and attract pedestrian movement in a differentiated way.

In addition to this description, hierarchies can be classified as flat or deep (Simon, 1996). Flat hierarchies feature a small number of levels, with elements distributed and interacting mainly horizontally within levels. In deep hierarchies, on the other hand, elements are distributed and interact mainly across levels. Looking at street networks, it may be argued that there is an optimum between these two types: too deep might create too many spatial barriers to lower levels (e.g. a tree-like network implies longer trips), while too flat might hinder movement on higher levels (e.g. a major road with too many intersections in an interconnected road network, i.e. in which speeds of movement are not segregated, might not allow for fast transit).

One of the urban spaces that are most contested by both vehicular and pedestrian movement is the riverfront (Tjallingii, 2015). More often than not, major thoroughfares built during the 20th century were placed on river embankments, resulting in barriers to pedestrian movement towards and across the river (Figure 7.3). In turn, recent urban transformation trends (e.g. riverfront redevelopment or reclamation projects, such as Paris Plages, Madrid Río and Île de Nantes) have shown an increasing interest in reclaiming the riverfront as a public space belonging to pedestrians and cyclists. Besides the traffic challenges raised by such reclamations, these trends create opportunities for urban design and regeneration. Released from the constrain of heavy car traffic, how should the riverfront be redesigned to encourage and accommodate social and ecological interactions? Even more than the transformation of urban roads into 'streets', 'avenues' and 'boulevards' to reintegrate pedestrian movement, urban rivers can be enforced as "connectors rather than dividers" (Carmona et al., 2010, p. 107) in a network of public and green spaces.

FIGURE 7.3 High-speed road network along River Tietê in Sao Paulo. Source: 3D view from Google maps.

69 Integration is typically used as a measure of accessibility and choice is a measure of through-movement, i.e. "the probability that a street segment falls on a randomly selected shortest path linking any pair of segments" (Space Syntax Glossary at http://otp.spacesyntax.net/glossary/. Accessed June 30, 2018)

Although road network characterisations, such as the ones given by Hillier & Hanson (1989), Carmona et al. (2010), Marshall (2005) and Read (2013), are useful for understanding the morphology of the urban fabric in general, URCs as spaces of social-ecological interaction require a description that also includes the *water network*. A potentially integrative model in this sense is Tjallingii's (2005, 2015) *Strategy of the Two Networks* (see also Section 2.2.5). In this model, the movement of people and ecosystem agents (animals and plants) can be assigned to a '*fast lane*' and a '*slow lane*', structured by the traffic network and the water network, respectively (Figure 7.4). This model establishes a synergic relationship, in which the two networks run in a reciprocally supportive spatial configuration as carrying structures of the urban landscape. Tjallingii positions his strategy in the networks layer of the Dutch Layer Approach (De Hoog, Sijmons & Verschuuren, 1998, cited in van Schaick & Klaasen, 2011), as it intermediates and integrates the occupation layer, where planning decisions are typically made, and the ground layer, where geomorphological processes can be understood in relation to the water system.

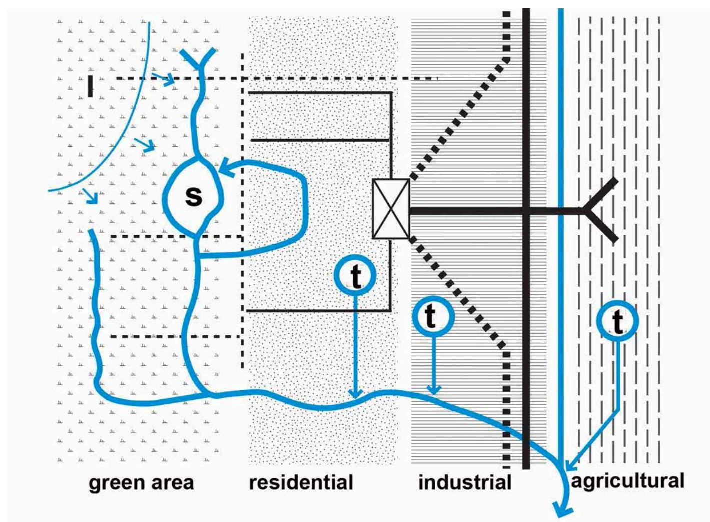


FIGURE 7.4 The Strategy of the two Networks (Tjallingii, 2005, 2015). Source: Tjallingii, 2015.

Tjallingii's Strategy of the Two Networks (2005, 2015) can be used as a basis for a three-dimensional description of URC connectivity. His guiding model is mainly representative for longitudinal connectivity, where there is a parallel (i.e. non-overlapping) and reciprocally supportive configuration of the water and traffic networks. Lateral connectivity of the traffic networks, or crossability and accessibility as referred to in Chapters 2 and 5, refers to the intersection of- and transition between the elements of the 'slow lane' and the elements of the 'fast lane'. According to Manning (1997), crossings are places of intense interaction between people and the river and, therefore, need to be designed as contact zones, where both the river and the city are highly accessible. The intersection, however, should be designed in such a way that it does not create barriers to longitudinal connectivity (e.g. elevated bridge with underpasses along the river banks). The transition between fast and slow longitudinal movement can be achieved by the distribution of major routes away and minor routes close to the river (Manning, 1997). Vertical connectivity, included in Tjallingii's model mainly in terms of water storage, can also be related to social aspect such as the presence of contact zones between the river and people (Manning, 1997).

As Viganò et al. (2016) suggest in a design study of Città Diffusa, an isotropic urban region in the north of Italy, the structuring elements of the urbanised landscape can be conceptualised as 'water' and 'asphalt' (Figure 7.5). The former includes "natural flows, artificial ones, reclamation/irrigation devices, and drainage systems", while the latter comprises "the entire mobility network which is sometimes made of asphalt roads, stone roads, dirt roads, or iron roads"[70] (Viganò et al., 2016, p. 15). The water network, described this way by Viganò et al., encompasses both geomorphologic conditions of the river system at the scale of the catchment area and rationalisations (e.g. rectifications, deviations) involving significant physical and ecological changes to the land. On the other hand, the traffic network, conceptualised as 'the asphalt' in their description, is composed of secondary roads which establish an osmotic (i.e. semi-permeable) relationship with settlements and the high-capacity infrastructure for fast, i.e. uninterrupted, vehicular movement that "establish, via operations of specialisation and sectionalisation, new relations and hierarchies in the territory" (Viganò et al., 2016, p. 41).

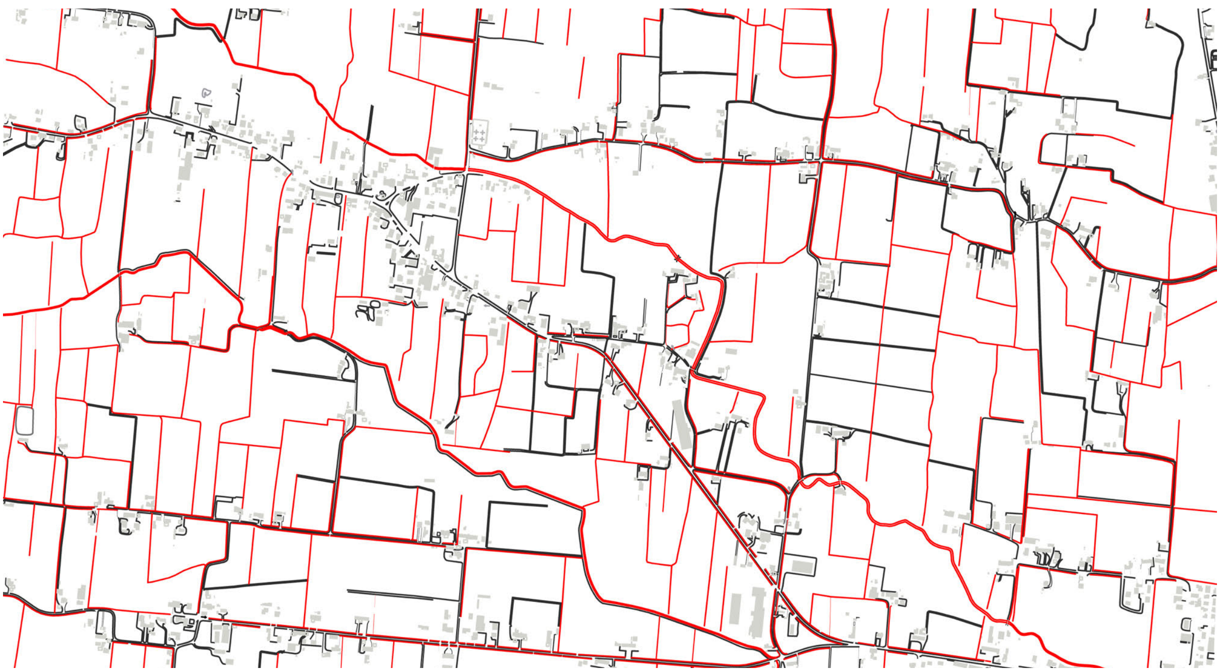


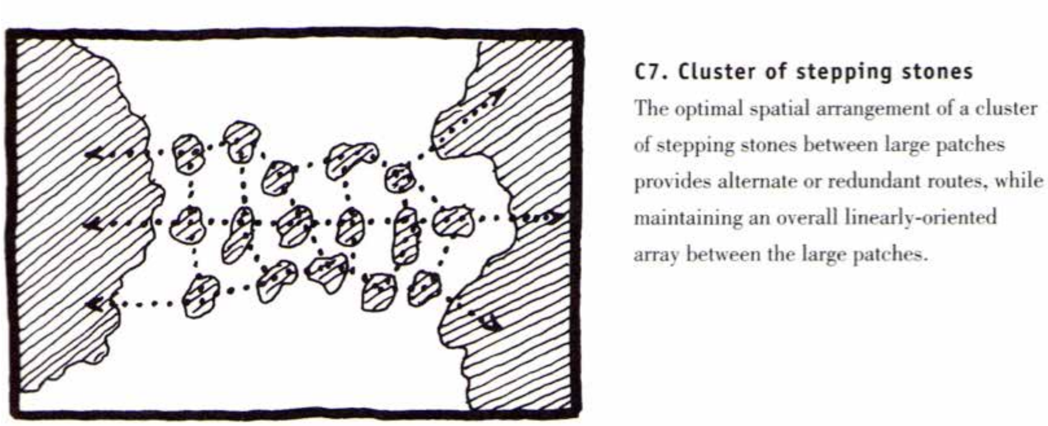
FIGURE 7.5 'Water' (in red) and 'asphalt' (in black), the main structural elements of Città Diffusa, as depicted in a detail map of Paola Viganò et al. Source: Viganò, 2009b; Viganò et al., 2016.

The isotropic configuration shown in Figure 7.5 illustrates the advantages of a less defined hierarchy, a feature which is otherwise difficult to observe in compact urban forms. If separated from its function of accommodating vehicular movement, the road network can be interpreted as a non-hierarchically defined network, a field of possibilities for pedestrian movement in which hierarchy manifests as a self-organised structure. Also, the non-opposing nature of the relationship between city and countryside, visible in Tjallingii's model (2005, 2015) and in the conceptualisation of Viganò et al. (2016), can help in formulating and transferring spatial models capable of establishing synergies between ecological and social objectives in densely built urban areas.

70 In other investigations, Viganò (2009b) presented 'iron' as a separate category, relevant especially in the case of post-industrial landscapes in which the rail infrastructure plays an important role.

The water and traffic networks as carrying structures engender a third type of network, with a specific spatial configuration: the *ecological network*. The presence of water and the geomorphological conditions of the river system tend to generate linear patterns of vegetated land cover across the landscape, while traffic networks tend to fragment the landscape into separated habitat patches (Forman, 1995). Corresponding to these two spatial patterns, the elements of the landscape that contribute to ecological connectivity are called corridors and stepping stones, respectively (Dramstad et al., 1996). *Corridors*, often running along waterways or roads, create spatial continuities in the ecological network, acting as links or barriers for wildlife movement between habitat patches. For instance, power line corridors, road corridors or canals may act as barriers, while streams and river systems are important corridors for wildlife migration. When spatially segregated, i.e. not connected by corridors, habitat patches can act as *stepping stones* for wildlife movement. Different from corridors, they form networks defined by spatial proximity, not by spatial continuity. This means that any pair of individual patches (nodes in the network) can be considered connected if they are within a given distance from each other to allow for certain species to access or move through them. In addition to corridors and stepping stones, vertical connectivity of URCs is influenced by fuzzy boundaries between terrestrial and aquatic ecosystems, described in the late 1960s by Dutch ecologist Chris van Leeuwen as *gradients* (de Jong et al., 2015), that is, areas of transition between two biomes, characterised by high biodiversity and dynamic behaviour. The suitability of these three elements—corridors, stepping stones and gradients—in the description of the ecological networks of URCs is scale-dependent. While the former two provide a good description of longitudinal and lateral connectivity on the scales of the metropolitan area, the corridor and corridor segment, the latter is more representative for smaller scales, where the consistency of the edge between river and land is visible.

In highly fragmented habitat networks, such as urban areas, where continuous corridors are scarce, and the landscape is more fragmented (e.g. Ahern, 2007; Marcus & Berghauser Pont, 2015), stepping stones, transversal corridors and gradients at smaller scale play an essential role in longitudinal and lateral connectivity. The spatial configuration of these elements determines the extent to which they can contribute to landscape connectivity. In one of their landscape ecology principles, Dramstad et al. (1996) propose the 'cluster of stepping stones' as a redundant configuration of migration routes, meant to offer multiple choices for wildlife movement (Figure 7.6a). Another principle is the so-called 'ladder pattern' (Figure 7.6b), characterised by an alternating configuration of open spaces and large patches crossing a river corridor. This principle can be interpreted in an urban context as an alternation of urban spaces and ecological patches along an urban river. Finally, the principle 'edge abruptness' (Figure 7.6c) is representative for gradient complexity and how it determines interaction across (soft boundary) or movement along (hard boundary).



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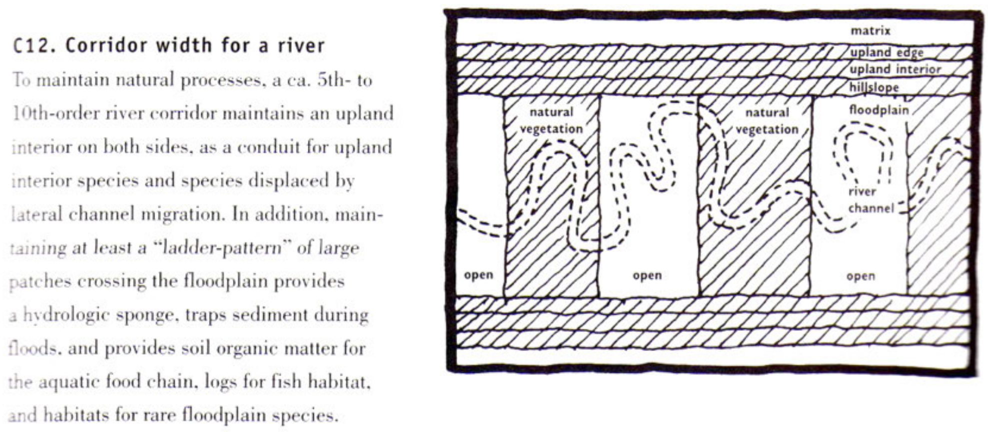

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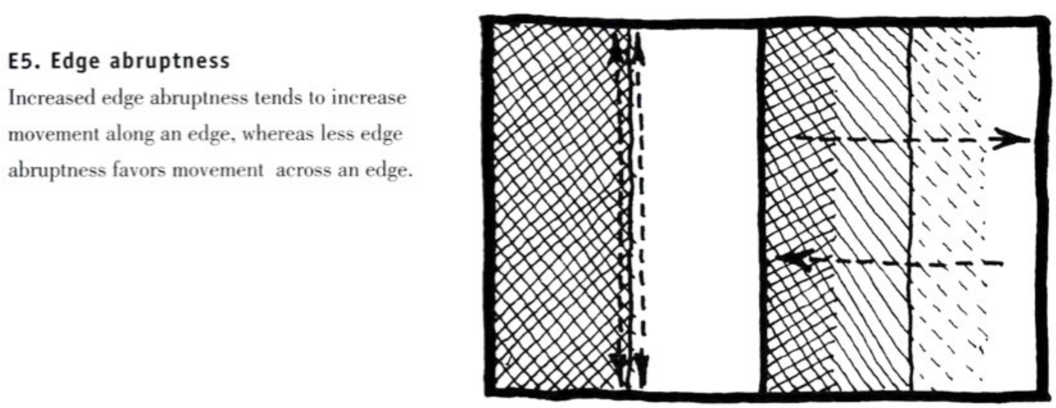

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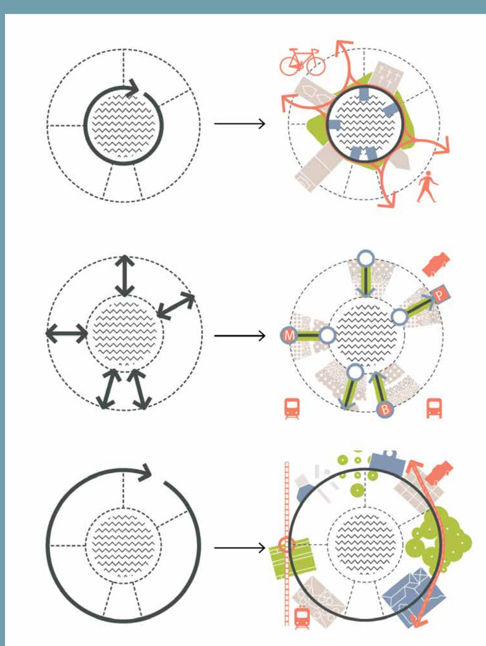
FIGURE 7.6 Three landscape ecological principles as depicted by Dramstad et al. (1996). (a) The "cluster of stepping stones" (Dramstad et al., 1996, p. 38). In an urban context, this diagram resembles the fragmented patches of open space found within the continuous urban fabric (the white space in this diagram), patches that connect to the continuous landscape outside the city. (b) The "ladder-pattern" is a principle specific to river corridors (Dramstad et al., 1996, p. 39). Just like in a natural context, as illustrated in this diagram, the alternation of built and open spaces may be sufficient to provide a hydrological sponge. (c) The principle "edge abruptness" describes how the abruptness/softness of a habitat edge influences movement along and across an edge (Dramstad et al., 1996, p. 29). This principle may be applied to an urban river edge: the harder the edge is, the weaker the interaction between the river and people is, and vice versa. Source: Dramstad et al., 1996.

BOX 7.1 **'342,914 km of scaffolding'—a project for URC Colentina**

- Type of project: Competition entry (LE:NOTRE International Landscape Forum Bucharest 2015), first prize
- Date: April 2015
- Team: Claudiu Forgaci, Maria Alexandrescu, Anca Ioana Ionescu
- Location: Bucharest, Romania

FIGURE 7.7 The network of strategic links proposed as a scaffolding.

As part of the LE:NOTRE Landscape Forum 2015 organised in Bucharest, an international ideas competition was launched with the title (Re)Discovering the Emerald Necklace, depicting the lakes of River Colentina crossing the north of Bucharest. The lakes, artificially created by the stepped damming of River Colentina starting with the 1930s, have exceptional natural qualities, especially due to the abundance of green spaces still available around them. The lakes closest to the city centre are enclosed by urban parks that are popular among the inhabitants of Bucharest. Yet, most lakeside urban areas have been strongly fragmented and disconnected from the public realm by the privatisation of lakeside properties during the years of post-communist transition. The competition recognised both the exceptional natural qualities and the advanced disconnectedness of the lakes and prompted a comprehensive strategy for their (re)integration in the city.



The competition entry, entitled '342,914 km of scaffolding', put forward a strategy of *Interconnectedness* to rediscover and enforce the relationship between the city and the lakes. The proposed scaffolding is an integrative framework making use of the network of actual (existing network of roads and paths) and potential links (desire paths) found in the URC, which were assigned as *explorers*, *gatherers* and *enforcers* of key destinations along the lakes and the urban fabric surrounding them (Figure 7.7). The scaffolding is realised with a strategic module (Figure 7.8) on the scale of a lake consisting of three elements: (1) an outer ring linking key urban destinations, (2) an inner ring enforcing the edge of the lake and (3) links binding the rings together. With this topological definition, the module is capable to adjust to the particularities of each lake" (Figure 7.9) and to establish connections with the network of destinations and public spaces (Figure 7.10; *Absorptive Capacity*) on the scale of the city and recreational spaces in the metropolitan area (*Interscalarity*) (Figure 7.11).[71]

FIGURE 7.8 The proposed strategic module.

71 In an article published one year after the competition, Alexandrescu, Forgaci and Ionescu (2016) give an extended description of the project and discuss its implications for the future development of Bucharest.

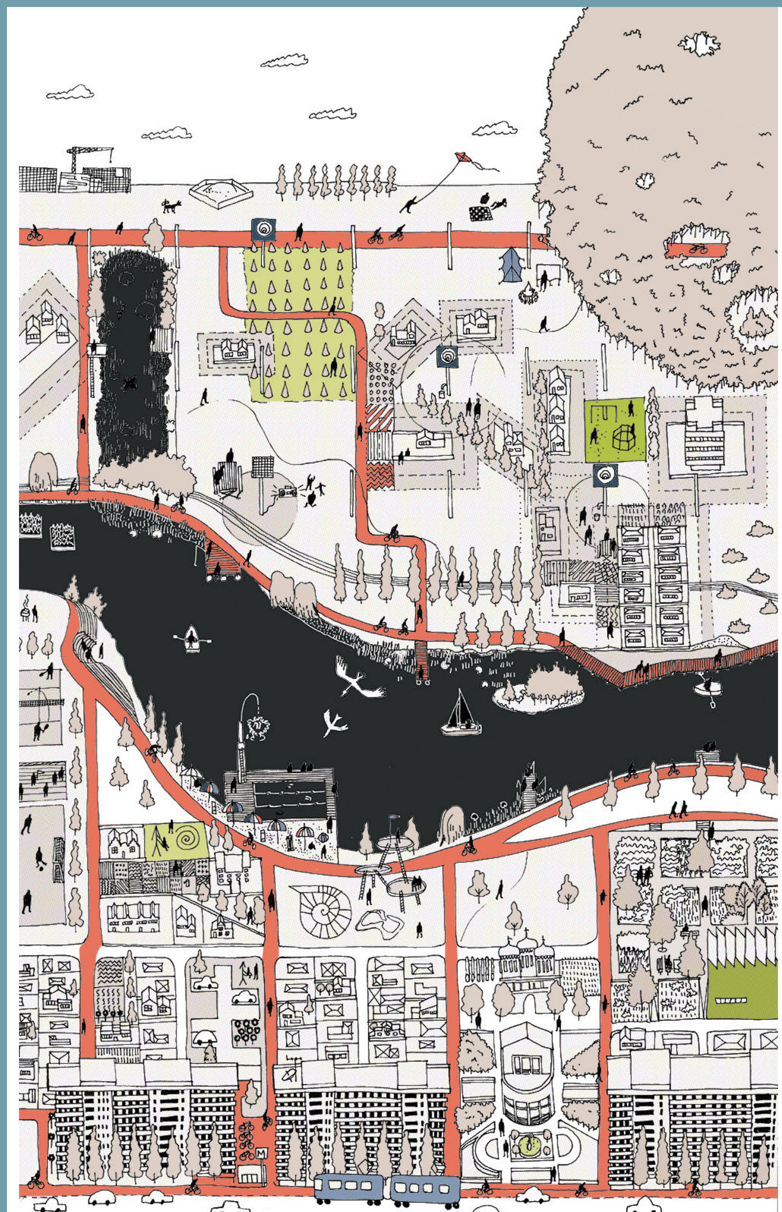


FIGURE 7.9 The proposed vision illustrated on Lake Grivița. Key interventions in public and green spaces (in grey and green) collected by the proposed network of the scaffolding (in red) are used to spatially integrate the lake and the city.

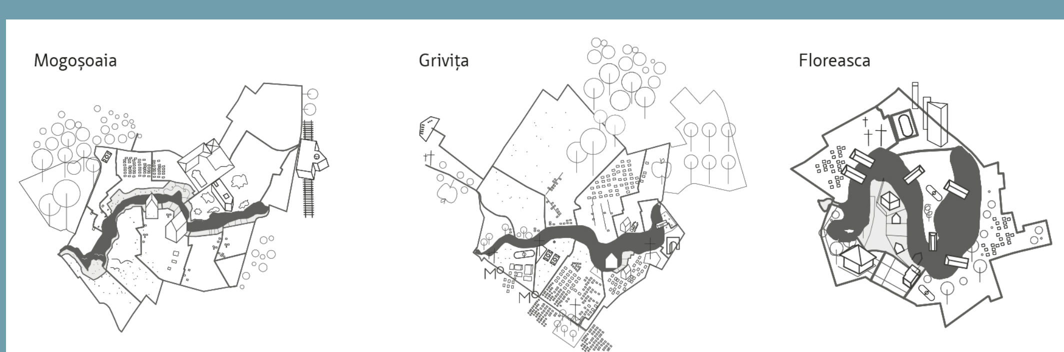


FIGURE 7.10 Sample of three lakes showing how the scaffolding connects (potential) destinations and open spaces found in the URC.

FIGURE 7.11 The network of connections proposed in the 'scaffolding' of the URC connects to the networks of public and green spaces at the scales of the city and the metropolitan area.

Network elements and spatial configuration

The elements of the spatial networks of URCs—the water network, the traffic network and the ecological network—, as described so far in this section and as discovered through design explorations such as the project shown in Box 7.1, are summarised in Table 7.2 and illustrated in Figure 7.12. In its actual configuration, the traffic network comprises the street network with primary (i.e. major traffic lines) and secondary elements (i.e. streets dedicated to slower traffic and accessible to pedestrians). The water network consists of the river system (i.e. main channel and tributaries) and rationalisation (e.g. bypasses, sluices, canals) affecting the flow of water. The ecological network is composed of green corridors (e.g. linear parks, rows of trees), green spaces acting as stepping stones (e.g. parks, gardens, green roofs) and gradients (e.g. vegetated river banks). Besides existing elements, elements that can potentially added to the networks are included as well: former meanders found along the thalweg (i.e. the line of minimum elevation in the valley), as well as disconnected tributaries, are considered elements that can potentially be added to the water network; desire paths (unpaved informal routes, usually visible on bare ground) and former crossings (bridges) are added as potential elements that can reinforce the traffic network, with emphasis of pedestrian links between or to social and public spaces; non-vegetated open spaces, such as parking lots, brownfields, or former industrial platforms, can be transformed into new stepping stones in the network of habitat patches or (in case of impervious surfaces) into infiltration areas added to the water network. The spatial configuration of URCs is given by the way in which the three networks (i.e. the water network, traffic network, and ecological network) are assembled following the requirements of three-dimensional (i.e. longitudinal, lateral and vertical) connectivity.

TABLE 7.2 The spatial networks of URCs, their elements (emphasis added to potential elements) and spatial configuration.

SPATIAL NETWORK	ELEMENTS OF THE SPATIAL NETWORK	SPATIAL CONFIGURATION
Traffic network	• Primary road network as ‘pipes’, ‘supergrid’, or ‘primary distributors’ • Secondary road network as ‘sponge’ or ‘access roads’ • *Desire paths* • *Former or missing river crossings*	A ‘fast lane’ should be positioned outside the river valley and a ‘slow lane’ should be centred on the river, with a gradual transition of speeds in-between. Transversal links should not create barriers to longitudinal movement, nor should longitudinal flows impede transversal movement. Access points to the river should be provided. (Based on Manning, 1997; Tjallingii, 2005, 2015)
Water network	• The river system (main channel and tributaries) • Rationalisations (e.g. canals, bypass channels) • *Former meanders of the river (along the thalweg direction)* • *Disconnected tributaries*	Longitudinal connectivity can be improved by the removal of in-channel obstacles. If tributaries are reactivated as major drainage lines, more water can be stored in the valley. A permeable riverbed (provided that water quality is good) allows for groundwater exchange. (Based on e.g. Prominski et al., 2017)
Ecological network	• Green corridors • Habitat patches as stepping stones • Gradients (e.g. vegetated river banks as gradients between land and water) • *Non-vegetated open spaces (e.g. parking lots, brownfields)* • *Non-vegetated infrastructure lines (e.g. irrigation canals, roads)* • *Hard river edges (e.g. concrete canal edge)*	A redundant network of corridors, stepping stones and gradients establishes a predominantly longitudinal, but also lateral, connectivity in the URC. Contact zones with the river are designed as ecotones aiding vertical connectivity. (Based on Dramstad et al., 1996).

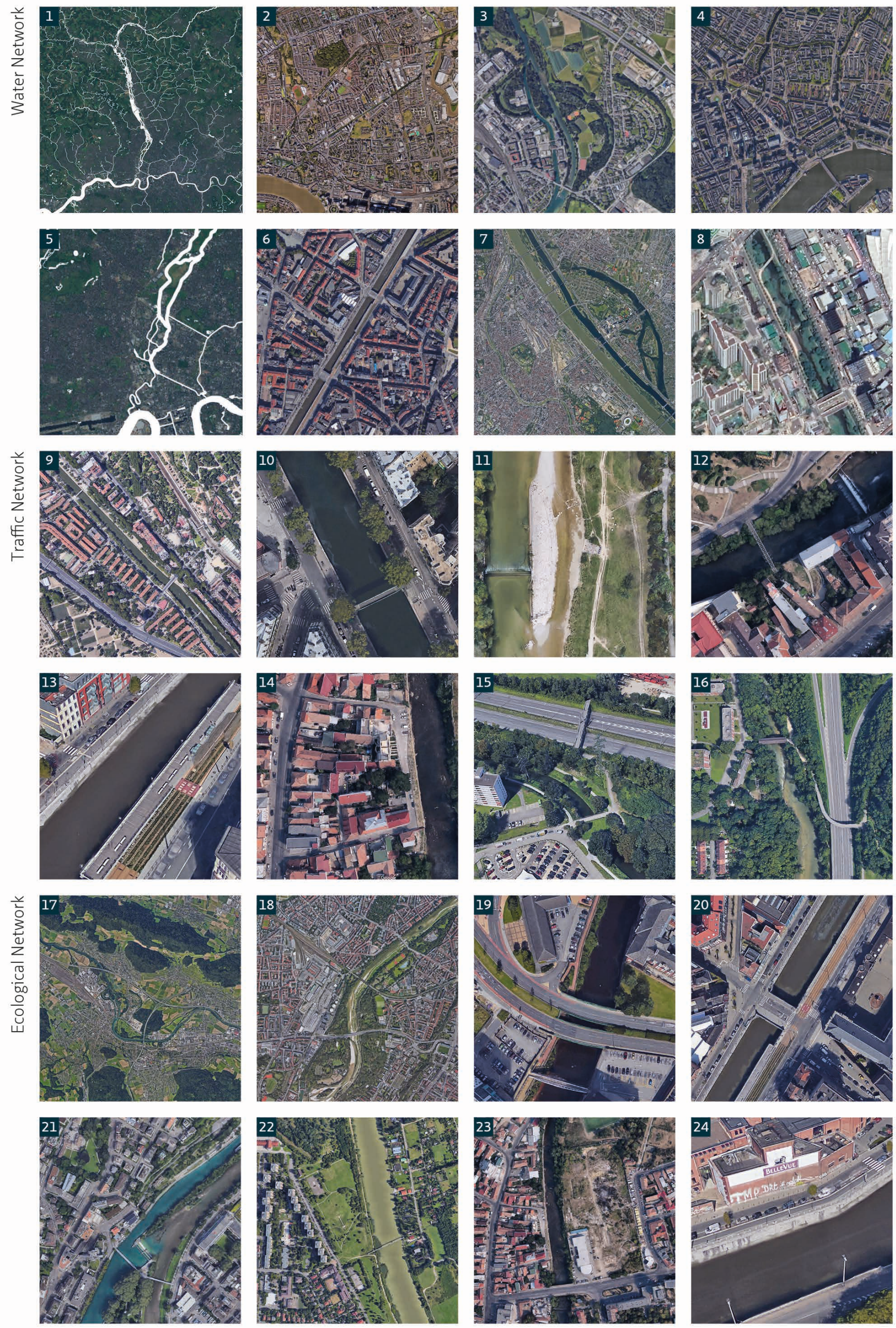


FIGURE 7.12 Photographic samples of URC network elements: (1) Lea River in London; (2) bypass between Lea River and Thames, London; (3) former meanders, Limmat River, Zurich; (4) disconnected Tributary Rotte River from Maas River, Rotterdam; (5) detail of Lea River system: bypass and confluence with Thames; (6) channelized and covered Senne River, Bruxelles; (7) former meanders visible within the city structure, Danube in Vienna; (8) uncovered and redesigned Cheonggyecheon River, Seoul; (9) major traffic lines along the river, Manzanares River, Madrid; (10) secondary road network along Canal Saint-Martin, Paris; (11) desire paths, Isar River, Munich; (12) former bridge trajectory, missing and planned connection, Someș River, Cluj-Napoca; (13) road network following Channelized Senne, Bruxelles; (14) access road, Someș River, Cluj-Napoca; (15) green and pedestrian connections on Leutchenbach River, Zurich; (16) slow mobility network and ecological connections along and across Elster Millrace River, Leipzig; (17) GBI and ecological connections, Limmat River, Zurich; (18) green Corridor, Isar River, Munich; (19) parking space, non-vegetated, Don River, Sheffiled; (20) sealed surfaces along channelized Senne River, Bruxelles; (21) patches as stepping stone, Limmat River, Zurich; (22) green corridor and river park, Danube River, Budapest; (23) brownfields, non-vegetated space on Someș River, Cluj-Napoca; (24) sealed surfaces along channelized Senne River, Bruxelles. Sources: Google Earth; Burgos, Garrido, Porras-Isla, Muller, & Matthews, 2014; Prominski et al., 2017.

Principle 1: Interconnectedness

In order to facilitate the movement of people, animal and plant species, and water, and to provide a spatial framework for social-ecological integration, URCs require an interconnected spatial configuration (Figure 7.13), which has three components:

- A grid-like network of streets, informed by spatial-morphological analyses (e.g. Space Syntax analyses of accessibility or through-movement), in which the number of existing and potential elements of connectivity along, towards/across and within the river is maximised, in order to improve the freedom of choice for pedestrian (i.e. hierarchically not predefined) movement. Moreover, the traffic network hierarchy is (re)configured as a gradient of speeds from a 'fast lane' positioned outside the valley edge to a 'slow lane' positioned on the river edges. The public transport network can also be present in the 'slow lane', as long as its infrastructure does not hinder pedestrian movement.
- A redundant ecological network configuration, which consists of existing and potential corridors, stepping stones and gradients that connect the ecological network of the city to the river, and cross the city to connect larger habitats in the urban periphery. Stepping stones are defined by ecologically significant proximity rules (e.g. maximum Euclidean edge-to-edge distance for flying species or based on inter-visibility distances for visually-oriented species). Gradients are found or created at the edge between land and water (vegetated riverbanks).
- A restored water network, flowing, as much as possible, along the line of minimum elevation in the valley representing the former trajectory of the river (i.e. the thalweg of the river), in which in-channel barriers to longitudinal connectivity are minimised. If disconnected or culverted, tributaries should be restored as surface water drainage lines. In addition, a distributed network of water storage and drainage solutions is included in the street network and the ecological network.

As shown in the project for URC Colentina in Box 7.1, there are at least two distinct situations in which design for interconnectedness is encountered: corridor-scale design, addressing the configuration of the network as a whole (e.g. Figure 7.7 and Figure 7.11), and site-scale design, in which local linkages to the wider social and ecological networks are sought (e.g. Figure 7.9).

At the scale of the corridor, *Interconnectedness* requires an inventory of the spatial elements found in the URC that act as either barriers or potential links for pedestrian movement, animal and plant routes of dispersion, and water flow. This inventory may include a variety of public space elements, such as crossings, pedestrian routes to the public space network, riverside walkways or promenades, accessible embankments, bicycle infrastructure, public (land and water) transport routes and stops, beaches, and pontoons; and elements of ecological space, such as linear parks, rows of trees, gardens, and fish ladders. Corridor-scale design is typically informed by prior analysis or assessment and is concerned with questions such as "how can the spatial configuration of the elements of connectivity be improved to support interconnectedness?" and "how can the network elements of the corridor be (better) designed to improve the connectivity of the URC?"

Site-scale design can be located either in the river space or in the surrounding urban fabric of the URC. Design at this scale needs to respond to corridor-scale conditions and related ambitions. Regardless of the availability of a prior corridor-scale assessment, a number of questions related to connectivity may be considered when designing for interconnectedness on site scale: "how can a given site in the URC be (better) connected to the networks of public and green spaces?"; "how can the river be (better) reached or crossed from a given site within the URC?"; "how can the site (better) contribute to transversal green(-blue) corridors in the URC?"; or "how does the design at the scale of a site in the URC improve the physical interaction of people with the river?"

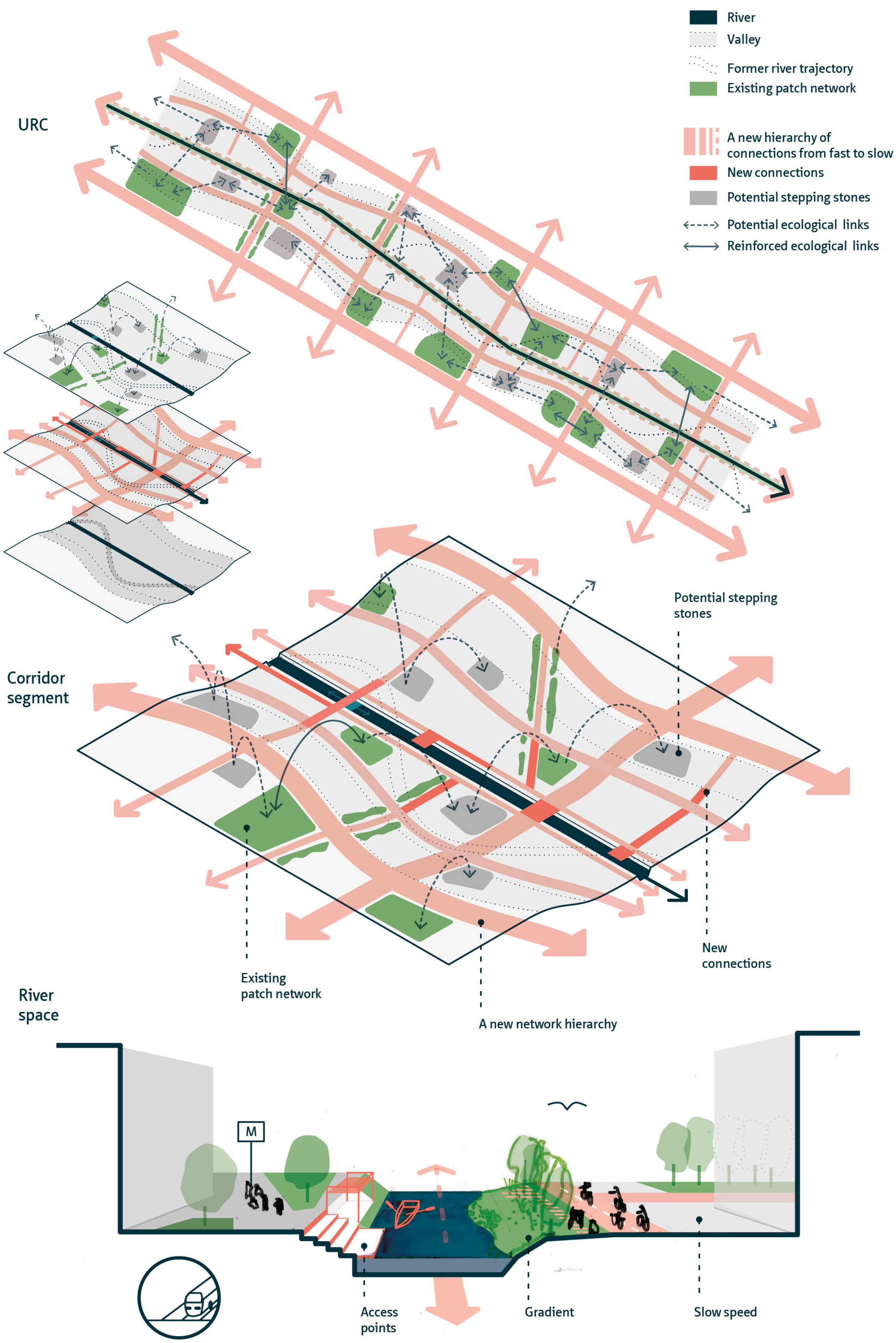


FIGURE 7.13 Diagram of the *Interconnectedness* principle on the scale of the URC (top), corridor segment (middle), and river space (bottom).

§ 7.3.2 Intensifying open spaces

Open space amenity was identified in Section 2.2.6 as an essential feature of URCs describing the capacity of riverside open spaces to accommodate and sustain water, ecological habitats and human activities. Accordingly, Chapter 5 devised indicators of spatial diversity (e.g. biodiversity and mix of uses), quality (e.g. visual permeability of the river space and level of water pollution) and composition (e.g. open space and green space coverage) to assess the extent to which desirable targets of spatial capacity are met in a given URC. In addition to those quantifiable targets, potentials for improved open space amenity and spatial capacity can be explored through design, and guidelines can be given through design principles. General urban design principles summarised in Table 7.1 target open space amenity through spatial and functional diversity, spatial and functional redundancy, constitutedness of street frontages, porosity of urban spaces, and spatial quality. Although the regeneration of built and unbuilt spaces and the provision of amenity in riverside urban spaces were also highlighted in Table 7.1, further analysis of the particularities of URC design is needed.

The spaces of URCs

A basic requirement in urban river design, pointed out by Prominski et al. (2017, p. 15, emphasis added), is "more *space for water*, more *space for plants and animals*, more *space for people*". The simplicity of this statement makes it a good starting point for analysing the spatial prerequisites of URCs. Let us start by reacting to this proposition with a few questions: Why is more space a requirement? If it is more that is required, than how much more? Where can more space be gained from? And is more space only a matter of quantity?

The reason why more space is required is not because it is always, and in any quantity, desirable, but to recognise that there is insufficient space. As explained in Chapters 1 and 2, and further illustrated in Chapters 3 and 4, urban rivers all around the world have been restrained by the built fabric and by traffic infrastructure. Water is restrained in less space, as it is mostly drained instead of being stored; green spaces are under constant development pressure; and public space is subdued by vehicular traffic. The urgency of the matter can be recognised in several attempts at restoring spatial capacity along urban rivers. For instance, the Dutch *Room for the River* programme, implemented between 2006-2015, aimed to improve the flood resilience of the country by increasing flood capacity along the Rhine, Meuse, Waal and Ijssel rivers. Measures included receded dykes, depoldering, bypass channel construction, channel widening and removal of in-channel obstacles. Perhaps the most emblematic intervention within this programme is the *Room for the river Waal* in the city of Nijmegen, in which a bypass channel and dedicated floodable areas were constructed to relieve the pressure on the bottleneck at the sharp turn of the river crossing the city centre (Figure 7.14).

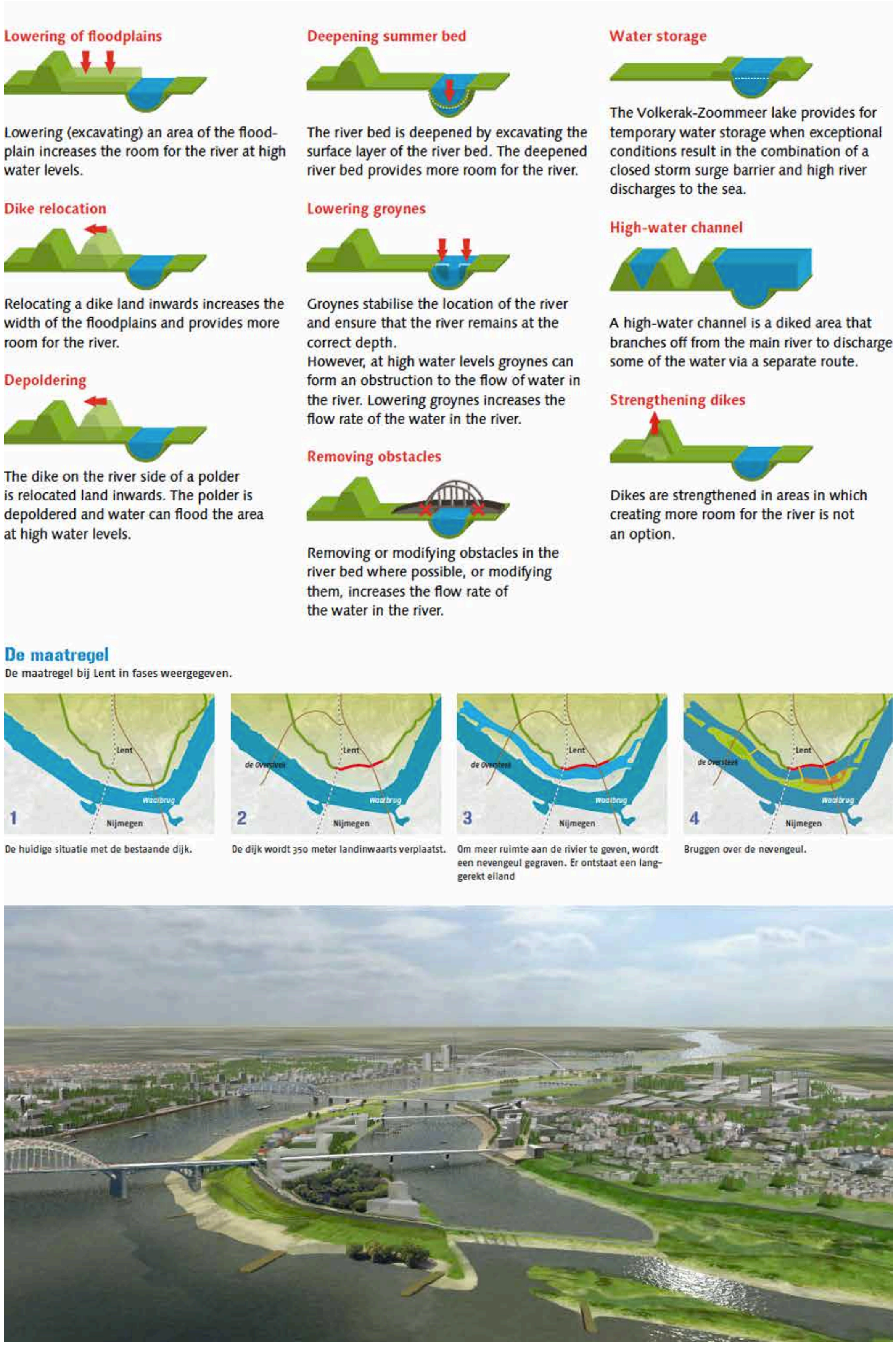


FIGURE 7.14 The project for the bypass channel on River Waal in Nijmegen: general Room for the River principles (top), plan of the transformation (middle), aerial perspective (bottom). Sources: ruimtevoorderivier.nl. Retreived from: https://www.ruimtevoorderivier.nl/english/ (Accessed: 1 August 2018).

How much more space is required, depends on the context. As shown in Chapters 5 and 6, the spatial capacity of URCs can be quantified, and desirable target values can be determined, but those values are always relative to the hydrological, ecological, environmental, social and economic conditions in which measurements are made. Most of the time it is not even a matter of how much more space is needed, but how much convertible space is available and what are the desirable targets. If in the case of Room for the river Waal space could be ceded to the river by relocating parts of the village Lent, opposite Nijmegen, a similar intervention is less likely to be implemented in city centres in which both sides of the river are densely built up or occupied by road infrastructure. In the case of Madrid Río (Burgos et al., 2014), one of the most extensive riverside infrastructure and public space projects to date, the Spanish capital buried a whole section of a motorway running along River Manzanares to free up the space for a large public and green space (Figure 7.15). A similar but less extensive riverside intervention is Paris Plages, mentioned in Section 1.1, in which riverside car traffic was removed and the river was reclaimed as a pedestrian space. In both cases, public space or green space was gained by the relocation or reallocation of the space of vehicular movement.

FIGURE 7.15 River Manzanares before and after the Madrid Río project. Source: eoi.es. Retreived from: http://www.eoi.es/blogs/imsd/project-management-rio-madrid-project/ (Accessed: 1 August 2018).

Coming back to the statement of Prominski et al., it is not likely that target values, if any, of all three recipients—water, wildlife and people—can be reached. They are on an equal footing, which means that allocating more space to all three involves, to some extent, a confrontation of needs and a superposition of spaces. In this sense, the combined—green, social, hydrological—functionality of open spaces is at least as important as reaching a certain quantifiable target. In this sense, *Water Square Benthemplein* designed by the Dutch urban and landscape design office De Urbansiten is a well-known example in which storm-water storage and recreation were accommodated in the same space (Figure 7.16). Green and Blue Infrastructure (GBI) solutions, described in Section 2.2.2, have also been successfully implemented all over the world as a way to combine water and green space in order to reduce storm-water runoff, to increase infiltration, and to improve micro- and meso-climate, among other benefits. Moreover, GBI is an urban amenity, as it is often designed to provide public space functions.

FIGURE 7.16 The Water Square Benthemplein in Rotterdam, the Netherlands, is designed as an urban public space that can also store storm water during extreme rainfall. Photo credit: Jeroen Musch.

Hence, the association between more space, on the one hand, and its recipients water, animals and plants and people, on the other hand, makes the statement of Prominski et al. (2017) both quantitative and qualitative. The former suggests an increase in spatial capacity, while in the latter the capacity is assigned to specific needs. Spatial quality is, thus, reflected in storm water quality typically addressed in GBI solutions (Perini & Sabbion, 2017), in aspects such as biodiversity and habitat composition in urban space for animals and plants (e.g. Beatley, 2011), in the diversity, visual permeability, identity, and legibility of urban space for people (e.g. Lynch, 1960), and in the psychological benefits of integrating nature in public space (Kaplan & Kaplan, 1989). Overall, this quantitative and qualitative characterisation of open spaces reminds of the concept of porosity (Viganò, 2009a), that is, the balanced distribution of open and meaningful urban spaces permeable by water, people and ecosystem agents.

In addition to spatial dimensions, the temporal dimension must be taken into account, especially considering the spatial impact of urbanization on rivers, as described in Section 1.1 and illustrated with the case of Bucharest in Chapter 3. Understanding the transformations of the spatial relationship between the river corridor and the urban fabric throughout history is crucial. For instance, the relationship between an urban fabric and a river prior to rationalisation (e.g. through rectification or canalisation), was characterised by a certain dynamic interaction, in which open spaces were formed and distributed as a result of a long-term process of mutual interaction between culture and nature. In this sense, juxtaposition of the river's natural trajectory and geomorphology on the city's current urban fabric, can give insight into how open spaces should be reconnected, and thus become carriers for ecology. The project presented in Box 7.2 builds on this juxtaposition to devise a strategy of social-ecological integration and spatial reactivation in URC Dâmbovița.

BOX 7.2 **'Bucharest: Between North and South'—a project for URC Dâmbovița**

- Type of project: Post-master thesis (European postgraduate Masters in Urbanism)
- Date: June 2013
- Author: Claudiu Forgaci
- Location: Bucharest, Romania

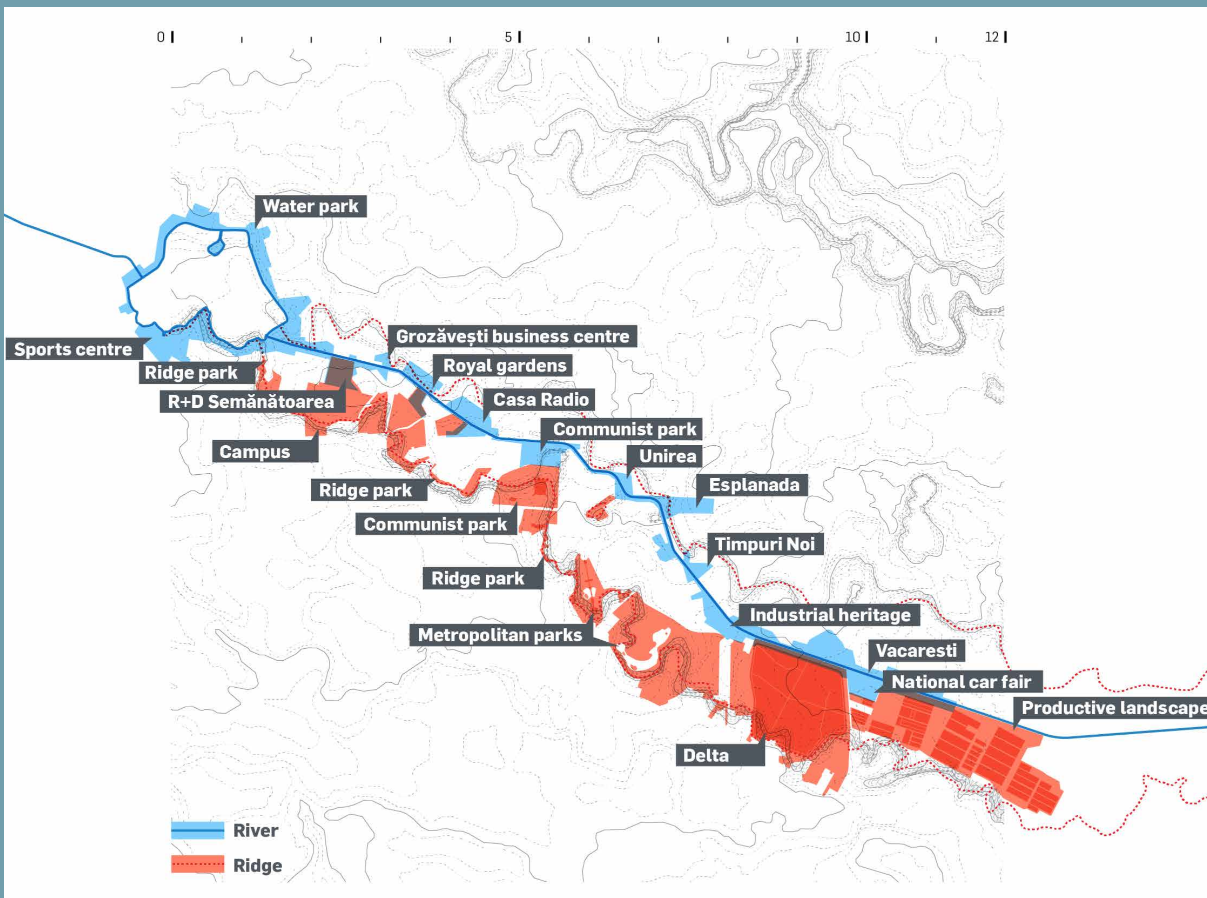


FIGURE 7.17 Strategic public and ecological corridors collecting meaningful places along the URC Dâmbovița (Forgaci, 2013).

This project departed from the hypothesis that the divide between the north and south of Bucharest is partially caused by the transformation of Dâmbovița, the river crossing the centre of the city, from a meandering river and a dynamic floodplain into a technical infrastructure designed for flood protection and vehicular traffic, i.e. a physical barrier. Inspired by regional urbanisation patterns carried by rivers and the networked configuration of urban settlements connected by rail and road networks, the strategy centres urban development on the river. To that end, the projects built on the hidden spatial potentials of the river valley found in the configuration and scale of the urban fabric (Figure 7.18).

As shown in Figure 7.17, the project identifies major public spaces along canalised River Dâmbovița (in blue) and ecological spaces along the southern valley edge (in red) as strategic spaces of integration making use of the topography of the river valley. As a strategy of *Absorptive Capacity*, the project makes use of public spaces, non-residential private spaces and underused spaces (Figure 7.19) located in the river space or along the southern valley edge. By enforcing the continuity of these spaces with networks running along and across the corridor, it increases the *Interconnectedness* of the URC.

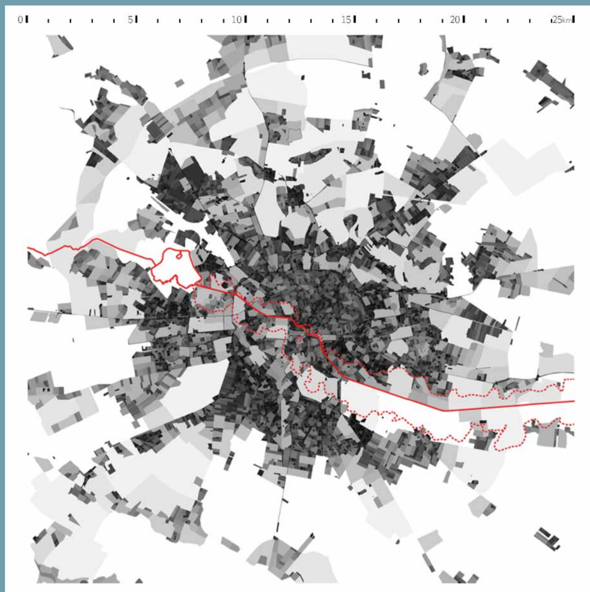


FIGURE 7.18 The relative size of urban islands in Bucharest from small (black) to large (white).

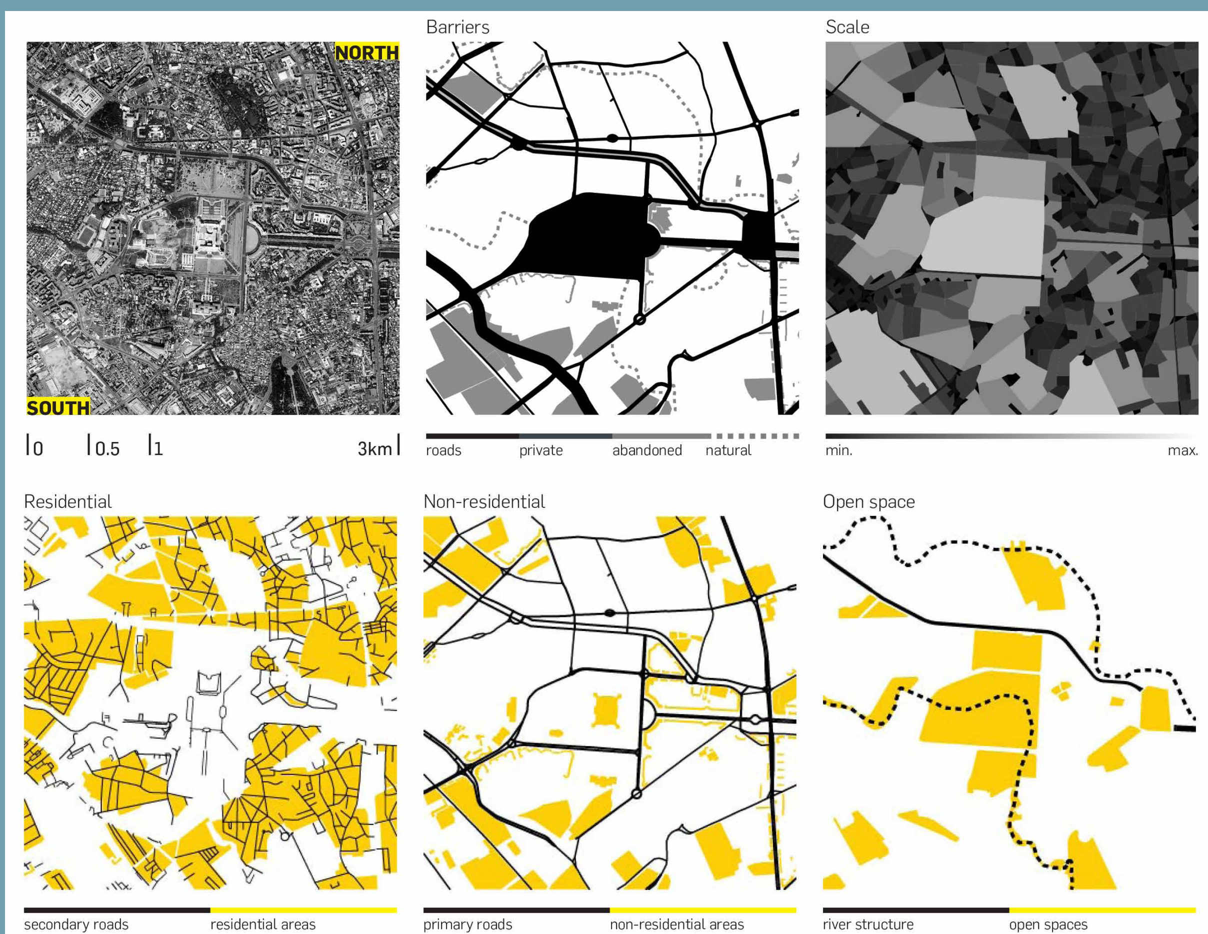


FIGURE 7.19 Analysis of spatial barriers, scale (grain) of urban space (classified by size of urban islands), residential and non-residential uses in relation to secondary and primary roads and open spaces found in one of the key sites along River Dâmbovița. Based on this spatial analysis, the strategy works with barriers and open spaces to restore spatial continuities along the corridor, and it proposes new uses within those spaces to improve the spatial amenity of River Dâmbovița.

Spatial elements and composition

As summarised in Table 7.3, the open spaces of URCs consist of water space, social space, and green space. Here social space refers to all spaces accessible to pedestrians which afford social interaction (i.e. public space) or spaces with different degrees of publicness (semi-public, semi-private or private) that have an impact on the quality of public space in their proximity. For instance, the design of the latter can contribute to safety, visual permeability, attractiveness through their architectural or landscape design and use (e.g. green or transparent fence, no technical ground floor, uses that animate public space). Such targets can be attained through the involvement of local actors, as well as urban rules or policies addressing riverside design and planning. Partially coinciding with social space is green space, which includes parks, lawns, rows of trees, forests, but also gardens, green roofs, or buffer areas that may not be publicly accessible nor necessarily open to social interaction. The design, use and maintenance of green spaces influences the quality of the social and ecological space. The water space comprises all surface water (e.g. the river, lakes, ponds) and spaces which temporarily drain and store water, with degrees of perviousness ranging from hard surfaces (e.g. water square) to bare soil or vegetated surfaces (e.g. green and blue infrastructure). In addition to these three categories, there are undefined and underused open spaces (e.g. leftover industrial areas, brownfields), found even in densely built urban areas, that may be repurposed to afford amenities. These spatial categories are not exclusive in relation to one another; they can potentially increase each other's spatial capacity and quality, as shown in Table 7.3.

TABLE 7.3 The spaces of URCs, their elements (emphasis added to potentials for multifunctionality) and spatial composition.

SPACES OF THE URC	SPATIAL ELEMENTS	SPATIAL COMPOSITION
Social space	• Public space: Squares, sidewalks, pedestrian streets, shared spaces • Semi-public, semi-private and private spaces contributing to the quality of public space or to social interaction (e.g. public functions at grade)	Space for people can be gained by relocating individual vehicular space away from public spaces. The environmental, ecological and psychological benefits of public space can be improved by incorporating green spaces and temporary water storage solutions. The quality and capacity of social space in the river front and surrounding urban spaces can be improved by guiding interventions in semi-public, semi-private and private spaces towards a positive visual (e.g. visibility and transparency of building frontages) and functional (e.g. mixed use and public uses at grade) impact on public space. (Based on e.g. Kaplan & Kaplan, 1989; Lynch, 1960; Prominski et al., 2017)
	• *Freed up and repurposed vehicular space (parking spaces, downgraded roads, shared spaces, slowed paths and river crossings)*	
	• *Storm water storage in public space (more water space, e.g. water square)*	
	• *Ecological potential in public, semi-public and private space: parks, gardens, green roofs (more green space)*	
Green space	• Vegetated open spaces: parks, gardens, yards, buffer zones, vegetated traffic islands, green roofs.	Green space can be gained and sustained through green and pervious public spaces. Green spaces should integrate public uses (e.g. recreation, contemplation), provide ecosystem services (e.g. micro-climate regulation), and make use of green and blue infrastructure and water sensitive urban design solutions to store, infiltrate and drain storm water. (Based on e.g. Perini & Sabbion, 2017)
	• *Recreational potential (more social space)*	
	• *Increased water infiltration (more water space)*	
Water space	• Water surfaces in the URC: rivers, streams, lakes, ponds, wetlands.	Space for water can be gained by widening the river or restoring its meanders and by providing potentially floodable areas in a buffer zone along the thalweg. Storage, infiltration and circulation of water (provided that water quality is good), in accordance with favourable subsoil conditions in the valley, is encouraged. (Based on e.g. Prominski et al., 2017)
	• *Water storage spaces*	
	• *Restored river meanders*	
	• *Recreational potential (more social space)*	
	• *Ecological potential (more green space)*	

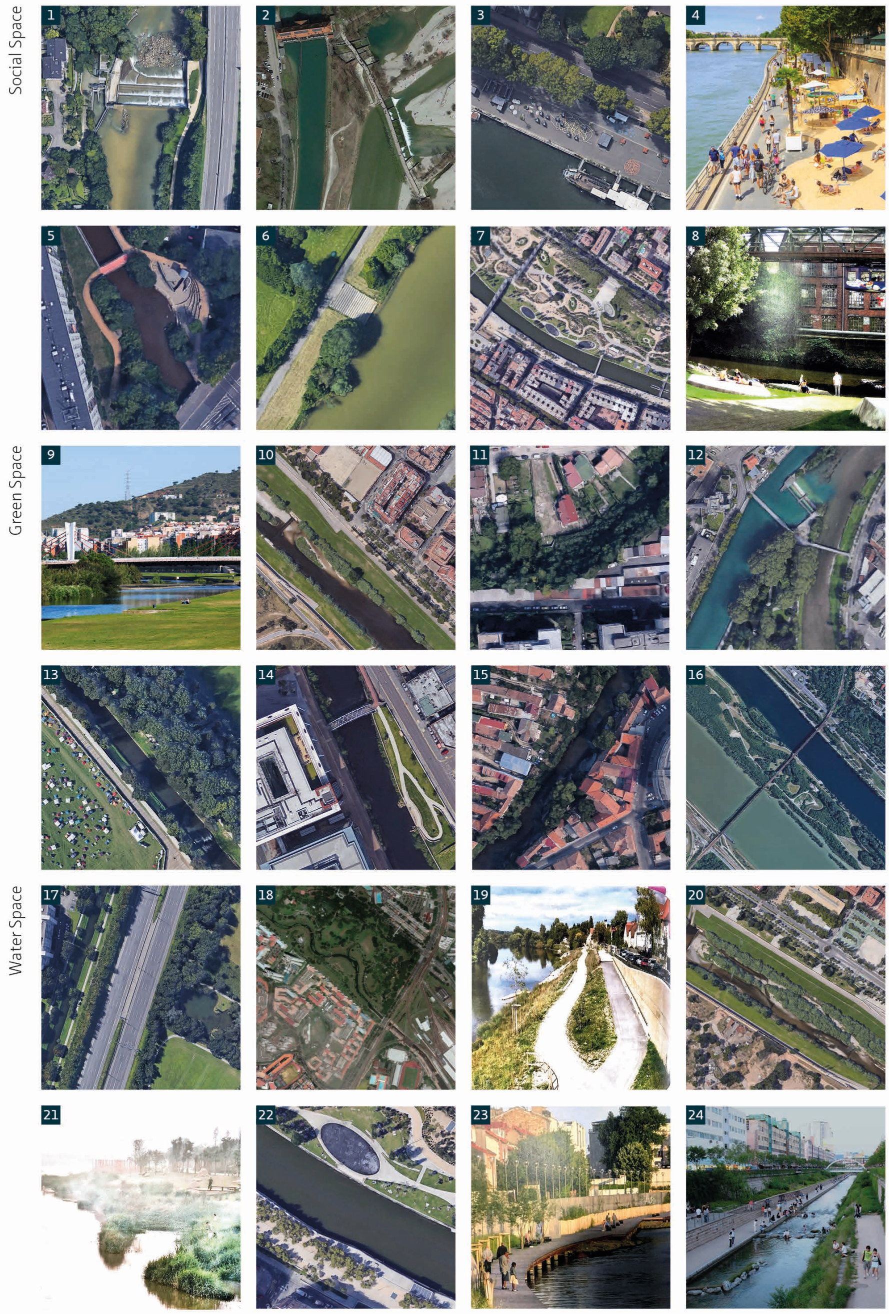


FIGURE 7.20 Photographic samples of open space elements: (1) sidewalk and fish leader, Regen River, Regensburg; (2) beach spaces and public space on Isar River, Munich; (3) downgraded road, shared space and public space, Paris Plages project, Seine River, Paris; (4) sidewalk and beach on downgraded road, Paris Plages project, Seine River, Paris; (5) water square and slow mobility networks, Don River, Sheffield; (6) access point to the water, Limmat River, Zurich; (7) parks and public space on top of buried highway, Manzanares River, Madrid; (8) parks and public space, from industrial purposed waterway to urban river, Wupper River, Wuppertal; (9) vegetated river banks and (10) water storage park, wetlands on Besos River, Barcelona; (11) private gardens and semi-private garages towards Someș River, Cluj-Napoca; (12) vegetated traffic island, Limmat River, Zurich; (13) recreational river space (event field, camping, sidewalk and park) on Limmat River, Zurich; (14) green river bank and slow mobility on Don River, Sheffield; (15) private and semi-private river bank with ecological potential, Someș River, Cluj-Napoca; (16) vegetated traffic stepping stone, Danube River, Vienna; (17) water space, Limmat River, Zurich; (18) new river meanders, Kallang River, Singapore; (19) floodable pathway, Regen River, Regensburg; (20) river restoration growing ecological and public space potentials, Besos River, Barcelona; (21) restored river wetlands and places for social activities, Yongning River, Taizou; (22) water squares, Manzanares River, Madrid; (23) floodable pathway, Seine River, Choisy-le-rois; (24) uncovered and redesigned water space of Cheonggyecheon River, Seoul. Sources: Google Earth; Burgos et al., 2014; Prominski et al., 2017.

Principle 2: Absorptive Capacity

Absorptive Capacity, proposed in this section, is a principle meant to guide the design of riverside open spaces while maintaining a balanced relationship with the built fabric. Besides the capacity to accommodate and to sustain, it considers the attractiveness of riverside open spaces. In addition to the spatial configuration of URCs networks addressed under the principle of *Interconnectedness*, *Absorptive Capacity* focuses on *spatial composition* to show what and how much is (or should be) there and in what relative abundance.[72] Hence, it aims for a *more porous urban space*, in which capacity is conditioned by both the composition and quality of open spaces.

Both from social and ecological point of view, the abundance of open space must be balanced with spatial configuration. Spatial abundance is not sufficient neither for well-functioning public spaces, nor for green spaces. Public spaces need to be combined with built densities in spatial configurations and principles in which buildings define, or are designed together with, open space, and their relation with the surrounding open space is considered in a qualitative way (e.g. public functions at grade or visual permeability). From an ecological point of view, the spatial configuration of habitat patches in urban areas is as important as their composition.

In order to spatially accommodate, sustain and attract water, ecosystems and people, URCs must have *Absorptive Capacity*, that is, a redundant and attractive composition of three categories of open space: water spaces, social spaces and green spaces (Figure 7.21).

- *Spatial redundancy* for can be achieved by allocating undefined urban spaces to at least one of the three categories or by re-distributing existing open spaces among the three categories. It can also be achieved by upgrading the multifunctionality of existing open spaces (i.e. combining elements of water space, social space and river space).
- *Attractiveness* is achieved, by providing extra space for people and ecosystems, by gaining advantage from the potential multifunctionality and diversity of open spaces, and by determining the optimal sizes and locations in regard to their configuration at multiple scales.

In designing URCs towards *Absorptive Capacity*, any open space in the URC may be considered as potentially green, social, and water space. Open space, according to this principle, is in itself a potential and its integrated (social-ecological) identity should be inherent in the case of URCs. For instance, a parking lot has the potential of becoming a green space, a water square or a community space. A canal can be redesigned as a recreational space or a migration route for species.

72 Composition is used here according to its definition from landscape ecology, which is different from its usage in design. In design, composition refers to a spatial arrangement, which is configuration in landscape ecology.

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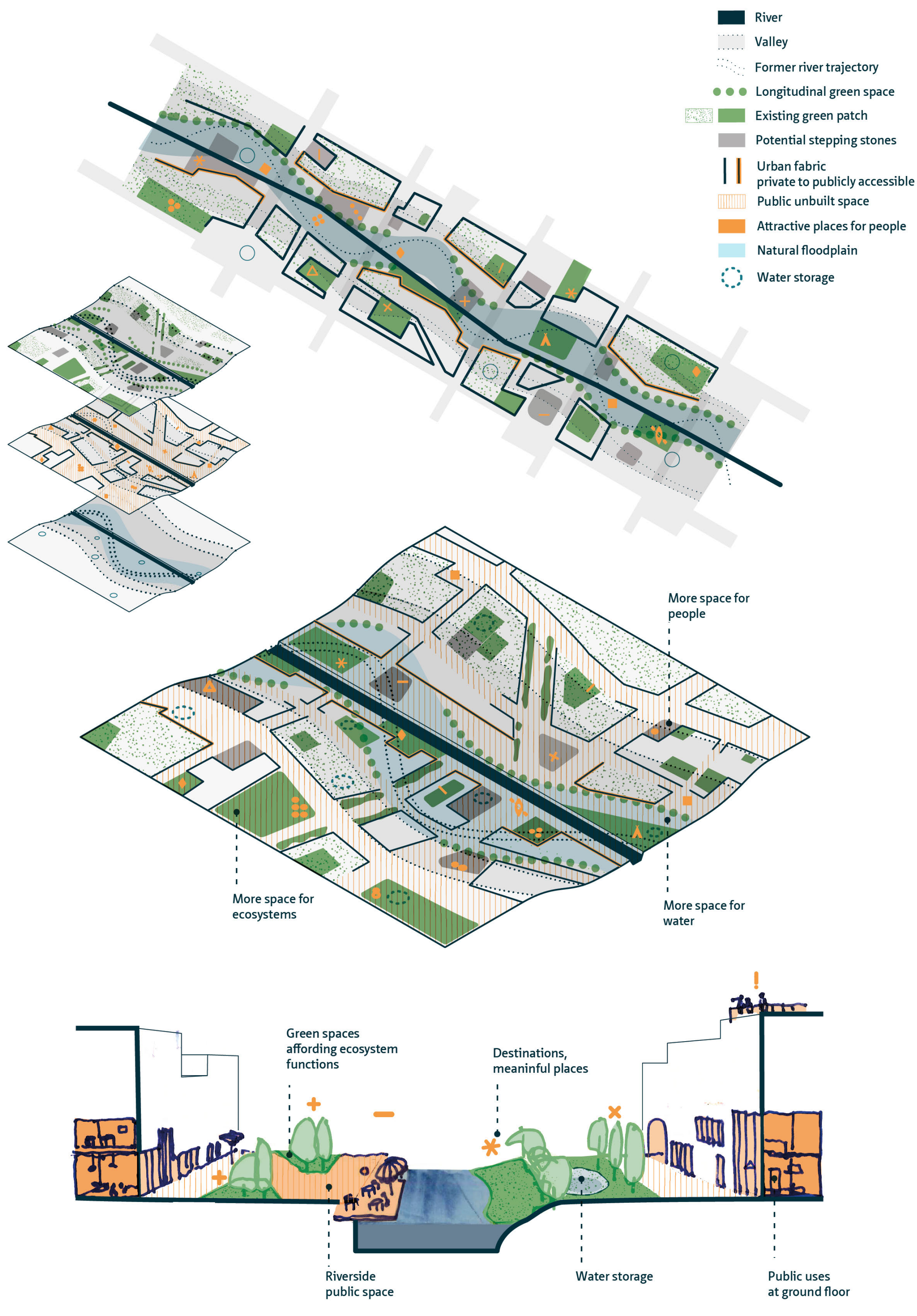

FIGURE 7.21 Diagram of the principle of *Absorptive Capacity* on the scale of the corridor (top), corridor segment (middle), and river space (bottom).

Growing synergies

Integration was presented throughout the thesis as a central goal in transdisciplinary research (Section 1.5.2), as well as in the description (Section 2.2.6) and assessment (Section 5.4.4) of URCs as social-ecological systems.[73] Urban design principles (Table 7.1) address integration by balancing built-up density with open space, by promoting design with the landscape (e.g. topography, vegetation, climate) and by integrating nature in urban space, e.g. through green infrastructure (GI). Integration is a central requirement in the design of URCs, achievable by a joint use of the networks and spaces of the city and the river (e.g. waterfront promenades connected to the network of public spaces of the city, green and blue infrastructure solutions).

Coupling the networks and spaces of URCs—synergies and conflicts

Resilient urban development requires a view of the city as an integrated social-ecological system, in which ecosystem services and urban system services are jointly addressed in urban design (Barthel et al., 2013). As shown in Figure 7.22, designing the elements and networks and addressing the actors and processes of both the ecological and the social system can lead to an improved provision of ecosystem and urban system services.

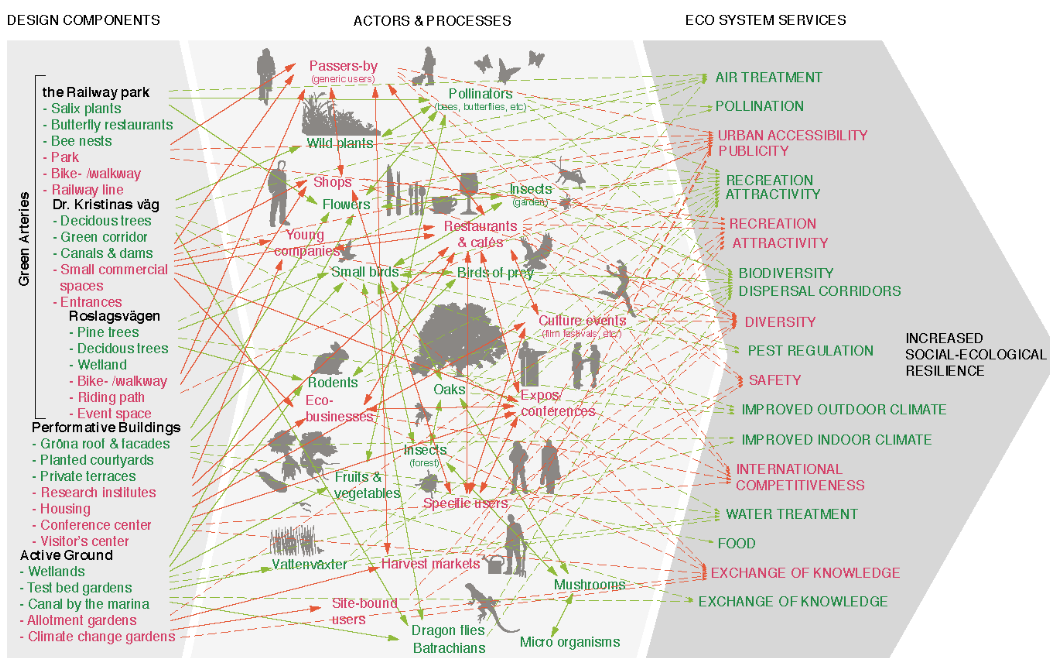

FIGURE 7.22 In their study of Albano Campus in Stockholm, entitled "Principles of Social-Ecological Urbanism", Barthel et al. (2013) identify design components that can improve ecosystem services and urban system services. Source: Barthel et al., 2013.

73 Other similar approaches to integrated systems have evolved in parallel with social-ecological systems (SES) theory. Notable examples are coupled human and natural systems (CHANS), coupled human-environment systems, or human-environment systems (e.g. Liu et al., 2007).

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Building on the integrative potential of three-dimensional connectivity (May, 2006), the principle of *Interconnectedness* proposed a spatial configuration, in which the social, ecological and water networks can be assembled in a non-conflicting way (see project in Box 7.1). Integration was also visible in the definition of *Absorptive Capacity*, in which social, ecological and water spaces overlapped to form multifunctional open spaces (e.g. see project in Box 7.3). However, the spatial dimension of networks and the topology of spaces remained implicit in the two principles. An integrated approach should make this two-way relation between networks and spaces explicit. This way, an integrated pattern-process understanding (Turner & Gardner, 2015) of URCs can be attained. Potentials for networks can be sought in open spaces, not necessarily spatially connected on the ground (e.g. an impervious open space can be transformed into a stepping stone in the ecological network), open spaces can be created along elements of the network or they can be made more accessible by new connections.

Social-ecological integration is a challenge for design, as the relationship between the social and ecological systems is unavoidably and inherently subject to reciprocal tuning. This is due to the contested nature of urban river space, on one hand, and due to the necessity of involving different stakeholders, on the other. As shown in Table 7.1, illustrative in this sense is the aim of urban design to find a balance between densification and the provision of green space (e.g. Beatley, 2000; Benedict & McMahon, 2006). Another fundamental principle of urban design is that of stakeholder involvement, as opposed to design as an individual act of creation. Accordingly, design for social-ecological integration in URCs requires an understanding of *conflicts* and *synergies* arising from the spatial juxtaposition of the network and spatial elements of the URC. As shown in Table 7.4, synergies and conflicts between and across network- and spatial elements found in the URC can be addressed.

TABLE 7.4 Conflicts and synergies found in and between the elements of the networks and open spaces in the URC.

	NETWORK ELEMENTS	SPATIAL ELEMENTS	NETWORK AND SPATIAL ELEMENTS
Conflicts	• Barriers to movement across, along or within the river (e.g. high-speed traffic along the river banks or bridge inter-rupting ecological connectivity along a river, or weirs acting as barriers for fish movement)	• Impervious and non-vegetated urban spaces that do not store water and do not accommodate elements of green space	• Public spaces that do not participate in the network of ecological patches • Infrastructure lines that create barriers to species movement (e.g. power lines, rail lines or high speed vehicular traffic lines)
Synergies	• Multifunctional streets • Non-overlapping and reciprocally supportive spatial configuration of the water-, traffic- and ecological networks	• Multifunctional open spaces • Ecosystem services (e.g. micro- and meso-climate regulation) provided by green or green-blue infrastructure	• Green streets acting as links between ecological patches

BOX 7.3 **'Someș turns its face towards the city'—a project for URC Someșul Mic**

- Type of project: Competition entry
- Date: September 2017
- Team: Paola Viganò, Claudiu Forgaci, Qinyi Zhang, Anca Ioana Ionescu, Iulia Sârbu, Stella Armelli
- Consultants: Cristian Tetelea (river restoration), Alessandra Crosato (river engineering), Norbert Petrovici (urban sociology)
- Location: Cluj-Napoca, Romania

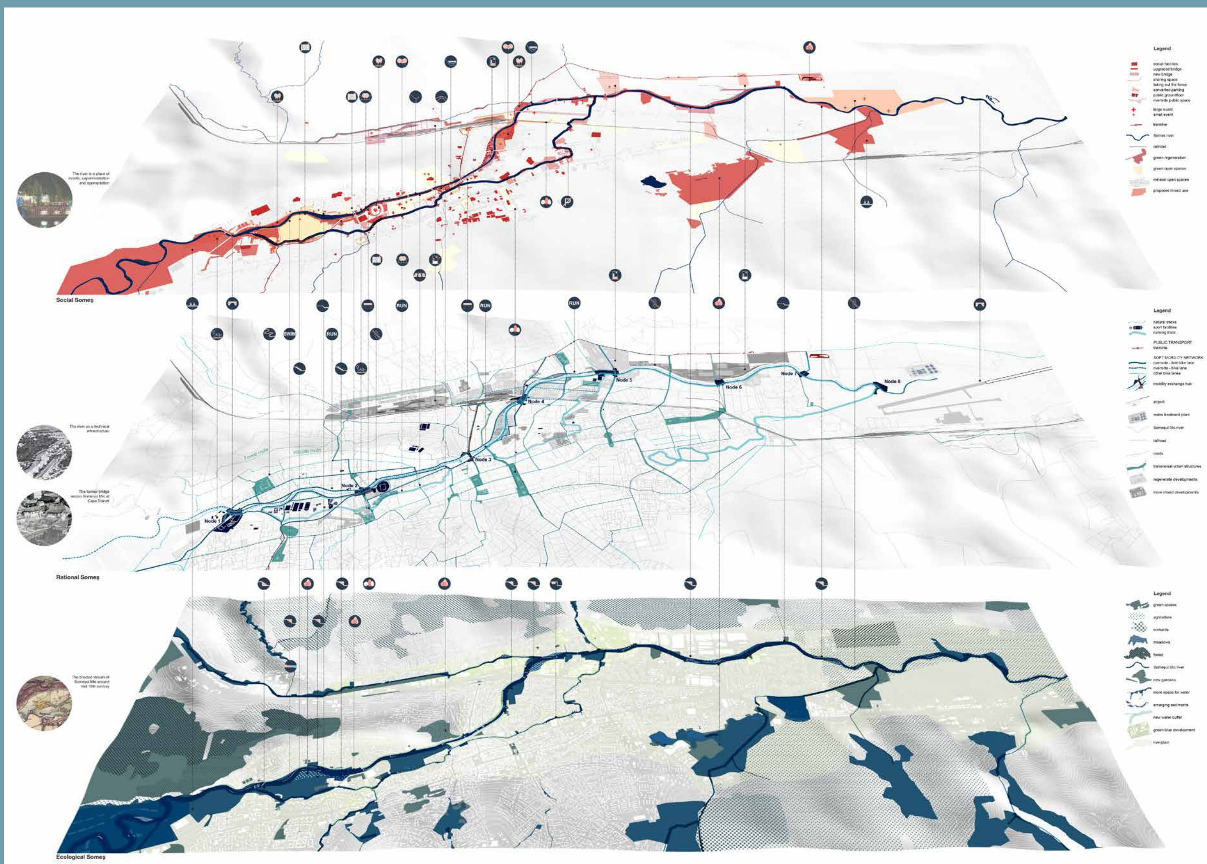


FIGURE 7.23 The three proposed scenarios (from top to bottom) Social Someș, Rational Someș, and Ecological Someș were overlapped and strategic actions were devised where conflicts and synergies were identified.

The project for River Someșul Mic employed a strategy that put emphasis on *Interconnectedness*, *Absorptive Capacity* and *Social-Ecological Integration*. The spaces of the river (i.e. the river space and green space, under the scenario 'Ecological Someș') and of people (i.e. social space under the scenario 'Social Someș'), and the underlying infrastructures (referred to as 'Rational Someș') form the base of an integrated urban development plan. Strategic actions were proposed where conflicts or synergies arose between these three extreme scenarios of the river (Figure 7.23). The method of scenarios was employed to uncover the full potential of the river for integration and to base design ideas on the synergies and conflicts between the three scenarios. The scenarios were built and confronted across temporal and spatial scales, in order to reveal cross scalar interdependencies. For instance, the damming of the river upstream (i.e. on catchment scale) determined the armoured character of the river (i.e. the lack of sedimentation). Or, the study of the past trajectories of the river led to the identification of a site for a bypass channel proposed in the project where a former braided section of the river was located. Given the transdisciplinarity of the topic, the process was guided by the collaboration and co-building of the scenarios together with experts from different fields: a local urban sociologist, a river engineer, and a river ecologist.

Principle 3: Social-Ecological Integration

Drawing on the previous two principles—*Interconnectedness* and *Absorptive Capacity*—and informed by design explorations (e.g. Box. 7.3), *Social-Ecological Integration* is a design principle seeking to build synergies between the social and ecological elements of the networks and open spaces found in the URC. Hence, the *Social-Ecological Integration* of URCs can be improved by targeting areas of (potential) conflict and synergy at the spatial superposition of network elements (i.e. actual and potential connectivity) and spatial elements (i.e. actual and potential spatial capacity) as follows (Figure 7.24):

- Social-ecologically integrated URCs combine water networks, ecological networks and traffic networks in a non-conflicting and reciprocally supportive spatial configuration. A parallel (in a topological sense) configuration of three-dimensional connectivity is encouraged, in which barriers to social, ecological and water movement at the intersection of the three dimensions are avoided.
- In social-ecologically integrated URCs, open space is a resource that is preferably shared by people, ecosystems and water, thus multifunctionality and hybridity is encouraged.
- *Social-Ecological Integration* establishes a complementary and reciprocal relation between the networks and the elements of URCs. Networks can increase the importance of open spaces by enhancing their accessibility, while spatial elements (through open space amenity) can add quality and increase the importance of network elements in relation to one another.

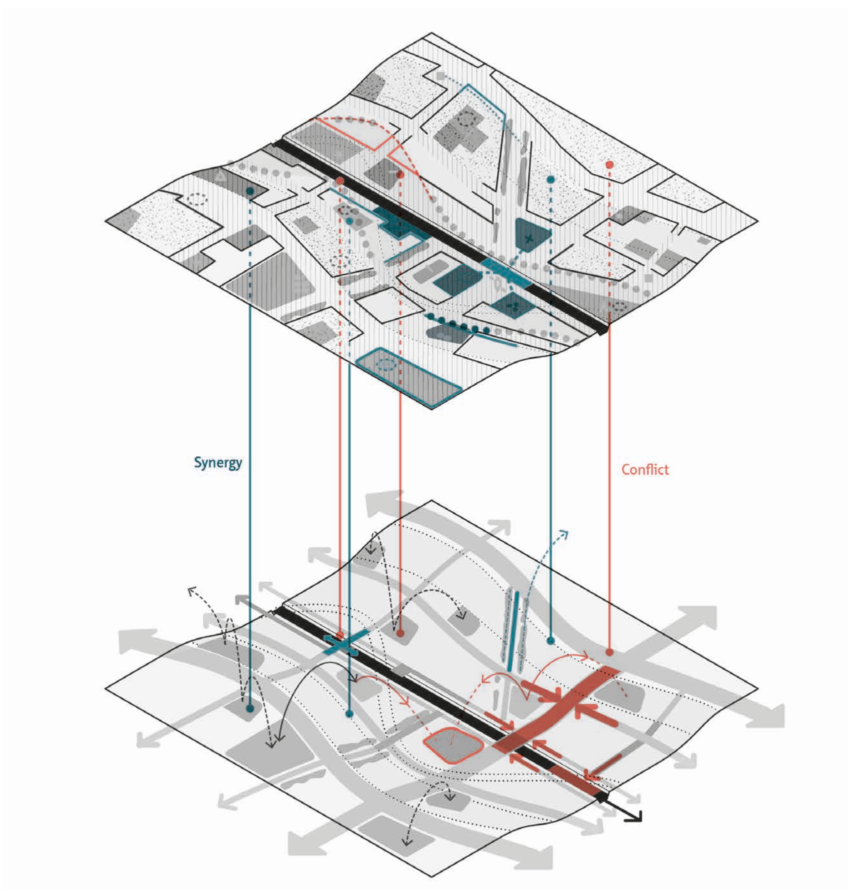


FIGURE 7.24 *Social-ecological integration*: synergies (in green) and conflicts (in red) among and across the elements of *Interconnectedness* and *Absorptive Capacity*.

When designing for *Social-Ecological Integration*, areas of conflict and of synergies are approached differently:

- In the design of areas of conflict (e.g. floodable area in public space), adaptation of traditional functions or solutions are sought (e.g. water square).
- Areas of synergy (e.g. beach in the inner bend of a river) are promoted and designed as key destinations; improved connectivity to and increased spatial capacity of these spaces is a priority.

§ 7.3.4 Bridging scales

As concluded in Section 2.2.6, a *multiscalar* approach is necessary for determining the boundaries of URCs as social-ecological systems. Such an approach raises the question: "Which spatial and temporal scales should be considered for a total understanding of URCs?" Yet, a description at multiple scales does not necessarily specify interdependencies across scales, a requirement also pointed out as one of the urban design principles related to multiscalarity in Table 7.1. Design across scales makes interdependencies explicit by asking an additional question: "How and to what extent are URCs constrained or sustained by cross-scalar interactions?" Such an approach is especially important considering that URCs are complex adaptive systems (CASs) (Holland, 1992; Portugali, 2012), characterised by emergent behaviour (Batty, 2003) and cascading effects across scales (Kinzig et al., 2006). Hence, a design principle addressing cross-scalar interactions in URCs requires knowledge of scale as a general concept, of the range of scales specific to URCs, and of the interactions between those scales.

What is scale?

In Cosmic View: The Universe in 40 Jumps, Dutch educator Kees Boeke (1957) set out to describe the universe by means of visual frames at different scales, ranging from the human scale up to the scale of the universe and down to sub-atomic scales. Each successive frame, magnified or reduced ten times from the previous one, had a different identity and a different story. Adopted and popularised twenty years later by Charles and Ray Eames in a film—thus introducing a seamless transition between the frames of Boeke—, Powers of Ten (1977) became a widespread educational tool for understanding scale (Figure 7.25). The reason why this tool was so effective is because, on one hand, it showed things at scales that otherwise could not be seen (from the abstract scale of subatomic particles to that of the known universe) and because, on the other hand, it made the nested relation between those scales explicit.

The neutral frame used by Boeke and the Eames—a 1x1m square incrementally magnified or reduced by a factor of 10—is effective as an educational tool about the nature of the universe. In practice, however, frames and their level of detail (grain) are determined the other way around, based on the object and phenomenon that is being studied. According to de Jong (2012), the frame is given by the smallest circle or sphere circumscribing an object while the grain can be described in terms of the radius of the largest circle that the object's smallest component can contain. To generalise de Jong's observation and Boeke's description, there is a limited range of relevant scales, each with a different identity (see Figure 7.25), which is defined by a system boundary. Scale is a key concept in fields like landscape ecology (Turner & Gardner, 2015), systems ecology (Odum, 1971), geography (Herod, 2011), and in the study of complex human-environment systems (Manson, 2008). For the purposes of spatial (i.e. urban and landscape) design, landscape ecology develops a workable definition that is representative of all these fields: scale is "the spatial or temporal dimension of an object or a process, characterised by both grain and extent" (Turner & Gardner, 2015, pp. 17–18), in which the extent is determined by the object/system boundary and grain is the smallest meaningful unit. In a spatial representation of geographic data, for instance, the grain can be a grid cell in a raster image or a Minimum Mapping Unit (MMU) in a vector dataset.

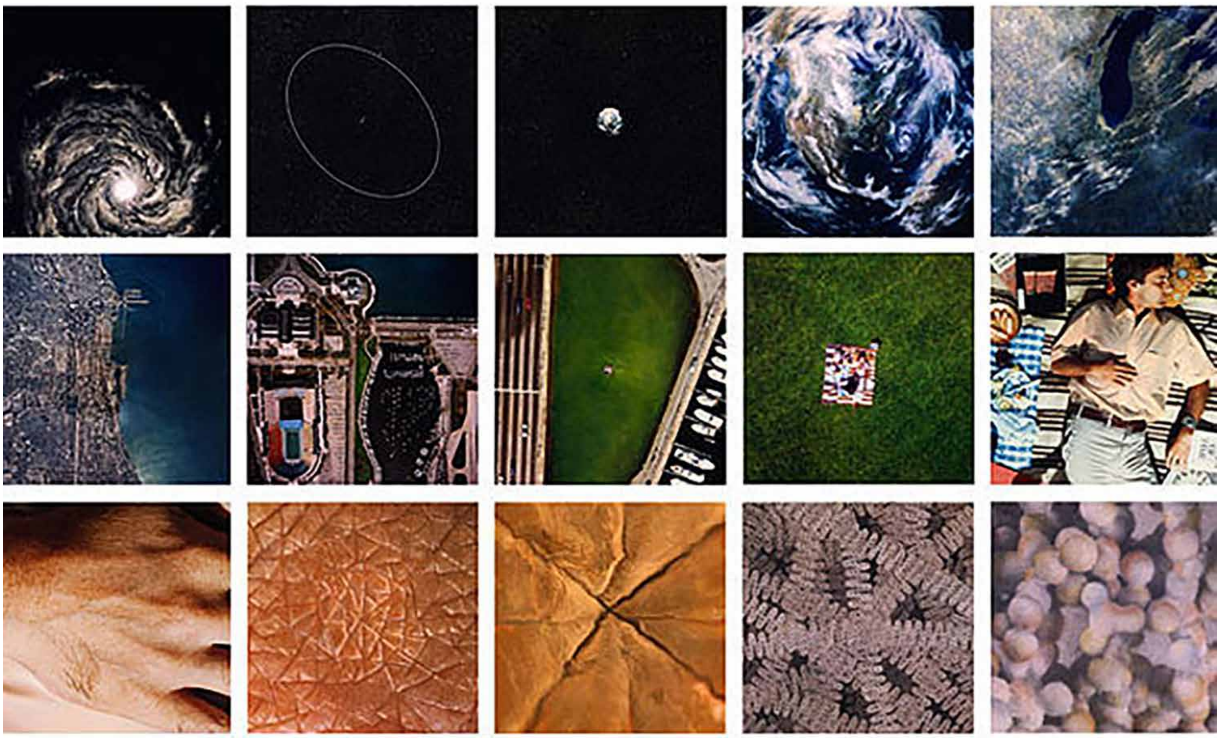


FIGURE 7.25 Frames from the film Powers of Ten (1977) by Charles and Ray Eames. Source: Icon Magazine. Retrieved from https://www.iconeye.com/opinion/icon-of-the-month/item/9949-powers-of-ten (Accessed June 30, 2018).

Cross-scalar interactions

In social-ecological systems, interactions across scales are determined by the *hierarchy* (structure) (e.g. Odum, 1971) and *panarchy* (dynamics) (Gunderson & Holling, 2002) governing the system.

Hierarchies were already introduced in the description of road networks in Section 7.3.1. Distinction was made between the emergent (often spatially interconnected) hierarchies of pedestrian movement, described by the social logic of street networks (Hillier & Hanson, 1989), and the imposed (i.e. with differentiated speeds) or spatially explicit (i.e. dendritic) hierarchies of streets dedicated to vehicular movement (e.g. Marshall, 2005). Although the two kinds of hierarchies have the same grain, the former is representative of smaller scales (i.e. smaller extent; the scales of the street or district), while the latter includes larger scales (i.e. a potentially larger extent, e.g. that of the metropolitan vehicular traffic network).

In systems ecology, the levels-of-organisation hierarchy of Odum (1971) emphasizes the fact that system behaviour and, accordingly, -organisation changes with scale. Centred on the level of an organism, systems ecology characterises scales above the organism (i.e. the environment up to the level of the ecosphere) by the pulsating paradigm of homeorhesis and scales below the organism (down to the level of molecules) by homeostasis.[74] Evolutionary ecology (Pianka, 2011) further correlates spatial scales of biological phenomena with temporal scales by noting that communities and ecosystems are subject to phenomena on larger spatial scales and longer temporal spans than phenomena occurring on organism and sub-organism levels. With a shift in focus from organism to the spatial manifestation of ecosystems (i.e. spatial heterogeneity of landscape pattern and process), landscape ecology defines scale in terms of a three-level hierarchy, in which a *level of focus* is contained by a *level of constraints* (above) and it is detailed by a *level of components* (below) (Turner & Gardner, 2015). As illustrated in Figure 7.26, each level of the hierarchy contains holons, i.e. elements which are both parts and wholes.[75] Thus, the hierarchy defined this way is relative and it depends on the system in question and on what is chosen as the focal unit. According to Turner & Gardner (2015), cross-scale interactions, enabled by connectivity, spatial composition and configuration of focal units, are important because they can generate emergent behaviour. Connectivity among focal units allows changes to propagate through the system, while the spatial composition and configuration of the units determines their relative importance in the system.

FIGURE 7.26 The levels of a hierarchy in which upper levels constrain lower levels and lower levels provide detail. Redrawn from: Turner & Gardner (2015).

Panarchy (Gunderson & Holling, 2002), introduced in Section 1.3, can be described as a hierarchy of adaptive cycles (Folke et al., 2010), in which cycles in upper levels affect smaller, faster levels in the renewal phase, while lower level cycles may cascade to upper levels. It adds a temporal dimension to the spatial hierarchies described above. In this sense, understanding past dynamics of elements at the scales of focus, constraints and components can reveal potentials for design in URCs. For instance, the former trajectory of a rectified river can be restored in order to improve river hydrology. Or, knowledge of historical routes built along the river and their transformations can inform plans for the future transformation of the traffic network.

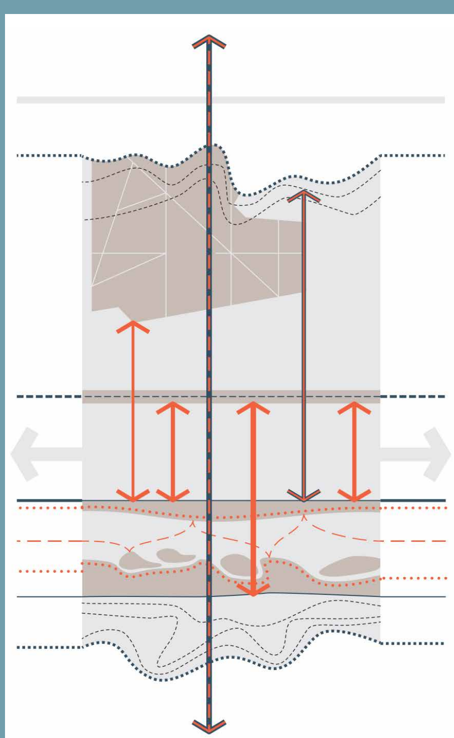
74 *Homeorhesis* is the dynamic behavior that describes the tendency of a system to return to a *trajectory*, while *homeostasis* describes the tendency of a system to maintain a *state* of dynamic equilibrium.

75 The term 'holon' was coined by Arthur Koestler in his book The Ghost in the Machine (1967). According to him, holons exhibit a degree of self-reliance and can respond to disturbances without being restricted or controlled by an upper authority. A holarchy is a particular form of hierarchy that does not have a top and bottom, as its components, all holons, are simultaneously parts and wholes.

BOX 7.4 **'Three faces of Vernon'—a project for URC Seine**

- Type of project: Competition entry
- Date: June 2015
- Authors: Claudiu Forgaci, Anca Ioana Ionescu
- Collaborators: Maria Alexandrescu, Maria Ionescu, Lila Athenasladova
- Location: Vernon, France

FIGURE 7.27 The proposed design of the riverside park combines landscape and urban elements to establish meaningful connections with the surroundings.



The project 'Three faces of Vernon' is based on three qualities of the city: in-betweenness of the valley as a space concentrating longitudinal through-movement at regional scale, perpendicularity, as a new transversal topology at the scale of the valley, and permeability, i.e. a sponge-like social-spatial network of public and private spaces subject to transformation at the scale of the urban fabric. The vision articulates these three topological qualities as 'faces' of Vernon that can be combined in a strategy of *Interconnectedness* across three scales (*Interscalarity*). 'In-between Vernon' brings all three scales together by proposing key destinations along two regional carrying structures of the city, the railway and River Seine. These destinations include a redeveloped station area and a riverside park (Figure 7.27) 'Perpendicular Vernon' is a new transversal topology meant to reconnect the two banks of the Seine, the station area and riverside natural areas. The topological map presented in Figure 7.29, is a multi-scalar plan representation of new or reassigned transversal connections (e.g. new boat routes across the river, a pedestrian-bike bridge) in the city and the river valley (Figure 7.28).

FIGURE 7.28 A vision of Vernon that slows down parallel flows with an enforced transversal topology connecting multiple scales. If reinforced, these connections could re-design the relation between the city of Vernon and the natural territory of Seine valley.

'Permeable Vernon' provides a framework for infill projects that make use of the potentials of open spaces to provide functions that contribute to the quality of public space (e.g. green pockets, cafés). Overall, this project worked extensively with reinforcing the conditions for spatial interaction (*Absorptive Capacity*) between different levels of connectivity (*Interconnectedness*) and across different scales (*Interscalarity*).

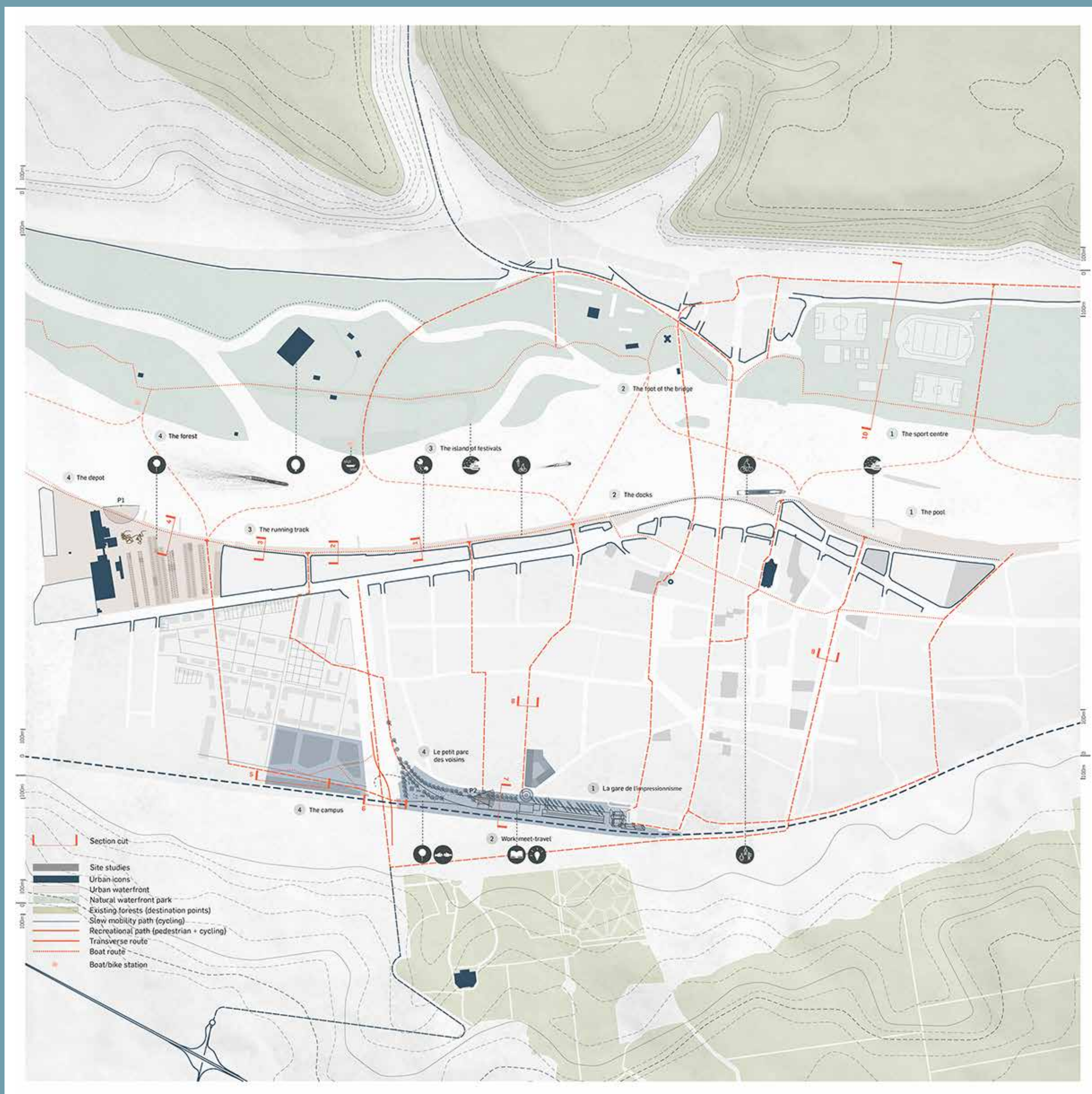


FIGURE 7.29 Proposed topological map of Vernon. The map combines spatial elements at different scales to emphasise valuable transversal connections between the city and the valley.

The scales of URCs

For a better understanding of interactions across these scales, the whole system, including the larger river catchment and the metropolitan area, must be taken into consideration (Figure 7.30). In other words, the boundaries of the system must be established. As shown in Box 7.4, a cross-scalar approach involves a concomitant representation of social-ecological connections and spaces at *scale(s) of focus*, *scale(s) of constraint*, and *scale(s) of components*.

As shown in the environmental-ecological and planning-governance on URCs perspectives (Sections 2.2.2 and 2.2.4), the scale of the larger river catchment, represented by a river management unit, such as the River Basin District (RBD) of the Water Framework Directive (WFD) in Europe (EU, 2000), must be considered regardless of the scale of the area of interest. The catchment is where the territory of the river as a whole is visible. At this scale, hydrological and geomorphological conditions can be understood. From a social-economic perspective the waterfront as a social-economic space at human scale is visible at the scale of the river space.

Apart from the boundaries of the river system, the planning, governance and spatial design of URCs must consider the boundaries of the urban system too. The urban system as a whole can be understood at the scale of the metropolitan area, or what is called in Europe and OECD countries the Functional Urban Areas (FUAs), or large urban zones (LUZs), comprising a spatially contiguous urban core, non-contiguous cores linked to the main core by major commuting patterns, and a hinterland defined by a "worker catchment area" (OECD, 2013).

Working on multiple spatial and temporal scales is a common practice in urban design (Carmona et al., 2010), landscape design (Manning, 1997) and river design (Ingaramo & Voghera, 2016). Urban designers mostly focus on sites at neighbourhood scale, street scale or plot scale where the elements of urban space can be discerned and experienced by people. In landscape design, the range of scales is widened to encompass natural processes at micro- (e.g. garden design), meso- (e.g. urban park design), and macro scales (e.g. regional forest trail network). As a particular form of landscape design, river design is constrained by catchment- and corridor-scale processes and puts emphasis on the scale of the river space. Manning (1997), for instance, describes the importance of river convolution, curvature and diversity on macro (corridor) and micro (river edge) scale for human-nature coexistence and, thus, for the design of riverside landscapes.

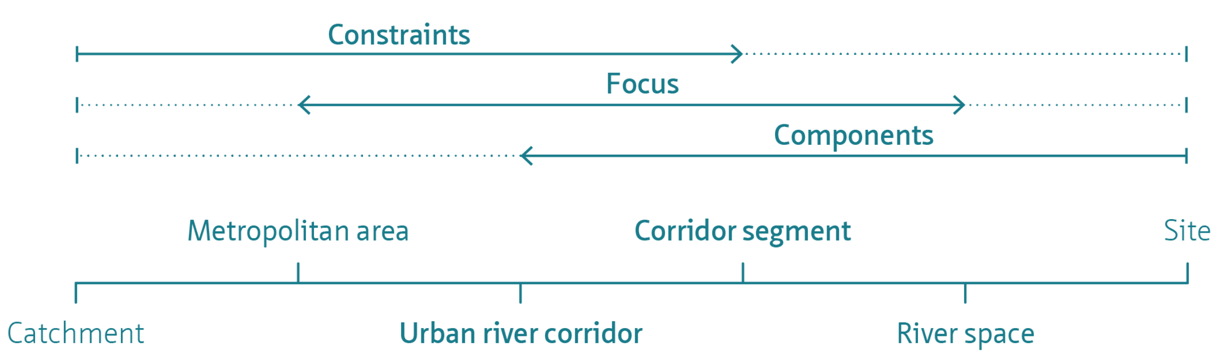


FIGURE 7.30 Continuum of scales of constraints, focus, and components in relation to the scalar framework of URCs defined in Section 2.3: (1) the catchment for the river system and the metropolitan area for the urban system; (2) the urban river corridor and the corridor segment; (3) the river space and the site representing typical scales of detail.

When applied to URCs, the three-level hierarchy of nested scales used in landscape ecology (Turner & Gardner, 2015, Figure 7.26) can be used as a framework to organise the scales introduced in Section 2.3 (Figure 7.30) as a continuum ranging from the scale of the catchment to the scale of the site, wherein the *level of context (constraints)* and the *level of details (components)* are located on the upper and lower ends, respectively, and the URC and its segments are the *levels of focus*.

Principle 4: Interscalarity

Like *Social-Ecological Integration*, *Interscalarity* is a relational principle, as it addresses the distribution and interaction of URC elements across scales. *Interscalarity* in URC design can be attained by considering the whole scalar spectrum of the river system and the urban system, ranging from the catchment scale and metropolitan scale on upper levels, through the scale of the corridor and corridor segment as units of focus, to the scale of the river space and sites within the corridor as scales of detail. Therefore, when designing in URCs, interscalarity can be achieved:

- by responding to the constraints of the *catchment* (e.g. altered sedimentation regimes due to damming upstream, or impact of industrial land use on the quality of water downstream) and the *metropolitan area* (e.g. metropolitan traffic management);
- by focusing on the consequences of the intervention on the *corridor* (e.g. transformation of a parking lot into a green space with an impact on corridor-wide patch network connectivity) and on the urban context of the *corridor segment* (e.g. the morphological particularities of a riverside neighbourhood); and
- by carrying out or demonstrating (i.e. testing the implications of a larger strategy) the spatial transformation on the scale of the *river space* (e.g. transformation of riverside traffic line into a shared space with access points to water) and/or the *site* (e.g. architectural intervention in a vacant lot of the URC with a public ground floor and green roof).

Depending on the design assignment, the scale of focus may vary on the spectrum shown in Figure 7.30, as long as interactions and interdependencies with scales of constraint and scales of components on the rest of the spectrum are taken into consideration. The focus of design can be anywhere on the spectrum, but it is more likely to be located on the scales of the metropolitan area (e.g. metropolitan park system), URC scale (e.g. slow mobility line along the corridor), URC segment scale (e.g. transversal green corridors in a riverside neighbourhood), or river space (e.g. shared space design in the riverfront). *Interscalarity* as a design principle implies a response to a design assignment at one of these scales of focus, while having a desirable impact on the scales of context and scales of detail.

Accordingly, questions in design related to interscalarity are: How can design on one scale have positive effect on larger scales? Or, what kind of small-scale interventions can a system at large afford? For instance, a site-scale design must also consider corridor- or corridor segment scale conflicts or synergies highlighted according to the principle of *Social-Ecological Integration*. It is often the case in river design and planning, that by solving problems locally, other problems are created upstream or downstream. Examples include flood protection measures which can cause flooding in settlements upstream or downstream, or the local insertion of polluting activities that may affect downstream settlements. Local increase in river capacity, such as the new bypass channel in the Room for the Waal project (Figure 7.14), can have a positive impact on the functioning of the river system as a whole. Metropolitan-scale mobility constraints and catchment-scale hydrologic conditions may also have an impact locally. Therefore, even in very localised interventions, the whole scalar spectrum must be considered. Another example is a corridor-scale design in which key sites, important for the interconnectedness of the URC, are identified in certain corridor segments, both in the river space and inside the urban fabric. In this case, catchment- and metropolitan-scale constraints can further narrow the selection criteria of key sites.

§ 7.4 Discussion

Developed from the four key properties of URCs defined in Chapter 2—*connectivity*, *open space capacity*, *integration* and *multiscalarity*—and germinated in four river design projects (Boxes 7.1-7.4), the principles proposed in this chapter—*Interconnectedness*, *Absorptive Capacity*, *Social-Ecological Integration*, and *Interscalarity*—form a comprehensive set. As shown in Figure 7.31, *Interconnectedness* and *Absorptive Capacity* refer to the spatial elements of URCs, while *Social-Ecological Integration* and *Interscalarity* describe the spatial-temporal and systemic relations between those elements.

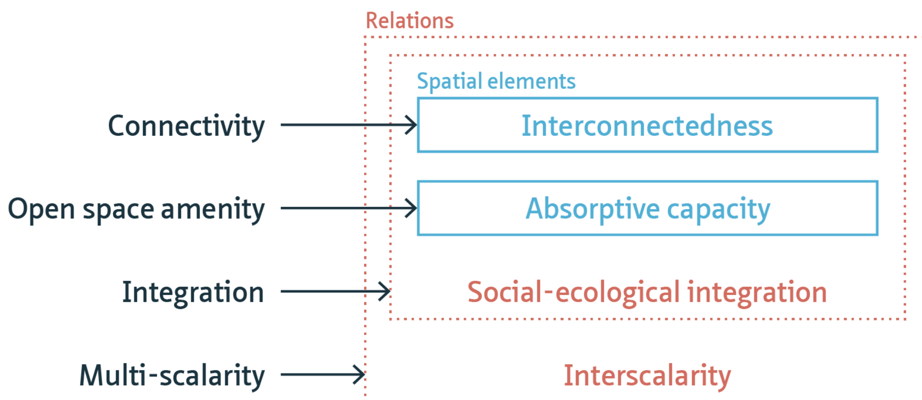


FIGURE 7.31 The four design principles proposed in the thesis (right), as derived from the four key properties of URCs (left).

Interactions and interdependencies between the network- and open space elements identified under *Interconnectedness* and *Absorptive Capacity* were already pointed out in the descriptions of *Social-Ecological Integration* (e.g. major infrastructure lines as barriers to the movement of ecosystem agents) and *Interscalarity* (e.g. the influence of individual green spaces on the network of habitat patches on corridor or landscape scale), However, a number of aspects regarding their combined application in design and, as they are built on transdisciplinary grounds, their mixed knowledge base present a number of conceptual challenges.

First of all, *Interconnectedness* and *Absorptive Capacity* contain elements from both urban design and landscape ecology, in which the interaction and movement of people, on the one hand, and the movement of animals and plants, on the other hand, are conceptualised and represented differently. The movement of people is typically represented as a network, in which links are trips (e.g. by foot, by car, by public transport) and nodes are origins or destinations (e.g. buildings, parks, streets). In case of ecosystems, on the other hand, it is movement, different from that of people (i.e. less constrained by linear network infrastructures), which is implied in the patch representation of land mosaics. This conceptual overlap between *Interconnectedness* and *Absorptive Capacity* was clarified by the use of synergies and conflicts in the principle of *Social-Ecological Integration*.

Social-Ecological Integration and *Interscalarity* reveal relations between the elements of *Interconnectedness* and *Absorptive Capacity*. They are less defined spatially and depend on what have been identified as elements of *Interconnectedness* or *Absorptive Capacity*. Therefore, in the design process, *Social-Ecological Integration* and *Interscalarity* are likely to be used after *Interconnectedness* or *Absorptive Capacity*. *Interscalarity* is of particular interest here. Normally, scales in a project are defined in early stages of the design process as part of a brief or assignment, with little to no possibility to understand interscalar dependencies. Because these dependencies can only be identified after spatial elements and the system have been understood, *Interscalarity* is employed, or at least revised, in a later stage of the design process. The three-level hierarchy of scales—scale(s) of constraint, scale(s) of focus and scales(s) of components—used in the *Interscalarity* principle is reflective: it reveals scalar interactions and interdependencies after the spatial configuration and composition of URC elements have been understood.

All in all, the four principles are meant to inform the design process by making the elements and relations of the URC explicit. By identifying and incorporating the networks, spaces, synergies and scales highlighted through these principles, the design process is better informed to create affordances for social-ecological integration.

Urban design is a process, not a product, in which principles must respond to ever-evolving problems and potentials. Thus, another challenge in defining and using design principles is that they must be easily adaptable to local and real-world conditions while remaining generally applicable. Besides the theoretical background elaborated in this chapter, the principles were distilled through design iterations, shown in the four URC projects presented in Boxes 7.1-7.4. The projects were instrumental in developing the principles in an exploratory way; thus, similar iterations and applications are recommended for further knowledge on applicability and adaptability of the design principles to different real-world URC conditions.

§ 7.5 Conclusion

As put forward in this chapter, the assessment framework presented in Part 2 must be complemented with a frame of how to achieve and discover potentials of social-ecological integration in URCs. Even when projects lack the resources or the knowledge at hand to carry out an assessment, design principles are useful to inform and guide the design process in an accessible way. Hence, this chapter has developed a set of four principles for the design of social-ecologically integrated URCs—*Interconnectedness*, *Absorptive Capacity*, *Social-Ecological Integration* and *Interscalarity*—, derived from the four key properties of URC elaborated in Section 2.2.6 and from the design explorations presented in Boxes 7.1-7.4. *Interconnectedness* proposes a non-overlapping and reciprocally supportive spatial configuration of the traffic network, water network, and ecological network of the URC. *Absorptive Capacity* offers guidelines for increased capacity and quality of water space, social space and green space in the URC. *Social-Ecological Integration* highlights conflicts and synergies between the network elements and open space elements. *Interscalarity* reveals interactions and interdependencies between network- and spatial elements across scales of constraint, scales of focus and scales of components in the elements. Are these principles useful for designers? Do they enable or constrain the design process? Are they applied in the right order? Answers to such questions will be sought in Chapter 8, in which the design principles, formulated as design instruments, are tested in a workshop environment on the two URCs of Bucharest.

8 Applying the Principles through Design Instruments

§ 8.1 Introduction

The design principles put forward in Chapter 7—*Interconnectedness*, *Absorptive Capacity*, *Social-Ecological Integration* and *Interscalarity*—are meant to guide the design of social-ecologically integrated URCs. The design instruments developed in this chapter, namely *the Connector*, *the Sponge*, *the Integrator*, and *the Scaler*, are proposed as means to implement those principles in the design process (Figure 8.1). Hence, the objective of this chapter is to demonstrate how the design principles can be applied in a real-world design assignment through design instruments and to report on how the use of the instruments was tested. To that end, a design workshop was organized in Bucharest between 4-10 March 2017, with the participation of an international group of M.Sc. students, Ph.D. candidates and young professionals coming mainly from design-related disciplinary backgrounds.

The chapter starts by defining the four design instruments in Section 8.2. Section 8.3 proceeds with an explanation of the design workshop methodology, that is, the selection of the participants, the description of the workshop set-up and the methods of data collection and analysis. Section 8.4 describes, analyses end evaluates the results as collected during the workshop (design process) and delivered afterwards (final design and reflection on the process). Finally, Section 8.5 discusses the refinements that have been made to the instruments as a result of the evaluation and reflects on the methodological challenges encountered during the research.

SUB-QUESTION AND OBJECTIVES:		
Sub-question 8:	**How do design instruments aid the design of social-ecologically integrated URCs?**	
Objective 8.1:	Develop a set of design instruments to apply the design principles of social-ecologically integrated URCs.	Section 8.2
Objective 8.2:	Demonstrate and test the design instruments on the URCs of Bucharest.	Sections 8.3-8.5

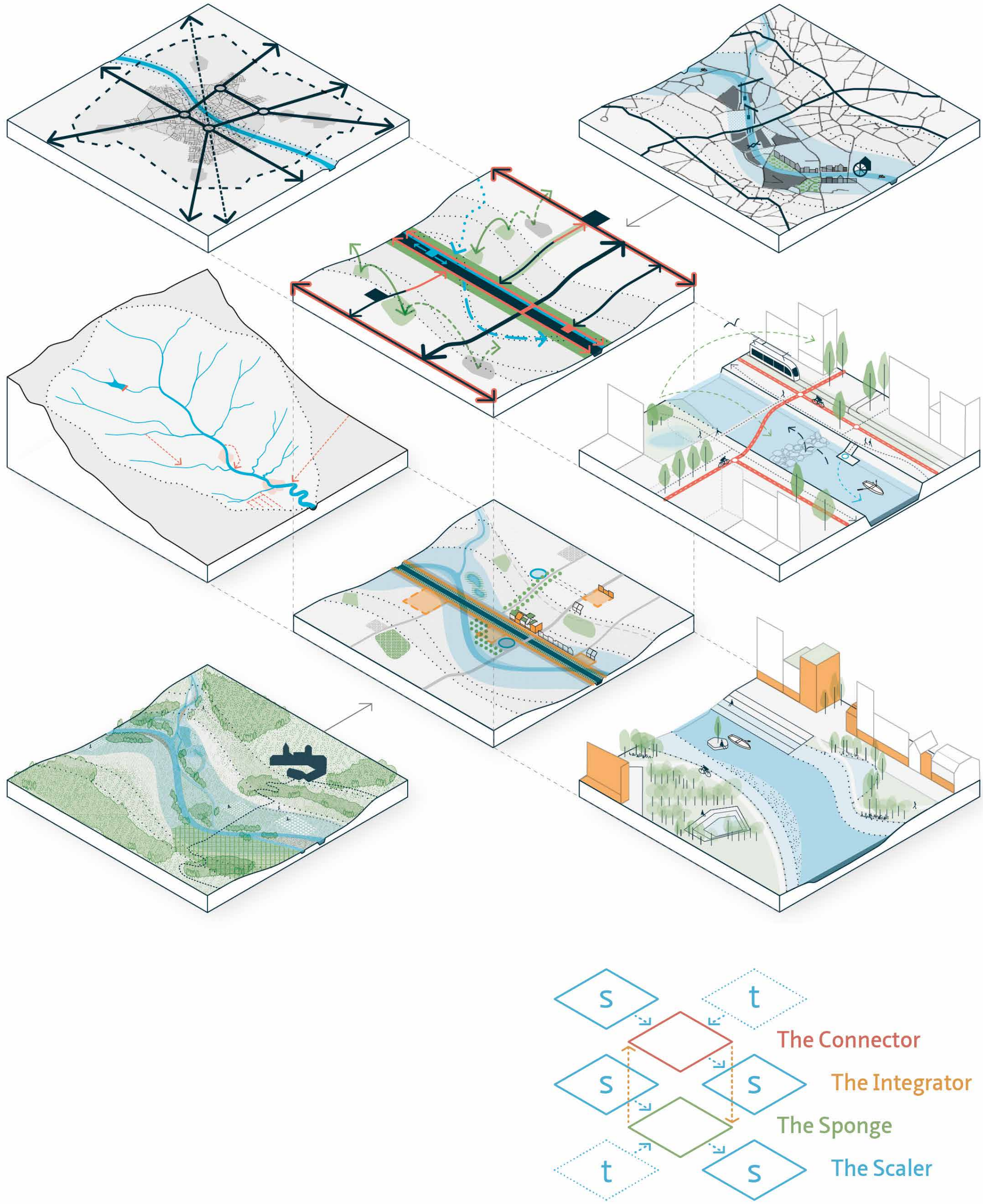


FIGURE 8.1 The design instruments developed in this chapter (bottom right), represented in relation to the spatial-morphological definition of URCs introduced in Section 2.3 (Figure 2.3): *The Connector* (in red); *the Sponge* (in green); *the Integrator* (in yellow); and *the Scaler* (in blue), including spatial scales (s) and temporal scales (t).

§ 8.2 Design instruments

An instrument, defined as "a means whereby something is achieved, performed, or furthered" or as an implement "designed for precision work" (Instrument, n.d.), can make the bridge from goal to application.[76] Accordingly, design instruments are employed in this thesis as means to apply the design principles for social-ecologically integrated URCs through a certain way of approaching a design assignment that responds to two essential questions: What key spatial elements and relations of URCs should designers be aware of? And how can they address those elements and relations in their design of or in URCs? The answer to the former question has already been given in the way the four design principles were defined in Section 7.3. The design instruments proposed in what follows will attempt to answer the latter in order to aid designers in building social-ecologically integrated URCs.

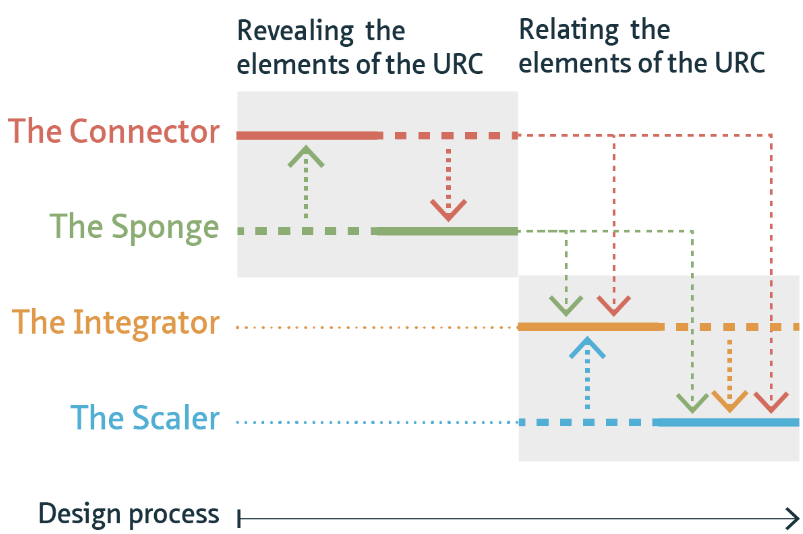


FIGURE 8.2 Diagram of the instruments applied in the design process in two stages: revealing and relating the elemenets of the URC. Thick lines represent the moment of focus on the instrument, thick dotted lines represent potential iterations on the instrument together with the instrument from the same stage, thin dotted lines represent the implicit involvement of the instrument in the design process.

The set of instruments put forward below consists of *the Connector*, *the Sponge*, *the Integrator*, and *the Scaler*. In correspondence with to the definition of the design principles, *the Connector* and *the Sponge* address the elements of the URC, while *the Integrator* and *the Scaler* are used to establish the relations among those elements. As illustrated in Figure 8.1 and Figure 8.2, the four instruments function as an interdependent set; therefore, one must consider them together when designing in or for social-ecologically integrated URCs. The order in which they are presented in Figure 8.2 is the one recommended to be used in the design process. In Section 8.5, this recommendation is further discussed.

76 Defined this way, an instrument is different from a tool. A tool has a specialised function and is used to carry out a particular task. The distinction between these two terms is important in the context of design, as instruments are not meant to lead to a particular outcome, but to aid the integration of a particular perspective in the design process.

§ 8.2.1 Revealing the elements of the URC

The Connector and *the Sponge* are two instruments that deal with the configuration and the composition of the spatial networks and open spaces of the URC, respectively. Both instruments read urban space as a field of possibilities, in which potentials for movement (in the case of *the Connector*) and for accommodating social-ecological processes spatially (in the case of *the Sponge*) are revealed. The following sections describe the functions of these instruments in detail.

The Connector

The Connector is the design instrument used to apply the principle of *Interconnectedness* (Section 7.3.1). *The Connector* operates with the three networks of URCs:

- *the traffic network*, which consists of roads and paths for movement at all speeds, including informal networks such as desire paths typically found in peripheral or less urbanised segments of URCs;
- *the water network*, including all the natural elements (e.g. tributaries, meanders) and rationalisations (e.g. canals, dams, retention lakes) of the river network;
- *the ecological network*, comprising corridors (e.g. tree lines, green buffers along roads or utility networks) and habitat patches as stepping stones (e.g. parks, gardens, green roofs, green traffic islands).

Drawing on the current configuration of these networks, *the Connector* is used to highlight existing elements, to reassign their role in the network (e.g. by downgrading or upgrading) or to add new elements (missing links) as follows (Figure 8.3):

- On the longitudinal dimension, main urban streets running outside and along the valley are assigned as main lines of fast vehicular movement along the corridor (**T1**: the 'fast lane'), releasing riverside paths from the barrier caused by traffic, which in turn are connected to form a continuous line accommodating slow mobility (**T2**: the 'slow lane'). To facilitate the interaction between the city and the river, key transversal links are selected where they connect a point of attraction on either the 'slow lane' or the 'fast lane' or when they represent potential lines of crossing (**T3**). Vertical connectivity is improved by designing points of contact with water (**T4**: pontoons, stairs, alleys, etc.), either in locations of high accessibility and visibility (mostly at the intersection of a transversal link with riverside paths) or in less accessible locations along the river.
- Elements of the water network can be restored to improve hydrological and ecological connectivity. Daylighting culverted tributaries (**R1**), restoring meanders (**R2**) and removing in-channel obstacles, such as weirs and bridge piers, (**R3**) can improve longitudinal connectivity. Vertical connectivity is achieved by restoring the interaction between the river and groundwater through a permeable river bed (**R4**).
- The ecological network can be enforced in two ways on the longitudinal dimension: with a continuous riparian zone along the river (**E1**) and with a network of ecological patches acting as stepping stones along the valley (**E2**). Ecological stepping stones, like transversal green corridors, also contribute to lateral connectivity (**E3**). Vertical connectivity is enabled by gradients or ecotones between aquatic habitats and the riparian zone along the river banks (**E4**).

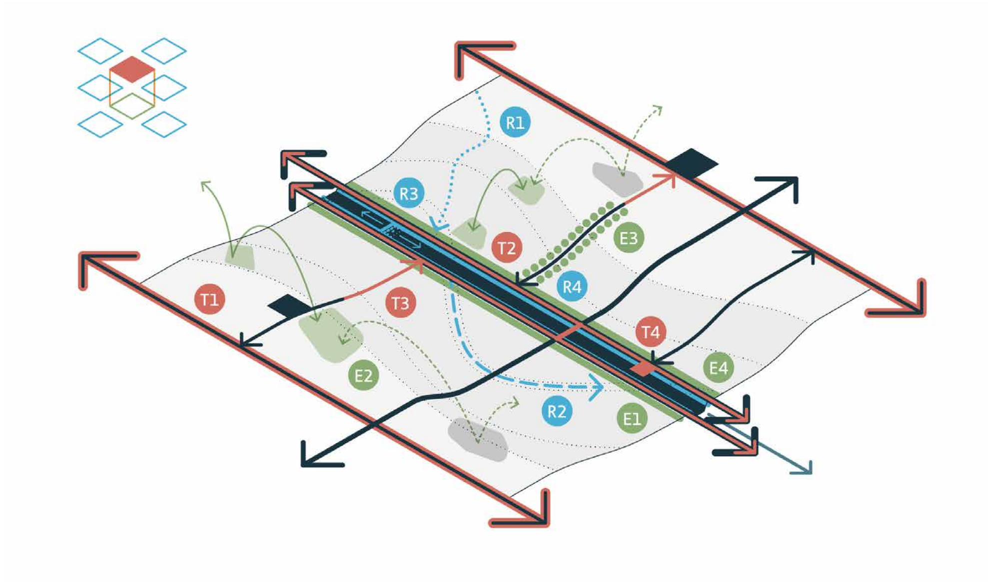


FIGURE 8.3 The design instrument Connector and the key elements of the traffic network (T1-T4), water network (R1-R4), and ecological network (E1-E4), illustrated in a generic URC segment.

The Sponge

The Sponge applies the principle of *Absorptive Capacity* (Section 7.3.2) by making an inventory of all open spaces and amenities found in the URC and by highlighting potentials of increased spatial capacity and attractiveness in the elements of *social (public) space*, *ecological (green) space* and *water space* (Figure 8.4):

- *Social space* represents all outdoor and indoor spaces, regardless of ownership, that create the conditions for social interaction. An inventory of open spaces found in the corridor, as well as public and semi-public functions at grade (the 'ground floor' of the URC; see Section 7.2), is made to identify potential additions to public space. Potential riverside public spaces may include embankments transformed into shared spaces (**P1**) and converted parking spaces (**P2**). Open spaces in the rest of the corridor may be added to the network of public spaces (**P3**). Non-residential ground floor functions are encouraged in the river space (**P4**).
- *Ecological space* includes all public and private green spaces (e.g. parks, gardens, vegetated traffic islands, infrastructure buffer zones). Green space can be potentially gained by renaturalising river banks (**G1**), by creating wetlands and increasing vegetation cover in floodable areas (**G2**), and by transforming non-vegetated open spaces, such as parking lots, brownfields (**G3**), or rooftops (**G4**).
- *Water space* includes all spaces that are permanently or temporarily occupied by water (the river, lakes, ponds, canals, wetlands and water storage facilities). It can be potentially extended by widening the channel, by restoring former meanders (that is, increasing regular flow capacity) of the river (**W1**), or by transforming riverside open spaces into floodable areas (that is, increasing the capacity of the corridor to absorb floods; **W2**). These potentials are located within a buffer along the natural course of the river. In addition, water storage and infiltration can be increased in the whole corridor with vegetated and non-vegetated GBI solutions for water storage and infiltration (**W3**) and by increasing the perviousness of pavements (**W4**).

These functions are not exclusive. On the contrary, combinations of the three functions are sought. For instance, pervious surfaces can contribute to reducing the amount of storm water runoff. Or, accessible green spaces can become attractive public spaces.

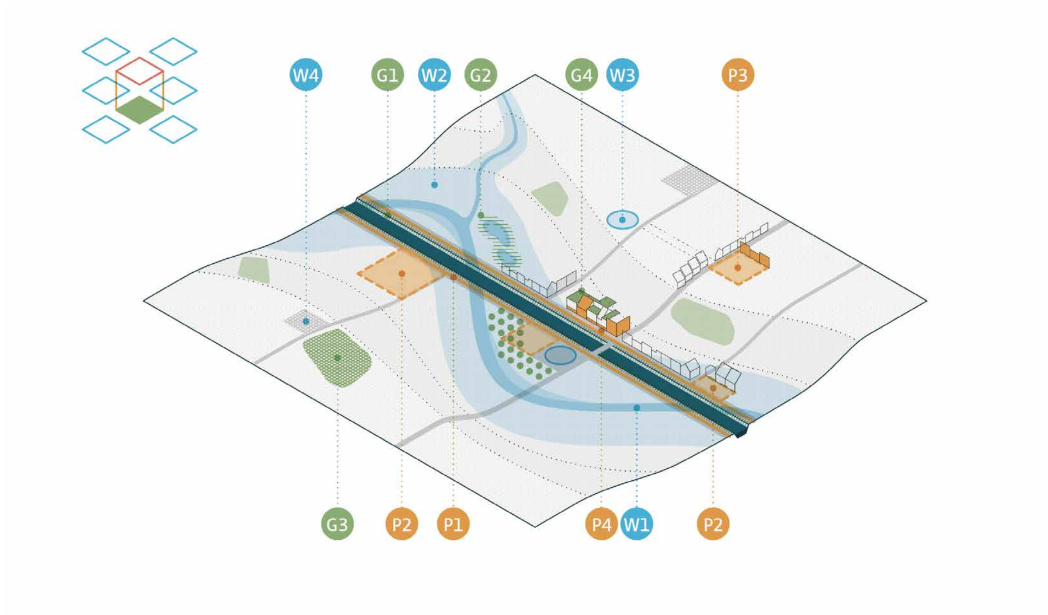


FIGURE 8.4 The design instrument Sponge and the key elements of social (public) space (P1-P4), water space (W1-W4), and ecological (green) space (G1-G4), illustrated in a generic URC segment.

§ 8.2.2 Relating the elements of the URC

Both *the Integrator* and *the Scaler* are reflective, relational and strategic. They are reflective in the way they reveal relations that are (or, in terms of the design process, have already been) implicit in the application of *the Connector* and *the Sponge* (Figure 8.2). They are relational in their focus on identifying and targeting key relations among spatial or topological elements. They are strategic, as they highlight spaces with the highest potential for intervention.

The Integrator

Used to apply the principle of *Social-Ecological Integration* (Section 7.3.3), *the Integrator* highlights *conflicts* and *synergies* between the social and ecological elements of the URC. To that end, *the Integrator* is used to identify potentials for multifunctionality, hybridity, complementarity and reciprocity between the network elements revealed by *the Connector*, between the open spaces highlighted by *the Sponge*, and between the elements of *the Connector* and *the Sponge* (Figure 8.5):

– Although the non-conflicting spatial configuration of the network elements proposed under *the Connector* establishes a synergic social-ecological relationship, *the Integrator* further reveals potential conflicts at the intersection of different network elements, such as the spatial overlap between a restored meander and an important transversal street (**C1**), and potential synergies, such as the combination of a slow mobility route with a riverside green corridor (**S1**).
– By increasing the spatial capacity of the URC through multifunctional open spaces, *the Sponge* also contributes to integration. *The Integrator* further identifies synergies where, for example, the potential for multifunctional open spaces is combined with high diversity of public functions at grade (**S2**). Similarly, conflicts are identified, for instance, where increased open space perviousness would hinder the multifunctional use of public space (**C2**).

TOC

– Finally, *the Integrator* highlights synergies and conflicts between spatial elements of connectivity and open spaces. The spatial configuration highlighted by *the Sponge* can provide knowledge on potential social and ecological connections, while the interconnected spatial networks assembled by *the Connector* can indicate where more open space is needed. Synergies can be found, for example, in new public spaces that were made more accessible by new connections to the river (**S3**) or in non-vegetated open spaces that could become stepping stones in the ecological network of the URC. A conflict can be identified where the ecological qualities of a green space are affected by a traffic corridor acting as a barrier to species' movement (**C3**).

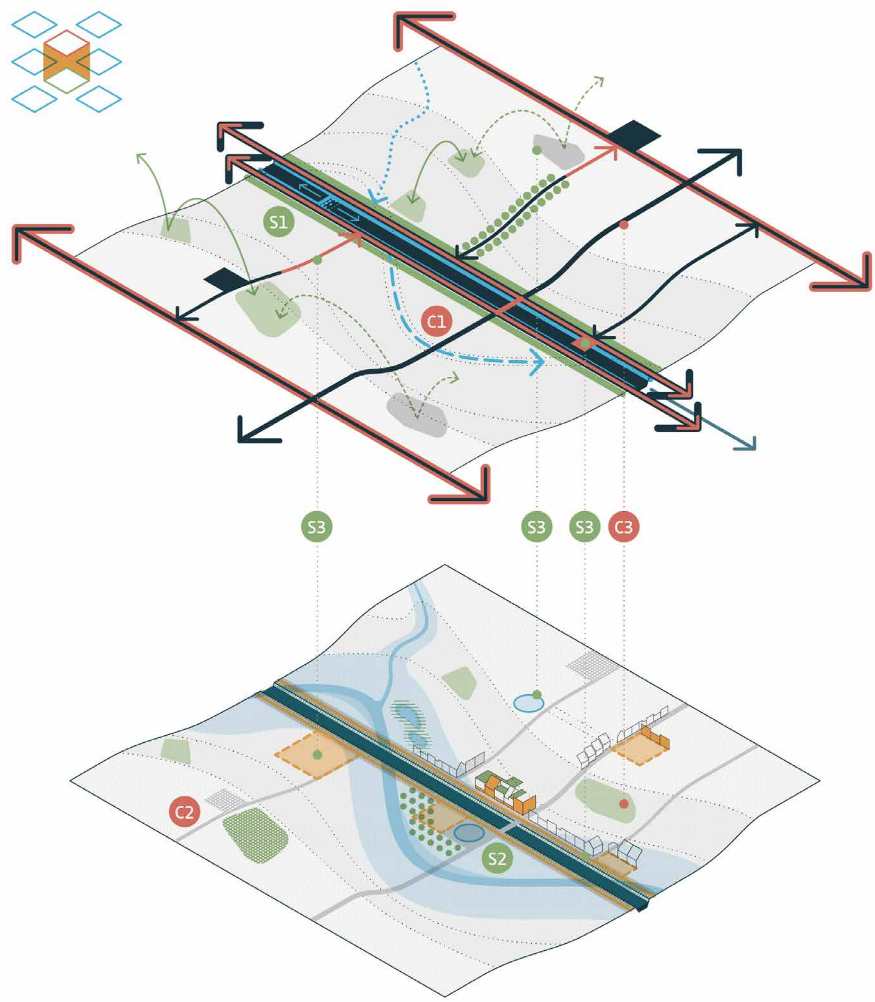
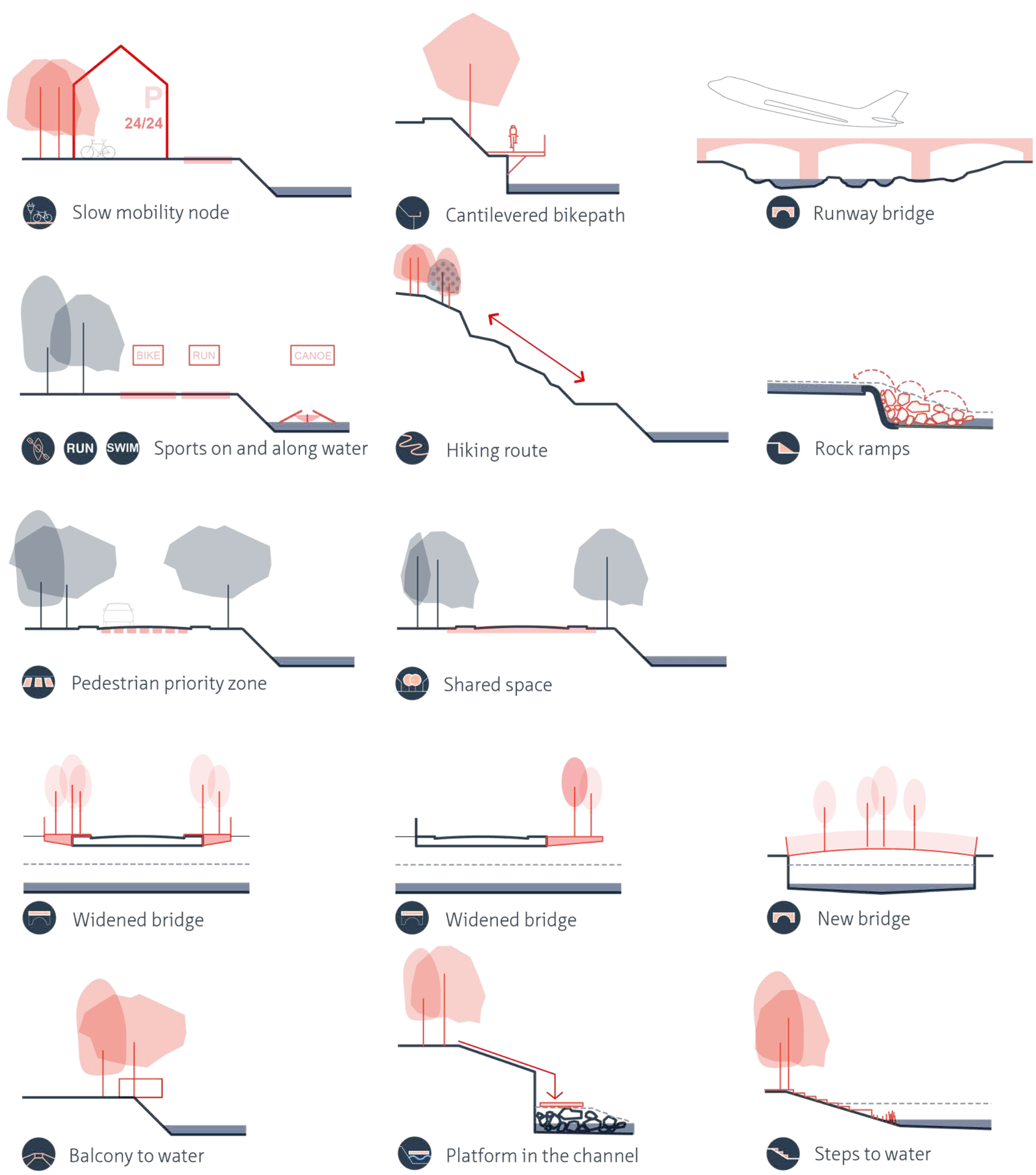


FIGURE 8.5 The design instrument Integrator addressing conflicts (C1-C3) and synergies (S1-S3), illustrated in a generic URC segment.

All in all, *the Integrator* makes these relations explicit and aids the designer or planner in selecting the spaces of strategic importance in the URC or in devising strategic actions that can have a positive impact on the scale of the URC. Box 8.1 shows an example of strategic actions that had been distilled from the analysis of conflicts and synergies between the social, rational and ecological elements of URC Someșul Mic in Cluj-Napoca, Romania (see project description in Box 7.3).

BOX 8.1 **Strategic actions for URC Someșul Mic in Cluj-Napoca, Romania**

As part of the project "Someș turns its face to the city" presented in Box 7.3, the following sections have been developed in response to the conflicts and synergies identified between the three scenarios used in the project (Social Someș, Ecological Someș and Rational Someș). These generic sections represent strategic actions, which are either replicable along the urban river corridor or are inserted in key locations. This set of actions emerged from the specificity of the project and context in which they were developed. Nevertheless, it serves as an example of how elements of *the Connector* (e.g. rock ramps, cantilevered bike paths), *the Sponge* (e.g. room for the river—slope, ecotone—wetland, or mixed-use waterfront), and *the Integrator* (e.g. waterside green event space) can be translated into concrete actions.



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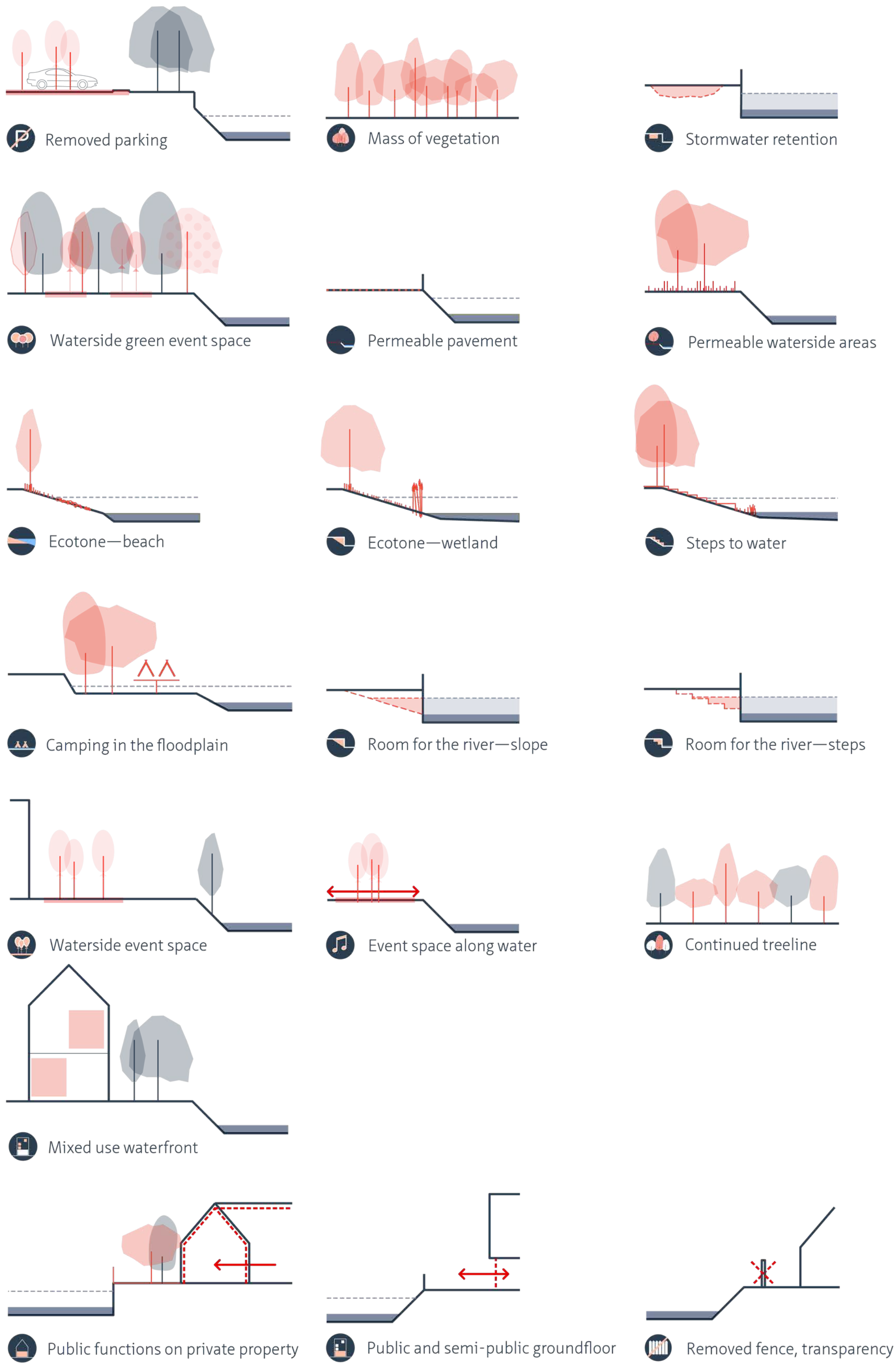

FIGURE 8.6 Generic sections of strategic actions employed in the project "Someș turns its face to the city" (Box 7.3).

The Scaler

The Scaler implements the principle of *Interscalarity* (Section 7.3.4) and addresses two aspects: (1) it establishes or reflects on the scalar framework of the project; and (2) it identifies interdependencies across spatial scales and path dependencies or historical 'clues' across temporal scales.

- Guided by the spatial-morphological definition of URCs (Figure 8.8), the *scales of constraint*, *scales of focus* and *scales of components* of the design are identified and described on the scalar framework shown in Figure 8.7.
- The major river catchment (**S1**) and the metropolitan area (**S2**) are typically scales of constraint. Catchment-scale constraints include river discharge patterns or geomorphological conditions, while metropolitan-scale constraints are related to human activities, such as commuting patterns. If the scale of focus is lower on the spectrum shown in Figure 8.6, constraints can be found on the scale of the URC and corridor segment too.
- The current situation and potentials at the scales of focus (URC and URC segment) have been described with *the Connector* and *the Scaler*. Depending on the design assignment, the focus (i.e. the targeted problem or potential) may be located anywhere between the metropolitan scale and the river space scale. The site scale is not included as a scale of focus, as the outcomes of any intervention should be beneficial on the scale of the URC.
- The scale of components, representing the level of detail of the design, can range from the scale of the URC to the scale of the individual site. A typical scale of components is that of the river space (**S3** and **S4**), in which actions on the scale of the URC are demonstrated or tested. The scale of the individual site may be relevant in interventions located outside of the river space.
- In addition, *the Scaler* takes into consideration the temporal dynamics of spatial configurations and compositions found in *the Connector* and in *the Sponge*. Historical knowledge of the spatial configuration of the urban fabric before the alteration of the river corridor (**T1**) can provide insights for improving connectivity. Knowledge of past spatial compositions, configurations and dynamics of the river corridor in a pre-disturbance state (**T2**) can shed light on possibilities for river restoration or rehabilitation in design.

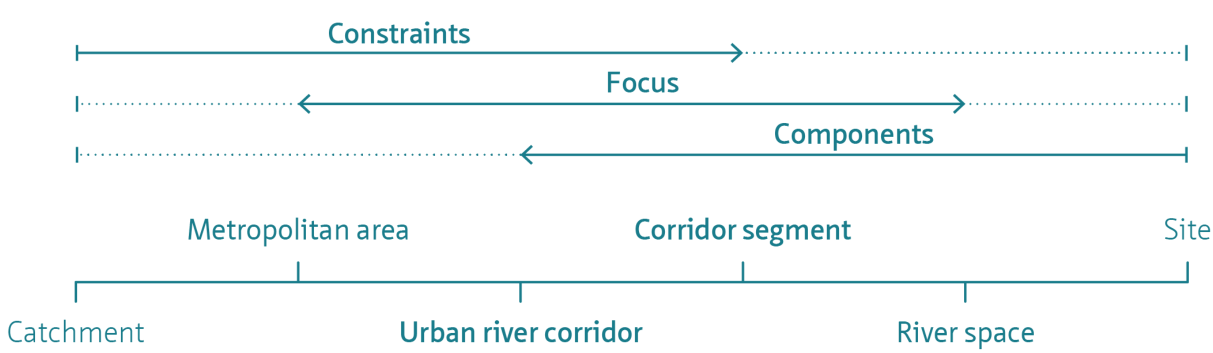

FIGURE 8.7 The spectrum of scales of constraint, focus, and components used by the design instrument Sponge.

The Scaler can be used to determine the relative importance and impact of the elements revealed by *the Connector* and *the Sponge* across scales. For instance, *the Scaler* can reveal how a certain link added with *the Connector* influences the networks of the URC. An example for this would be the transformation of riverside thoroughfares, relevant for city-scale vehicular transport network, into slow mobility routes makes the river space more compatible with pedestrian movement on local scale.

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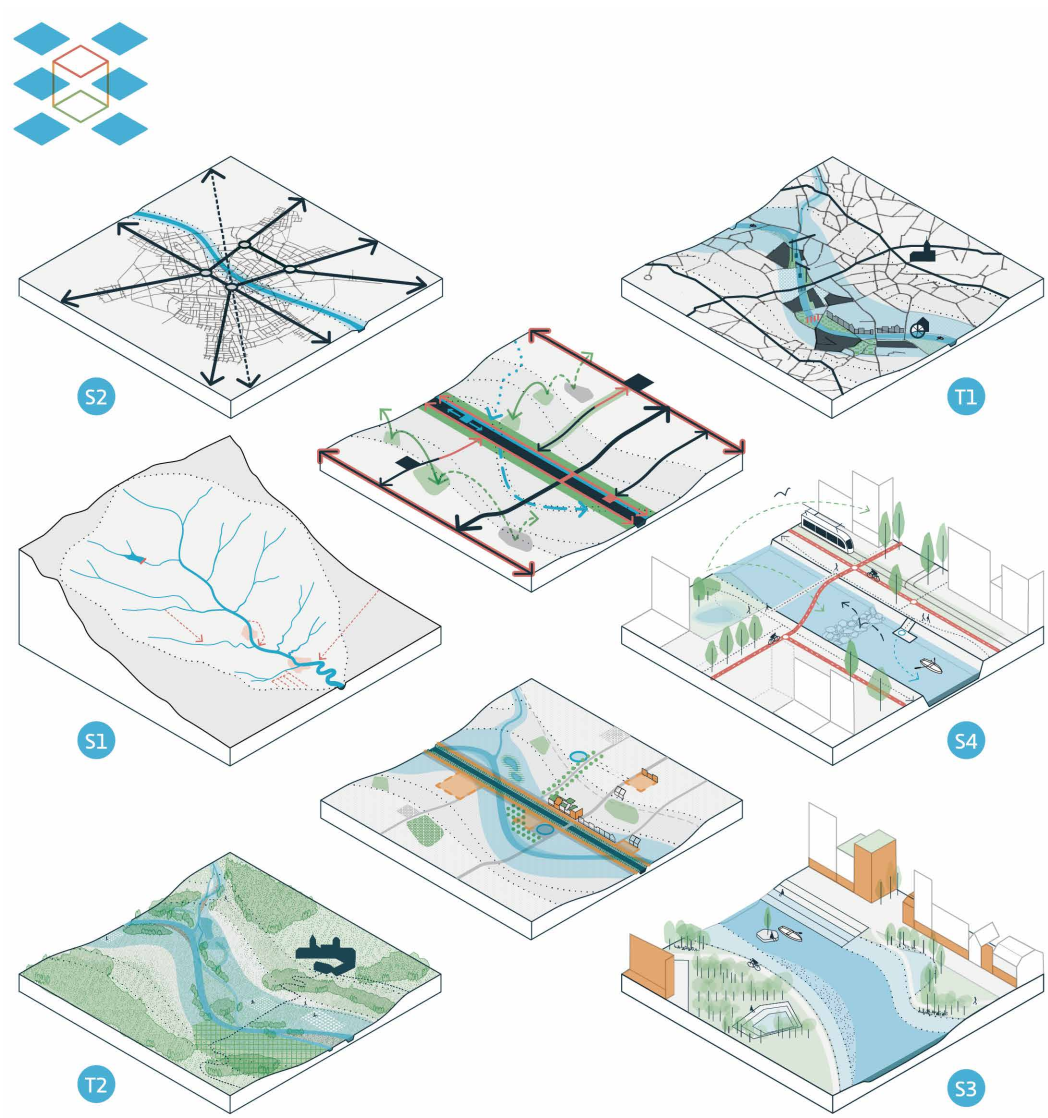

FIGURE 8.8 *The Scaler* reflects on the spatial (S) and temporal (T) scalar framework of the design project by referring to the spatial-morphological definition of URCs. It considers two large-scale constraints, the river catchment (S1), the metropolitan area (S2), and two different conditions at the scale of the river space (S3 and S4) corresponding to *the Connector* and *the Sponge*. In addition, two temporal scales reveal the historical patterns of urban morphology in relation to the river valley (T1), and past river corridor dynamics (T2).

§ 8.3 Workshop methodology

The design instruments defined in Section 8.2 have been developed through iterative design processes undertaken as part of four design projects dealing with URCs. Formulated initially as an outcome of the projects presented in Boxes 7.1-7.4, the design instruments were evaluated in an intensive design workshop by a larger group of designers. The design workshop was chosen as a research methodology for demonstrating and testing the use of the four design instruments on the URCs of Bucharest. This approach is especially suitable for research designs addressing complex real-world situations—such as the case study design adopted in this thesis—, in which a more inductive (or abductive) approach is needed.

In general, workshops can be employed in three ways (Ørngreen & Levinsen, 2017): as means to achieve a particular goal; as practice, with focus on their form and outcomes; or as research methodology. The perspective adopted in this study is the workshops as research methodology, an approach that is, "on one hand, authentic, as it aims to fulfil participants' expectations to achieve something related to their own interests. On the other hand, the workshop is specifically designed to fulfil a research purpose: to produce reliable and valid data about the domain in question [...] regarding forward-oriented processes, such as [...] design. The findings feed back into the domain theory, the methodology, and/or the practices regarding future agency" (Ørngreen & Levinsen, 2017, pp. 72–73).

Design workshops, in particular, can be defined as activity-based collaborative work used to educate designers, to facilitate participation in the design process, to generate solutions to a design problem, or to test methods and techniques of design. With a focus on testing, but also involving problem-solving and education, the design workshop for the URCs of Bucharest was set up to facilitate the collection and analysis of data on the usage of the proposed instruments. Moreover, the competitive and intensive nature of the workshop, with the involvement of a careful selection of trained designers, was considered to be a fruitful and stimulating environment for the development of creative solutions for social-ecologically integrated URCs in Bucharest.

§ 8.3.1 Selection of participants

The design workshop was intended for 32 participants, that is, 4 teams of 4 on each river corridor (4 teams x 4 participants x 2 corridors). Out of the 32 places, 8 post-master students from Delft University of Technology were pre-selected and the remaining 24 places were occupied upon a call for applications open for young professionals, master students and doctoral candidates in the fields of urban design, planning, landscape architecture, and architecture, who were either familiar with the context of Bucharest or had prior experience in similar topics. In consideration of transdisciplinarity, young professionals or students from other disciplines were also encouraged to submit their application. The call for applications was launched online in December 2016 on a website dedicated to the workshop.[77] The application (see full procedure in Appendix A) consisted of a CV, letter of motivation and a work sample. The selection of the 24 participants was carried out by the workshop organising committee at TU Delft, in consultation with the Faculty of Urbanism at UAUIM, from a total of 41 eligible applications. As shown in Table 8.1, the majority of the selected participants came from design-related fields, with only 4 participants representing other domains (see full list of participants in Appendix G).

77 https://urcb.weblog.tudelft.nl/ (Accessed on 25.03.2018)

TABLE 8.1 Participants in the workshop by selection procedure, level of expertise and discipline.

SELECTION PROCEDURE AND LEVEL OF EXPERTISE	DISCIPLINES
Pre-selected: - 8 post-master students (PM) **Selected based on application:** - 10 master students (M) - 3 PhD candidates (P) - 11 young professionals (YP)	**Designers:** - 13 architects (a), incl. 1 economist (ae) and 1 visual artist (va) - 7 architects/urbanists (au) - 1 landscape architect/urbanist (lau) - 6 urbanists (u) incl. 1 structural engineer/urban mobility professional (sem) - 3 landscape architects (la) **Non-designers:** - 1 biologist/ geographer/ ecologist (bge) - 1 geographer (g)

The number of places was determined in such a way that a sufficient number of sites (4 sites per corridor) would cover most of the different urban conditions along the corridor and the teams were large enough to allow for diverse but well negotiated design proposals to emerge (4 members per team). The composition of the teams was established according to (1) the preference of the participants for one of the two corridors expressed during the application procedure, (2) prior experience on one of the sites; and (3) a good disciplinary mix within the teams (Table 8.2).

TABLE 8.2 Distribution of the participants in the teams of Colentina (C1-C4) and Dâmbovița (D1-D4), by level of expertise and disciplinary background.

TEAM C1	TEAM C2	TEAM C3	TEAM C4	TEAM D1	TEAM D2	TEAM D3	TEAM D4
PM/au	PM/au	PM/au	PM/au	PM/au	PM/au	PM/lau	PM/au
M/a	YP/a	YP/u	YP/a	YP/g	YP/a,va	M/a	M/a
M/u	YP/a	M/u	YP/la	M/a	M/u,sem	M/a	P/u
P/bge	M/u	YP/a	YP/a,ae	M/la	P/la	YP/a	YP/a

§ 8.3.2 Workshop set-up

As shown in Figure 8.9, a one-week intensive program was set up to include site visits (two days), the design workshop (Days 1-4), and final presentations and evaluation of the outcomes (Day 5). Apart from the site visits and the evening lectures,[78] all workshop activities took place in a workshop space located on the bank of River Dâmbovița in Bucharest. The workshop was relatively self-contained, i.e. it did not require prior preparation nor subsequent work from the participants, except the post-workshop evaluation and reflection sketches. Besides the sessions dedicated to instrument testing and design, the site visits, seminars and lectures provided knowledge about the context and inspiration from current urban and landscape design practice related to the themes tackled in the workshop. All these were considered necessary sources of knowledge for the design process and for the quality of the output.

78 The evening lectures were open to the public and took place in a lecture hall at UAUIM.

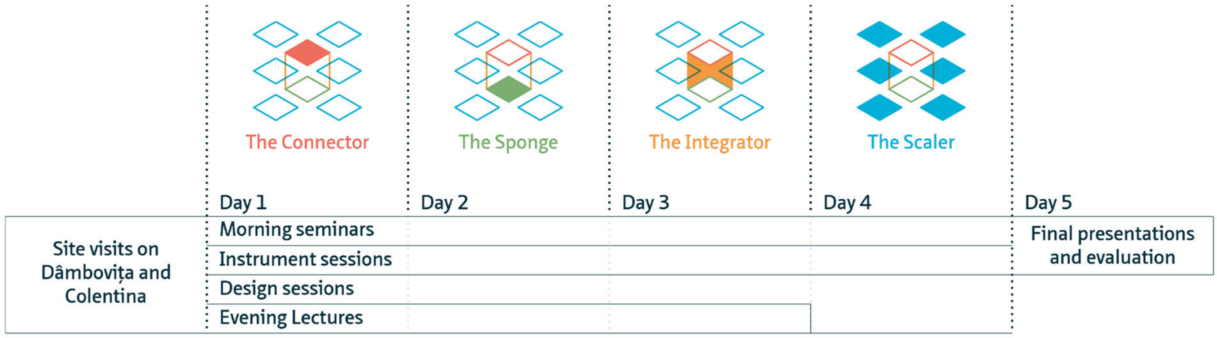

FIGURE 8.9 Workshop process (For a detailed calendar, see Appendix H).

Site visits

Before the start of the workshop, two site visits, one for each corridor, were organized along URC Colentina and URC Dâmbovița. This allowed the participants to get a sense of the URCs prior to engaging with design activity or the approach put forward in the workshop. In order to provide background information and an overview of key issues, local experts were invited to guide the site tours and an introductory lecture was given about the entire corridor. As shown in Figure 8.10, the participants were instructed to observe and record four aspects of the site that would be later discussed in the workshop: connections, open spaces, ecology, and people's relation to the river.

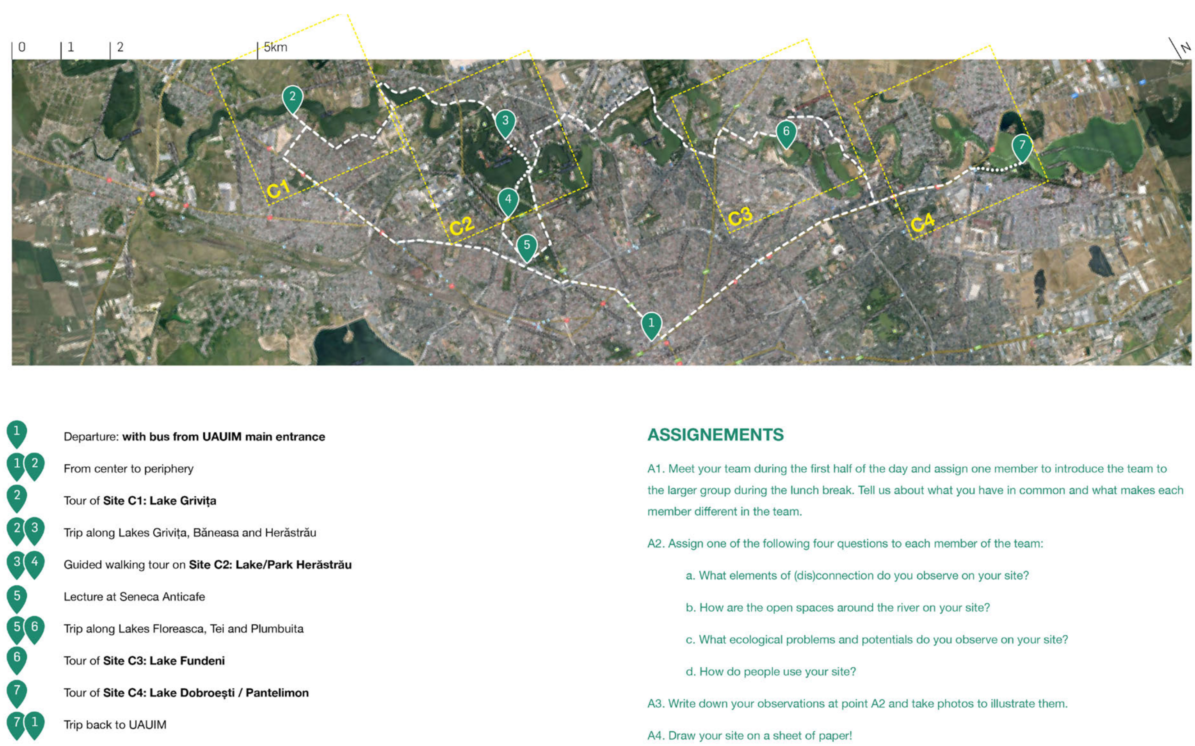

FIGURE 8.10 Pages from the site visit handout with the route and the assignment given during the site visit on URC Colentina.

Seminars and lectures

Each of the four workshop days (Days 1-4) consisted of a morning seminar (Figure 8.11) preceding the instrument application session, in which local experts gave input on the theme of the day—spatial morphology (Day 1), water and the city (Day 2), social-ecological integration (Day 3), and scales of the city (Day 4)—in relation to the URCs of Bucharest. In addition, a series of public lectures were given in the evenings of Days 1-3 by international guests and local experts in order to further inform and inspire the participants and to engage with the public on the themes tackled in the workshop.

FIGURE 8.11 Seminar on the Day 3 of the workshop. Photo credit: Sebastian Apostol.

Instrument sessions

The daily instrument application sessions started with a theoretical introduction and instructions on the use of the instrument, also provided in a handout (Figure 8.12). Next, the participants applied the instruments on their sites, first individually and then in a group. This way, the variation in individual applications of the instruments could be recorded for further analysis (see Section 8.3.3) and the participants could discuss differences and similarities. Large format base maps and transparent paper (Figure 8.13) were provided for the instrument application and for the design sessions.

FIGURE 8.12 The handouts containing the theoretical introduction and instructions for the daily instrument training sessions (see example of a handout in Appendix I).

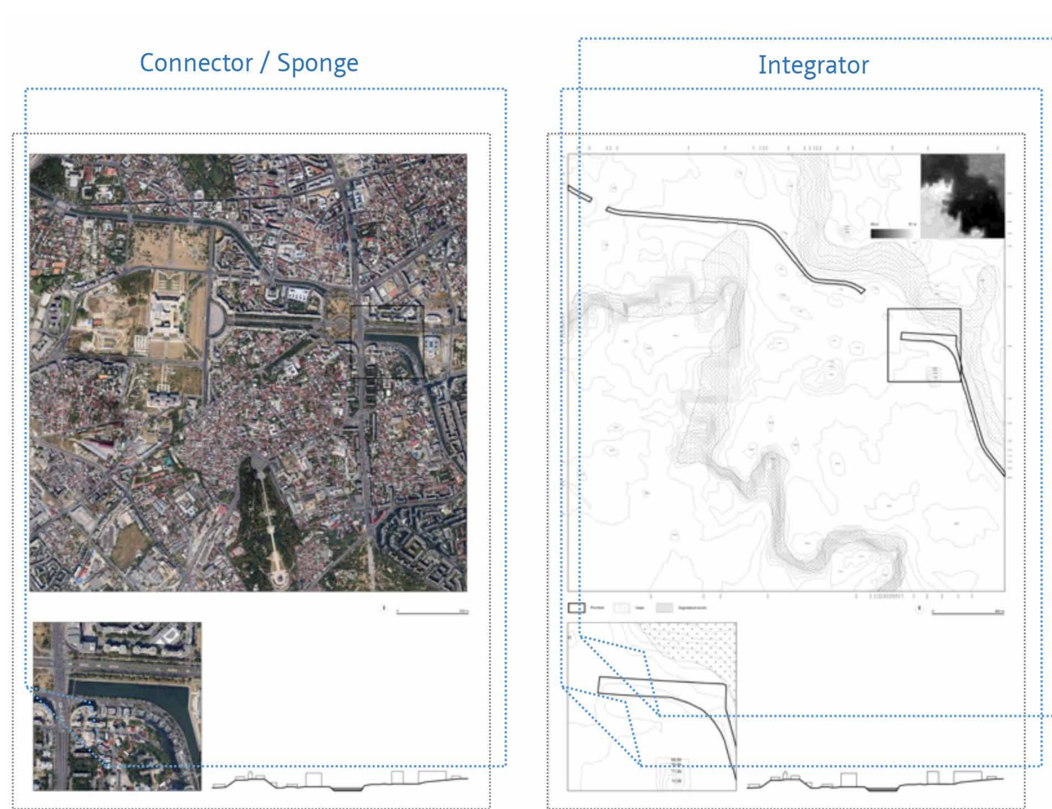

FIGURE 8.13 Base maps used for the application of *the Connector* and *the Sponge* (left) and for *the Integrator* (right) on site D3 (See this example enlarged in Appendix J).

Design sessions

The afternoons were dedicated to design sessions, during which participants developed their design proposals under the guidance of guest tutors from TU Delft and from the Faculty of Urbanism of “Ion Mincu” University of Architecture and Urbanism, Bucharest. To further test the usefulness of the instruments, the design sessions were not constrained by the results of the instrument application sessions; the participants had the freedom to choose not to use the instruments in their proposal.

A number of exercises were organized during the design sessions to aid the design process. In the collage exercise (Figure 8.14, top left), carried out on Day 1, participants were asked to formulate a vision by combining photos taken as part of the site visit assignment. The daily 'Scale up!' sessions (Figure 8.14, bottom left and right) brought the teams of each corridor together to discuss the implications of local interventions for the entire corridor. A model for each corridor was used to facilitate negotiation and the representation of corridor-wide strategies. These sessions were later useful for the construction of the scalar framework with *the Scaler*. On Day 5 the design proposals were presented in front of an international jury, which gave two prizes, one to a team of each corridor.

FIGURE 8.14 The collage exercise (top left) and Scale up! session (bottom left and right). Photo credits: Sebastian Apostol (left, top), Lucian Ștefan Călugărescu (left, bottom), Johanna Jacob (right).

§ 8.3.3 Data collection

In order to evaluate the design workshop and the use of the instruments, a *multi-method approach* was used to collect data during the design workshop, with an emphasis on how the participants understood the principles and used the instruments. In this multi-method approach, the work of the participants and the design process was recorded and evaluated from three angles:

- *External observation*: an unstructured observation of the participants by an observer who was not involved in the design process. The observer took notes and shared their observation after the workshop.
- *Internal evaluation*: a structured, paper-based questionnaire (see Appendix K) was filled in by the participants at the end of each workshop day to evaluate the instrument of the day. After the workshop, the participants filled in an online questionnaire (see Appendix M) to evaluate retrospectively the whole instrument set.
- *Workshop results*: the design projects were recorded on standardised formats, with base maps at the same scales and a written project description to allow for further analysis and comparisons in evaluation (see Appendix O). An external jury of experts evaluated the projects and submitted an evaluation report.

In addition, qualitative aspects of the design process and the behaviour of the participants was recorded through filmed interviews. Each team was interviewed about the instruments, the design process, group dynamics, and their overall impression about the workshop (see Appendix N).

§ 8.3.4 Data analysis and interpretation

The responses from the daily evaluation forms were summarized (see example of a daily summary table in Appendix L), as follows:

- *Summary statistics*: mean and standard deviation of values recorded in 10-point Likert scale questions, to show overall scores and agreement;
- *Content analysis* of the open-ended questions to identify themes and to order them according to the number of occurrences across the sample.

Data from post-workshop evaluation was collected and summarized in a similar way with the online surveying platform *Qualtrics*.

Finally, the drawings produced in the workshop were examined to evaluate the use and impact of the instruments in the development of the proposals.

§ 8.4 Results

Data collection was carried out successfully, with an overall high response rate to the evaluation forms filled in during and after the workshop (Table 8.3).

TABLE 8.3 Evaluation response rate (percentage of a total of 32 participants).

INSTRUMENT	DAILY EVALUATION (PAPER-BASED)		POST-WORKSHOP EVALUATION (ONLINE)
The Connector	97%	(31/32 – Day 1)	90% (29/32 – within 3 weeks from the completion of the workshop)
The Sponge	100%	(32/32 – Day 2)	
The Integrator	100%	(32/32 – Day 3)	
The Scaler	84%	(28/32 – Day 4)	

In the following pages, the application of the instruments is presented in response to the questions listed in Table 8.4. Each instrument is described in terms of (1) ease of use, (2) usefulness, (3) influence on the design, and (4) suggested improvements, as reported by the participants in the daily evaluation forms. The instrument set is evaluated regarding (1) the order in which the instruments are applied in the design process, (2) the relative attractiveness of the instruments, (3) the completeness of the set, (4) and suggested improvements.

TABLE 8.4 Data sources used to analyse and interpret the workshop results.

QUESTION	DATA SOURCE				
	Daily evaluation (paper-based)	Post-workshop evaluation (online)	Design projects	Interviews	Corridor sketches
Instruments in the design process					
I1: How easily can the instruments be applied in designing (in) URCs?	x	x			
I2: How useful are the instruments in designing (in) URCs?	x	x			
I3: To what extent does the use of the instruments lead to results which would otherwise not be achieved?	x	x	x	x	x
I4: How can the design instruments be improved?	x	x			
Instrument set in the design process					
S1: In what order, if any, should the instruments be applied in the design process?		x			
S2: How do the instruments rank in terms of attractiveness and why?		x			
S3: Should any of the four instruments be left out? If so, which one and why?		x			
S4: Is there something missing from the instrument set?		x			
S5: How can the instrument set be improved?		x			
Outcome of the design process					
			x	x	x

§ 8.4.1 The instruments in the design process

The Connector

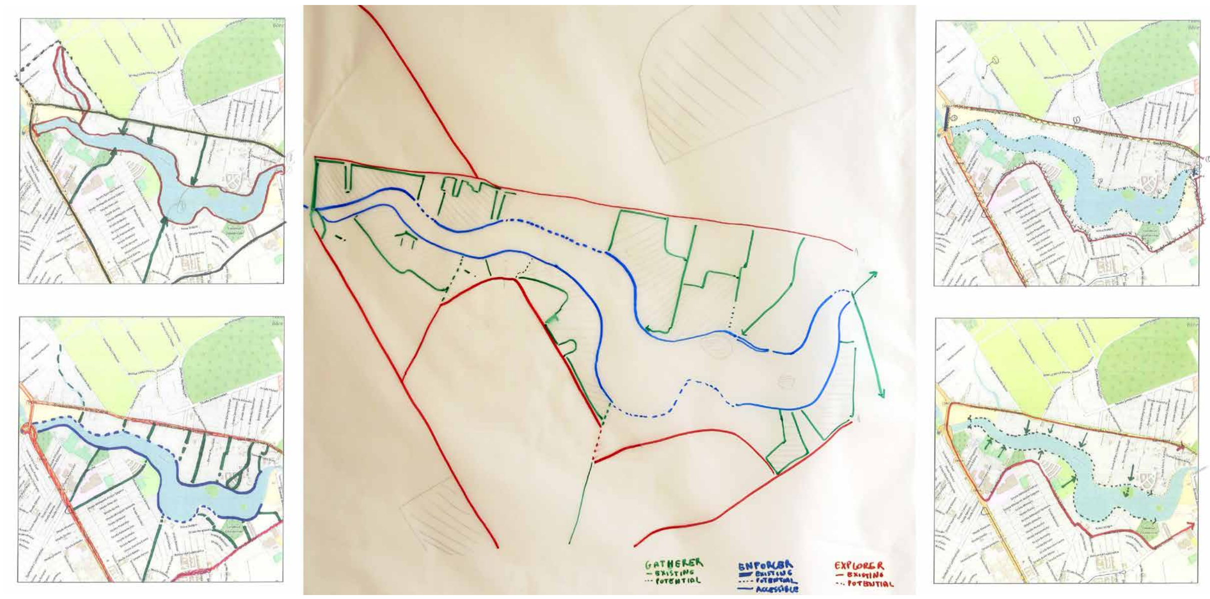

FIGURE 8.15 *The Connector* applied on site C1-Lake Grivița: individual attempts (left and right), followed by a common drawing (centre).

The Connector was the first instrument introduced in the workshop. As shown in Figure 8.15, *the Connector* was presented in the workshop with three elements: *the explorer*, which highlights the main urban structure parallel to the river; *the enforcer*, which follows the edge of the river as closely as possible and in a continuous way; and *the gatherer*, which is a transversal link that connects the two other components following important transversal links. Although its definition given during the introduction was initially confusing, *the Connector* turned out to be intuitive and easy to use once the participants started to apply it. In retrospect, the participants evaluated *the Connector* as easy to use (Figure 8.16).

Table 8.5 provides a summary of how the participants evaluated *the Connector*, along with a set of suggestions for improvement. The most appreciated aspect of *the Connector* was that it helped the participants quickly and better understand the site and the structure of the surrounding urban fabric. On the other hand, it was stated that it is difficult to apply in dense urban areas. Also, there were ambivalent opinions regarding the abstractness, simplicity and flexibility of *the Connector*. Another important remark was that the instrument tends to encourage the connection of everything with everything. In this sense, the representation of barriers, as suggested by a participant, or disconnection as a quality should be incorporated in the definition of *the Connector*.

As stated in the suggestions for improvement, a more detailed description of the elements of the instrument and the way they function, with examples, would improve the way *the Connector* is used. Moreover, further clarity in the definition and naming of the elements would allow for greater application and understanding of *the Connector*. A particular element that could be better defined was the node, i.e. the interaction between elements.

TABLE 8.5 Evaluation of *the Connector* by the workshop participants.

LIKED	DISLIKED
– It is very useful to understand the site and the structure of the urban fabric.	– The explorer was difficult to use on Bucharest's messy urban fabric.
– It is widely applicable.	**– It is difficult to apply in a dense urban fabric.**
– It is a good way to start a project.	– It tends to encourage connecting everything.
– It is an abstraction that clarifies.	– It is too abstract.
– It is simple and intuitive.	– It is too simplistic.
– It gives a lot of freedom to interpretation.	– It is vague and unfinished.
– It is both practical and theoretical.	– The naming is confusing.

SUGGESTIONS FOR IMPROVEMENT
– Be more explicit about the interaction between the three elements.
– Improve the description of the elements and give examples of how the instrument should be used.
– Improve the names.
– Detail the classification of the elements.
– Add representation of barriers.
– Elaborate more on the consistency of the elements.
– Consider that the elements can be surfaces and masses, not just lines.
– Specify the nature of connectivity: ecological, transport, etc.

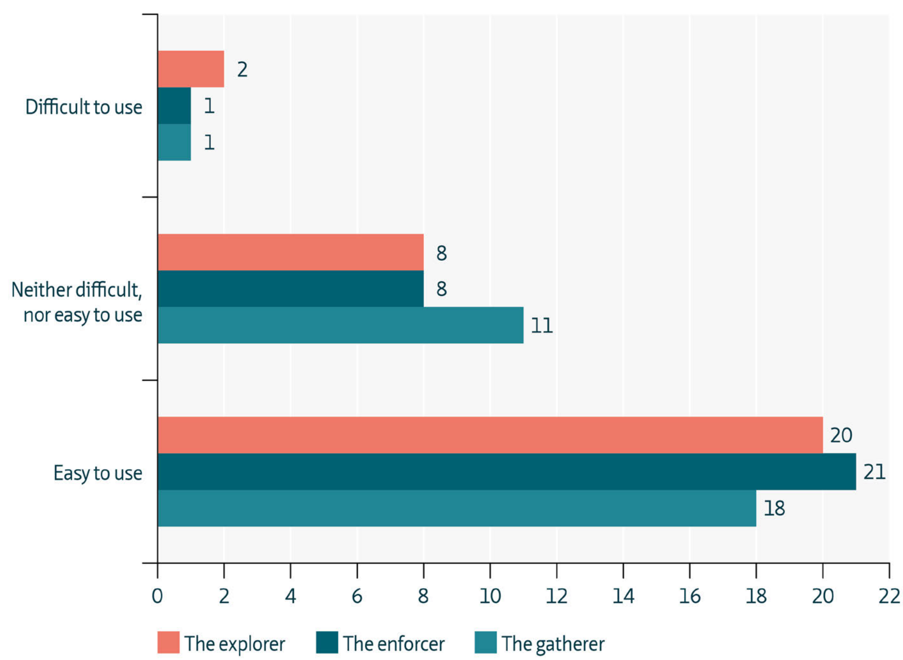

FIGURE 8.16 The difficulty of applying the three functions of the instrument Connector, as perceived by the workshop participants.

FIGURE 8.17 Two examples of how *the Sponge* was applied: team D4, Lake Văcărești (left) and team C2, Lake Herăstrău (right).

The Sponge was applied by the participants on the satellite base map to extract open spaces and to identify possible continuities between patches (see examples in Figure 8.17). As stated during the interviews, it was the most preferred instrument, because it was easy to use, and it was the least abstract. Also, as pointed out by several respondents in the post-workshop evaluation (Table 8.6), it was helpful to reveal areas of hidden potential. On the other hand, a few participants considered it over-simplified and insufficiently informed in terms of ecology. Overall, the three functions of the instrument were considered easy to apply (Figure 8.18).

The most important suggestions for improvement pointed out (1) that an additional layer of legal boundaries could be added to clarify the relation and application of *the Sponge* with legal and property boundaries, (2) the importance of the multi-functionality of patches, (3) the importance of detailed ecological criteria in addition to the information from the satellite map, and (4) the need for a scalar framework with a clearly defined hierarchy of patches. The importance of a correlation of the patches with the natural trajectory of the river, anticipating the use of geomorphology with *the Integrator*, was also mentioned.

TABLE 8.6 Evaluation of *the Sponge* by the participants after the workshop.

LIKED	DISLIKED
– It is easy to use. – It is very useful. **– It is helpful to determine open spaces.** **– It reveals areas of hidden potential.** – It reveals green-blue structures. – It is helpful to understand the urban fabric in the corridor. – The ecological potential of working with patches. – It shows the relationship between the city and water. – The name/concept. – It is helpful in formulating a strategy. – The possibility of a continuous corridor of connected patches.	(11/32 responses did not dislike anything) – It is difficult to differentiate between space for water, ecological patches and public space. – It is not realistic to map private spaces. – It tends to be over-simplified to a green sponge. – It is too top-down for a proper ecological understanding. – It is not clear how it informs the design. – More sub-classes required. – It requires landscape architecture knowledge. – The name is too abstract. – It is simplistic. – It is difficult to determine the scale of the Sponge.

SUGGESTIONS FOR IMPROVEMENT
– Specify in the introduction how the Sponge relates to ownership (private land can be used too). – Explain better with examples of how the Sponge is used. – Allow for multi-functional patches. – Add sub-classes. – Include interior public spaces (for this, a satellite map is not sufficient). – Make the link with design clearer. – Add a hierarchy to the patches. – Take the historical trajectory of the river into consideration when identifying space for water. – Specify the scale of the Sponge. – Allow for flexibility in the patches. – Add more detailed criteria for ecological identification.

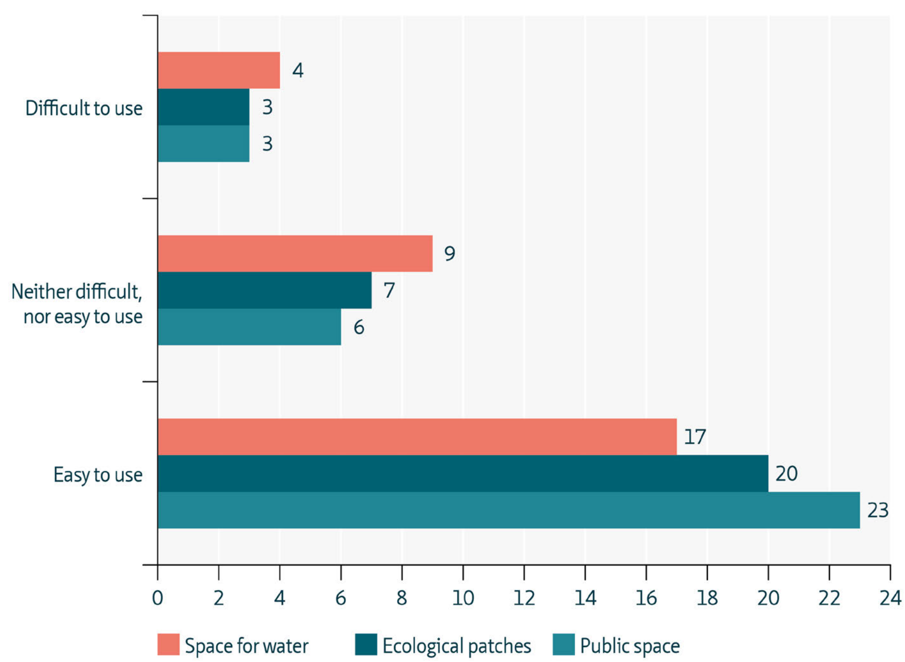

FIGURE 8.18 The difficulty of applying the three functions of the instrument Sponge, as perceived by the workshop participants.

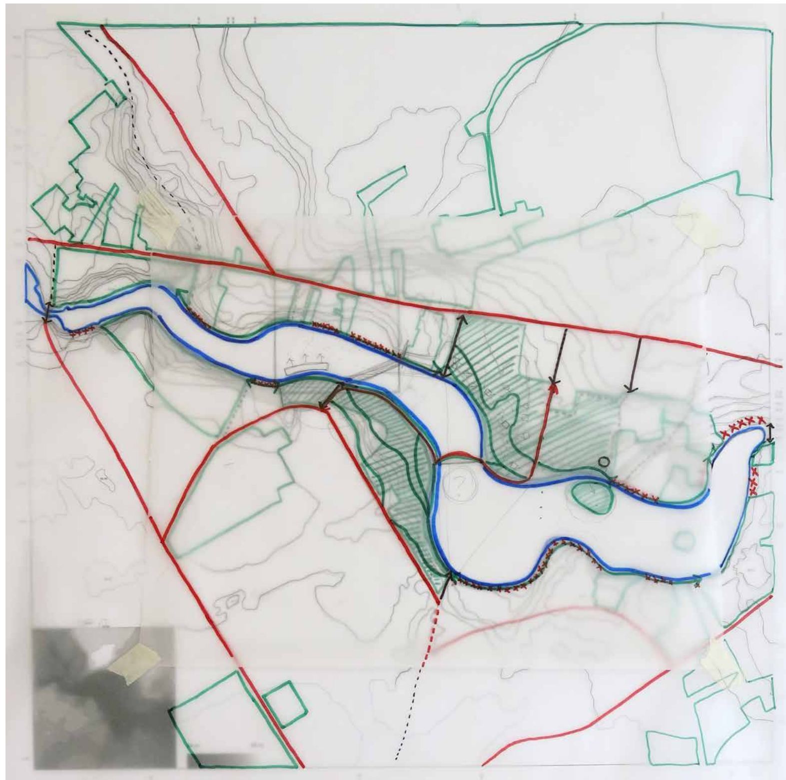

FIGURE 8.19 An example of how *the Integrator* was used to overlap *the Connector* and *the Sponge* on a base map of geomorphology – Lake Grivița, team C1.

As summarized in Table 8.7, *the Integrator* was found essential, but also redundant by some participants, as it was already applied naturally in the previous step with *the Sponge* and *the Connector*. The addition of the layer of geomorphology, however, made it a separate and more difficult step. As shown in Figure 8.20, the work with geomorphology was the most difficult part of *the Integrator*.

Among the main suggestions for improvement were (1) the introduction of knowledge on geomorphology earlier in the design process, and (2) a better way to assess and illustrate the outcome of *the Integrator*, perhaps by using an abstract grid to aggregate and assess spaces of strategic integration.

TABLE 8.7 Evaluation of *the Integrator* by the participants after the workshop.

LIKED	DISLIKED
– The superimposition with geomorphology. – It is easy to use. – The superimposition of the previous two layers. – It was naturally the next step. – It helped to identify the potential of an area and strategic spaces.	– The work with geomorphology. – Unclear relation to with the design. – Just overlapping is not sufficient. – The integrator was redundant. – It is hard to apply in a messy city like Bucharest. – It's not common practice.

SUGGESTIONS FOR IMPROVEMENT
– Work with geomorphology earlier. – Add more layers to overlap and more steps to discover integration. – Find a way to illustrate the outcomes of the assignment. – Make a clearer link between analytical instruments and design. – Consider adding an abstract grid to control the scale and to assess the potential for integration.

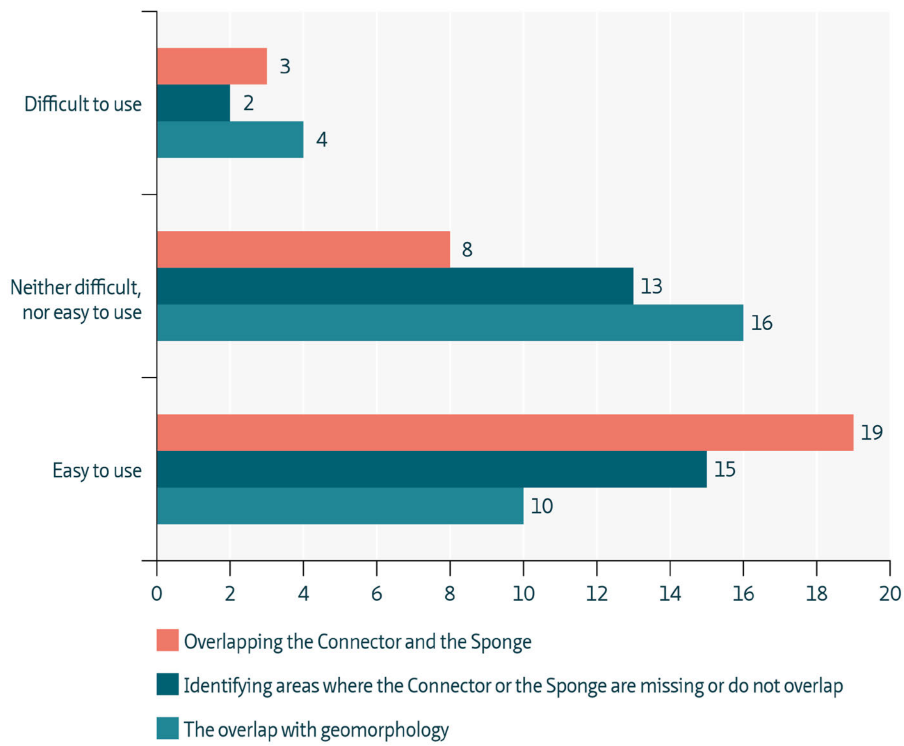

FIGURE 8.20 The difficulty of applying the three functions of the instrument Integrator, as perceived by the workshop participants.

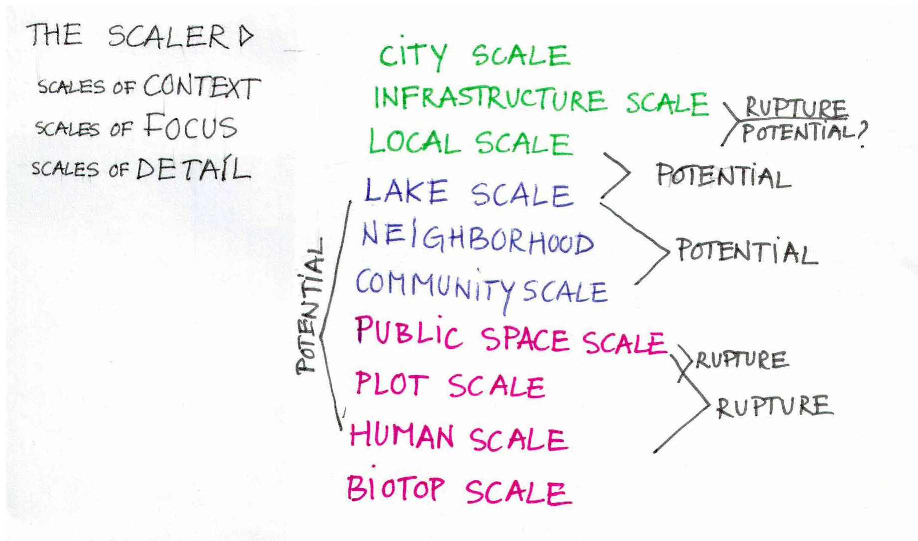

FIGURE 8.21 *The Scaler* applied by team C3 – Lake Fundeni.

The Scaler was introduced as an instrument of reflection. The designer evaluates the scales used implicitly in the design process and categorizes them in scales of context, focus and detail, in order to clarify the effects of their proposal. Figure 8.21 is an example of how one of the teams used the list of levels of scale to identify potentials and problems across scales. This instrument is different from the other three, because it highlights aspects of the proposal that have already been addressed implicitly during the design process.

The participants found this instrument the most difficult to apply and confusing (Figure 8.22). As shown in Table 8.8, most of the confusion regarding *the Scaler* was caused by the fact that it was already addressed as part of the other instruments, it was used too late, and the terminology was vague. On the other hand, it helped the participants to further connect their proposals to the scale of the whole corridor, to adopt a holistic perspective, or to adjust the proposals to the human scales. The main suggestions for improvement included a better connection to the other instruments, employ it earlier in the process, illustrate it with examples, and integrate it in the other instruments.

TABLE 8.8 Evaluation of *the Scaler* by the workshop participants.

LIKED	DISLIKED
– The scaler helped in linking the site to the corridor. – It encourages work across scales. – It is useful for the project. – It was useful in identifying the problems. – It was easy to use. (see difficulty assessment) – It was natural to use. – It provided a holistic perspective. – It helped organizing the proposal. – It provided a different perspective. – It was a new layer. – It drew attention to the human scale.	– It was already addressed in the previous days. – It came too late. – The Scale Up! session did not work. – The integration between teams working on the same corridor did not happen. – It was difficult. (see difficulty assessment) – It is subjective. – The terminology was vague. – There wasn't enough time.

SUGGESTIONS FOR IMPROVEMENT
– Find a way to represent it graphically. – It should not be a separate step, but part of all previous ones. – Give an example when explaining the instrument. – It should be earlier in the process. – Clarify that certain elements can be multi-scalar. – Connect it better to the other tools. – Clarify the rules. – Easier to use on a larger scale. – Include the scale of the whole city to the analysis.

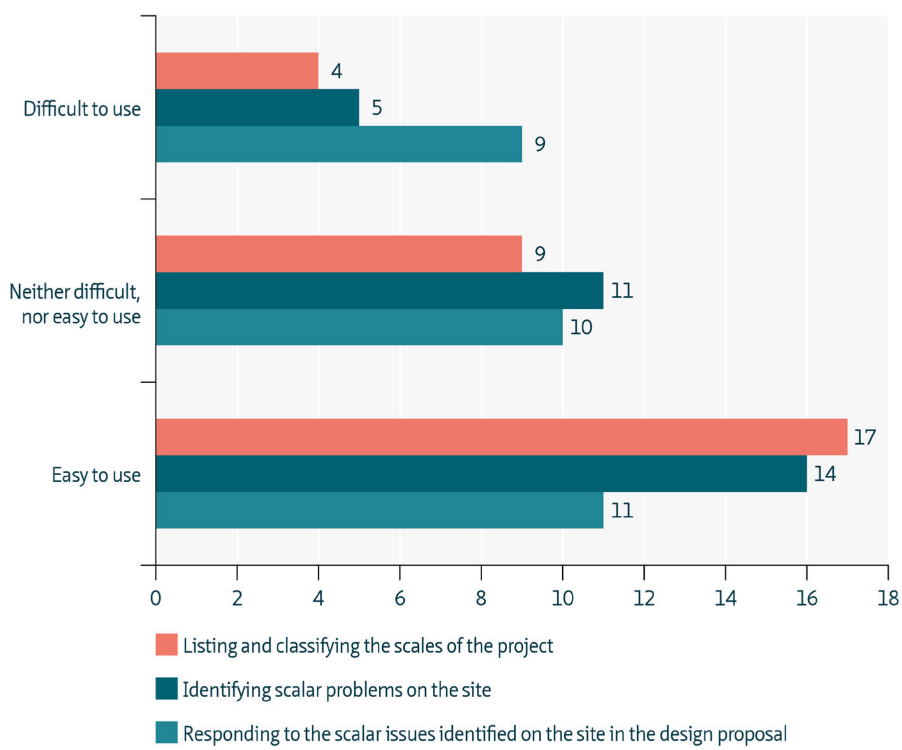

FIGURE 8.22 The difficulty of applying the three functions of the instrument Scalar, as perceived by the participants after the workshop.

The instrument set

In the ranking of the four instruments according to the preference of the participants, as reported in the post-workshop evaluation and in the interviews (see Appendix N), *the Sponge* scored the highest, followed by *the Connector* and *the Integrator*, while *the Scaler* was the less preferred instrument (Figure 8.23). This can be explained by the level of abstraction of the instruments, as there seems to be a higher preference for the least abstract (*the Sponge* and *the Connector*) and a lower preference for the most abstract ones (*the Integrator* and *the Scaler*). Different from the other instruments, *the Scaler* scored high on both the 1st position (10 responses) and on the 4th (11 responses). This indicates that the instrument was considered interesting, but more difficult to understand than the other three.

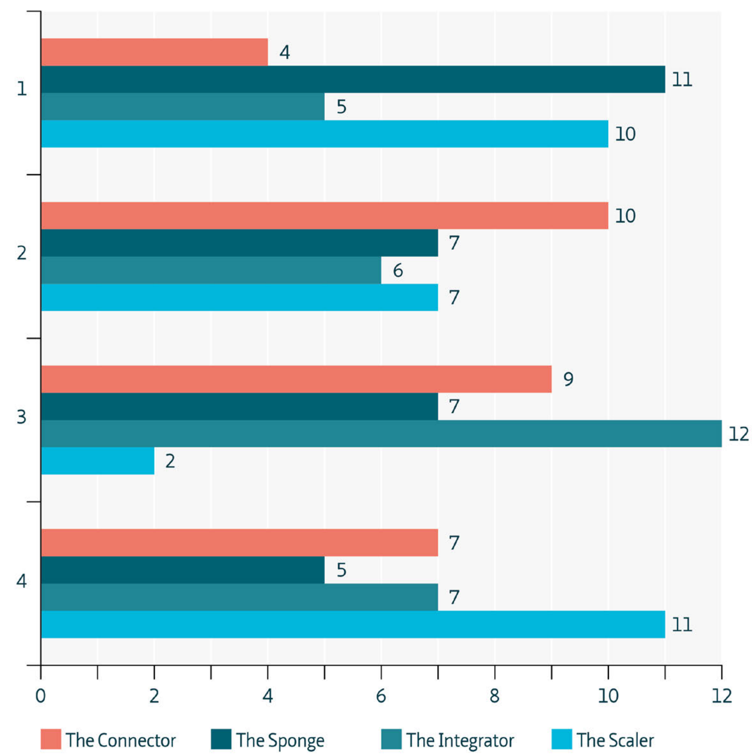

FIGURE 8.23 Ranking of the four instruments according to the preference of the respondents. 1 represents the highest preference and 4 represents the lowest preference in the rank order.

TABLE 8.9 Summary of the scores and level of agreement on the ease of use and usefulness of the four instruments.

		THE CONNECTOR	THE SPONGE	THE INTEGRATOR	THE SCALER
Ease of use	MEAN	8,79	8,48	8,41	8,96
	STDEV	1,01	1,49	1,48	1,20
Usefulness	MEAN	8,64	8,13	8,26	8,70
	STDEV	1,20	1,70	1,64	1,21

The daily workshop evaluation, however, reveals some additional aspects related to the usefulness of these instruments. What stands out in Table 8.9 is that there is less agreement and lower average scores on the ease of use and usefulness of *the Sponge* and *the Integrator*. This is especially surprising for *the Sponge*, which was reported as one of the favourite instruments during the interviews.

When asked whether any of the four instruments can be left out, more than half of the participants (15 out of 28) answered that all instruments are useful and should be kept. The rest of the respondents considered that one of the two least preferred instruments—*the Scaler* or *the Integrator*—can be discarded. Some participants (7 out of 28) considered that *the Scaler* can be left out, because (1) it can be integrated with the other instruments, (2) it can be merged with *the Integrator*, or because (3) it is too different from the others. Others (6 out of 28) suggested that *the Integrator* should be left out, because (1) it can be merged with *the Scaler*, (2) it was the least used instrument, (3) it was the most disconnected from the design, (4) the superimposition was anyway obvious, or (5) because it was redundant following the first two instruments.

In the third question, asking whether there is something missing from the set of instruments, respondents mentioned the following aspects: the social dimension, underground (invisible) infrastructure, perception and quality, urban morphology, administrative aspects, practical use, barriers, or a more detailed (sub-)classification.

Overall, the order of the instruments, as presented in the workshop, was considered to be correct. As shown in Figure 8.24, this is very clear for *the Connector* and for *the Sponge*. However, even if on average it was considered the least preferred, *the Scaler* had a high number of responses positioning it as the most preferred. Also, *the Integrator* scored the highest on the third and the last position, but, as *the Scaler* was positioned on the 4th, *the Integrator* remained on the 3rd position.

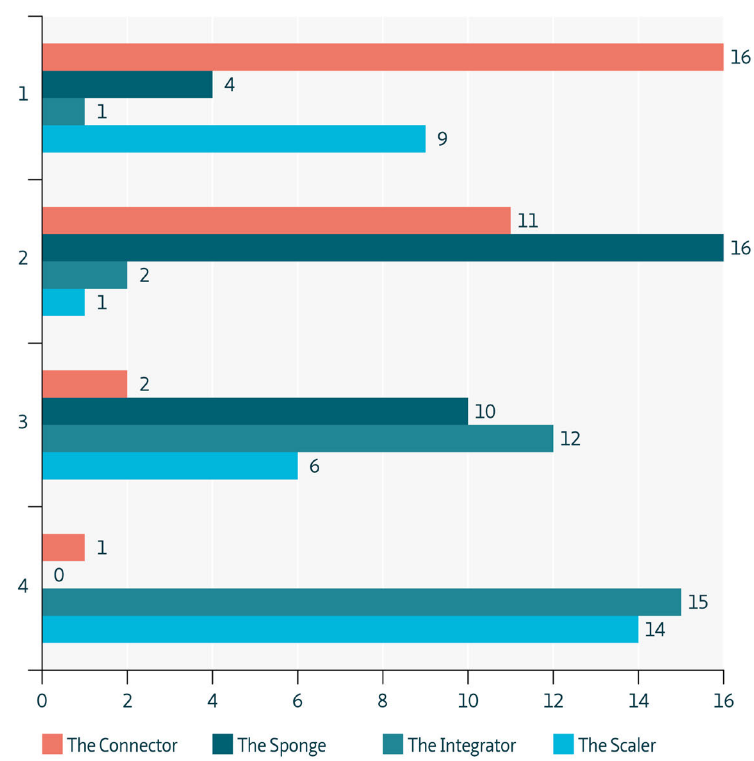

FIGURE 8.24 The order of the instruments as proposed by the participants.

§ 8.4.2 The design projects

At the end of the design workshop, the eight projects were evaluated by an international jury according to five criteria: communication, methodological coherence, social-ecological integration, scalability and level of completion (Appendix P), and two best projects (one for each corridor) were selected.

The project "From Barrier to Link" on site D2 of URC Dâmbovița (Figure 8.25, top) was selected by the jury due to its good use of local potentials, its coherent strategy, and scalability. As stated in the project description (Appendix O), interventions in the key sites identified by the team along Dâmbovița aim for a positive impact on connectivity, attractiveness, integration and on the quality of the URC as a whole through replicable interventions in the form of floating platforms (*the Sponge*: extra public space in the river space). The team identified the conflict between riverside traffic and pedestrian accessibility to the river and proposed a three-phased strategy to overcome the barrier caused by riverside traffic. Although this problem has been addressed, the jury considered that a better overview of systemic issues (i.e. interdependencies across scales), mainly related to traffic and alternative modes of transport, could have been further developed in the project.

On URC Colentina, the project "Amphibious Communities of Fundeni Lake" (Figure 8.25, bottom) was selected by both the jury and the participants as one of the best projects. Building on the exceptional ecological qualities of Lake Fundeni and on the problems and potential of a socially disadvantaged community occupying its shores, team C3 devised a community-based social-ecological strategy, in which bottom-up initiatives combined with natural restoration goals were encouraged (Appendix O). This way, the team aimed for a more "symbiotic" (i.e. integrated) relation between the community and the river. The jury appreciated this holistic approach, but also pointed out the need for a better definition of the spatial outcomes of the project. In this project, *the Sponge*, as well as transversal accessibility revealed by *the Connector*, have played a role in identifying the spaces of social-ecological interaction.

In addition, "Linking Park" by team D4 (Figure 8.26) was voted by the public (participants and guests) and appreciated by the jury for the quality of the visualisations, revealing spatial details at several scales, and for the use of *the Sponge* interlaced with *the Connector* in a strategic way. Making use of the abundance of open space around and inside the delta landscape of Lake Văcărești, an abandoned retention lake in the valley of Dâmbovița, and acknowledging the contrast between the total absence of traffic inside the lake and the traffic barrier that cuts the river from the delta, team D4 proposed a social-ecological buffer zone around the lake and ecological stepping stones and connections towards the surrounding urban areas. This way, the project made a gradual transition across the edge of the lake, softening barriers with a gradient of slow connections and social-ecological spaces, but preserving the contrast between the city and the ecological richness of the delta.

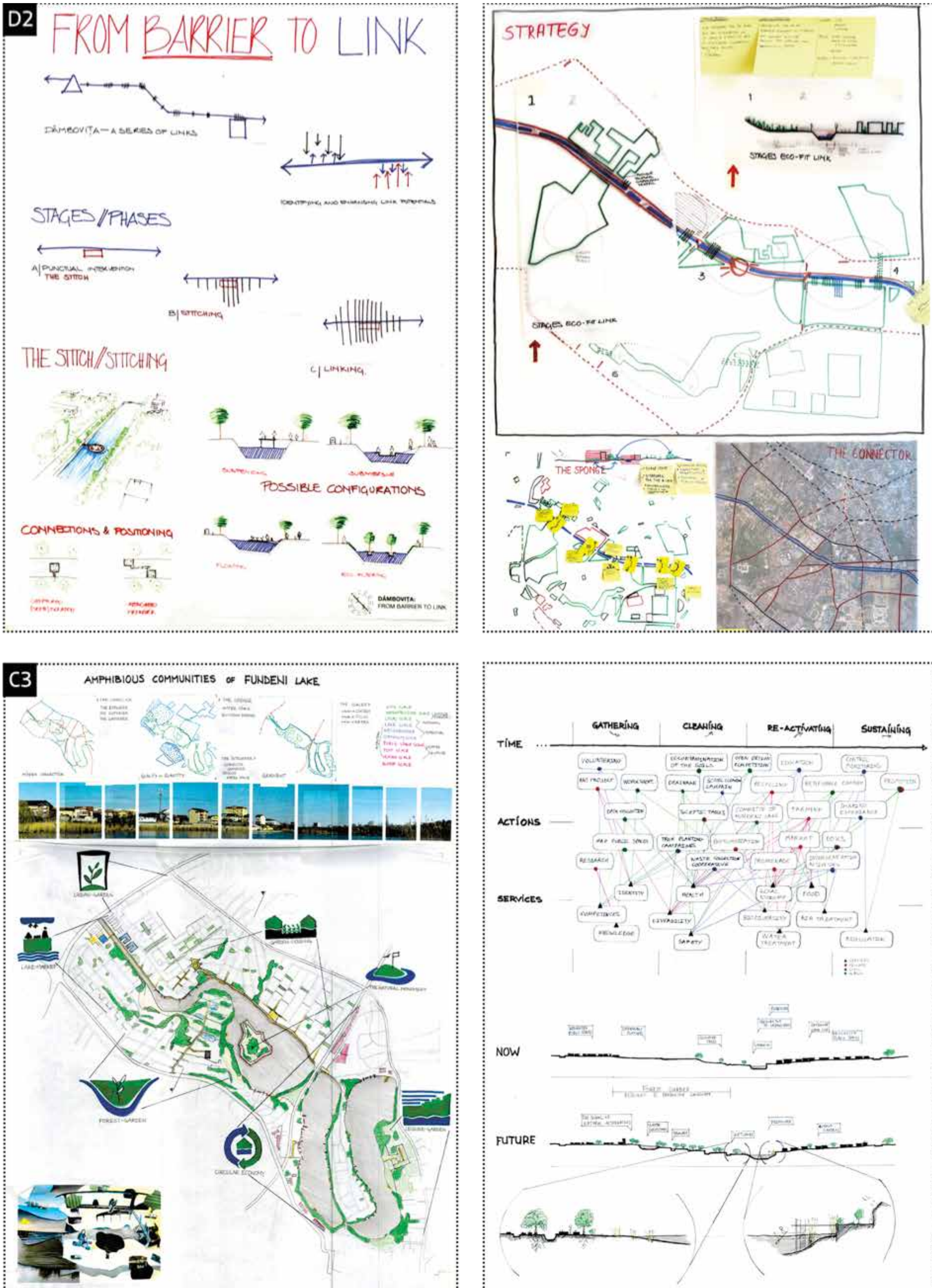

FIGURE 8.25 The projects "From Barrier to Link" by team D2 on URC Dâmbovița and "Amphibious Communities of Lake Fundeni" by team C3 on URC Colentina, selected by the Jury as the best projects in the workshop.

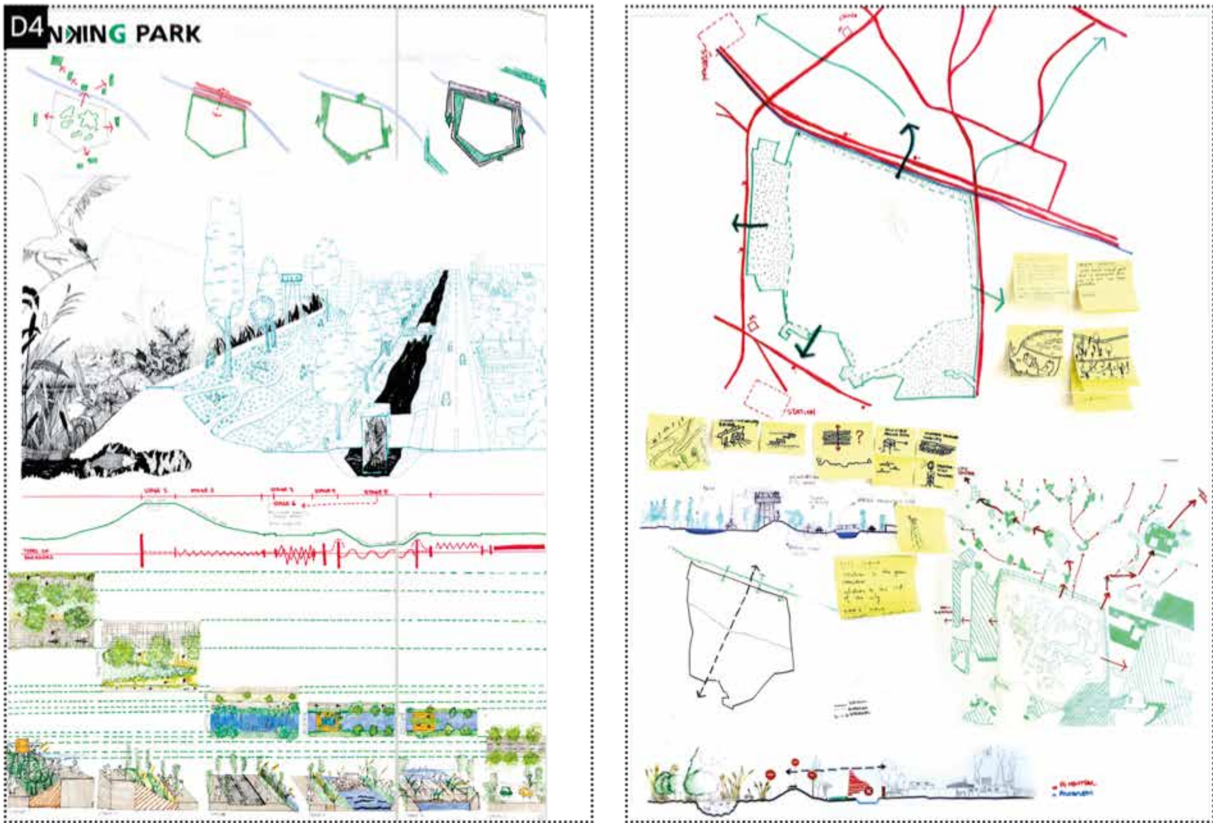

FIGURE 8.26 "Linking Park" (site D4), voted as the best projects by the workshop participants, as well as by the public and the guests invited to the final presentation.

Overall, the projects developed in the workshop (Appendix O) made use of the instruments, while gaining depth and developing creative strategies and design ideas in a short time. As pointed out by some participants in the interviews (Appendix N), *the Connector* was helpful in understanding of the complex spatial configuration of the site. *The Sponge* was the most liked instrument, because it helped the participants in identifying spaces with potential to connect people and nature. Although perceived as more abstract, *the Integrator* and *the Scaler* were considered by some teams useful in taking strategic decisions across scales and depicting points of challenge (i.e. conflicts and synergies) where social-ecological integration can respond to local problems.

§ 8.5 Discussion

As noted in the introduction, the design workshop has been employed to demonstrate and to test the application of the four design instruments in a real-world context. As discussed below, this set-up led to a number of insights regarding the use of the instruments and posed a number of methodological challenges.

§ 8.5.1 The use of the instruments

The results presented in Section 8.4 are related to the design as a process (Section 8.4.1) and to design as an outcome of the process (Section 8.4.2). Internal evaluation (evaluation forms) and external interpretation (interviews and design projects) of the use of instruments have refined the way the instruments can be employed in the design process. These refinements have been incorporated in the process diagram shown in Figure 8.2.

First, the order in which the instruments were applied in the workshop has been questioned by some participants. It was noted that *the Scaler* should have been used earlier in the process. The purpose of *the Scaler*, however, was to postpone the decision on a scalar framework to a later stage, so that the problem and systems at hand are analysed in an unbounded way. So, instead of changing the order of the instruments, *the Scaler* was clarified as present in the whole process and that the scalar framework may be revised in different stages of the design process (see Figure 8.2). *The Integrator* was similarly found confusing to apply in the sequence of in instruments. Some participants even questioned its usefulness, as the overlap between *the Connector* and *the Sponge* was anyway obvious or implicit. However, as presented in Section 8.2, the use of *the Integrator* is meant to make relations—i.e. synergies and conflicts—explicit. The definition of *the Integrator*, as presented in Section 8.2, clarifies this aspect.

Second, it became clear that *the Connector* and *the Sponge* are different from *the Integrator* and *the Scaler*. It is visible both in the design proposals and in the evaluations that the former two are more tangible and easy to understand, whereas the latter two are more abstract and more difficult to understand. Thus, the former two have been specified as instruments that reveal elements of the URC, while the latter two have been defined as instruments addressing the relations between those elements.

These observation, along with more general suggestions distilled from the analyses of the workshop results (Table 8.10) is expected to improve the usability of the four instruments in future applications.

TABLE 8.10 **Suggestions for improvement applicable to all instruments.**

- Provide a more detailed introduction and explanation of the instruments.
- Give examples to illustrate the use of the instrument.
- Simplify the naming. The naming needs to be supported with graphical information. This way, the instrument will be less abstract and easier to understand.
- Provide a clear scalar framework for the application of the instrument.
- Specify whether the instruments highlight existing and/or potential aspects of the urban environment.

§ 8.5.2 Methodological challenges

Given the challenges of the design workshop as a research methodology, and, hence, its influence on the outcomes, this chapter requires a separate discussion of research quality (i.e. validity and reliability). Factors such as the subjectivity of decisions taken in the design process, biases, the experience of participants as designers, and the roles assumed by the researcher can have a significant impact on the results. Although these limitations remain to a certain extent, some counter measures were included in the methodology. First, the involvement of the researchers in the design process was minimal. Using Ørngreen & Levinsen (2017) terminology, their role maintained a balance between that of 'ethnographers' focusing on the research and that of 'clinicians' taking care of the participants needs. For additional guidance, external tutors, unaware of the workshop methodology, were invited to guide the participants in the problem-solving process. Second, as the application to the workshop was voluntary, participants did have a sense of ownership and were genuinely engaged in the activities of the workshop. Third, professional biases were reduced, as much as possible, by forming diverse teams and encouraging transdisciplinary thinking. Although the challenge of transdisciplinarity has been partially met (with only 4 participants from non-design-related disciplines or specialisations), the workshop may be considered relatively successful in this sense. The mix of different levels of expertise played an important role here too.

In addition to its methodological role, the workshop created the chance to explore possibilities of social-ecological integration through design, and to contribute to the debate on the future development of the URCs of Bucharest. In this sense, the workshop addressed a real-world problem and demonstrated, using Ørngreen & Levinsen's (2017) classification of ways to employ workshops, its added value as means to achieve a societal goal (e.g. furthering the debate and raising awareness on the URCs of Bucharest) or as practice (e.g. design education).

§ 8.6 Conclusions

This chapter elaborated a set of four design instruments, named *the Connector*, *the Sponge*, *the Integrator*, and *the Scaler*, as means to implement the four design principles introduced in Chapter 7. *The Connector* is used to reveal and reassign existing elements and to add potential elements to the spatial networks of the URC in a non-conflicting spatial configuration. In a similar way, *the Sponge* reveals, reassigns and combines existing and potential open spaces in the URC, where people, water and ecosystems can be jointly accommodated. *The Integrator* shows conflicts and synergies between the elements revealed with *the Connector* and *the Sponge* to highlight strategic sites for design intervention. Finally, *the Scaler* helps in building the scalar framework and reveals cross-scalar interdependencies of the URC.

To demonstrate and evaluate the use of the instruments in the design process, *a workshop methodology* was carried out as part of the overall research design of the thesis. The design workshop, organized in Bucharest, provided a rich set of quantitative and qualitative data, which was used to evaluate and refine the definition of the instruments as they were presented here. Although the workshop participants reported that the instruments were overall useful and easy to use, they also made valuable suggestions for a better application of the instruments. Key insights were gained mostly on how the instruments relate to each other in the design process. The scheme presented in Figure 8.1 shows a comprehensive set, which was refined by the evaluation carried out in the workshop.

As a conclusion to Part 3 of this thesis, this chapter has demonstrated a potentially significant contribution to the knowledge on designing social-ecologically integrated URCs. Future steps and how this contribution relates to the other findings of the thesis will be discussed in detail in the next chapter.

9 Conclusions and Discussion

§ 9.1 Conclusions

Urban rivers have always been shaped by the tension between the pulsating power of seasonal water flows and the aspired fixedness of settlement form. As cities developed along rivers, ever since the earliest civilisations, a complex system of rationalisations has been constructed, extending far beyond urban boundaries, in order to adjust river systems to human needs and safety. Until not long ago, this system of rationalisations had been effectively keeping river dynamics under control, while cities had grown less aware of the above-stated tension. Yet, the combined effect of accelerated urbanisation and climate change have led to several failures in this control-driven approach to urban river engineering and planning. Recurring floods, environmental degradation, loss of biodiversity, decreasing liveability and environmental stress are symptoms that signal the loss of synergy between rivers and cities. As shown in Section 1.2, these symptoms reveal *four specific problems*. As urban rivers were transformed into elements of technical infrastructure to facilitate longitudinal flows (storm water runoff, car traffic), they became *physical barriers to people, ecosystems and water* (Section 1.2.1). Once rivers were transformed from their undisturbed state as systems which combined drainage with storage into systems mainly based on controlling drainage and restraining natural fluctuations, a *latent flood risk* has built up (Section 1.2.2). In their effort to manage infrastructural flows, these same transformations *diminished the capacity of urban rivers to deliver ecosystem services* (Section 1.2.3) and *reduced their scalar complexity* (Section 1.2.4).

Small rivers—i.e. narrow enough to be easily bridged and not to be used for major water transport—were in particular affected, as they were the first to be tamed and the most extensively transformed. As shown in Figure 1.2, most inland European cities are crossed by small rivers. The largest European cities, which are located along major rivers, are also crossed by smaller tributaries (e.g. River Lea in London, Canal St. Martin in Paris, River Rotte in Rotterdam). Bucharest, the city examined in this study, is traversed by two small rivers, Dâmbovița and its tributary Colentina, which were both subjected to extensive transformations of technical and functional nature (Chapter 3) and, as a result, they are currently unattractive, deteriorating, dysfunctional and disconnected from the city (Chapter 4).

If Chapter 1 started with an outline of the shifting history of urban rivers and the problems that accumulated throughout that history, let us conclude by looking at the potentials discovered in this thesis that can restore the synergy between cities and their rivers. Drawing on social-ecological resilience and urban form resilience theory, and adopting the approaches of spatial morphology and landscape ecology, the thesis responds to these problems with the concept of social-ecologically integrated Urban River Corridors (URCs) and by raising the following research question:

How can social-ecological integration be spatially defined, assessed and designed in Urban River Corridors?

The research was laid out in three parts—titled Context (Part 1), Assessment (Part 2) and Design (Part 3)—, representing the three consecutive steps taken to answer the research question: *understanding*, *assessing*, and *designing* URCs. Each part, summarised in Sections 9.1.1-9.1.3, responded to a number of sub-questions and objectives put forward in the introduction (Section 1.4).

§ 9.1.1 Understanding Urban River Corridors

The first part of the thesis established the theoretical and practical context in which URCs are situated. In response to the sub-questions and objectives shown in Table 9.1, Chapter 2 gave a spatial-morphological definition, wherein key spatial properties were identified, principles from various disciplines were synthesized, and a method of spatial delineation was devised, while Chapters 3 and 4 provided an in-depth description and analysis of a real-world case.

TABLE 9.1 Sub-questions and objectives addressed in the chapters of Part 1.

CHAPTER #	SUB-QUESTION	OBJECTIVES
Chapter 2	**SQ2**: What are the spatial-morphological conditions for achieving social-ecological integration along urban rivers?	**Objective 2.1**: Identify key properties of URCs.
		Objective 2.2: Formulate a spatial-morphological definition of URCs.
		Objective 2.3: Devise a method of spatial delineation of URCs.
Chapter 3	**SQ3**: How has the social-ecological relationship between Bucharest and its rivers evolved through time?	**Objective 3.1**: Describe the geographic context of Bucharest's URCs.
		Objective 3.2: Describe the spatial-temporal dynamics of Bucharest's URCs.
Chapter 4	**SQ4**: What is the current state of knowledge on Bucharest's URCs?	**Objective 4.1**: Summarise the spatial effects of post-socialist transformations on URCs in Central and Eastern Europe.
		Objective 4.2: Identify the current problems and potentials of Bucharest's URCs related to urban development.

SQ2: What are the spatial-morphological conditions for achieving social-ecological integration along urban rivers?

The *Urban River Corridor (URC)* was adopted as an integrative and integrated concept that combines the river valley with the surrounding urban fabric. The definition of URCs was developed based on a transdisciplinary literature review of urban rivers from four perspectives: *environmental-ecological*, *social-economic*, *planning-governance*, and *spatial-morphological*. Following the review, *four key properties* were identified (Table 9.2). The first property, *connectivity*, defined on three dimensions—longitudinal, lateral and vertical—, was presented as a potentially integrative concept both from social and from ecological point of view. A three-dimensional understanding of connectivity can shed light on why rivers have become physical barriers (mainly accommodating longitudinal connectivity) and on how those barriers could be overcome. *Open space amenity*, the second property identified in literature, refers, on one hand, to the provision of ecosystem services through green-blue infrastructure solutions and, on the other hand, to the social and economic value of open space in waterfront (re)development. Understanding the relationship between built form and open space through diversified occupation and movement is essential for establishing a balanced relationship between the river and the city. Another key property identified in literature was *integration* of the knowledge from multiple disciplines, of planning decisions, and of the social and ecological systems. Finally, *multiscalarity* was highlighted in all the four perspectives of the literature review. The scales of URCs, ranging from the scale of the major river catchment to the scale of individual sites, were identified and defined. The spatial-morphological definition of social-ecologically integrated URCs combined these four properties in a spatial representation (Figure 2.3) and assembled a terminology that can aid transdisciplinary communication concerned.

TABLE 9.2 The key properties of URCs identified in the transdisciplinary literature review presented in Chapter 2.

URC PROPERTY	DESCRIPTION
Connectivity	Connectivity of URCs is used to describe the movement of water, people and ecosystems on three spatial dimensions: longitudinal, lateral and vertical.
Open space amenity	Diverse open spaces along URCs are important for accommodating hydrological, ecological and social processes.
Integration	URCs are integrated through multifunctionality, through a balanced configuration of built-up density and open space, or through multi- or interdisciplinary knowledge.
Multiscalarity	URCs must be understood on multiple scales from the context of the larger river catchment to the details of public space on human scale. Scales of URCs include: the major river catchment, the metropolitan area, the urban river corridor, the corridor segment, the river space, and the site.

SQ3: How has the social-ecological relationship between Bucharest and its rivers evolved through time?

Prior to the application of the spatial-morphological definition of URCs on Bucharest in Chapter 4, Chapter 3 gave a historical overview to reveal the social-ecological dynamics of the city and its rivers.

Due to its low-lying geographic location in the Romanian Plain, Bucharest has had a dynamic relationship with its rivers Dâmbovița and Colentina ever since it started to develop as a centre of regional importance in the mid-19th century. The pressure posed on the natural flow of River Dâmbovița by the man-made structures such as bridges, watermills and small industries dependent on water led to an increasing number of floods, thus prompting the need for the first river transformations in the 1880s. During the next century, the river was rectified, canalised, concreted and culverted as part of a series of modernisation projects. From a valley with a dynamic social and ecological landscape occupied by gardens, ponds, wetlands, islands, mills, monasteries, tanneries and the old court, Dâmbovița became a functional infrastructure used to drain water and guide traffic across the city. Seen through the definition of URCs, Dâmbovița became highly connected on a longitudinal dimension, while the lateral and vertical connectivity were considerably diminished. Most open spaces around the river were either built up or disconnected from the river by roads built on the embankment. Moreover, the transformation of the river into a traffic corridor shifted its scale from a 'backyard' space accessible locally to a city-scale infrastructure dedicated to higher speeds and longitudinal transit.

River Colentina, tributary of River Dâmbovița, was reached by the expansion of the city a few decades later, when the villages on its shores became peripheries of the city. As the marshy valley of Colentina presented a threat to the health of the population, a plan was devised in the 1930s for the reclamation and sanitization of the whole river valley. As with the case of Dâmbovița, the transformation became an opportunity for modernization. The river was transformed in several stages during the 20th century into a succession of lakes and parks forming a city-wide recreational space. In this case, longitudinal connectivity was diminished (the river was dammed, riverside traffic remained outside the valley), vertical connectivity partially reduced (concreted banks), while lateral connectivity was maintained and even improved locally. Conceived as a metropolitan green and blue corridor, a generous open space was maintained along the lakes, which could accommodate both recreational spaces for people and ecological patches, corridors, and gradients.

Although seemingly very different—Dâmbovița as a canal, Colentina as a succession of lakes—, both rivers had been highly engineered. The transformation of both rivers started off as a response to a threat: flood in case of Dâmbovița, the pestilential conditions of the wetlands along Colentina.

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On the other hand, both were driven by a vision. Dâmbovița was to become a perfectly controlled river replaced by a modern urban axis, while Colentina was pictured as a tamed landscape where all Bucharestians could spend their weekend close to nature. These transformations diminished the connectivity, spatial capacity, and scalar complexity of the rivers, and ultimately resulted in a weakened social-ecological relationship between the city and its rivers.

SQ4: What is the current state of Bucharest's URCs?

In the nearly three decades following the fall of Communism in 1989, in which the urgency of political, social and economic transformations prevailed over the need for spatial planning, the two rivers of Bucharest have not been actively transformed. Instead, they were subject to a process of uncontrolled development, which has yet to be fully documented in urban planning and design literature. The recent transformations and the current state, including problems and potentials, of the two URCs of Bucharest, have been investigated through interviews of local experts involved in planning, design, governance, engineering or civic initiatives related to the two rivers (Table 9.3).

The experts described Dâmbovița as the most problematic of the two URCs, mainly because it is completely canalised and, as it is bordered by roads on both sides, it acts like a physical barrier to pedestrian movement. Due to its disconnection from the pedestrian network, it was named by the experts a 'non-place', a space that lacks meaning for the inhabitants of the city. In addition, any spatial intervention along Dâmbovița is considered to be very difficult due to the lack of integrated planning and the crampedness of the river space in central segments of the corridor. At the same time, given its central location, Dâmbovița could become an axis of urban development, with a strong spatial identity and economic attractiveness. Dâmbovița could also benefit from the reactivation of the river valley and the abandoned urban areas and structures in its vicinity.

River Colentina and its surroundings were described by the experts as a fragmented territory. This fragmentation is visible both in the poor accessibility of the river, mainly due to lakeside privatisation, and in the social imbalance between poor and rich lakeside communities. According to the interviewees, the recent degradation of the river can be ascribed mainly to the weak urban legislation and derogative planning practices of the post-communist period. The experts also pointed out the great potential of the river to become a green-blue corridor and that, like Dâmbovița, it could become an axis of urban development mainly driven by recreational activities capitalising on the prevailing natural qualities of the corridor.

TABLE 9.3 The main problems and potentials of the URCs of Bucharest, as identified in the expert interviews.

	PROBLEMS	POTENTIALS
URC Dâmbovița	• canalisation • physical barrier • a 'non-place' • lack of integrated planning • crampedness	• axis of urban development • latent spatial capacity • a space of identity • the invisible valley • economic attractor
URC Colentina	• a fragmented territory • social exclusion • artificial nature • derogative planning	• green-blue corridor • axis of urban development • recreation

§ 9.1.2 Assessing Urban River Corridors

The second part of the thesis has developed an assessment framework meant to evaluate how the spatial-morphological definition of URCs is applied to empirical contexts. To that end, Chapter 5 has developed an indicator system and a method of assessment based on the key properties of URCs and current approaches to urban river assessment. In Chapter 6, the assessment framework was applied to the URCs of Bucharest. The sub-questions and objectives of these chapters are summarised in Table 9.4.

TABLE 9.4 Sub-questions and objectives addressed in the chapters of Part 2.

CHAPTER #	SUB-QUESTION	OBJECTIVES
Chapter 5	**SQ5**: How can the social-ecological integration of URCs be spatially assessed?	**Objective 5.1**: Review current approaches to the assessment of urban rivers.
		Objective 5.2: Build an assessment framework for social-ecological integration in URCs.
Chapter 6	**SQ6**: To what extent are the URCs of Bucharest social-ecologically integrated?	**Objective 6.1**: Assess social-ecological integration in URC Dâmbovița.
		Objective 6.2: Demonstrate the wider application of the assessment framework on URC Colentina.

SQ5: How can the social-ecological integration of URCs be spatially assessed?

In Chapter 5, an *assessment framework* of social-ecological integration in URCs was constructed following the spatial-morphological definition of URCs and building on current approaches to the spatial assessment of urban rivers. The *indicator system* that was developed for the assessment framework consists of social and ecological indicators organised under the categories longitudinal, lateral and vertical connectivity, as well as spatial diversity, spatial quality, and spatial composition (Figure 5.2). Target values were defined for each indicator and were classified on a standardised three-point scale. This way, the assessment of social-ecological integration could be carried out, as shown in Figure 5.3, by confronting social and ecological indicators under their corresponding categories (e.g. longitudinal social connectivity with longitudinal ecological connectivity). Multiscalarity could be ensured by aggregating data from scales of constraint (river catchment and metropolitan area) and from scales of components (river space and the scale of individual sites) to the scale of the URC and the URC segment defined as the scales of focus for assessment. After the measurements are made on the scale of a corridor segment, the results are aggregated to the scale of the URC, where the final assessment and interpretation of the results are made.

SQ6: To what extent are the URCs of Bucharest social-ecologically integrated?

In Chapter 6, the assessment framework was applied to the nine corridor segments of URC Dâmbovița (Sections 6.3) and it was further demonstrated on URC Colentina (Section 6.4). The main problems and potentials derived from the expert interviews in Chapter 4 were used as criteria to select the indicators relevant for the assessment of social-ecological integration in the URCs of Bucharest. In the selection, each category of the assessment framework was represented by at least one indicator. The assessment of URC Dâmbovița had the following results:

- Connectivity on the social side was mainly low on the longitudinal dimension, medium on the lateral dimension, and absolute low on the vertical dimension (Figure 6.3). These values appeared relatively similar for the social and ecological side of the evaluation.
- The values for spatial capacity were overall higher than connectivity scores (Figure 6.5). Spatial diversity and spatial quality received an overall medium score on the social side of the assessment and a preponderantly low score on the ecological side. Social spatial composition scored high in most central segments of the corridor, while ecological spatial composition was high in peripheral segments and medium in central segments.
- As shown in the example of URC segment CS03 (Figure 6.6), social-ecological integration was first assessed for each individual segment. By mirroring the scores on the social and ecological side of the assessment chart, values were determined by the minimum score for each of the six assessment categories. Where an imbalance between the two sides was observed, and hence a decrease in the mirrored score was applied, areas of potential improvement were identified. These results are useful in supporting segment-scale planning decisions targeting social-ecological integration. As shown in Figure 6.6, strategic interventions in CS03 aiming to increase longitudinal connectivity on the social side, spatial diversity, spatial quality and spatial composition on the ecological side would increase the overall score of the segment from low to medium.
- Corridor-scale assessment summarised the actual and potential scores of all segments. Not surprisingly, central segments scored high on the social side, while peripheral segments returned higher values in the ecological side. However, when potential integration—i.e. symmetry across the two sides—was considered, segments with different values had similar potential profiles. For instance, this was the case of CS03, CS04 and CS07, characterised by high potential spatial composition, medium potential spatial diversity and medium potential lateral connectivity (Figure 6.7).

The wider application of the assessment framework was further demonstrated at corridor segment scale on URC Colentina (Section 6.4) with two indicators—one that was used on URC Dâmbovița (network accessibility) and one that is specific to the spatial conditions of URC Colentina (green space coverage)—, confirming, for instance, that URC Colentina is less accessible than URC Dâmbovița.

§ 9.1.3 Designing Urban River Corridors

The third part of the thesis has elaborated a way to improve social-ecological integration in URCs through design, based on the spatial-morphological description of URCs introduced in Part 1 and the normative targets established in Part 2. In response to the sub-questions and objectives summarised in Table 9.5, in Chapter 7 it constructed design principles and in Chapter 8 it tested their application by means of design instruments.

TABLE 9.5 Sub-questions and objectives addressed in the chapters of Part 3.

CHAPTER #	SUB-QUESTION	OBJECTIVES
Chapter 7	**SQ7**: How can the design of URCs be guided towards social-ecological integration?	**Objective 7.1**: Formulate design principles of social-ecologically integrated URCs.
		Objective 7.2: Explore URCs through design.
Chapter 8	**SQ8**: How do design instruments aid the design of better integrated URCs?	**Objective 8.1**: Develop a set of design instruments to apply the design principles of social-ecologically integrated URCs.
		Objective 8.2: Demonstrate and test the design instruments on the URCs of Bucharest.

SQ7: How can the design of URCs be guided towards social-ecological integration?

Rooted in the spatial-morphological definition of URCs and informed by the design explorations presented in Boxes 7.1-7.4, Chapter 7 has constructed a set of four design principles specific to URCs: *Interconnectedness*, *Absorptive Capacity*, *Social-Ecological Integration*, and *Interscalarity*. The first two principles were used to define the elements of URCs—networks and spaces—as well as their configuration and composition, respectively. The latter two were defined as relational principles, as they guide design by revealing spatial linkages across the systems and scales of the URC. Design for social-ecologically integrated URCs requires an overall understanding of the potentials uncovered by each of these principles. Advanced as a comprehensive set, the four principles were defined as follows:

- **Interconnectedness** (Section 7.3.1) guides the design of the spatial elements of the *water network*, the *traffic network* (including the network of pedestrian movement), and the *ecological network* in the URC. According to this principle, these networks should have a non-conflicting and interconnected spatial configuration in order to accommodate hydrological, social and ecological connectivity on all three—i.e. longitudinal, lateral and vertical—dimensions.
- **Absorptive Capacity** (Section 7.3.2) is a design principle that addresses the elements of *water space*, *social space* and *green space* in the URC. According to this principle, the spaces of the URCs must have a redundant and attractive spatial composition, which is obtained, on one hand, from increased spatial capacity and, on the other hand, through functional and spatial diversity.
- **Social-Ecological Integration** (Section 7.3.3) is a relational principle according to which (potential) *conflicts* and (potential) *synergies* within and between the networks and the open spaces of the URC reveal strategic spaces for social-ecological integration. Synergies are reflected in non-conflicting spatial network configurations and in multifunctional open spatial compositions.
- **Interscalarity** (Section 7.3.4) makes relations across the scalar spectrum of URCs explicit. This principle establishes a framework which divides the scalar spectrum defined in Chapter 2 in *levels of constraint* (or context), *levels of focus* and *levels of components* (or detail). By making these relations explicit, interdependencies and cascading effects are accounted for in the design process. In addition, *Interscalarity* reveals temporal constraints and path dependencies inherent in the networks and spaces of the URC.

SQ8: To what extent do the four design instruments aid the design of better integrated URCs?

In line with the four design principles, Chapter 8 elaborated four design instruments, namely *the Connector*, *the Sponge*, *the Integrator* and *the Scaler*, and tested them on the two URCs of Bucharest.

- **The Connector** (Section 8.2.1) implements the principle of *Interconnectedness* with a procedure that helps the designer highlight and reconfigure the network elements of the URC and reassign them in a non-conflicting spatial configuration. *The Connector* is not comprehensive but strategic, as it selects network elements that are key to improving interconnectedness.
- **The Sponge** (Section 8.2.1), applying the principle of *Absorptive Capacity*, aids the designer in making an inventory of all open spaces of the URC, classifying them into (existing and potential) elements of water space, public space, and green space, and critically identifying their qualities and attractiveness.
- **The Integrator** (Section 8.2.2), implementing the principle of *Social-Ecological Integration*, helps the designers identify social-ecological conflicts and synergies on two levels. On the one hand, it examines the interaction between network elements and open space elements separately. On the other hand, it confronts the networks and open spaces to reveal further synergies between their spatial configuration and spatial composition.
- **The Scaler** (Section 8.2.2) applies the principle of *Interscalarity* by revealing scalar interactions among the spatial elements identified by *the Connector* and *the Sponge*. As a reflexive instrument,

the Scaler helps the designer identify the scales of context, focus and detail on the scalar spectrum of URCs and, in consequence, to make (potential) interdependencies, cascading effects and path-dependencies explicit.

The design workshop as a research methodology was used to test, refine and demonstrate the performance of the design instruments.

§ 9.1.4 Contribution

In response to the main research question, the thesis has constructed *a theory of social-ecologically integrated Urban River Corridors*, in which it proposed *a spatial-morphological definition*, *an assessment framework*, and *a set of design principles* and *instruments*. As shown in Table 9.6, the key properties, the set-up of the assessment framework, together with the design principles and instruments, form four continuous threads and thus bind the three parts of the thesis. The coverage of the four components within each of the three parts was theoretically grounded in Chapter 2, Chapter 5, and Chapter 7, while the interaction between the three parts was methodologically grounded, as explained in Section 1.8, by the linkages between the theoretical chapters (Chapters 2, 5 and 7), on the one hand, and between the empirical chapters (Chapters 4, 6 and 8), on the other (see Figure 1.11).

TABLE 9.6 The three components of the theory of social-ecologically integrated URCs advanced in the thesis.

UNDERSTANDING URCS	ASSESSING URCS	DESIGNING URCS	
Spatial-morphological definition	Assessment framework	Design principles	Design instruments
Connectivity	Indicators of connectivity	Interconnectedness	The Connector
Open space amenity	Indicators of spatial capacity	Absorptive Capacity	The Sponge
Integration	Assessment	Social-Ecological Integration	The Integrator
Multiscalarity	Scalar framework	Interscalarity	The Scaler

The proposed spatial-morphological definition advances a description of URCs in which the spatial requirements of urban systems (the 'social-') and ecosystems (the '-ecological') are considered on an equal footing. The four key properties put forward in the definition establish the spatial prerequisites upon which social-ecological integration can be achieved. The close analysis of the URCs of Bucharest has contextualised this definition and demonstrated the importance of the four properties in relation to real-world problems and potentials.

In order to assess how well the spatial-morphological definition is reflected in a given empirical context, the assessment framework has elaborated quantifiable targets for connectivity and spatial capacity of both social and ecological kind. With this assessment framework, planning and design decisions can be better informed about the current and potential social-ecological state of URCs. The assessment conducted on URC Dâmbovița of Bucharest demonstrated how the framework can offer strategic and actionable insights for planning and design for social-ecological integration.

Rooted in the spatial-morphological definition of URCs, design explorations and complementing the assessment framework, the design principles proposed in this thesis guide the spatial transformation of URCs towards social-ecological integration. Devised as user-friendly implements of the design principles, the design instruments help designers of and in URCs to identify strategic elements and relations of social-ecological integration.

§ 9.2 Discussion

Looking back at the initial set-up and the overall process of the research, a number of theoretical, methodological and epistemological challenges require further reflection, namely the initial claim that social-ecological integration contributes to general urban resilience and the challenges and opportunities of the transdisciplinary design study approach.

§ 9.2.1 Reflections on the impact of social-ecologically integrated URCs on general urban resilience

Social-ecological integration was introduced in Section 1.3.4 at the intersection of social-ecological resilience and urban form resilience, and it was defined as “the capacity of social-ecological systems to sustain synergies and to alleviate conflicts between the patterns and processes of coexisting ecological and social components” (p. 50) accommodated within their larger urban context. In urban areas, Urban River Corridors were identified as “spaces of social-ecological integration par excellence, where the interaction between the social system of the city and ecological systems is (potentially) the most intense” (p. 51). By growing synergies and alleviating conflicts between the networks and spaces of ecosystems and urban systems in URCs across scales and, consequently, establishing a reciprocal relationship, whereby resources are shared, it is argued that social-ecological integration has a positive impact on general urban resilience.

Then it is not surprising that the three contributions to defining, assessing and designing social-ecologically integrated URCs presented in Section 9.1 mirror the three major challenges of understanding, measuring, and building resilience. Social-ecological integration, as described in Section 1.3.4, “builds on general urban resilience, it addresses chronic stresses, and it adopts a proactive approach, by pooling the resources, adaptability and transformability of the social and ecological components of the system” (p. 50). This approach narrows the focus to parts of resilience that are generally germane to urban design and planning. As stated by Vale (2014), a proactive approach to resilience is particularly relevant to urban design and planning, allowing design and planning professionals to be involved much earlier in the resilience-building process. Hence, this thesis recognises the necessity of a normative agenda of resilience, as prompted by Weichselgartner & Kelman (2015), that can be potentially enabled by social-ecological resilience (Brand & Jax, 2007) and implemented through a spatial-morphological approach to achieve social-ecological integration. In addition, by making use of the concepts, methods and tools of spatial morphology and landscape ecology in the empirical investigation of Bucharest, this thesis potentially contributed to the knowledge on operationalising resilience.

The problems of URCs described in Section 1.2—the river as a physical barrier to pedestrians, latent flood risk, lack of ecosystem services, and reduced scalar complexity—cannot be described as acute shocks, i.e. sudden disruptions, such as floods, heatwaves and power outages, but as chronic stresses, characterised as continuous and latent disturbances. What makes problems of this kind especially difficult to grasp is that they represent an ongoing absence or insufficiency of something that appears non-vital on the short term, but nevertheless disturbing and unpredictable on the long term. Because a point of collapse, or critical threshold, is nearly impossible to foresee, the proactive/preventive approach found in both general urban resilience theory and urban design practice (Forgaci & van Timmeren, 2014) is at least promising.

The spatial-morphological definition and its applications in the assessment framework and the design principles have addressed this issue in two ways: by making the issues of the URC spatially explicit, and by focusing on potentials too. This way of approaching the problematique of URCs is visible in each part of the thesis: in the analyses of the problems and potentials revealed in the expert interviews (Chapter 4); by including both the current and potential situation in the assessment of Bucharest's URCs (Chapter 6); and in the design principles (Chapter 7) and instruments (Chapter 8), which guide the transformation of the spatial configuration and composition of key spatial elements and relations in the URC.

Finding direct correspondences or correlations between spatial properties of resilience, such as redundancy, diversity, modularity and density, and the four spatial properties of URCs was outside the scope of the thesis. Nevertheless, some important linkages could be observed, especially with regard to the design principles. By definition, both *Interconnectedness* and *Absorptive Capacity* aim for spatial redundancy and enable spatial diversity, thus having a potentially positive impact on resilience. Yet, when seen from the point of view of other resilience properties, their contribution to resilience may as well be questioned. It may also be argued that high connectivity decreases resilience, as it can propagate disturbances throughout the system, whereas a modular configuration would allow parts of the system to de-couple in case of a disruptive event. However, when talking about spatial implications of resilience, a distinction must be made between the system and the space within which it operates. *Interconnectedness* is mainly a spatial principle, not a systemic one, and urban space is not a 'system', but a physical manifestation of urban systems, on the one hand, and a field of possibilities in which urban systems have a certain freedom to manifest in different ways, on the other. That being the case, spatial interconnectedness affords both interconnected and modular system behaviour, whereas a less connected spatial configuration may allow for modularity but would limit potentially desirable interactions across the urban system. As explained in Section 7.3.1, interconnected road networks and redundant networks of habitat patches create choice to people and ecosystems to occupy or move in space in various ways.

Aimed at increasing spatial diversity and spatial redundancy, *Absorptive Capacity* also has a potentially positive impact on resilience. Nonetheless, as shown in the goals of sustainable urban form and green infrastructure planning, open space capacity and amenity needs to be balanced with density, another spatial property, introduced in the definition of resilient urban form (Section 1.3.2), which contributes to the built diversity and redundancy, necessary mainly for social resilience. The joint social-ecological definition of URC space, helps weighing built and unbuilt priorities of spatial diversity and redundancy. This balance was central to the definition of *Social-Ecological Integration* too. Capitalising on the differences between urban systems and ecosystems, *Social-Ecological Integration* highlights the potentials for diversity found in the spaces and networks of URCs. *Interconnectedness* assembles networks of different kind (the water network, the ecological network and the traffic network) in a non-conflicting spatial configuration. Similarly, *Absorptive Capacity* encourages multifunctional and overlapped compositions of different open spaces (water space, green space, social space), looking at their usage, morphological relations and qualities as social and ecological spaces. The diversity brought by these couplings is beneficial for resilience.

The Adaptive Cycle model, used in resilience theory to describe system dynamics along the two axes of potential and connectedness (see Figure 1.6 on p. 46), can be related to the design principle *Interconnectedness*. Once again however, an important distinction must be made between the spatial focus of *Interconnectedness* and the process-orientation of the Adaptive Cycle. Considering the complex dynamics of the urban environment, in which human agency has a defining role, the application of the Adaptive Cycle model is less straightforward then in an ecological system. Hence, instead of cycles of destruction and reorganisation, the urban environment can be better described in terms of persistence, adaptations and transformations, as in 'resilience thinking', that keep the urban system in a dynamic equilibrium. The cross-scalar description of the Panarchy model, i.e. a nested hierarchy of Adaptive Cycles used in social-ecological resilience theory (see Figure 1.6 on p. 46), may reveal current and potential interdependencies across the levels of constraint, focus and components as well as long-term dynamics considered by the principle of *Interscalarity*. Seen from a Panarchy perspective, adaptive cycles from the level of components can exhibit emergence. For instance, if several sites along the river are transformed into attractive public spaces (improved potential in the social dimension of *Absorptive Capacity*), the river space as a whole might change identity and allow for a large-scale transformation, gaining city-wide importance and increased potential for connectivity at various scales and speeds of movement (e.g. riverside slow mobility route supported by *Interconnectedness*). Similarly, catchment-scale dynamics and geomorphology (i.e. large and slow cycles) provide the 'memory' required for restoring or rehabilitating human-altered river functions and morphology. Understood form a historical perspective, the networks and spaces, as well as their interactions within and across scales, URCs reveal potentials that otherwise would not be visible.

§ 9.2.2 Challenges and opportunities of a transdisciplinary design study

Underlying the descriptive/analytical approach of Parts 1 and 2 and the design-based approach of Part 3, the thesis is defined as a transdisciplinary design study. This approach presents a number of challenges and opportunities for research and design. This section discusses how transdisciplinarity, as a prerequisite of rigorous sustainability scholarship, was achieved through 'methodological groundedness' and 'epistemological agility' (Haider et al., 2018) and how design was employed both as part of the research process (exploration and testing) and as part of the research outcome (principles and instruments).

Transdisciplinary research

Transdisciplinary research aims for a holistic understanding of problems and potentials that surpass disciplinary boundaries and, accordingly, it involves the exchange of theories, concepts and methods among various fields of knowledge (Montuori, 2013). In this respect, the main challenges of this study were of methodological and epistemological nature, as it required an integrated mix of qualitative and quantitative methods in a combined research strategy (i.e. comprising elements of design study, case study and logical argumentation) and it needed to overcome barriers encountered in the communication and transfer of knowledge. Following Haider et al.'s (2018) recommendations for rigorous sustainability science (Section 1.5.2), these challenges were met by ensuring high degrees of methodological groundedness ('depth' of research) and epistemological agility ('breadth' of research).

Given the mixed methods approach of this study, methodological groundedness was achieved separately in the three empirical segments of the research presented in Chapter 4 (qualitative data analysis of expert interviews), Chapter 6 (application of the assessment framework) and Chapter 8 (the design workshop as an environment for testing), respectively. In Chapter 4, criteria of trustworthiness—credibility, transferability, dependability and confirmability—were used to ensure the quality of the data collection and analysis procedures. This segment of the research constructed a grounded description of the current state of Bucharest's URCs. The assessment framework, grounded in the spatial-morphological definition introduced in Chapter 2, was applied in Chapter 6 on URC Dâmbovița and it was partially validated on URC Colentina. In Chapter 8, a multi-method approach was adopted for data collection in the design workshop. Overall research quality was achieved by linking these three grounded segments of the research to each other. As shown in Table 6.1, the results of the qualitative data analysis conducted in Chapter 4 were used as criteria for selecting the indicators for assessment in Chapter 6. The target values and the results of the assessment carried out in Chapter 6, as well as the detailed problem/potential analysis of the problems carried out in Chapter 4, were used to formulate the design assignments for Chapter 8.

If methodological groundedness is an established requirement in science, epistemological agility, that is, one's capacity to easily switch between different fields of knowledge and to work with transferable principles, is hardly achieved in research. Epistemological agility was enabled by the comprehensive knowledge base of URCs built in the transdisciplinary literature review of Chapter 2, and by its further applications in the development of the assessment framework (Chapter 5) and of the design principles (Chapter 7). As shown in Chapter 2, urban rivers have been studied in a variety of disciplines, such as river engineering, environmental history, environmental engineering, urban design and urban planning. To identify linkages between these fields, a frame of four domain families, clustering environmental-ecological, social-economic, planning-governance, and spatial-morphological aspects of urban rivers, was used to organise the knowledge surrounding the subject matter. In order to further align these different fields of knowledge, the thesis used a visual description in each of the three parts to summarise and communicate the spatial-morphological definition (Figure 2.3), assessment framework (Figure 5.2), principles (Figure 7.13, Figure 7.21, Figure 7.24, and Figure 7.30) and instruments (Figure 8.3, Figure 8.4, Figure 8.5, and Figure 8.8) of social-ecologically integrated URCs.

Design-driven research

Design, as a problem-solving activity, typically integrates various fields of knowledge (e.g. Carmona et al., 2010). Designers constantly formulate hypotheses, make assumptions, use analogies, devise metaphors and, while doing so, they switch between disciplines. This switch, however, requires a certain rigour and basic knowledge of the disciplines in question. In the case of URC design, an elementary comprehension of geomorphology, hydrology, and ecology, for instance, is essential. Transdisciplinary design meets this requirement in two ways: through design principles and a unified spatial language. Principles, it is argued, are the main 'currency' of transdisciplinarity, as they represent essential knowledge that is highly transferable. The practice of communicating and applying knowledge across disciplines through (often illustrated) principles is not new, as seen, for example, in the landscape ecology principles of Dramstad et al. (1996), presented in Section 2.2.5 and Section 7.3.1 (Figure 7.6), meant to guide landscape architecture and land-use planning towards a more ecologically aware practice.

The four URC design principles, presented in Section 7.3, could not have been constructed without the transdisciplinary knowledge gained in Chapter 2. The principle of *Interconnectedness* is built on knowledge of three-dimensional connectivity developed in the fields of river ecology and hydrology, corridor- and patch-based descriptions of habitat networks from landscape ecology, and road

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network configurations as described in urban morphology. *Absorptive Capacity* combined knowledge of landscape ecology, stormwater management, and public space design. In addition to these fields, *Social-Ecological Integration* built on resilience theory and strategic planning, and *Interscalarity* was informed by complexity theory and hierarchy theory. These four design principles reveal key spatial potentials of URCs that otherwise would have remained implicit. Hence, one of the main functions of these principles is that they make things explicit and, by doing so, they raise awareness and provide a rich description of what URCs are and how they should be transformed towards improved social-ecological integration.

Another important role in understanding URCs and in the development of design principles was played by the design explorations presented in Boxes 7.1-7.4, carried out in parallel to the rest of the research process. The project for River Dâmbovița, presented in Box 7.2, highlighted the importance of open spaces in the valley in constructing a continuous corridor that can accommodate both public and green spaces. The project, carried out prior to this research, had identified the problems of River Dâmbovița and had hinted to the potential of the river valley for social-ecological integration. In the project for River Colentina (Box 7.1), the spatial network of strategically chosen connections formed the basis of the principle of *Interconnectedness*. The project shown in Box 7.4, an urban design strategy for the French city of Vernon crossed by the Seine, was an exercise in understanding the scales of the city in relation to the river and how spatial connections across those scales—from a network of porous urban spaces within the city, through transversal city-river connections, to regional connectivity along the Seine—could be achieved. In the integrated urban development plan for River Someșul Mic in the Romanian city of Cluj-Napoca described in Box 7.3, the idea of synergies and conflicts between the river space, social space and ecological space was developed.

These four projects built upon each other and contributed to a better understanding of the connections, spaces, interactions and scales of URCs. Beyond the individual design assignments to which the projects had responded, they were part of a larger, reflexive process, wherein a distinction between particular and generalisable features was sought. In time, as the research evolved, the projects have demonstrated increasing awareness of the spatial morphology and design possibilities of URCs at large. If the first project (Box 7.2) was a conceptual exploration carried out individually, the most recent project (Box 7.3) benefited from the knowledge and it was carried out by a transdisciplinary team, including an urban sociologist, a river ecologist and a river engineer.

In order to be tested in a real-world setting, the principles were translated into instruments comprising specific procedures that could easily guide the design of social-ecologically integrated URCs. Less abstract than principles and more user-oriented, the instruments were necessary for facilitating the adoption and application of principles. The design workshop, presented in Chapter 8, was chosen as a testing and demonstration environment for the instruments. Beyond the methodological challenges of preparing, conducting and following up on a design workshop, discussed in detail in Section 8.3 and Section 8.5, the design workshop has proven to be an essential component of the transdisciplinary design study, because it brought to the overall research strategy an additional action research component, wherein it engaged in situ with local experts, resident and visiting designers, as well as professionals with different disciplinary backgrounds.

Neither design nor research are linear. On the contrary, they are essentially iterative and reflexive. The reflexiveness of a transdisciplinary research approach (Haider et al., 2018) resonates especially well with the non-linear character of a design process. Although the design projects and the design workshop were presented chronologically and with a certain emphasis—exploration and testing, respectively—, they were part of an iterative process. The four design projects employed in the exploration phase had already involved testing and optimisation. Similarly, the eight projects developed in the design workshop had contributed with further explorations into URC design. Consequently, the form in which the principles and instruments are presented in this thesis has as a result of that iterative process.

As pointed out in Section 1.5, a design-driven research approach is challenged by the disjunction between research as a question-driven activity and design as a goal-driven activity. As demonstrated above, cross-semination between these two different ways of approaching a problem on transdisciplinary grounds can create opportunities for both domains of activity. As design at urban and landscape scale can hardly be decontextualized, evidence-based design, especially when it makes use of transdisciplinary knowledge, is imperative. Design explorations, detached from methodological constraints, allow for discovery and can provide insights or hypotheses for the research process. Design workshops can provide fertile testing grounds both for research and design practice. All in all, transdisciplinarity can establish a common ground between research and design.

§ 9.3 Practical applications and implications

§ 9.3.1 Possible usage scenarios

Built on transdisciplinary grounds, the contributions of this thesis are of potential value for a diverse audience. The spatial-morphological definition, illustrated in Figure 2.3, is meant to facilitate further transdisciplinary research on the topic; hence, it can be used by researchers as a conceptual framework for any other research related to urban rivers. The assessment framework presented in Part 2 may be of interest as a decision support tool for city planners, as an analytical framework for urban and landscape designers, or as a participatory planning and design tool involving a wide range of stakeholders. The design principles formulated in Part 3 are mainly addressed to designers, but they may guide planners and policy-makers as well. In addition, the design principles and instruments may be of interest in urban and landscape design education. For the application of the assessment framework and the design principles in a practical context, three typical usage scenarios can be identified: corridor-focused assessment, corridor-focused design and site-focused design.

Corridor-focused assessment

As shown in Chapters 5 and 6, social-ecological integration is meaningful when it is understood at the scale of the URC. Hence, corridor-focused assessment, for preliminary diagnoses, for the support of planning decisions, as a prerequisite to corridor-scale design or for monitoring, is one of the most likely usage scenarios of the assessment framework. Depending on relevant local issues, the objectives of the assessment, data availability, and other technical constraints, an appropriate set of indicators is selected in such a way that each major category of the indicator system is represented by at least on indicator. As shown in Chapter 6, the assessment is carried out on each segment of the corridor and the results are compared and aggregated to the scale of the corridor for the final interpretation.

Corridor-focused design

Corridor-focused design is concerned with the design of spaces spanning along and across the URC and it is typically strategic. The project shown in Box 7.1 proposed a strategic topological module that was flexible enough to incorporate site specificities, but also generic enough to be replicated along the whole corridor. The project for URC Someșul Mic shown in Box 7.3 and Box 8.1 used strategic actions, i.e. key interventions that could be repeated in similar spatial conditions. However, a strategic approach to the design of social-ecologically integrated URCs does not only entail replicability, but also the work with key, sometimes even unique, locations, which are typically identified in areas of synergy or conflict (Section 7.3.3). The principles of *Interconnectedness* and *Absorptive Capacity* can be employed to identify patterns of spatial configuration and composition. To follow the principle of *Interscalarity*, knowledge of urban constraints from the scale of the metropolitan area as well as hydrological and environmental constraints from the scale of the catchment are key in devising a corridor-focused design strategy. Scales of detail are used to demonstrate the applicability of design interventions proposed at scales of focus to specific site conditions.

Site-focused design

Design interventions are most often located on specific, contained sites in the URC. The principles presented in Part 3 of the thesis can guide site-focused design in connecting to the networks and spaces of the URC. Design at this scale can follow proximity or location information (distances to the closest green spaces and public spaces) to contribute to the *Interconnectedness* and *Absorptive Capacity* of the URC. The use of pervious materials as well as green-blue infrastructure solutions are considered at this scale. *Social-Ecological Integration* is achieved by having a contribution to public space and green space. In terms of *Interscalarity*, the URC- and URC segment scale provide the immediate constraints for site-scale design. In case of sites located in the river space, longitudinal and vertical connectivity are prioritised, whereas sites located outside the river space have influence on lateral connectivity towards the river or, in case of valley-edge sites, on longitudinal traffic connectivity. Although catchment- and metropolitan-scale constraints may not be directly perceived at site-scale, especially when the site in question is located outside the river space, basic knowledge of large-scale influences, such as meso- and macro-scale environmental conditions or metropolitan traffic, might have an impact on localised site design.

§ 9.3.2 The implications of social-ecologically integrated URCs to urban development

URCs as axes of metropolitan development

Besides the impact on general urban resilience, as discussed in Section 9.2.1, the design and planning of URCs towards social-ecological integration might have wider implications to the spatial development of the city as a whole. Redefined as URCs, the structural importance of the rivers on metropolitan scale, as previously noted in the project for River Dâmbovița (Box 7.2), becomes apparent. In its reflection on the wider implications of a river-centred urban development strategy for the overall metropolitan structure of Bucharest, the project presented in Box 7.2 proposed a shift from the current radial-concentric understanding of the primary urban structure to a stacked linear model (Figure 9.1). With the principles proposed in this thesis, the development of such a model can be imagined. The non-conflicting spatial configuration of URC networks proposed through *Interconnectedness*, combined with increased attractiveness encouraged through the principle of

Absorptive Capacity, might promote the URCs of Bucharest to prime axes of urban development, as one of the main potentials pointed out by the experts in Chapter 4. With a reconfigured longitudinal connectivity, in which high speed traffic is moved outside the river valley, and the river banks are dedicated to slower mobility, Dâmbovița could become an urban development backbone that is well interlaced with both high-speed networks and the networks of pedestrian movement throughout scales. The concrete banks of the river upgraded with ecotones and points of access would increase vertical connectivity and spatial quality. Colentina could be revived as a green-blue corridor and metropolitan recreational space, as envisioned in the 1930s, through improved longitudinal connectivity along the lake shores, pedestrian accessibility, and spatial quality.

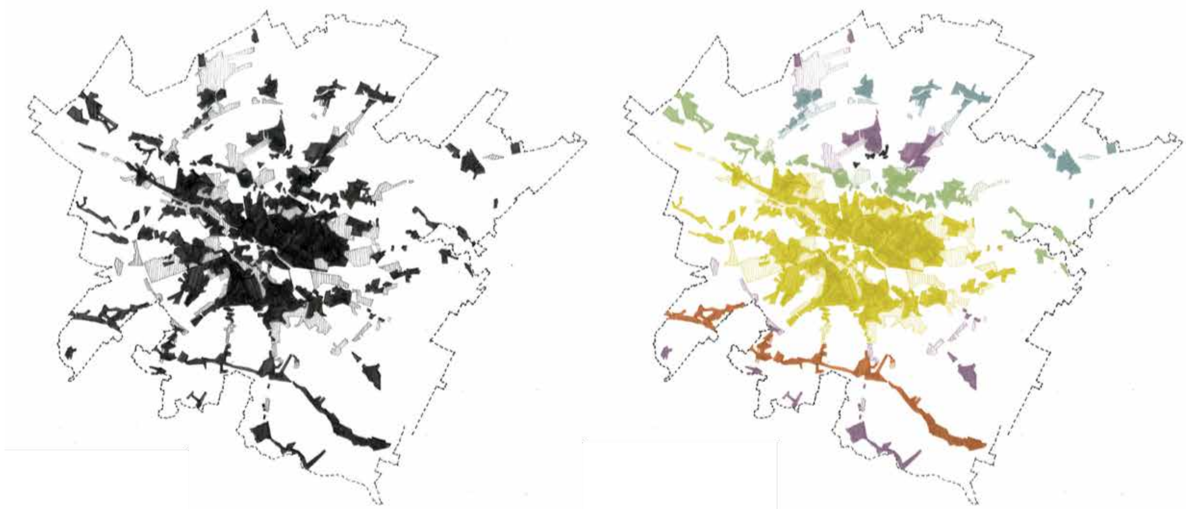


FIGURE 9.1 The urbanization of Bucharest can be interpreted in two ways: as radial-concentric pattern structured by the traffic network (left) or as a stacked linear pattern structured by rivers (right). Source: Forgaci, 2013. Drawing traced on Urban Atlas data.

URCs beyond the case of Bucharest

None of the observations derived from the assessment or from the design explorations and testing are uniquely applicable to Bucharest. As explained in Section 1.2, Chapter 3 and Chapter 4, Bucharest is not exceptional, but representative of the problems tackled in this thesis. A few other cities with similar problems or exemplary actions have been named throughout the thesis (e.g. Paris, Munich, Rotterdam, Antwerp, Seoul, Madrid), but there are many more around the world, which have recognised the need to reconnect with their rivers. It is assumed that the wider applicability of the research outcomes (the spatial-morphological definition, the assessment framework and the design principles and instruments for URCs), developed on the URCs of Bucharest, is possible. Future research pursuing such a possibility is nevertheless needed.

§ 9.4 Limitations and recommendations for future research

Throughout this research, indications of potential follow-up research have arisen. Some of those were limitations encountered during the research process, while others were discoveries of potential applications beyond the scope of this thesis. The close study of Bucharest and its URCs offered opportunities for in-depth research, as well as engagement and close cooperation with local actors. However, the study of a single empirical context as part of the mixed-methods study design, presented a number of limitations, in both the assessment (Part 2) and design phase (Part 3). To follow up on these limitations, further empirical research is needed for the validation and calibration of the assessment framework and for the testing of the design principles and instruments.

Context

URCs were chosen as strategic spaces of social-ecological integration. This way of looking at urban rivers situates urban systems and ecosystems in a relationship that is beneficial for the social-ecological resilience of the city as a whole. However, this approach to resilience is not limited to URCs. Open spaces outside URCs, as well as the rural-urban fringe are also potential spaces for social-ecological integration and resilience. Although the spatial-morphological definition constructed on the properties of connectivity, open space amenity, integration and multiscalarity is specific to URCs, the conceptual framework combining the theories of social-ecological resilience and urban form resilience with analytical instruments from spatial morphology and landscape ecology (Section 1.3.4) is potentially applicable to studies of other kinds of social-ecological systems as well.

Assessment

Although the results of the assessment shown in Chapter 6 are indicative of the current state of social-ecological integration in URC Dâmbovița, they are mainly an illustration of how the assessment framework can be applied on a real-world case. As stated in Section 6.5, a fully fledged assessment would require validation on other URCs in other cities and calibration of benchmarks (e.g. with a complete assessment repeated on URC Colentina) and, to further increase the accuracy of results for URC Dâmbovița, weights should be applied to the indicator system. By assessing other URCs, the comparison of results across cases can be used to validate the assessment method, to calibrate benchmarks and to devise a method for weighing the indicators. A weighting method could involve the evaluation of the indicator system by an expert panel, e.g. through a pairwise comparison of the indicators.

Design

The design workshop presented in Chapter 8 was not be carried out in a different city, and therefore conclusions could not be drawn on the wider applicability of the design principles and the design instruments either. Consequently, the applicability of the findings on other empirical contexts is yet to be demonstrated in future design-driven research. Furthermore, design explorations and analyses of precedent river design projects can situate the findings of this research in current trends of riverside urban development. Moreover, to support the implementation of the URC design principles, URC design instruments can be further developed through design-based methodologies, like the design explorations presented in Boxes 7.1-7.4 and the design workshop described in Sections 8.3-8.5. Design explorations can give new insights on possible applications of the design principles beyond URCs. Implemented in other cities, a design workshop methodology similar to the one employed in this thesis can shed further light on the external validity of the design principles and can provide further input on the usefulness and possible applications of the design instruments.

Future significance

This thesis is explorative in combining research and design, as it goes beyond analysing design or illustrating research in design to involve design both as a way to develop concepts and patterns in the design process and as a grounded evidence-base rooted in transdisciplinary knowledge. In the light of the methodological and epistemological challenges encountered with such an approach, research in the field of urbanism needs to further develop design-driver research methodologies that are problem based and unrestricted by disciplinary boundaries. Hence, different forms of combining the two discourses, informed by transdisciplinary knowledge, should be further explored in the field of urbanism. This is an imperative for a truly evidence-based design practice and sustainability-driven scholarship.

References

Ahern, J. (2007). Green infrastructure for cities: the spatial dimension. In V. Novotny & P. Brown (Eds.), *Cities of the Future: Towards Integrated Sustainable Water and Landscape Management* (pp. 267–283). London: IWA Publishing.

Ahern, J. (2011). From fail-safe to safe-to-fail: Sustainability and resilience in the new urban world. *Landscape and Urban Planning*, *100*(4), 341–343. https://doi.org/10.1016/j.landurbplan.2011.02.021

Ahern, J. (2013). Urban landscape sustainability and resilience: The promise and challenges of integrating ecology with urban planning and design. *Landscape Ecology*, *28*(6), 1203–1212. https://doi.org/10.1007/s10980-012-9799-z

Alberti, M. (1996). Measuring urban sustainability. *Environmental Impact Assessment Review*, *16*(4-6), 381-424. https://doi.org/10.1016/S0195-9255(96)00083-2

Alberti, M., Booth, D., Hill, K., Coburn, B., Avolio, C., Coe, S., & Spirandelli, D. (2007). The impact of urban patterns on aquatic ecosystems: An empirical analysis in Puget lowland sub-basins. *Landscape and Urban Planning*, *80*, 345–361.

Alexander, C. (1965). A city is not a tree. *Architectural Forum*, *122*(1), 58–62. https://doi.org/10.1017/CBO9781107415324.004

Alexandrescu, M., Forgaci, C., & Ionescu, A. I. (2016). Urban Scaffolding: A Topological Design Tool. In C. Dahl, L. Diedrich, G. Lindholm, V. Vicenzotti, & N. Vogel (Eds.), *Beyond Ism: The Landscape of Landscape Urbanism Conference Proceedings*. Alnarp: Swedish University of Agricultural Sciences.

Andersson, E., & Bodin, Ö. (2009). Practical tool for landscape planning? An empirical investigation of network based models of habitat fragmentation. *Ecography*, *32*(1), 123–132. https://doi.org/10.1111/j.1600-0587.2008.05435.x

Avădanei, C. (2012). Amenajarea râurilor Argeș și Dâmbovița pentru navigație și alte folosințe. In *Viata si activitatile in mari aglomeratii urbane. Bucuresti, prezent si viitor. Lucrările ediției a VII-a a conferinței anuale "Zilele Academice ale A.S.T.R"* (pp. 14–28). București: A.G.I.R.

Băncescu, I., & Calciu, D. (2014). On Changes in the Dwelling Conditions of the Romanian Roma under Communism. In *Reading the Architecture of the Underprivileged Classes*. London: Routledge. https://doi.org/10.4324/9781315603766-19

Barthel, S., Colding, J., Ernstson, H., Erixon, H., Grahn, S., Kärsten, K., … Torsvall, J. (2013). *Principles of social-ecological urbanism. Case study: Albano campus, Stockholm*. Stockholm: KTH Royal Institute of Technology.

Bartos-Elekes, Z. (2015). *The Habsburg mapping of Moldavia and Walachia*. In Proceedings of the 27th International Cartographic Conference. Rio de Janeiro. Retrieved from https://icaci.org/files/documents/ICC_proceedings/ICC2015/papers/18/fullpaper/T18-696_1428396969.pdf

Baschak, L. A., & Brown, R. D. (1995). An ecological framework for the planning, design and management of urban river greenways. *Landscape and Urban Planning*, *33*(1–3), 211–225. https://doi.org/10.1016/0169-2046(94)02019-C

Batista e Silva, J., Saraiva, G., Ramos, I. L., Silva, F. N. da, & Câmara, C. (2004). Classification of Aesthetic Value of Urban Rivers - Application and Methodology. Lisbon.

Batista e Silva, J., Saraiva, M. da G., Ramos, I. L., & Bernardo, F. (2013). Improving Visual Attractiveness to Enhance City–River Integration—A Methodological Approach for Ongoing Evaluation. *Planning Practice and Research, 28*(2), 163–185. https://doi.org/10.1080/02697459.2012.704734

Batista e Silva, J., Serdoura, F., & Pinto, P. (2006). Urban Rivers as Factors of Urban (Dis)integration. In *42nd ISoCaRP Congress 2006*.

Batty, M. (2003). The emergence of cities: complexity and urban dynamics. *Evolution*, *44*, 0–16. Retrieved from www.casa.ucl.ac.uk

Beatley, T. (2000). *Green Urbanism: Learning from European Cities*. Washington, DC: Island Press.

Beatley, T. (2011). *Biophilic Cities: Integrating Nature into Urban Design and Planning*. Washington, DC: Island Press. https://doi.org/10.5822/978-1-59726-986-5

Benedict, M. A., & McMahon, E. T. (2006). *Green Infrastructure: Linking Landscapes and Communities*. Washington, DC: Island Press. https://doi.org/10.1007/s10980-006-9045-7

Bentley, I., Alcock, A., Murrain, P., McGlynn, S., & Smith, G. (1985). *Responsive environments: a manual for designers*. London: Architectural Press. https://doi.org/10.1016/0169-2046(88)90064-3

Bernhardt, E. S., & Palmer, M. A. (2007). Restoring streams in an urbanizing world. *Freshwater Biology*, *52*(4), 738–751. https://doi.org/10.1111/j.1365-2427.2006.01718.x

Boeing, G. (2017). Measuring the Complexity of Urban Form and Design. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2958923

Boeke, K. (1957). *Cosmic view: the universe in 40 jumps*. New York: The John Day Company.

Brand, F. S., & Jax, K. (2007). Focusing the meaning(s) of resilience: Resilience as a descriptive concept and a boundary object. *Ecology and Society*, *12*(1), 23. https://doi.org/10.5751/ES-02029-120123

Briassoulis, H. (2001). Sustainable Development and its Indicators: Through a (Planner's) Glass Darkly. *Journal of Environmental Planning and Management*, *44*(3), 409–427.

Brundtland, G. H. (1987). *Our Common Future: Report of the World Commission on Environment and Development*. (G. H. Brundtland, Ed.), *United Nations Commission* (Vol. 4). Oxford: Oxford University Press. https://doi.org/10.1080/07488008808408783

Bryman, A. (2016). *Social research methods* (Fifth edition). Oxford: Oxford University Press.

Burgos, F., Garrido, G., Porras-Isla, F., Muller, A., & Matthews, W. (Translator). (2014). *Landscapes in the city: Madrid Río: geography, infrastructure and public space*. Turner.

Burkhard, B., & Maes, J. (Eds.). (2017). *Mapping ecosystem services*. Sofia: Pensoft Publishers. https://doi.org/10.1016/S0065-2156(09)70001-8

Burton, E., Jenks, M., & Williams, K. (2004). *The Compact City: A Sustainable Urban Form?* London: Routledge.

Burton, E., Jenks, M., & Williams, K. (2013). *Achieving Sustainable Urban Form*. London: Routledge.
Büttner, G., Feranec, J., Jaffrain, G., Mari, L., Maucha, G., & Soukup, T. (2004). The Corine Land Cover 2000 Project. *EARSeL EProceedings*, *3*(3), 331–346.
Büttner, G., Soukup, T., & Kosztra, B. (2014). CLC2012. Addendum to CLC2006 Technical Guidelines (Vol. 2).
Caranfil, N. G. (Uzinele C. B., Pavel, D., Corbu, D. R., Vuzitas, A. G., & Vladimirescu, G. (1936). *Asanarea lacurilor Colentinei*. București: "Marvan" S.A.R.
Carbonaro, G. (2010). *Integrated plans for sustainable urban development in the context of JESSICA*. Retrieved July 5, 2018, from http://ec.europa.eu/regional_policy/archive/funds/2007/jjj/doc/pdf/jessica/20100325_integrateplans.pdf
Carmona, M., Heath, T., Oc, T., & Steve, T. (2010). *Public Places Urban Spaces* (2nd ed.). London: Architectural Press.
Carpenter, S. R., Arrow, K. J., Barrett, S., Biggs, R., Brock, W. A., Crépin, A. S., ... de Zeeuw, A. (2012). General resilience to cope with extreme events. *Sustainability*, *4*(12), 3248–3259. https://doi.org/10.3390/su4123248
Carpenter, S., Walker, B., Anderies, J. M., & Abel, N. (2001). From Metaphor to Measurement: Resilience of What to What? *Ecosystems*, *4*(8), 765–781. https://doi.org/10.1007/s10021-001-0045-9
Carson, R. (1962). *Silent Spring*. Boston, New York: Houghton Mifflin.
Cavalcanti, M. D. B. U. (1997). Urban reconstruction and autocratic regimes: Ceausescu's Bucharest in its historic context. *Planning Perspectives*, *12*(1), 71–109. https://doi.org/10.1080/026654397364780
CCPEC. (2012). *Strategia de dezvoltare integrată a municipiului București și a teritoriului său de susținere și influență (Conceptul Strategic București 2035*. Bucharest: UAUIM. Retreived from http://www.csb2035.ro/ (Accessed 1 August 2018).
Choice (n.d.). In *Space Syntax Glossary*. Retreivede from http://otp.spacesyntax.net/term/choice/.
CNU, Talen, E. (Ed.). (2013). *Charter of the New Urbanism* (2nd ed.). McGraw-Hill Education. https://doi.org/10.1177/027046760002000417
Cocoș, O. (2006). Hidrologia bazinului hidrografic al Argeșului - Principalul colector al râurilor din zona capitalei. In *Managementul apei în municipiul București* (pp. 68–103). București: Editura Ars Docendi.
Comănescu, L., Nedelea, A., & Stănoiu, G. (2017). Geomorphosites and Geotourism in Bucharest City Center (Romania). *Quaestiones Geographicae*, *36*(3), 51–61.
Copernicus Land Monitoring Service. (2016). Mapping Guide v4.7 for a European Urban Atlas.
Creswell, J. W. (2014). *Research Design (International Student Edition): Qualitative, Quantitative, and Mixed Methods Approaches* (4th ed.). Thousand Oaks, California: SAGE Publications, Inc.
da Silva, J., & Moench, M. (2014). *City Resilience Framework*. London: Arup.
Dąbrowski, M. (2008). Structural funds as a driver for institutional change in Poland. *Europe-Asia Studies*, *60*(2), 227–248. https://doi.org/10.1080/09668130701820101
Davis, J., & Uffer, S. (2013). *Evolving Cities: Exploring the relations between urban form resilience and the governance of urban form*. London: London School of Economics and Political Science.
Davoudi, S. (2012). Resilience: A Bridging Concept or a Dead End? *Planning Theory & Practice*, *13*(2), 299–333. https://doi.org/10.1080/14649357.2012.677124
de Jong, T. M. (2012). *Diversifying Environments through Design* (Doctoral dissertation). Delft: Delft Univesity of Technology.
de Jong, T. M., & van der Voordt, D. J. M. (Eds.). (2002). *Ways to Study and Research Urban, Architectural and Technical Design*. Beeldrecht Hoofddorp: DUP Science.
de Jong, T. M., de Vries, G., Tjallingii, S., Duijvestein, K., & Sijmons, D. (2015). *The theory of Chris van Leeuwen. Some important elements*. Delft: Faculty of Architecture and the Built Environement, Delft University of Technology.
DETR, & CABE. (2000). *By Design, Urban design in the planning system: towards better practice*. London: DETR.
Dinu, I. (1994). *Bazinul râului Dâmbovita: studiu de geografie fizică cu privire specială asupra hidrogeografiei* (Doctoral dissertation). Bucharest: University of Bucharest.
Dramstad, W. E., Olson, J. D., & Forman, R. T. T. (1996). Landscape Ecology Principles in Landscape Architecture and Land-use Planning. *Landscape Ecology (Vol. 2)*. Cambridge, MA: Harvard University Graduate School of Design. https://doi.org/10.1007/BF00125090
Duany, A., & Talen, E. (2002). Transect Planning. *Journal of the American Planning Association*, *68*(3), 245–266. https://doi.org/10.1080/01944360208976271
Dumitrache, L., Zamfir, D., Nae, M., Simion, G., & Stoica, I. V. (2016). The urban nexus: Contradictions and dilemmas of (post) communist (sub)urbanization in Romania. *Human Geographies*, *10*(1), 39–58. https://doi.org/10.5719/hgeo.2016.101.3
Eames, C., & Eames, R. (1977). Powers of Ten.
EC. (1992). Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora.
EC. (2013). Green Infrastructure (GI) — Enhancing Europe's Natural Capital. Communication from the Commission to the European Parliament, the European Economic Council, The European Economic an Social Committee and the Committee of the Regions, (COM(2013) 249 final), 13. https://doi.org/10.1017/CBO9781107415324.004
EC. (2014). *Living well, within the limits of our planet: 7th EAP — The new general Union Environment Action Programme to 2020*. https://doi.org/10.2779/57220
ECRR. (n.d.). *What is river restoration?* Retrieved from: http://www.ecrr.org/RiverRestoration/Whatisriverrestoration/tabid/2614/Default.aspx
EEA. (2006). CLC 2006 technical guidelines.
EEA. (2012). Annual report 2012 and Environmental statement 2013.
EEA. (2015). SOER 2015, The European environment. State and outlook, 2015.
Ellin, N. (2006). *Integral urbanism*. New York: Routledge. https://doi.org/10.4324/9780203956854
Erixon Aalto, H., Marcus, L., & Torsvall, J. (2018). Towards a Social-Ecological Urbanism: Co-Producing Knowledge through Design in the Albano Resilient Campus Project in Stockholm. *Sustainability*, *10*(3), 717. https://doi.org/10.3390/su10030717
EU. (2000). Directive 2000/60/EC of the European Parliament ond of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. *Official Journal of the European Parliament*, *L327*, 1–73.

EU. (2006). Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration.
EU. (2007). Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks.
EU. (2008). Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC,.
EU. (2009). Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds.
EU. (2011). *Mapping Guide for a European Urban*.
EU. (2013a). Decision No 1386/2013/EU of the European Parliament and of the Council of 20 November 2013 on a General Union Environment Action Programme to 2020 'Living well, within the limits of our planet.'
EU. (2013b). Directive 2013/39/EU of the European Parliament and of the Council of 12 August 2013 amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy.
EU. (2013c). Regulation (EU) No 1293/2013 of the European Parliament and of the Council of 11 December 2013 on the establishment of a Programme for the Environment and Climate Action (LIFE) and repealing Regulation (EC) No 614/2007.
Everard, M., & Quinn, N. (2015). Realizing the value of fluvial geomorphology. *International Journal of River Basin Management*, *13*(4), 487–500. https://doi.org/10.1080/15715124.2015.1048457
Farr, D. (2007). *Sustainable urbanism: urban design with nature*. Hoboken, NJ: John Wiley & Sons, Inc.
Felson, A. J., & Pickett, S. T. a. (2005). Designed experiments: new approaches to studying urban ecosystems. *Frontiers in Ecology and the Environment*, *3*(10), 549–556. https://doi.org/10.2307/3868611
Filipeanu, A. (Project leader) (2000). Plan Urbanistic Zonal - Dambovita , "Axa verde structuranta a Bucurestiului". București: Institutul de Arhitectura "Ion Mincu", Centrul de Cercetare, Proiectare, Expertize si Consulting.
Findlay, S. J., & Taylor, M. P. (2006). Why rehabilitate urban river systems? *Area*, *38*(3), 312–325. https://doi.org/10.1111/j.1475-4762.2006.00696.x
Folke, C. (2006). Resilience: The emergence of a perspective for social–ecological systems analyses. *Global Environmental Change*, *16*(3), 253–267. https://doi.org/10.1016/j.gloenvcha.2006.04.002
Folke, C., Carpenter, S. R., Walker, B., Scheffer, M., Chapin, T., & Rockström, J. (2010). Resilience Thinking: Integrating Resilience, Adaptability and Transformability. *Ecology and Society*, *15*(4), 20.
Forgaci, C. (2010). *Limita intre oraș și apă. Morfologia limitei la apă in imaginea si structura urbană* (Unpublished master's thesis). "Ion Mincu" University of Architecture and Urbanism, Bucharest, Romania.
Forgaci, C. (2013). *Bucharest: Between North and South* (Master's thesis, Delft University of Technology, Delft, Netherlands). Retreived from http://resolver.tudelft.nl/uuid:bd583cbe-a1b3-4067-a165-f1070cf1263f
Forgaci, C., & van Timmeren, A. (2014). Urban Form and Fitness: A Space-Morphological Approach to General Urban Resilience. In *Proceedings of the 20th International Sustainable Development Research Conference* (pp. 213–223). Trondheim: Norwegian University of Science and Technology.
Forman, R. T. T. (1995). *Land Mosaics: The Ecology of Landscapes and Regions*. Cambridge: Cambridge University Press.
Forman, R. T. T. (2008). *Urban Regions: Ecology and Planning Beyond the City*. Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9780511754982
Forman, R. T. T. (2014). *Urban Ecology: Science of Cities*. Cambridge: Cambridge University Press. https://doi.org/10.2134/jeq1983.00472425001200020030x
Forman, R. T. T., & Godron, M. (1986). *Landscape ecology*. New York: Wiley.
Friese, S. (2011). Using ATLAS.ti for Analyzing the Financial Crisis Data. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, *12*(1), 39.
Friese, S. (2014). *Qualitative data analysis with ATLAS.ti*. London: SAGE.
Fulicea, V. (Project leader) (1999). Zona lacurilor Colentinei. Studiu analitic si prospective de fundamentare a PUG Bucuresti. București: Institutul de Arhitectura "Ion Mincu", Centrul de Cercetare, Proiectare, Expertize si Consulting.
Geddes, P. (1915). *Cities in evolution: an introduction to the town planning movement and to the study of civics*. London: Williams & Norgate.
Georgescu, F., Cebuc, A., & Daiche, P. (1966). *Probleme edilitare bucureștene. Alimentarea cu apă, canalizarea Dâmboviței, asanarea lacurilor din nordul capitalei*. București: Muzeul de Istorie a Orașului București.
Gerring, J. (2007). *Case study research*. Cambridge: Cambridge University Press.
Gil, J., & Duarte, J. P. (2013). Tools for evaluating the sustainability of urban design: A review. *Proceedings of the Institution of Civil Engineers: Urban Design and Planning*, *166*(6), 311–325. https://doi.org/10.1680/udap.11.00048
Gordon, D. L. A. (1996). Planning, design and managing redevelopment change in urban waterfront. *The Town Planning Review*, *67*(3), 261–290. https://doi.org/10.2307/40113388
Gregory, K. J. (2006). The human role in changing river channels. *Geomorphology*, *79*(3–4), 172–191. https://doi.org/10.1016/j.geomorph.2006.06.018
Groat, L. N., & Wang, D. (2013). *Architectural Research Methods* (2nd ed.). Amsterdam: Wiley.
Groot, R. de, Braat, L., & Costanza, R. (2017). A short history of the ecosystem services concept. In B. Burkhard & J. Maes (Eds.), *Mapping Ecosystem Services*. Sofia: Pensoft Publishers.
Gunderson, L. H., & Holling, C. S. (2002). *Panarchy: Understanding Transformations in Human and Natural Systems*. Washington, DC: Island Press.
Gustafson, E. J. (1998). Quantifying Landscape Spatial Pattern: What Is the State of the Art? *Ecosystems*, *1*(2), 143–156. https://doi.org/10.1007/s100219900011
Habermas, J. (1984). *The theory of communicative action*. Boston: Beacon Press.

Haider, L. J., Hentati-Sundberg, J., Giusti, M., Goodness, J., Hamann, M., Masterson, V. A., … Sinare, H. (2018). The undisciplinary journey: early-career perspectives in sustainability science. *Sustainability Science*, *13*(1), 191–204. https://doi.org/10.1007/s11625-017-0445-1
Hamblin, W. K., & Christiansen, E. H. (2003). *Earth's Dynamic Systems* (10th ed.). Upper Saddle River, N.J: Prentice Hall.
Harhoiu, D. (1997). *București, un oraș între Orient și Occident / Bucharest, a city between Orient and Occident*. București: Simetria.
Hassler, U., & Kohler, N. (2014). Resilience in the built environment. *Building Research & Information*, *42*(2), 119–129. https://doi.org/10.1080/09613218.2014.873593
Hauer, F., Hohensinner, S., & Spitzbart-Glasl, C. (2016). How water and its use shaped the spatial development of Vienna. *Water History*, *8*(3), 301–328. https://doi.org/10.1007/s12685-016-0169-7
Hayward, T. (2013). *Ecological space: the concept and its ethical significance*. Edinburgh: Just World Institute, University of Edinburgh. Retrieved from http://www.sps.ed.ac.uk/jwi
Henriquez, L., & van Timmeren, A. (2017). *Under pressure: water and the city.* Delft, Amsterdam: TU Delft & AMS Institute.
Herod, A. (2011). *Scale* (New Ed). London: Routledge.
Hilberseimer, L. (2012). *Metropolisarchitecture and Selected Essays*. (R. Anderson, Ed.). New York: GSAPP BOOKS.
Hillier, B. (2007). *Space is the machine*. London: Space Syntax. https://doi.org/10.1016/S0142-694X(97)89854-7
Hillier, B. (2012). The Genetic Code for Cities: Is it simpler than we think? In J. Portugali, H. Meyer, E. Stolk, & E. Tan (Eds.), *Complexity Theories of Cities Have Come of Age* (pp. 129–152). Berlin: Springer. https://doi.org/10.1007/978-3-642-24544-2
Hillier, B., & Hanson, J. (1989). *The Social Logic of Space* (Reprint). Cambridge: Cambridge University Press.
Hirt, S. (2013). Whatever happened to the (post)socialist city? *Cities*, *32*, S29–S38. https://doi.org/10.1016/j.cities.2013.04.010
Holland, J. H. (1992). Complex Adaptive Systems. *Daedalus*, *121*(1), 17–30. Retrieved from http://www.jstor.org/stable/20025416
Holling, C. S. (1973). Resilience and Stability of Ecological Systems. *Annual Review of Ecology and Systematics*, *4*(1973), 1–23.
Holling, C. S. (1996). Surprise for Science, Resilience for Ecosystems, and Incentives for People. *Ecological Applications*, *6*(3), 733–735. https://doi.org/10.2307/2269475
Hough, M. (1984). *City form and natural process: towards a new urban vernacular*. London: Croom Helm.
Hoyer, J., Dickhaut, W., Kronawitter, L., & Weber, B. (2011). *Water Sensitive Urban Design: Principles and Inspiration for Sustainable Stormwater Management in the City of the Future*. Berlin: Jovis.
ICPDR. (2006). *Danube Facts and Figures*. Romania. Retreived from https://www.icpdr.org/main/sites/default/files/RO%20Facts%20Figures.pdf (Accessed 01 August 2018).
Ingaramo, R., & Voghera, A. (Eds.). (2016). *Topics and Methods for Urban and Landscape Design. From the river to the project*. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-51535-9
Instrument [Def. 2a,3]. (n.d.). In Merriam-Webster Dictinary. Retrevied from https://www.merriam-webster.com/dictionary/instrument
Ioan, A. (2007). The peculiar history of (post) communist public places and spaces: Bucharest as a case study. In K. Stanilov (Ed.), *The Post-Socialist City* (pp. 301–312). Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-1-4020-6053-3_15
Jabareen, Y. R. (2006). Sustainable Urban Forms Their Typologies, Models, and Concepts. *Journal of Planning Education and Research*, *26*(1), 38–52. https://doi.org/10.1177/0739456X05285119
Jenks, M., & Jones, C. (2010). *Dimensions of the Sustainable City*. Dordrecht: Springer.
Kambites, C., & Owen, S. (2006). Renewed prospects for green infrastructure planning in the UK. *Planning Practice and Research*, *21*(4), 483–496. https://doi.org/10.1080/02697450601173413
Kaplan, R., & Kaplan, S. (1989). *The Experience of Nature. A Psychological Perspective*. Cambridge: Cambridge University Press. https://doi.org/10.2307/2011391
Khan, A. Z., Moulaert, F., Schreurs, J., & Miciukiewicz, K. (2014). Integrative Spatial Quality: A Relational Epistemology of Space and Transdisciplinarity in Urban Design and Planning. *Journal of Urban Design*, *19*(4), 393–411. https://doi.org/10.1080/13574809.2014.936142
Kinzig, A. P., Ryan, P., Etienne, M., Allison, H., Elmqvist, T., & Walter, B. H. (2006). Resilience and regime shifts: assesing cascading effects. *Ecology and Society*, *11*(1), 20. http://www.ecologyandsociety.org/vol11/iss1/art20/
Koestler, A. (1967). *The ghost in the machine*. New York: Macmillan.
Kondolf, G. M., & Pinto, P. J. (2017). The social connectivity of urban rivers. *Geomorphology*, *277*, 182–196. https://doi.org/10.1016/j.geomorph.2016.09.028
Kostof, S. (1992). *The City Assembled: The Elements of Urban Form Through History*. London: Thames & Hudson.
Krenz, K. (2017). Employing Volunteered Geographic Information In Space Syntax Analysis. In *Proceedings of the 11th Space Syntax Symposium* (p. 150.1-150.26). Retrieved from http://www.11ssslisbon.pt/docs/proceedings/papers/150.pdf
Kucsicsa, G., & Grigorescu, I. (2018). Urban Growth in the Bucharest Metropolitan Area: Spatial and Temporal Assessment Using Logistic Regression. *Journal of Urban Planning and Development*, *144*(1), 05017013. https://doi.org/10.1061/(ASCE)UP.1943-5444.0000415
Kumar, R. (2014). *Research Methodology: A Step-by-Step Guide for Beginners* (4th ed.). Thousand Oaks, CA: SAGE Publications Ltd.
Lascu, N. (2011). *Bulevardele Bucureștene până la Primul Război Mondial*. București: Simetria.
Lerner, D. N., & Holt, A. (2012). How should we manage urban river corridors? *Procedia Environmental Sciences*, *13*(8), 721–729. https://doi.org/10.1016/j.proenv.2012.01.065
Liao, K.-H. (2012). A Theory on Urban Resilience to Floods—A Basis for Alternative Planning Practices. *Ecology and Society*, *17*(4), 48. https://doi.org/10.5751/ES-05231-170448
Liu, J., Dietz, T., Carpenter, S. R., Folke, C., Alberti, M., Redman, C. L., … Provencher, W. (2007). Coupled Human and Natural Systems. *Ambio: A Journal of the Human Environment*, *36*(8), 639–649. https://doi.org/10.1579/0044-7447(2007)36[639:CHANS]2.0.CO;2
Llewelyn-Davies, & Alan Baxter & Associates. (2007). *Urban Design Compendium*. London: English Partnerships and The Housing Corporation. https://doi.org/10.1080/00994480.1973.10732231

Lynch, K. (1960). *The Image of the City*. Cambridge: The M.I.T. Press.

Lynch, K. (2007). The Presence of the Past. In M. Carmona & S. Tiesdell (Eds.), *Urban Design Reader* (pp. 293–301). Oxford: Architectural Press.

MacGarigal, K. (2015). Fragstats Help. Documentation for FRAGSTATS, (April), 1–182. https://doi.org/10.1002/ejoc.201200111

MacKaye, B. (1940). Regional Planning and Ecology. *Ecological Monographs*, *10*, 349-353.

Mader, A., & Berghöfer, A. (2011). *The economics of ecosystems & biodiversity: TEEB manual for cities: Ecosystem services in urban management*. Geneva: TEEB.

Manning, O. D. (1997). Design imperatives for river landscapes. *Landscape Research*, *22*(1), 67–94. https://doi.org/10.1080/01426399708706501

Manson, S. M. (2008). Does scale exist? An epistemological scale continuum for complex human–environment systems. *Geoforum*, *39*(2), 776–788. https://doi.org/10.1016/j.geoforum.2006.09.010

March, L. (1984). The Logic of Design. In Ni. Cross (Ed.), *Developments in Design Methodology*. Chichester: John Wiley & Sons. https://doi.org/10.1017/CBO9781107415324.004

Marcus, L., & Berghauser Pont, M. (2015). Towards a social-ecological urban morphology: integrating urban form and landscape ecology. In *International Seminar on Urban Form ISUF 2015* (pp. 1–13). Rome.

Marshall, S. (2005). *Streets and patterns*. Abingdon: Spon Press. https://doi.org/10.1017/CBO9781107415324.004

Martin, L. (1972). The grid as generator. In M. Carmona & S. Tiesdell (Eds.), *Urban Design Reader* (1st ed., pp. 70–82). Oxford: Architectural Press.

May, R. (2006). "Connectivity" in urban rivers: Conflict and convergence between ecology and design. *Technology in Society*, *28*(4), 477–488. https://doi.org/10.1016/j.techsoc.2006.09.004

McHarg, I. L. (1969). *Design with nature*. New York: Natural History Press.

MEA. (2005). *Ecosystems and Human Well-Being: Wetlands and Water*. Washington, D.C: Island Press.

Meadows, D. H., Meadows, D. L., Randers, J., & William W. Behrens III. (1972). *The limits to growth*. New York: Universe Books.

Meerow, S., & Newell, J. P. (2016). Urban resilience for whom, what, when, where, and why? *Urban Geography*. https://doi.org/10.1080/02723638.2016.1206395

Meerow, S., Newell, J. P., & Stults, M. (2016). Defining urban resilience: A review. *Landscape and Urban Planning*, *147*, 38-49. https://doi.org/10.1016/j.landurbplan.2015.11.011

Mihăilescu, V. (2003). *Evoluția geografică a unui oraș - București*. (G. Niculescu & Șerban Dragomirescu, Eds.). București: Paideia.

Montuori, A. (2013). The Complexity of Transdisciplinary Literature Reviews. *Complicity: An International Journal of Complexity and Education*, *10*(1/2), 45–55.

Mostafavi, M., & Doherty, G. (2010). *Ecological Urbanism* (1st ed.). Baden, Switzerland: Lars Muller.

Müller, B. (2011). Urban and Regional Resilience – A New Catchword or a Consistent Concept for Research and Practice? In B. Müller (Ed.), *German Annual of Spatial Research and Policy 2010* (pp. 1–13). Berlin: Springer.

Mumford, L. (1968). *The urban prospect* (1st ed.). New York: Harcourt Brace & World Inc.

Munteanu, M., & Servillo, L. (2014). Romanian Spatial Planning System: Post-Communist Dynamics of Change and Europeanization Processes. *European Planning Studies*, *22*(11), 2248–2267. https://doi.org/10.1080/09654313.2013.830696

Nae, M., & Turnock, D. (2011). The new Bucharest: Two decades of restructuring. *Cities*, *28*(2), 206–219. https://doi.org/10.1016/j.cities.2010.04.004

Ndubisi, F. O. (2014). *The Ecological Design and Planning Reader*. Washington, DC: Island Press. https://doi.org/10.5822/978-1-61091-491-8

Norberg, J., & Cumming, G. S. (2008). *Complexity theory for a sustainable future*. New York: Columbia University Press.

O'Neill, R. V., Krummel, J. R., Gardner, R. H., Sugihara, G., Jackson, B., DeAngelis, D. L., ... Graham, R. L. (1988). Indices of landscape pattern. *Landscape Ecology*, *1*(3), 153–162. https://doi.org/10.1007/BF00162741

Odum, E. P. (1971). *Fundamentals of ecology* (3rd ed.). Philadelphia: Saunders.

OECD. (2013). Definition of Functional Urban Areas (FUA) for the OECD metropolitan database.

Ørngreen, R., & Levinsen, K. (2017). Workshops as a research methodology. *Electronic Journal of E-Learning*, *15*(1), 70–81.

Palazzo, D., & Steiner, F. (2011). *Urban ecological design: a process of regenerative places*. Washington, DC: Island Press. https://doi.org/10.5822/978-1-61091-226-6

Palmer, M. A., Bernhardt, E. S., Allan, J. D., Lake, P. S., Alexander, G., Brooks, S., ... Sudduth, E. (2005, March 14). Standards for ecologically successful river restoration. *Journal of Applied Ecology*, *42*, 208-217. https://doi.org/10.1111/j.1365-2664.2005.01004.x

Parlamentul României. (2001). LEGE nr. 350 din 6 iulie 2001 privind amenajarea teritoriului și urbanismul.

Pascariu, G. (2012). Overview of Romanian Planning Evolution. In *AESOP 26th Annual Congress*. Ankara.

Perini, K., & Sabbion, P. (2017). *Urban sustainability and river restoration: Green and blue infrastructure*. Chichester: John Wiley & Sons, Ltd. https://doi.org/10.1002/9781119245025

Petts, G. E., Heathcote, J., & Martin, D. (2002). *Urban rivers: our inheritance and future*. London: IWA Publishing.

Pianka, E. R. (2011). *Evolutionary ecology* (7th ed., eBook).

Pickett, S. T. A. A., Cadenasso, M. L., & McGrath, B. (2013). Ecology of the City as a Bridge to Urban Design. In S. T. A. Pickett, M. L. Cadenasso, & B. McGrath (Eds.), *Resilience in Ecology and Urban Design* (pp. 7–28). Springer Netherlands. https://doi.org/10.1007/978-94-007-5341-9

Pickett, S. T. A., McGrath, B., Cadenasso, M. L., & Felson, A. J. (2014). Ecological resilience and resilient cities. *Building Research & Information*, *42*(2), 143–157. https://doi.org/10.1080/09613218.2014.850600

Pieterse, E. (2004). Untangling "integration" in urban development policy debates. *Urban Forum*, *15*(1).

Portugali, J. (2012). Complexity Theories of Cities: Achievements, Criticism and Potentials. In J. Portugali, H. Meyer, E. Stolk, & E. Tan (Eds.), *Complexity Theories of Cities Have Come of Age* (pp. 47–62). Berlin: Springer-Verlag. https://doi.org/10.1007/978-3-642-24544-2

Prastacos, P., Lagarias, A., & Chrysoulakis, N. (2017). Using the Urban Atlas dataset for estimating spatial metrics. Methodology and application in urban areas of Greece. *Cybergeo: European Journal of Geography*, Aménagement, Urbanisme, document 815. https://doi.org/10.4000/cybergeo.28051

Principle [Def. 1]. (n.d.). In *Oxford Dictinary*. Retrevied from https://en.oxforddictionaries.com/definition/principle.

Pringle, C. (2003). What is hydrologic connectivity and why is it ecologically important? *Hydrological Processes*, *17*(13), 2685–2689. https://doi.org/10.1002/hyp.5145

Prominski, M., Stokman, A., Zeller, S., Stimberg, D., Voermanek, H., & Bajc, K. (2017). *River.Space.Design: Planning Strategies, Methods and Projects for Urban Rivers* (2nd ed.). Basel: Birkhäuser.

Ramadier, T. (2004). Transdisciplinarity and its challenges: The case of urban studies. *Futures*, *36*(4), 423–439. https://doi.org/10.1016/j.futures.2003.10.009

RCI. (2015). *Rotterdam Programme on Sustainability and Climate Change 2015-2018*. Rotterdam: City of Rotterdam.

Read, S. (2013). Intensive urbanisation: Levels, networks and central places. *The Journal of Space Syntax*, *4*(1), 1–17.

Rounsevell, M. D. A., Robinson, D. T., & Murray-Rust, D. (2012). From actors to agents in socio-ecological systems models. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *367*(1586), 259–269. https://doi.org/10.1098/rstb.2011.0187

Rouse, D. C., & Bunster-Ossa, I. F. (2013). *Green Infrastructure: A Landscape Approach*. APA Planning Advisory Service.

Salewski, C. (2013). *Dutch New Worlds*. Rotterdam: nai010 publishers.

Samant, S., & Brears, R. (2017). Urban Waterfront Revivals of the Future. In P. Y. Tan & C. Y. Jim (Eds.), *Greening Cities: Forms and Functions* (pp. 331–356). Singapore: Springer Nature Singapore Pte Ltd. https://doi.org/10.1007/978-981-10-4113-6_15

Sayyar, S. S., & Marcus, L. (2011). Urban diversity and how to measure it – an operational definition of classes and scales. In *18th International Seminar on Urban Form: ISUF 2011*. Montréal, Canada, 26 – 29 August 2011.

Scaduto, M. L. (2016). Theoretics and Methodology. In *River Contracts and Integrated Water Management in Europe* (pp. 1–13). Springer International Publishing Switzerland. https://doi.org/10.1007/978-3-319-42628-0_1

Schneiders, A., & Müller, F. (2017). A natural base for ecosystem services. In *Mapping Ecosystem Services* (pp. 35–40).

Sfințescu, C. (1931). Zonificarea urbanistică a municipiului București. *Buletinul Societății Politehnice*, *XLV*, 1–60.

Simon, H. A. (1996). *The Sciences of the Artificial* (3rd ed.). Cambridge, MA: The MIT Press.

Spirn, A. W. (1984). *The granite garden: urban nature and human design*. New York: Basic Books.

Spirn, A. W. (2000). Ian McHarg, Landscape Architecture, and Environmentalism: Ideas and Methods in Context. In Conan, M. (Ed.), *Environmentalism in Landscape Architecture* (pp. 97–114). Washington, DC: Dumbarton Oaks.

Stan, A. (2015). Urban expansion in Bucharest, after 1990: errors and benefits. In G. Doytchinov, A. Đukić, & C. Ioniță (Eds.), *Planning Capital Cities: Belgrade, Bucharest, Sofia* (pp. 224–233). Graz: Verlag der Technischen Universität Graz.

Stănescu, S. V. (2011). Aspecte ale Calității Apei Râului Colentina pe Traseul din Municipiul București (România). *Ecoterra*, *27*, 53–56.

Stanilov, K. (Ed.). (2007). *The Post-Socialist City: Urban Form and Space Transformations in Central and Eastern Europe after Socialism*. Dordrecht: Springer. https://doi.org/10.1007/978-1-4020-6053-3

Stematiu, D., & Teodorescu, D. (2012). Râul Dâmbovița în București - Sistemul de Apărare Împotriva Inundațiilor. In *Viata si activitatile in mari aglomeratii urbane. Bucuresti, prezent si viitor. Lucrările ediției a VII-a a conferinței anuale "Zilele Academice ale A.S.T.R"* (pp. 143–150). Bucharest: A.G.I.R.

Sternberg, E. (2000). An Integrative Theory of Urban Design. *Journal of the American Planning Association*, *66*(3), 265–278. https://doi.org/10.1080/01944360008976106

Stevens, Q. (2009). Artificial waterfronts. *URBAN DESIGN International*, *14*(1), 3–21. https://doi.org/10.1057/udi.2009.5

Swyngedouw, E. (2015). *Liquid Power: water and contested modernities in Spain*. Cambridge, MA: The MIT Press. https://doi.org/10.7551/mitpress/9780262029032.001.0001

Sýkora, L., & Bouzarovski, S. (2012). Multiple Transformations: Conceptualising the Post-communist Urban Transition. *Urban Studies*, *49*(1), 43–60. https://doi.org/10.1177/0042098010397402

Tetzlaff, D., Soulsby, C., Bacon, P. J., Youngson, A. F., Gibbins, C., & Malcolm, I. A. (2007). Connectivity between landscapes and riverscapes—a unifying theme in integrating hydrology and ecology in catchment science? *Hydrological Processes*, *21*(10), 1385–1389. https://doi.org/10.1002/hyp.6701

Tibbalds, F. (1992). *Making People-Friendly Towns: Improving the public environment in towns and cities*. London: Spon Press.

Tibbalds, F. (2007). "Places" matter most. In M. Carmona & S. Tiesdell (Eds.), *Urban Design Reader* (pp. 9–11). Oxford: Architectural Press.

Tjallingii, S. P. (1995). *Ecopolis: strategies for ecologically sound urban development*. Leiden: Backhuys Publishers.

Tjallingii, S. P. (1996). *Ecological Conditions: strategies and structures in environmental planning*. Delft: Delft University of Technology.

Tjallingii, S. P. (2005). Carrying Structures for the Urban Ecosystem. In E. Hulsbergen, I. T. Klaasen, I. Kriens, & S. M. van der Woolhouse (Eds.), *Shifting Sense. Looking back to the future in spatial planning* (pp. 355–368). Amsterdam: Techne Press.

Tjallingii, S. P. (2006). From Green belt to Green structure. In C. Y. Wang et. al. (Eds.) *Modernization & Regionalism. Proceedings of the Beijing Conference* (pp. 333–340). Delft: International Forum on Urbanism.

Tjallingii, S. P. (2012). Water Flows and Urban Planning. In E. van Bueren, H. van Bohemen, L. Itard, & H. Visscher (Eds.), *Sustainable Urban Environments* (pp. 91–111). Dordrecht: Springer Netherlands.

Tjallingii, S. P. (2015). Planning with water and traffic networks. Carrying structures of the urban landscape. *Research in Urbanism Series*, *3*(1), 57–80.

Tudora, I., & Stan, A. (2015). *The Bucharest Landscape: A Geographical, Historical & Green Structure Presentation of The Bucharest Landscape*. Le:Notre Landscape Forum 2015, Bucharest. Retreived from: http://forum.ln-institute.org/wp-content/uploads/2014/10/Bucharest_The_Birth_of_Landscape.pdf (Accessed: 1 August 2018).

Turner, M. G., & Gardner, R. H. (2015). *Landscape Ecology in Theory and Practice: Pattern and Process*. New York: Springer.

Tzoulas, K., Korpela, K., Venn, S., Yli-Pelkonen, V., Kaźmierczak, A., Niemela, J., & James, P. (2007). Promoting ecosystem and human health in urban areas using Green Infrastructure: A literature review. *Landscape and Urban Planning*, *81*(3), 167-178. https://doi.org/10.1016/j.landurbplan.2007.02.001

Udrea, A. (2015). The first urban plans of Bucharest in the rise of the 20th century. In G. Doytchinov, A. Đukić, & C. Ioniță (Eds.), *Planning Capital Cities: Belgrade, Bucharest, Sofia*. Graz: Verlag der Technischen Universität Graz.

Udrea, A., Popescu, T., Calotă, I., & Păun Constantinescu, I. (2015). *Cincinat Sfințescu. Începuturile urbanismului românesc.* București: Editura Universitară "Ion Mincu".

UNCED. (1992). *Agenda 21*. New York: United Nations. https://doi.org/10.1007/s11671-008-9208-3

Vale, L. J. (2014). The politics of resilient cities: Whose resilience and whose city? *Building Research and Information*, *42*(2), 191–201. https://doi.org/10.1080/09613218.2014.850602

van Schaick, J., & Klaasen, I. (2011). The dutch layers approach to spatial planning and design: A fruitful planning tool or a temporary phenomenon? *European Planning Studies*, *19*(10), 1775–1796. https://doi.org/10.1080/09654313.2011.614387

Vermont Agency of Natural Resources. (2004). *Vermont Stream Geomorphic Assessment*. Available at: https://www.uvm.edu/~wbowden/Teaching/Stream_Geomorph_Assess/Resources/Public/SGAT05/01_Phase1_Handbook/E_Corridor_Def.pdf (Accessed: 1 June 2018)

Vietz, G. J., Rutherfurd, I. D., Fletcher, T. D., & Walsh, C. J. (2016). Thinking outside the channel: Challenges and opportunities for protection and restoration of stream morphology in urbanizing catchments. *Landscape and Urban Planning*, *145*, 34–44. https://doi.org/10.1016/j.landurbplan.2015.09.004

Viganò, P. (2009a). *The Metropolis of the Twenty-First Century: the Project of a porous city. OASE*, (80), 91–107.

Viganò, P. (2009b). Water: on the Power of Form and Devices. In Feyen, Shannon, & Neville (Eds.), *Water and Urban Development Paradigms: Towards an Integration of Engineering, Design and Management Approaches* (pp. 207–212). London: Taylor & Francis Group.

Viganò, P. (2010). *I territori dell'urbanistica. Il progetto come produttore di conoscenza.* Roma: Officina Edizioni.

Viganò, P. (2013). Urbanism and Ecological Rationality. In S. T. A. Pickett, M. L. Cadenasso, & B. McGrath (Eds.), *Resilience in Ecology and Urban Design: Linking Theory and Practice for Sustainable Cities* (pp. 407–426). Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-5341-9_25

Viganò, P., Fabian, L., & Secchi, B. (Eds.). (2016). *Water and asphalt: the project of isotropy*. Zürich: Park Books.

Waldheim, C. (Ed.). (2006). *The Landscape Urbanism Reader* (1st ed.). New York: Princeton Architectural Press.

Waldheim, C. (2016). *Landscape as Urbanism: A General Theory*. Princeton: Princeton University Press.

Walker, B., Holling, C. S., Carpenter, S. R., & Kinzig, A. (2004). Resilience, Adaptability and Transformability in Social-ecological Systems. *Ecology and Society*, *9*(2), 5. https://doi.org/10.1103/PhysRevLett.95.258101

Walker, B., & Salt, D. (2012). *Resilience Practice: Building Capacity to Absorb Disturbance and Mantain Function.* Washington, DC: Island Press.

Walsh, C. J., Roy, A. H., Feminella, J. W., Cottingham, P. D., Groffman, P. M., & Morgan, R. P. (2005). The urban stream syndrome: current knowledge and the search for a cure. *Journal of the North American Benthological Society*, *24*(3), 706–723. https://doi.org/10.1899/04-028.1

Weichselgartner, J., & Kelman, I. (2015). Geographies of resilience: Challenges and opportunities of a descriptive concept. *Progress in Human Geography*, *39*(3), 249–267. https://doi.org/10.1177/0309132513518834

Welter, V. M. (2002). *Biopolis: Patrick Geddes and the City of Life*. London: The MIT Press.

Wilkinson, C. (2011). *Social-ecological resilience: Insights and issues for planning theory. Planning Theory*, *11*(2), 148–169. https://doi.org/10.1177/1473095211426274

Wohl, E., & Merritts, D. J. (2007). What Is a Natural River? *Geography Compass*, *1*(4), 871–900. https://doi.org/10.1111/j.1749-8198.2007.00049.x

Wylson, A. (1986). Urban Waterfront: Water Corridors. In *Aquatecture: Architecture and Water* (pp. 71–102). London: Architectural Press.

Yang, B., Li, M. H., & Li, S. (2013). Design-with-nature for multifunctional landscapes: Environmental benefits and social barriers in community development. *International Journal of Environmental Research and Public Health*, *10*(11), 5433–5458. https://doi.org/10.3390/ijerph10115433

Yin, R. K. (2003). *Case Study Research. Design and Methods* (3rd ed.). Thousand Oaks, California: SAGE Publications, Inc. https://doi.org/10.1097/FCH.0b013e31822dda9e

Zaharia, L., Ioana-Toroimac, G., Cocoș, O., Ghiță, F. A., & Mailat, E. (2016). Urbanization effects on the river systems in the Bucharest City region (Romania). *Ecosystem Health and Sustainability*, *2*(11), 1–19. https://doi.org/10.1002/ehs2.1247

Zeisel, J. (2006). *Inquiry by Design: Environment/Behavior/Neuroscience in Architecture, Interiors, Landscape, and Planning*. New York: W.W. Norton & Company.

Zetterberg, A., Mörtberg, U. M., & Balfors, B. (2010). Making graph theory operational for landscape ecological assessments, planning, and design. *Landscape and Urban Planning*, *95*(4), 181–191. https://doi.org/10.1016/j.landurbplan.2010.01.002

Zevenbergen, C., Cashman, A., Evelpidou, N., Pasche, E., Garvin, S., & Ashley, R. (Eds.). (2012). *Urban Flood Management*. Boca Raton, FL: CRC Press.

Biography

Claudiu Forgaci (1986) is an architect and urbanist, born in Miercurea-Ciuc, Romania. He holds a Master of Architecture from "Ion Mincu" University of Architecture and Urbanism, Bucharest (2010) and a Master of Science (Cum Laude) from the European Post-Master in Urbanism (EMU) at Delft University of Technology (2013). For his studies at TU Delft, he was awarded with the "Open Horizons" scholarship by the "Dinu Patriciu" Foundation in Romania and a scholarship from the Romanian-American Foundation.

Claudiu worked for several years in the practice of architecture (2005-2012) and co-authored, as part of the Bucharest-based ADN BA architecture studio (2009-2012), a series of award-winning projects, such as the "Dogarilor Apartment Building", nominated for the Mies van der Rohe Award in 2014.

In 2013, he started his research as a Climate-KIC label Ph.D. candidate at Delft University of Technology under the supervision of Prof. Arjan van Timmeren and Dr. Machiel van Dorst on the topic of urban resilience and social-ecological integration in urban river corridors. This topic continued explorations from his two master's theses elaborated previously: "The limit between city and water. The morphology of the waterfront in the image and structure of the city" (Forgaci, 2010) and "Bucharest: Between North and South", which explored the strategic potentials of River Dâmbovița in Bucharest (Forgaci, 2013).

The Ph.D. research gave him an international experience through the Climate-KIC Summer Schools "The Journey" (2015) in Utrecht (NL), Budapest (HU) and Coventry (UK), and "Urban Metabolism and Circular Economy" (2016) in Bologna (IT); through the Idea League Doctoral School "Resilient Urban Systems" held in Rotterdam (NL), Singapore, Guangzhou (CN) and Aachen (DE); and through his doctoral mobility in the Spatial Morphology Research Group at Chalmers University of Technology, where he worked on models for spatial integration using Space Syntax theory under the supervision of Prof. Lars Marcus and Dr. Meta Berghauser Pont.

During his Ph.D. research, he used design projects to research design principles for river corridors. In 2015, he led the team that won the first prize in the international ideas competition (Re)Discovering the Emerald Necklace Colentina Chain of Lakes organised in the Le:Notre Landscape Forum 2015 in Bucharest, amongst other design competitions, such as Europan 12 on River Seine in Vernon (FR) or Rethinking Someș on Someșul Mic River crossing the city of Cluj-Napoca (RO). Claudiu gave a number of lectures on the topic of urban rivers, such as the one at One Architecture Week in Plovdiv, Bulgaria, supported by the Romanian Cultural Institute, and organised in 2017 the international urban design workshop "The Urban River Corridors of Bucharest" in Bucharest, Romania.

Currently, he is a research fellow at AMS Amsterdam Institute for Advanced Metropolitan Solutions, engaged in understanding how spatial urbanisation patterns, at multiple scales, are related to urban resilience and seeks to drive forward his approach in research projects and in the practice of design.

List of publications

Journal articles:

Fonseca, J. A., Estévez-Mauriz, L., **Forgaci, C.**, & Björling, N. (2017). Spatial heterogeneity for environmental performance and resilient behavior in energy and transportation systems. *Computers, Environment and Urban Systems*, *62*, 136–145. https://doi.org/10.1016/j.compenvurbsys.2016.11.001

Estévez-Mauriz, L., Fonseca, J. A., **Forgaci, C.**, & Björling, N. (2016). The livability of spaces: Performance and/or resilience? Reflections on the effects of spatial heterogeneity in transport and energy systems and the implications on urban environmental quality. *International Journal of Sustainable Built Environment*. https://doi.org/10.1016/j.ijsbe.2016.10.001

Conference papers:

Forgaci, C., & Timmeren, A. van. (2014). Urban Form and Fitness: A Space-Morphological Approach to General Urban Resilience. In *Proceedings of the 20th International Sustainable Development Research Conference* (pp. 213–223). Trondheim: Norwegian University of Science and Technology.

Forgaci, C., & Timmeren, A. van. (2014). A Spatial-Hormetic Approach to Urban Resilience. In *Urban Regions under Change: Towards Social-Ecological Resilience*. Hamburg: HafenCity University.

Alexandrescu, M., **Forgaci, C.**, & Ionescu, A. I. (2016). Urban Scaffolding: A Topological Design Tool. In C. Dahl, L. Diedrich, G. Lindholm, V. Vicenzotti, & N. Vogel (Eds.), *Beyond Ism: The Landscape of Landscape Urbanism Conference Proceedings*. Alnarp: Swedish University of Agricultural Sciences.

Theses:

Forgaci, C. (2013). *Bucharest: Between North and South* (Master's thesis, Delft University of Technology, Delft, Netherlands). Retreived from http://resolver.tudelft.nl/uuid:bd583cbe-a1b3-4067-a165-f1070cf1263f

Forgaci, C. (2010). *Limita intre oraș și apă. Morfologia limitei la apă in imaginea si structura urbană* (Unpublished master's thesis). "Ion Mincu" University of Architecture and Urbanism, Bucharest, Romania.

Articles in professional magazines:

Forgaci, C. (2016). The Conditions of Bucharest-South Urbanity. *Zeppelin*, *144*(December 2016-February 2017), 67–69.

Alexandrescu, M., **Forgaci, C.**, & Ionescu, A. I. (2016). 342,914 km de eșafodaj. O strategie de reintegrare spațială a salbei de lacuri a râului Colentina / 342,914 km of scaffolding. A spatial strategy for the disjointed Colentina lakes in Bucharest. *Zeppelin*, *142*(Iunie 2016-August 2016), 164–169.

Forgaci, C. (2015). O vale restructurată între nord și sud. *Zeppelin*, *132*, 68–72.

Appendices

Appendix A Interview schedule

Interviewee / Persoană intervievată: ………………………………………………
Length / Durată: approx. 1h
Date / Data: ………………………………………………………………………………

Questionnaire / Chestionar

Part I [Problem definition 1: general problems/potentials of Bucharest and how those problems relate to the two rivers / Definirea problemei 1: probleme/potențiale generale ale orașului București și cum acestea se relaționează cu cele două râuri]

1. What do you think are the three most important problems of Bucharest in terms of urban development? / Care considerați că sunt cele mai importante trei probleme ale orașului București din punctul de vedere al dezvoltării urbane?
1. ……………………………. 2. ……………………………. 3. …………………………….

2. What do you think are the three most important potentials of Bucharest in terms of urban development? / Care considerați că sunt cele mai importante trei potențiale ale orașului București din punctul de vedere al dezvoltării urbane?
1. ……………………………. 2. ……………………………. 3. …………………………….

3. Do you think the rivers crossing the city play an important role in addressing those problems/potentials? / Credeți că cele două râuri joacă un rol important în aceste potențiale/probleme?
Dâmbovița: (Dezacord total) 1-2-3-4-5 (Acord total)
Colentina: (Dezacord total) 1-2-3-4-5 (Acord total)

Part II [Problem definition 2: problems/potentials of the two rivers / Definirea problemei 2: probleme și potențiale ale celor două râuri]

4. What do you think are the three main problems of Dâmbovița/Colentina? / Care considerați că sunt cele mai importante trei probleme ale râului Dâmbovița/Colentina?
Dâmbovița: 1. ……………………… 2. ……………………… 3. ………………………
Colentina: 1. ……………………… 2. ……………………… 3. ………………………

5. What do you think are the three main potentials of Dâmbovița/Colentina? / Care considerați că sunt cele mai importante trei potențiale ale râului Dâmbovița/Colentina?
Dâmbovița: 1. ……………………… 2. ……………………… 3. ………………………
Colentina: 1. ……………………… 2. ……………………… 3. ………………………

6. What do you think are three main function that Dâmbovița/Colentina should provide to the city? / Care considerați că sunt cele mai importante trei funcții pe care cele două râuri le oferă orașului?
Dâmbovița: 1. ……………………… 2. ……………………… 3. ………………………
Colentina: 1. ……………………… 2. ……………………… 3. ………………………

Part III [Problem definition 3 / Definirea problemei 3]

7. Do you consider that Dâmbovița/Colentina is a physical barrier? / Considerați că Dâmbovița/Colentina este o barieră fizică în oraș?
Dâmbovița: (Dezacord total) 1-2-3-4-5 (Acord total)
Colentina: (Dezacord total) 1-2-3-4-5 (Acord total)

8. Do you think that flooding is an issue along the two rivers of Bucharest? / Considerați că inundațiile sunt o problemă în cazul celor două râuri?
Dâmbovița: (Dezacord total) 1-2-3-4-5 (Acord total)
Colentina: (Dezacord total) 1-2-3-4-5 (Acord total)

9. Does the city make use of the ecosystem services provided by the two rivers? / Se folosește orașul de serviciile de ecosistem pe care cele două râuri le oferă?
Dâmbovița: (Dezacord total) 1-2-3-4-5 (Acord total)
Colentina: (Dezacord total) 1-2-3-4-5 (Acord total)

10. Is there a comprehensive multi-scalar plan/strategy for Dâmbovița/Colentina? / Există strategii sau planuri multi-scalare pentru integrarea Dâmboviței/Colentinei în oraș?
Dâmbovița: (Dezacord total) 1-2-3-4-5 (Acord total)
Colentina: (Dezacord total) 1-2-3-4-5 (Acord total)

Interview guide / Interviu

Part IV [Social-ecological processes / Procese social-ecologice]

11. How would you describe the spatial relationship between Dâmbovița/Colentina and the urban fabric surrounding it? / Cum ați descrie relația spațială dintre Dâmbovița/Colentina și țesutul urban înconjurător?

12. To what extent do the rivers and the (built/unbuilt) spaces surrounding them accommodate social-economic activities? / În ce măsură spațiile adiacente râurilor atrag activități social-economice?

13. To what extent do urban spaces adjacent to the river allow or hinder the development of ecological processes? / În ce măsură spațiile adiacente râurilor permit dezvoltarea proceselor ecologice?

Part V [Trends / Tendințe]

14. Do you know about any projects/strategies/initiatives that try to integrate the rivers into the city? / Ce proiecte/strategii/inițiative cunoașteți care încearcă să integreze cele două râuri în oraș?

15. What is your opinion about the way current urban plans/strategies address the two rivers? / Ce părere aveți despre felul în care planurile care reglementează orașul în prezent adresează cele două râuri?

16. How do you think the two river corridors should be governed (at what scale(s), and to what extent; within which administrative boundaries)? / Cum (la ce scară/scări, sub ce formă administrativă) credeți că ar trebui planificate și gestionate cele două culoare hidrografice?

Part VI

17. How do you personally use the two rivers? / Cum utilizați (ca locuitor al orașului) cele două râuri?

18. To whom else should I talk to? / Cu cine îmi recomandați să mai stau de vorbă?

19. Do you have any suggestions for literature on planning for/with the two rivers in Bucharest? / Aveți vreo sugestie bibliografică în legătură cu temele discutate?

Appendix B List of interviewed experts

LIST OF INTERVIEWED EXPERTS			
Interviewee no.*	Date	Profession	Affiliation and expertise
Interviewee 01	22/04/2016	Architect	Architect and teacher of architecture at UAUIM[1], involved in the development of TUB, later known as PIDU.
Interviewee 02	26/04/2016	Architect	Assistant professor at the Dep. of History & Theory of Architecture and Heritage Conservation, Fac. of Architecture, UAUIM[1], coordinator of the stART Dâmbovița project.
Interviewee 03	27/04/2016	Environmental scientist	Professor in environmental sciences at the Dep. of Regional Geography, UB[2], expert in environmental issues of Bucharest.
Interviewee 04	27/04/2016	Urban & territorial planner	Associate professor of urban and territorial planning at UAUIM[1], expert in territorial planning
Interviewee 05	28/04/2016	Architect and journalist	Chief editor at architecture magazine Zeppelin and associate professor of architecture at UAUIM[1], coordinator of several projects that engage the professional and wider public.
Interviewee 06	06/05/2016	Urbanist	Professor in urbanism at UAUIM[1], with vast experience in urban planning; coordinated the Zonal Urban Plan for the North of Bucharest.
Interviewee 07	09/05/2016	Architect and urbanist	Arhitect who worked on large projects on Colentina and was part of the team developing the General Urban Plan.
Interviewee 08	09/05/2016	Landscape architect	Associate professor of landscape architecture at UAUIM[1], with vast experience in landscape-related urban projects; coordinated the Zonal Urban Plan for Dâmbovița.
Interviewee 09	10/05/2016	Landscape architect	Associate professor of landscape architecture at University of Agronomic Sciences and Veterinary Medicine.
Interviewee 10	10/05/2016	Hydrologist	Professor of hydrology at the Dep. of Hydrology and Meteorology, UB[2], with experience in anthropic pressures on the hydrological system of Bucharest.
Interviewee 11	10/05/2016	Urbanist	Professor of urban design at UAUIM[1], with vast experience in urban planning; coordinated the Zonal Urban Plan for Bucharest's Central Zone, and Bucharest Strategic Concept 2035 (CSB2035).
Interviewee 12	11/05/2016	Urban planner	Associate professor of urban planning at UAUIM[1], with expertise in urban policies and management in Bucharest; coordinator of Bucharest Strategic Concept 2035 (CSB2035).
Interviewee 13	11/05/2016	Urban planner	Professor of urban planning at UAUIM[1], with experience in (national,regional and county level) territorial planning.
Interviewee 14	12/05/2016	Urban designer	Associate professor in urbanism at UAUIM[1], expert in urban morphology; studied the relationship of the two rivers with the urban fabric.
Interviewee 15	12/05/2016	Architect	Former Chief Architect at the Municipality of Bucharest.
Interviewee 16	12/05/2016	Architect and Entrepreneur	Dâmbovița Smart River (DSR); initiator of TUB/PIDU, DSR; representative of the private sector.
Interviewee 17	14/05/2016	Urban designer	La Firul Ierbii, Wolfhouse Productions; grassroots initiator.
Interviewee 18	16/05/2016	Urban planner	UAUIM, PUG2020; works at the new General Urban Plan (2020).
Interviewee 19	16/05/2016	Cultural anthropologist	Professor of sociology at NUPSPA and leading Romanian cultural anthropologist.
Interviewee 20	16/05/2016	Urban sociologist	Assistant professor of urban sociology at UAUIM, PhD thesis in urban sociology on Bucharest.
Interviewee 21	17/05/2016	Urban planner	Professor of urban design and planning at UAUIM; coordinator of the new General Urban Plan (2020).
Interviewee 22	17/05/2016	Urban designer	Author of a blog popular blog dealing with urban issues in Bucharest

**All interviews have been anonymised. [1] UAUIM – "Ion Mincu" University of Architecture and Urbanism, Bucharest; [2] UB – University of Bucharest; [3] UASMV - University of Agronomic Sciences and Veterinary Medicine, Bucharest; [4] NUPSPA - National School of Political Science and Public Administration, Bucharest.*

Appendix C Example of a transcribed, translated and coded expert interview

Interviewee:	[redacted]	**Code:**	[redacted]
Affiliation:	[redacted]		
Expertise:	[redacted] Sustainable Management of Water Resources; PhD in Geography [redacted] Urban Ecology [redacted] environmental assessment of different land-uses in urban areas, understanding the relation between built-up and green infrastructure, socio-economic [redacted]		
Relation to the topic:	Expert in environmental issues of Bucharest		
Date:	27-April-2016		
Location:	[redacted]		
Length:	1h20min.		
Main quotes:			

Q1:

I think that the main problem, if there's a **no.1**, is about **the imbalance between built and unbuilt**. …the fact that this tendency of replacing everything that is open, is quite evident and it already has serious projections, not only in the quality of life of people, but also in the fact that **Bucharest often does not have many opportunities for future development anymore**. Then, also as an urbanistic problem [**no.2**], I think that **the chaotic development of both buildings and infrastructure**...this is another relevant aspect. **Third**, another problem is connected to the peripheries, the fact that B.—also in the interior as we do not only refer to the position of peripheries in a structural way—does not manage its peripheries as it should… **the poor management of peripheries**, that are not only this area […] and Ferentari; we refer, to a certain extent to the historical center of B too, which has some areas that have more the appearance of a periphery…or more this part with Sf. Gheorghe and all this area towards Viitorului, which are former peripheries of Bucharest that the city never integrated from a functional p.o.v. […] From a social and urbanistic p.o.v. these areas kept their peripherial character. There are just a few discontinuities from the communist period created by the resiedential blocks that blocked their visibility. But, from a structural p.o.v., socially, those are peripheries that are very difficult to integrate.

I think that the mai… — B_PRB_SPA-MOR_the overocc…
I thin… — B_PRB_SPA-MOR_chaotic urb…
Third, another… — B_PRB_PLA-GOV_poor interac…

Q2:

[…] On one hand there are the abandoned land…rather **large surfaces of abandoned land** that are inside the city and which at this moment have a rather toxic management, but in perspective they can be elements of potentials. Another potential is connected to population…**the largest concentration of human capital**…meaning that here is where the worst and the best of Romania gather. Last but not least, also as a potential in urban development, are the built spaces…especially the **office developments that were built in the last years**, which are still very under-rated/capitalized. I refer here to everything that's office locations…those are buildings that allow B to develop very much in this direction. [Do

On one h… — B_POT_SPA-MOR_spatial rese…
Another p… — B_POT_SOC-ECN_human capi…
Last but not least, — B_POT_SOC-ECN_office areas…

you refer to the developments in the North…] I refer not only to the developments in the North, especially in the Pipera area, which are amazing, even though I think that, from the point of view of an environmental scientist, their impact on the urban environment is quite high at this moment… both in terms of *air quality* and *the increasing of the urban heat island effect*, and from the p.o.v. of transport as well, because that area at this moment is suffocated, especially in key moments, in public as well as private transport. But I mainly refer to the development of these… from an economic p.o.v. these are interesting areas [he points out the economic potential of office development areas in the city]. There are buildings that have very high capacities. Many of them don't have an occupation rate higher than 60%, so they have the potential of attracting more…and there are large companies [redacted] -most of those companies went there because it is interesting as an option… [Here I'd like to stop for a second. What is your opinion about such developments? Most of large urban development, especially office developments, seem to be in the North side of the city. What is your opinion, from this point of view, about the South of Bucharest? Should it develop in the same way?] Unfortunately, **the South doesn't have the same opportunities. From a morphological p.o.v., it was always a place with problems. Practically we refer to North-South, as related to Dâmbovița.** Because D, practically, has the right bank which is lower and the left bank (in the North), which is the higher bank. These things during history created this dissociation between the North that is, as it happens everywhere, it is richer, and the South which is, historically, poorer. Because, practically, the Southern area of Bucharest, if we take historically the *Calicilor Bridge*, with all the *mahalas*, and with the areas where the *roma slaves* were concentrated, who belonged to the patriarchy [?]…were in the South. These things, even though… from an urbanistic p.o.v. remained…even during the communism when practically the Ferentari Neighborhood was designed, it was also in the South and it emphasized those things. Also, all the sacrificed areas of Bucharest, were also in the South, South-East. We refer to the landfill at Glina and Chiajna, the water treatment plant, [redacted] with the animal waste plant, the largest cemeteries (Pantelimon, Glina, Popești-Leordeni)…these were assigned as sacrificed areas from the very beginning. **The water** […] **from D**, after crossing Bucharest, **is of a very poor quality**. So all these areas… from this p.o.v., the South doesn't have a high potential; it doesn't have the same resources, it doesn't have access to the same type of image—because the image of a space is created historically... The North is green, it has a certain personality, which differentiates it. When you say the South of B…you go to Berceni, Ferentari, Giurgiului…areas that automatically label any company that goes there differenty.

B_PRB_SPA-MOR_the divide b…

D_PRB_ENV-ECO_poor water …

B_PRB_SPA-MOR_the divide b…

[I refer to my master thesis here…to the fact that the population is equally distributed in the two halves of the city…and the strategy for D as a facilitator of connections between N and S] The idea is that any change of this kind, changes that have a social dimension, require hundreds of years…even if we refer to a society that evolves rapidly…but the major changes are very few. We refer to small changes and additions to an existing construction, but the foundation remains the same. From my p.o.v., it is very complicated to change, even in the case of a connection…the underlying things stay there…the label of being a resident of Berceni…the neighborhood Berceni already has a pattern…that is different from Balta Alba [another residential neighborhood in the periphery] from the p.o.v. of the personality of the individual living there. Or, not to mention Ferentari and Giurgiului… there we have a different neighborhood profile. These things are not about connections…but about the fact that in the collective mind there was a certain image of that space…

Q3:

From a geomorphologic/geographic point of view, yes, D created these problems. From a geographic p.o.v. (I refer to the relief here) there were two areas. The South, that is, the right bank, was the one that was more exposed to floods. By being exposed to floods, normally, those who had better financial resources, went to less exposed areas…and this is where the differences started from. From the other points of view, **at this moment D isn't D anymore**. The current D is a simple canal that, from a structural p.o.v. is neither a barrier, nor a potential element, nor a simple road…Yes it is a thing draining some water in a controlled way, depending on how much is released from Lake Morii. So from this p.o.v., currently D doesn't have any role for B. It's just a canal in which we guide water that couldn't follow a different trajectory. [So from a hydrologic p.o.v. the canal is needed…] From a hydrologic p.o.v. you need it because you need to carry the water somewhere. [I mean, if this water could be diverted towards Arges, without crossing B, would that be possible?] That would be possible, because **the current flood defense system** would allow this. Practically, that's why the flood protection system **protects B in more than 90% of critical situations**, because *most part of high discharge, for instance, when Lake Morii cannot store it, goes to Arges, and it floods those on Arges and Bucharest is safe.* It isn't ethical, it isn't correct, but this is what is happening, and it has happened frequently in the last years with these increased quantities of precipitation. And on the other side, if there are high water flows on Colentina, everything is diverted to Ialomita…and there are derivations that are built quite well.

D_PRB_ENV-ECO_flood risk

D_POT_SPA-M…_geomorphol…

D_PRB_ENV-ECO_canalisation

D_FCT_drainage

D_FCT_flood protection

But Bucharest needs water, and here's the big problem. It needs water, and it had during communism; and this is the logic, the need for water, especially for industry; and the water of D, and C too, was used and it is still used [for industry]. For instance, CET South still functions with water from Cernica, Pantelimon, from those lakes. They cannot afford to use

D_FCT_water supply

cooling water from the public network… Water is important, for a city of this kind it is very important. The problem is that the type of approach chosen during communism was a quite destructive one, I think, for the so-called aquatic ecosystem and unfortunately, at this moment, there aren't really opportunities, at least on D, to revive it. I was looking, for instance, to **Munich with Isar**, or **Dresden with Elbe**, and there are many cases in Europe, or **Rhone in Lyon**, there are already areas where they try to bring people closer to the water, to create more attractive leisure areas, to bring in aquatic transport, etc. **…D doesn't have this potential…D is just a canal with water.** D poses large problems from this p.o.v. I would say that D has, as a current problem, the score of **4**; in terms of potential, I totally disagree, so **1**. However, at C, the problems and potentials are around the middle, **3**, because at this time C, above all, is the a place with potential…and there are projects…and C was thought from the very beginning as a succession of lake accompanied by parks. And even at that time they thought about the fact that these parks should be connected…and now there are a few small projects (Plumbuita with Floreasca, Tei, to be connected with pedestrian paths). But, from the p.o.v. of problems, at C there's **this strong proximity of a** (deep) [profund] **rural built-up area**, especially on the left bank…a deep rural…that means waste, used water that is discharged in these lakes…and their potentials, processes of eutrophication, the decrease of bathing…are serious problems. But anyway, C is much higher …more untouched, even though there are also some transformation as I just said.

Q4:

D: First of all, **the excessive control of water drainage**. Then, there are problems related to **the quality of water**, especially in the warm season. And I think another problem is connected to the fact that there's **no surface water infiltration**. There would be one more… D is a canal and an underground collector…so clean water on top, and the ugly things underground…And these things, from a technical p.o.v., are ok—practically, you hide the dirt. Practically, you prevent the Bucharestean to be aware of the waste that they create. But this is more ethics…

C: The main problem is **the proximity of the rural residential**. It is **the lack of connectivity of green spaces**; *C has the potential to become a green corridor*, and unfortunately there are many areas of discontinuity. And another problem is linked to the fact that **during the Summer especially, C functions as an element that increases the urban heat island effect of Bucharest** with the large volume of water…and this is a strange thing, because we know that usually large water bodies, flowing water bodies, reduce the UHI effect; but in the case of the lakes of C, where the water is still, it stores heat, end the potential for evaporation decreases. The evaporation processes that chill the atmosphere are considerably exceeded by the fact that the water heats up. We had evaluations, for instance, in the last years both on the C lakes and on lake Morii, where the water temperature reached 28 degrees, to a 30-40cms depth. So this water volume during the night continues to heat up the atmosphere. Theoretically, it cools down, but this functions like a radiator and it releases the heat back to the atmosphere. This means that when the sun rises in the morning, the starting temperature isn't a low one, but one that is higher. It is interesting…This is why I say that D from this p.o.v. has this problem that is doesn't flow. It transfers the water that already got warm and stinky in Lake Morii further. And on the shore of Lake Morii, interestingly, there are new developments…for instance near Chiajna there's a sheep farm that discharges everything in Lake Morii. […] This means that animal manure goes to the lake, from the lake, with all the microorganisms, it comes to Bucharest… Ok, only a few categories of people use D for swimming, but the exposure is incredible…

Q5:

D: It is the area of **Lake Morii**, which from the p.o.v. of leisure activities can be stimulated a lot. There things, even if it is from the period of communism, I think that at this moment it has a large potential, with the only condition that the shore towards Bucharest and the left bank should be broken a bit of industrial activities which are there. There are a few industrial activities that block the residential areas' access towards Lake Morii, and of course the modernization that is needed there. From the other points of view, potential, I wouldn't see on D…

[What is you opinion about Lake Vacaresti?] Lake Vacaresti is an interesting thing. Honestly, I don't see it a protected area (I mean, in the Romanian system), because unfortunately we have tons of protected areas which are not maintained properly, and we claim that one that is in the middle of the city, at 3km from the centre of the city, will be correctly administered. No, there are real estate interests, with no connection to conservation whatsoever. That area is interesting, true, we even have this month a workshop at Strasbourg on this topic, on how to manage an abandoned land in such a situation, but the problem there is, again, …here things are always put foolishly…there are in fact some land owners who want to obtain compensations ['despagubiri'] from the government or from the municipality for that land that cannot be capitalized, because there it is hard to do anything, unless you do large investments. So they found this trick, a legislative loophole that allows you to do so. **There an ecologic park, with a wild character would be very good**. [I tell him that the park has recently been declared a natural park…] It might be very recent information. I know that it is possible. Less than two weeks ago at the ministry of environment they were inventorying the land owners in that area. [redacted]

[redacted] But I said it—I had meetings at the Fac. of Architecture—, in my opinion, it doesn't make sense, because B does not afford to manage such a surface because it is extremely expensive; practically, you have to clean up all that area...it is crazy, what is there is incredible…there are invasive [species?], it is difficult to manage a space of this kind. It is clear that it cannot be left abandoned, but, in my opinion, there's a need for a large public investment and planned in several phases, by using what has already developed there, with a medium-term intervention that would discipline things there, because there are invasive plants, plants with high allergen potential, some little animals that aren't so friendly with people, mosquitos (and you cannot afford this in B)…there are many things that need to be managed carefully. We'll see…until the real estate dynamics don't calm down, I cannot…

At D, I wouldn't see any other potential besides Lake Morii. Maybe the fact that it gives water, especially for **washing the streets**. D is used for washing the streets, but it isn't the best sanitary solution. But I see D more like a zone with problems.

D_FCT_water supply

C: Regarding C, the potential is enormous on **recreation**. The potential is high on **biodiversity** too, on **ecosystem services**, on… If the **connectivity of this green corridor** is achieved, it is incredible what could be in that area. At the same time, it is the area that has the highest importance in flood protection in B, but this is part of ecosystem services. And also as a potential, it is a place that **can attract smart investments**, developments that are smarter, greener, etc. There are those neighborhoods that clearly require (I remember what the students told me…)… There's an area called Peninsula, somewhere on Dobroesti Park. There we had some water quality assessments and I sent some students to bring me water samples and they told me that they finally saw Mogadishu for the first time. Mogadishu is the capital of Somalia. [redacted] continues the joke…] That they were there and saw how Mogadishu is. Great, no visa required, they managed to return with undamaged equipment…but it's incredible. And it is true, from a social p.o.v., that area is incredible. Practically, Dobroesti starts from Plumbuita [He made a mistake, Dobroesti is after Fundeni…I correct him], and there's an area there… But it's an interesting place… The same is in **Plumbuita**, that area next to **the monastery**, that extraordinary neighborhood… If those areas are integrated in the urban—I was looking at the French, who have this trend of breaking their immigrant ghettoes… and to create different interventions that are extraordinary; especially in Lyon, Le Havre—if we start too and if we'll have mony for such a thing, to change the façade…there's a good area for this kind of green intrventions. And especially…I saw the same thing on this side…a simple bike lane but with several green infrastructure elements in Ljubljana. **Ljubljana in WWII was a closed city, it had a wall. Later they demolished this wall and replaced it with a 'pot' it's called, a bike alley, along which…it's incredible…allotment gardens, incredible green spaces. It is superb...it is crazy. Colentina could have the potential for such a thing**. [What is the river crossing Ljubljana?] I think Ljuba…Ljublinca..samething like that [It's Ljubljanca and Sava], a small river. In fact, there are two canals that cross, also canalized, but what I liked a lot—of course, they have a different dimension…maybe slightly smaller than D—is that the banks were green. We also had this idea of making the banks green, but 'tovarașul' [a colloquial way of referring to Nicolae Ceaușescu] did not like the idea. He wanted to see the cement, the concrete on the surface, because during communism the concrete was a symbol of power, showing that man rules over nature.

C_POT_SOC-ECN_recreation
C_POT_ENV-ECO_ecosystem ...
C_POT_ENV-ECO_ecology and...
C_FCT_flood protection
C_POT_SOC-ECN_economic a...
#international and national ref...
D_PRP_add vegetation to the ...
D_PRB_ENV-ECO_canalisation

Q6:

D: Simply, **water supply**; **flood protection**, categorically, because of the lake; and…nothing else.

D_FCT_flood protection
D_FCT_water supply

C: **Recreation, leisure**…; **ecosystem services on water drainage**…it is a surface that ensures water drainage…practically, rainwater in the urban environment, when it does not infiltrate into the soil, or it does not drain further, represents a waste, used water that I have to manage. So C in the North represents an outlet for this kind of water; habitat for several species which are very interesting from an ecologic pov. The management started to be milder, although, you know, the lakes are emptied during winter for [maintenance?] No, not maintenance, but to create space for the Spring flows […] some lakes, like Herăstrău, are emptied. Pantelimon isn't emptied, the rest are… The only thing that remains is the service flow ['debit de servitute'], a small stream. [So the storage of the water isn't only in Buftea, but also in the lakes of Colentina in a distributed way?] Yes, the water is stored on all lakes when the water is high. Buftea is the key element in the flood defense system, because it is connected to Ialomita. This is where all the complication comes from ['toata nebunia']: You release when it isn't possible to release towards the other side in Dambovita [C?], through Bilciuresti. And another function, maybe it offers **a better residential area**.

C_FCT_drainage
C_POT_SOC-ECN_recreation
C_FCT_flood protection
C_FCT_residential

Q7:

The current D is **1**, not at all. The only place where it is a barrier is at Lake Morii. There it is really a barrier. […] Colentina, yes it is a barrier. I would say that it is a barrier in a proportion of **3**, although there are these areas between the lakes which allow the connection of the city. But in Herăstrău, for instance, two functional zones are completely broken. I know *there was* [redacted] ut the idea wasn't implemented because it was considered too strange, but it could be an idea. Plumbuita is broken too [The barrier is of two kinds, between the two banks, and between the lakes...] Yes, it is difficult, if we go for water transport…no it

D_PRB_SPA-MOR_physical bar...
C_PRB_SPA-MOR_physical bar...
C_PRB_SPA-MOR_discontinuit...

isn't…C has a system of sluices which makes aquatic transit difficult. [Even for pedestrians in certain areas it is difficult to cross from one lake to another] Yes, categorically, for pedestrians, because there's no continuity between lakes. For instance, Floreasca is discontinuous…Yes it is true.

…it is difficult, i…

Q8: On D no, categorically [1], but if we talk about flooding, we talk about river overflow, not exceeded sewage capacity, because the latter is a different story. On C, however, we can go for a **2**, because there have been some situations in which especially the bordering residences were exposed. There were some bags put there in…2008 (or 2005) I think, but not very serious.

On D… D_PRB_ENV-ECO_flood risk
On C, however… C_PRB_ENV-ECO_flood risk

[I mention the ANAR report about flood risk]. There are two different problems here. On one hand, the problem of D depends on the situation of the dam. If the dam breaks…that's another problem, we enter a different discussion. But if we talk about D, it's just what enters Lake Morii, but problems can appear at most… in the back of Lake Morii, for instance, where there was a plan for the construction of the new Zoo, on the left bank. There's a certain area under 80m which is floodable. Those areas were created at some point as floodable area ['incinta']. In case D becomes too large, those were areas that would flood in a controlled way. The problem is that at this moment there are many 'intelligent people' in that area who started to bring material and to raise it above the floodable 80m, to bring sterile material, construction materials, in order to lift the area out of the flooding zone and to make it buildable. [redacted]—started to say that these floodable zones are not logical, because they create a supplementary pressure on the dam. This is false; on contrary, the pressure gets lower… Anyway... So at this moment this potential of expansion of D has been reduced. Besides these zones, **B is very safe. The proof is that B had such catastrophic events with a 10-year frequency, and the last ones were in '86.** Now we are in 2016 and we can't say that there were no rains in B, or floods on a national level. Bucharest didn't have serious problems anymore.

[I mention the ANAR report about flood risk]. There are two different problems… D_PRB_ENV-ECO_flood risk

Q9: D is **1**, besides the fact that it drains the rainwater…but this can be done by a sewage system—and in fact this is what it is, a slightly cleaner and more visible sewage. However, at C, it is currently **3**, the potential is 5, because it is a great area from this p.o.v.. What others abroad do in similar places is incredible. And **this is what C lacks most: connectivity between lakes**. If I would connect green, pedestrian in those zones, it would be incredible, because it can offer even a cycling area…there are many interesting things… Our problem is that many developed constructions—and there are more and more constructions—are very close to the lake, even on the lake's protection area, which will be an obstacle for many of the future projects.

D is 1… D_FCT_sewage; D_PRB_ENV-ECO_lack of ecos…
at C, it is… C_POT_ENV-ECO_ecosystem …
this is what C lacks mo… C_PRB_SPA-MOR_discontinuo…; C_PRB_SPA-MOR_discontinuit…

[I mention Le:Notre] I know, I was invited but could not make it. We also did some research, especially on the quality of water and the monitoring of lake-side land use. [I describe our proposal… and the fact that we acknowledged the potential for continuity along the pearl of lakes] There's a great potential, but I was looking, for instance, while entering the city on Grivita, where it is not possible to reach the lakeshore anymore… [I mention that Lake Grivita was our main case study…]

Ther… C_PRB_SPA-MOR_inaccessibil…

Q10: Both on C and D there are the management plans that are made at the scale of Arges hydrographic basin. [Arges or Arges-Vedea?] Arges-Vedea, but the management plan as far as I know is for Arges separate... From an urbanistic p.o.v. there were a few plans at a certain port in the 90s, on the Lake Morii area. I know that they were brought up again at some point, when Lake Morii's development was in discussion, quite recently. […]

And on Colentina…nothing comes to my mind…something integrated… There are these sectorial plans, connected to Sector 2, on Floreasca-Tei-Plumbuita, that mess of an amusement park…In they they made a large wheel like in London [London Eye], like [in Prater] in Vienna…it is crazy what's there…that park is destroyed. I can't wait to start with the complaints when they open it. I don't understand. Everybody wants silence, places to sit and clear their minds…space for a madhouse ['balamuc']… I understand that those spaces bring a lot of money, for certain categories of people, but practically you destroy a space that–of course, not unique, there are other opportunities too—but, anyway…administration. [I clarify the question] The answer is that there is nothing like that. Here the institutions think like this. The Romanian Water Board, the Environmental Protection Agency, which currently works on its local environmental action plan, the municipality (general and sectors)… [redacted]

This is more or less the functionality of things… because unfortunately there are things here… [redacted] and they discuss…we discuss and discuss... we arrive to a final document and then the boss comes and [redacted] I hope things will not pulverize, fragment, as it happened in the case of Colentina.

Q11: In general, in my opinion, the relationship [with the urban fabric] is bad, because it is a relation of profit for the use on the waterside. Rivers function as areas of transferring the problems on the banks…you hide them easily…you throw the garbage in water, it isn't visible

In general, in… D/C_poor relationship with the…

anymore […] This is more or less the relation.

Q12: [skipped]

Q13: In case of D, the problem is not related to adjacent spaces, but more to the initial project. But the neighboring uses… first of all the residential areas came very close to the river, so everything that is macro, fauna cannot develop anymore. Then there's **the problem of uncontrolled evacuation of waste water, that, again, disrupts many of the ecological processes**. Then there are the problems related to the fact that the closer man is to water the higher the risk of waste water (which have organic etc.) …but also substances that are toxic. I sow many situations in B. I saw one while one was puring thinner ['diluant'] into Lake Pantelimon. He had like 20 bottles… Ok, it goes away fast…there's a thin layer on the water, the Environmental Agency won't notice…nobody would know where it comes from. **The closer you are (anthropically) to the aquatic zone, the higher the vulnerability of the water body is.** On top of this are the processes of washing from precipitations… the closer (especially) the traffic networks are, the higher the risk of bringing pollutants from traffic and what is on the asphalt (break residues, etc.) brought into the water as suspended particles is high. And these things disrupt. Then also these waterside urban fabrics force aggressive intervnetions, especially in the case of C, because on C in some areas there have developed patches of reed, which are interesting aesthetically but also from the p.o.v. of fauna…birds. And in situations like this the neighboring uses often, and there have been complaints, disband these areas… They consider these areas insalubrious, risky…

Q14: Which plans? [he laughs] the PUG is the old one [1999-2000] and at that time the corridors were not taken into consideration so much… **I like to call that a very defensive plan.** It tried to defend the city of something… it did not succeed at all because then the legal changes that were made in urbanism and urban development destroyed it anyway. The PUG doesn't have anything to do with reality, in microns of it maybe…[PUZ-uri…] The new plan, I haven't seen it yet in detail and I know that currently it is very late and I don't see it finished in the following years… On the other plans, however, the PMUD, Local Environmental Action Plan, there aren't integrated… What's about C and D… **with D, again, you have to be over ambitious…there things are very complicated to approach... what should I do? Should I break up the concrete of the canal to let it flow differently? No, it isn't possible, because it is so bounded by what's at the surface, the underground canal, the metro network, the sewage network, it's crazy. It is a utopia to think that something will change there.** Lake Morii is the only problem and on C the plans that were pulverized… becaue on C, on what we worked on, and the people from architecture, were the plans (PUZ) that were made only for the parks that integrated the lakes too. But those were isolated. As a whole, there's no direction, because there needs to be a certain amount of madness there… it's logical, this is a waterbody that flows, it needs to be approach in an integrated manner. I think there are too many interests in those areas and I think there's too little authority in the public institutions, in order to allow for such a strong approach. Moreover, we talk about right bank, Bucharest, left bank, Ilfov… [isn't it on the other way around?] which is a huge problem! [Ideally, how do you think that these corridors should be administered best?] I think that, first of all, …there are two aspects: **one** when we talk about C, right bank – left bank, **there's the problem that B is in a kind of strange relation, or non-relation, with the neighboring territorial administrative units (UTRs)**. Practically, it is broken, decoupled. Yet B needs Otopeni, Dobroesti, it needs all the surrounding settlements, because if there things go wrong, if those settlements become overdenisfied with buildings, many of B's problems will accentuate. These relate to urban air, congestion, etc. So one of the key things is the normalization of this relationship, the normalization of the relationship with the surrounding administrative units—which also means transport, environment, it means many things that are on standby because of this lack of communication, and not necessarily communication, because this is not about talking, but to have common projects. **The second issue** is the one of **land ownership**, which at this moment, it is very strange, because water shores should be public and it must be free for circulation for people. These are two key problems, this is where the discussion starts. If we do not have the relation between the two components, which have to be homogeneous. It's in vain to try to protect the water and create setbacks of buildings from water in B, while on the other side the contrary happens. It cannot function like this. So on one hand this collaboration, on the other hand the clarification, in the end, of land ownership. After this, things have to be thought of from the p.o.v. of connectivity. Then things are…not simple, but you can play, to put your imagination to work, to connect things from a functional p.o.v. I think that B is not aware of the things that it has from the p.o.v. of the health of the urban environment. **I think that B does not understand—when I say B, I refer to the institutions…intitutions which I am not even sure are interested in this thing—the fact that the bucharestan tends to live in an environment that is too aggressive, and B tends to loose its competitiveness exactly due to the fact that people do not have the capacity to be productive, because of noise, air pollution, boorishness, several stress factors, of insecurity that is related even to misery, which practically don't discharge.** Yet all these continuous, not fragmented, spaces—because fragmentation is annoying too; one is to have a fragmented landscape in the mountains, in combination with the landscape, and another thing is to have this fragmentation when exiting the park and hitting your head into a wall—practically from a mental p.o.v. generate important services for the population.

…

first… D_PRB_SPA-MOR_crampedness; D_PRB_ENV-ECO_limited ecol…

Then there are the problems related to th… C_PRB_ENV-ECO_poor water …

the PUG is the old… B_PRJ_GUP2000

The new… B_PRJ_GUP2020

the P… B_PRB_PLA-GOV_lack of integ…

with D, again, you have t… D_PRP_renaturalisation; D_PRP_waterfront transformat…; D_PRB_SPA-MOR_crampedness; D_PRB_ENV-ECO_canalisation

More… C_PRB_PLA-GOV_lack of colla…

when we talk about C, right bank – left ba… C_PRB_PLA-GOV_lack of colla…; continued by 1:71 It's in vain t…

B needs Otop… B_PRB_SPA-MOR_traffic; B_PRB_ENV-ECO_air and wate…

The seco… C_PRB_PLA-GOV_privatization…; C_PRB_SPA-MOR_discontinuo…; continued by 1:71 It's in vain t…

It's in vain to t… C_PRB_PLA-GOV_privatization…; C_PRB_PLA-GOV_lack of colla…; 1:57 when we ta… continued by; 1:58 The secon… continued by

I think that B is not aware of… B_PRB_SOC-ECN_continuous …; B_PRB_SOC-ECN_lack of civic…; B_PRB_ENV-ECO_unhealthy ur…

all these conti… B_PRB_SPA-MOR_landscape f…

TOC

When, practically, we arrive to critical areas, when the growing number of situations with cancer will become public, or any other kind of tumors, which will be related to high levels of pollution, at that moment, yes, the attitude will change. Because, for instance in the central zone of Bucharest we talk about permanent exceeding of benzene levels… which means the increase of the risk of cancerous tumors with around 60%. [redacted] all this information goes under the bedsheets, nothing is monitored, we don't mention it, because people don't have to know about these things…and this is the public approach. It is complicated… We say that civil society has to do this. No, this is about institutions. If institutions do not function well, you can have as much of civil society as you wish. The civil society has limited attributions; the civil society needs to frame its ideals within the strategy that the institution realizes. I can't even go to Hamburg, which has 5% of the budget [?], for citizen initiatives. Not even there can I go to make an atomo-electric plant just because I like it…citizen initiative. [They are healthy, because they signal some problems, but do not have the power to implement…] Some even have that power, because there are some institutions of this kind which started to become strong, even too strong in my opinion. But and NGO has a fragmented strategy compared to institutions, because it, civil society in general, aim for isolated problems on short, medium, long term, doesn't matter, but the goals are fragmented. They aren't a large thing. Because it might happen that, by solving one situation, I would trigger completely different problems somewhere else. I solved my problems, and I killed some others somewhere else. But it's not my fault as a civil society; it's the institution's fault. **Institutions are the problems here**. And aspects of cadaster, ownership—and it's the same problem at Vacaresti with around 300 owners…it's crazy…with 3 large owners…who came with this 'great' idea […] But there too, the problem can be solved by clarifying the situation of land ownership and what's the availability of those owners to accept a certain solution…

Q17: As an inhabitant… [he laughs] D, only if I am walking, if I have to go to Grozavesti, if we go on Splai…but not from another p.o.v. And we use it as teaching material to show the idiocies that have been done there.

I use C often as a leisure area, as I live in that area, especially for walking. It is very nice, especially in this period, after they emptied the lake, and a lot of reed developed and many wild birds came, birds that come especially in the warm season. Very interesting for the children… it is interesting to see life around you. This I think is a great problem… the insensitivity of the city… you end up taking any pet in the house just to replace this life deficit which is in the urban… So mainly on this part, on the part of aesthetics… […] apropos of hygiene and bathing, […] which now is really a complicated problem. But before '89 you could swim in almost any lake. Even abroad, you can swim in Rhone…yes, there are specially designated areas for this, it is not about the quality of water. Here in B is a problem of water quality… in the statistics the water is very clean, but if I enter the water I will certainly get a dermatitis or something even worse. **I think that this aspect of bathing is important for the urban**. We prohibit such activities, we prohibit fish consumption… and this shows that the water is a mess.

Q18: For planning, you probably spoke to [redacted] Then, for planning in Bucharest, very good, and he also has a course on B, [redacted]. I recommend him, because he worked at the Ministry of Regional Development and he's very good. He works in planning. In my case planning is more related to the environment. […] He understands even the national dimension of things related to planning. On quality of life, [redacted] from the dep. of Human Geography, she had projects on quality of life in B. [I mention [redacted] from landscape ecology] she doesn't really deal with the urban landscape… […] I have a problem with this term 'landscape', of 'picture', it seems to me… it doesn't bring too much information beyond geographic space…which is the same. The French term is the same. Practically, what I see in front of me, but resulting from the mechanisms and relations that are behind. It sounds good, but… the aesthetic side of things is interesting…

Q19: [He offers to send me articles on the quality of water, Lake Morii, Lakes of Colentina etc.+ the functional part. Some articles can be downloaded from his website. He's offers his assistance for any further information. He recommends to look at a project financed by [redacted] on a metropolitan approach to Bucharest]

1

When, practically, we arrive to c… B_PRB_ENV-ECO_unhealthy ur…

We say that civil society has to do this. No, this is about institutions. If institut… B_PRB_PLA-GOV_dysfunction… B_PRB_PLA-GOV_conflict bet… B_PRB_SOC-ECN_lack of civic… B_PRB_SOC-ECN_resisting ch…

I use C often as a leisu… C_FCT_recreation

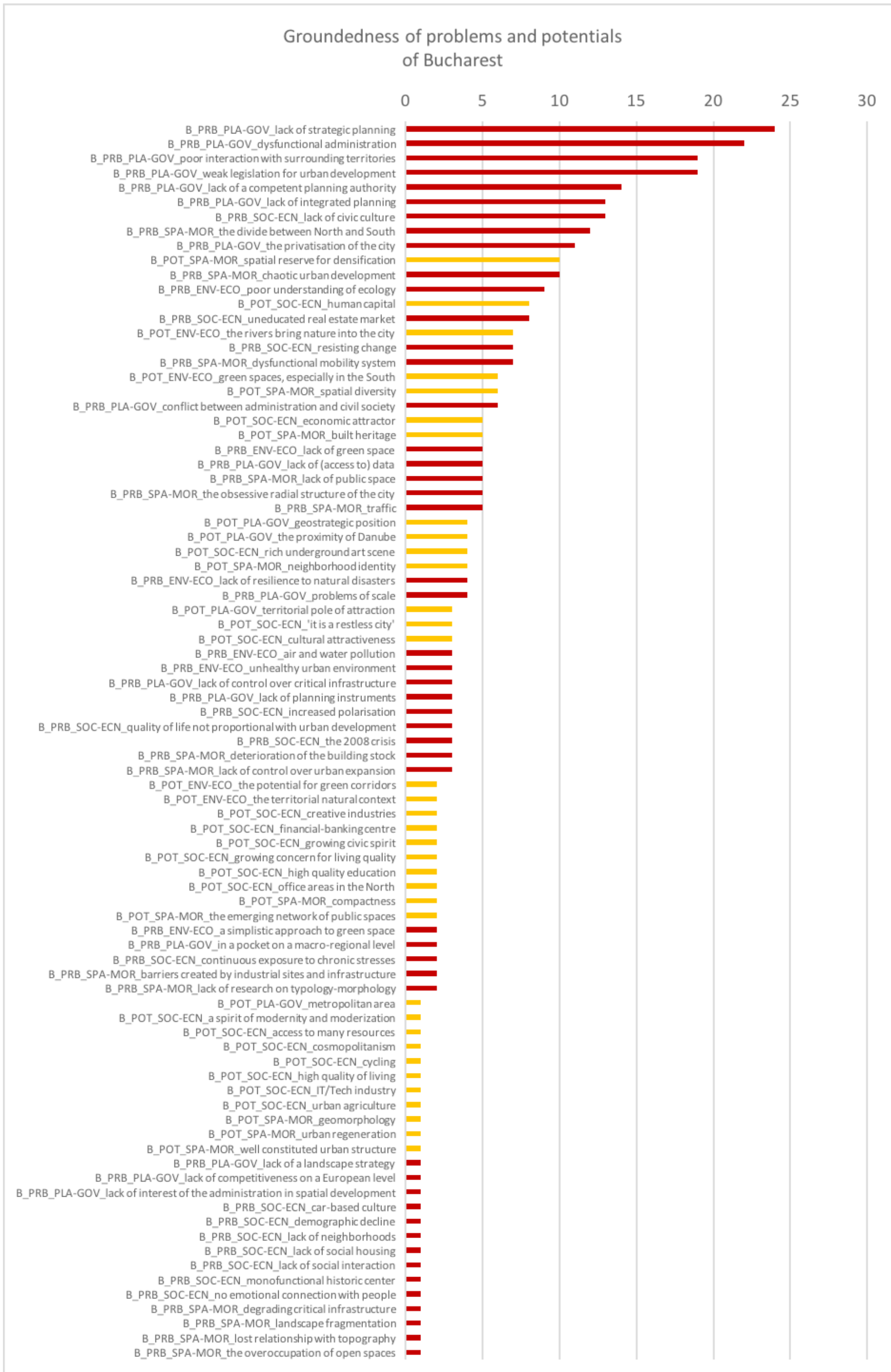
apropos of hygiene and bathing… C…

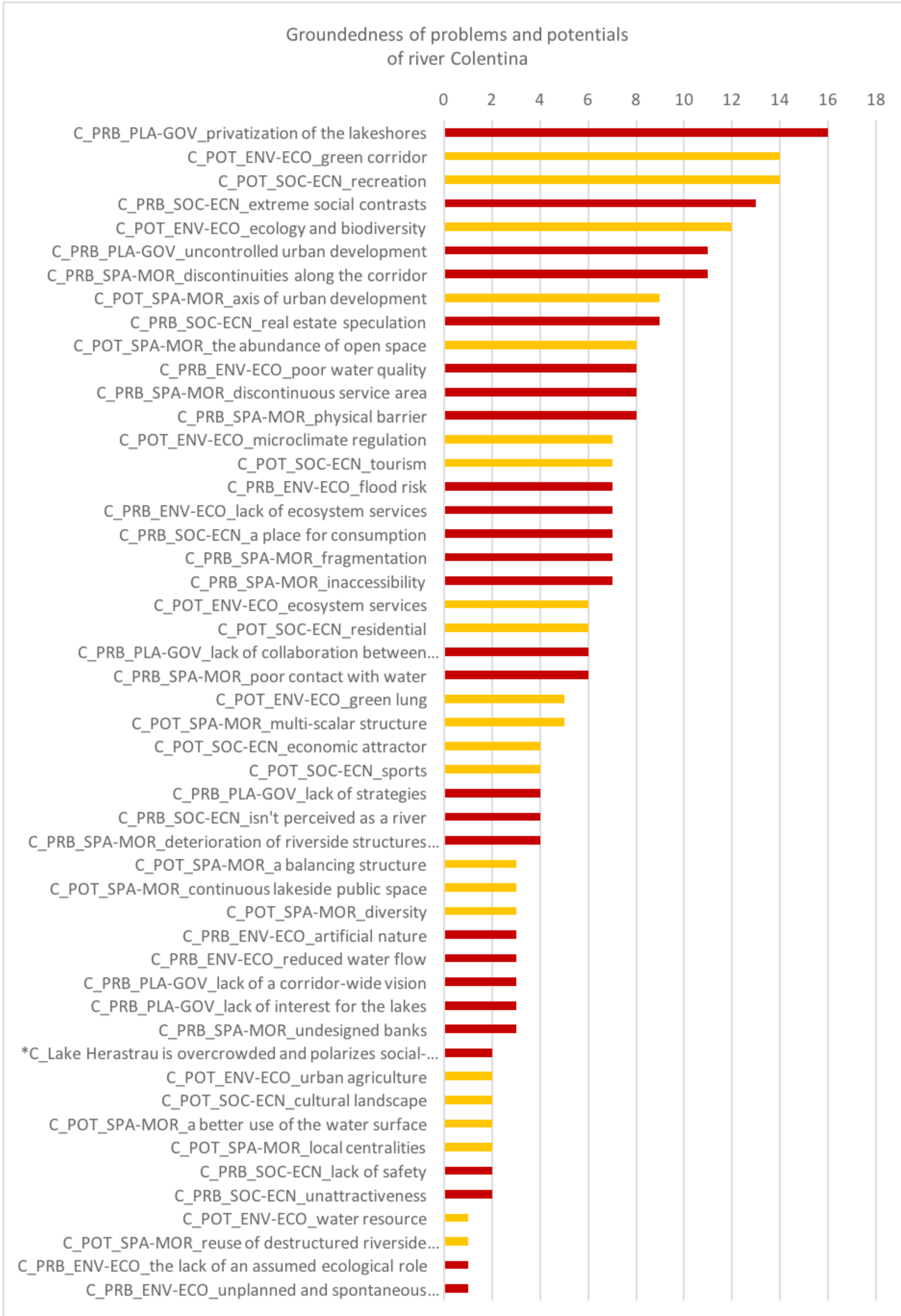
before '89 you could s… C_FCT_swimming and bathing

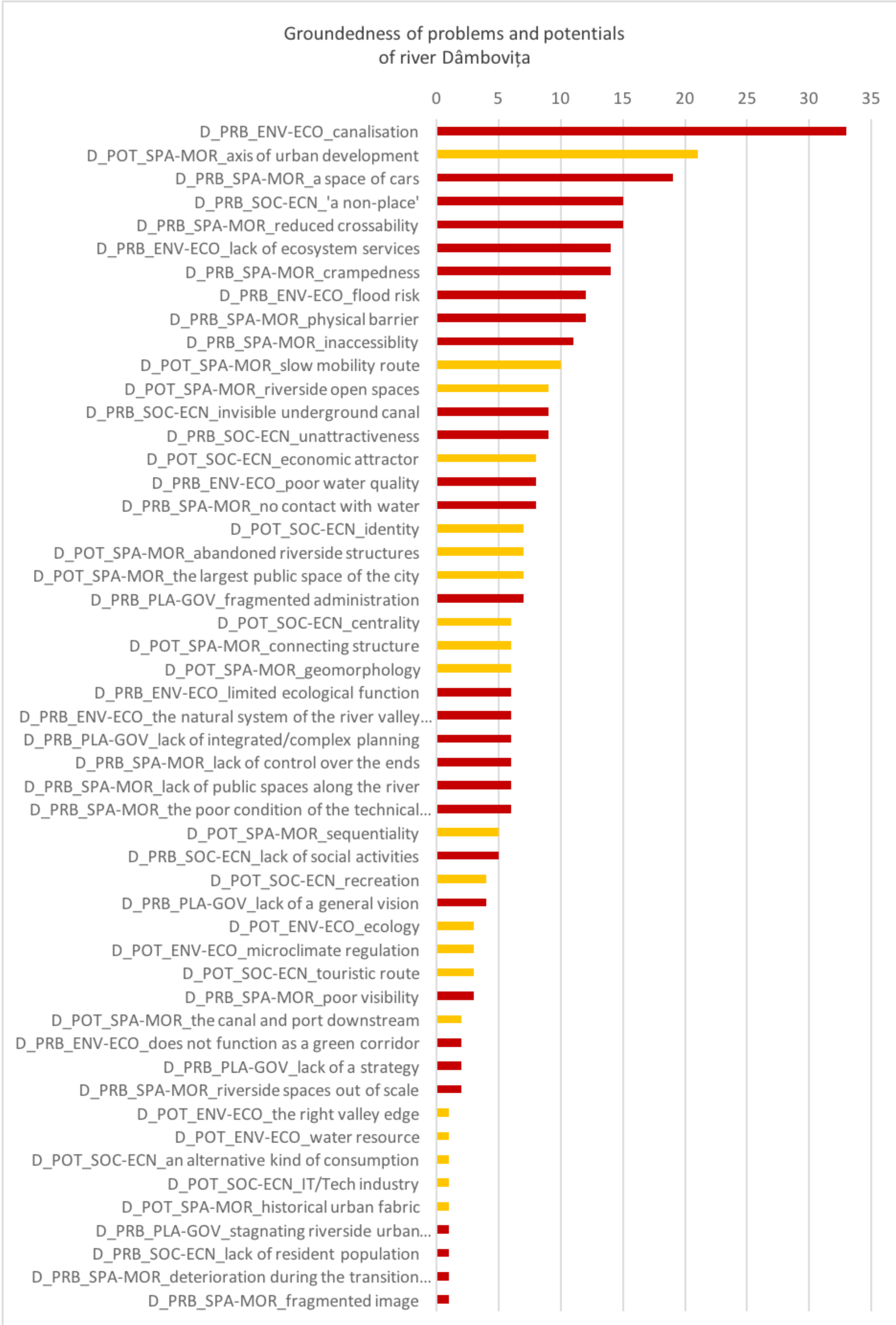
Even… #international and national ref…

For planning, you probably s… #other experts mentioned or r…

Appendix D Summary of the QDA of the expert interviews




Groundedness of problems and potentials
of river Colentina
0
2
4
6
8
10
12
14
16
18
C_PRB_PLA-GOV_privatization of the lakeshores
C_POT_ENV-ECO_green corridor
C_POT_SOC-ECN_recreation
C_PRB_SOC-ECN_extreme social contrasts
C_POT_ENV-ECO_ecology and biodiversity
C_PRB_PLA-GOV_uncontrolled urban development
C_PRB_SPA-MOR_discontinuities along the corridor
C_POT_SPA-MOR_axis of urban development
C_PRB_SOC-ECN_real estate speculation
C_POT_SPA-MOR_the abundance of open space
C_PRB_ENV-ECO_poor water quality
C_PRB_SPA-MOR_discontinuous service area
C_PRB_SPA-MOR_physical barrier
C_POT_ENV-ECO_microclimate regulation
C_POT_SOC-ECN_tourism
C_PRB_ENV-ECO_flood risk
C_PRB_ENV-ECO_lack of ecosystem services
C_PRB_SOC-ECN_a place for consumption
C_PRB_SPA-MOR_fragmentation
C_PRB_SPA-MOR_inaccessibility
C_POT_ENV-ECO_ecosystem services
C_POT_SOC-ECN_residential
C_PRB_PLA-GOV_lack of collaboration between...
C_PRB_SPA-MOR_poor contact with water
C_POT_ENV-ECO_green lung
C_POT_SPA-MOR_multi-scalar structure
C_POT_SOC-ECN_economic attractor
C_POT_SOC-ECN_sports
C_PRB_PLA-GOV_lack of strategies
C_PRB_SOC-ECN_isn't perceived as a river
C_PRB_SPA-MOR_deterioration of riverside structures...
C_POT_SPA-MOR_a balancing structure
C_POT_SPA-MOR_continuous lakeside public space
C_POT_SPA-MOR_diversity
C_PRB_ENV-ECO_artificial nature
C_PRB_ENV-ECO_reduced water flow
C_PRB_PLA-GOV_lack of a corridor-wide vision
C_PRB_PLA-GOV_lack of interest for the lakes
C_PRB_SPA-MOR_undesigned banks
*C_Lake Herastrau is overcrowded and polarizes social-...
C_POT_ENV-ECO_urban agriculture
C_POT_SOC-ECN_cultural landscape
C_POT_SPA-MOR_a better use of the water surface
C_POT_SPA-MOR_local centralities
C_PRB_SOC-ECN_lack of safety
C_PRB_SOC-ECN_unattractiveness
C_POT_ENV-ECO_water resource
C_POT_SPA-MOR_reuse of destructured riverside...
C_PRB_ENV-ECO_the lack of an assumed ecological role
C_PRB_ENV-ECO_unplanned and spontaneous...


Groundedness of problems and potentials
of river Dâmbovița
0
5
10
15
20
25
30
35
D_PRB_ENV-ECO_canalisation
D_POT_SPA-MOR_axis of urban development
D_PRB_SPA-MOR_a space of cars
D_PRB_SOC-ECN_'a non-place'
D_PRB_SPA-MOR_reduced crossability
D_PRB_ENV-ECO_lack of ecosystem services
D_PRB_SPA-MOR_crampedness
D_PRB_ENV-ECO_flood risk
D_PRB_SPA-MOR_physical barrier
D_PRB_SPA-MOR_inaccessiblity
D_POT_SPA-MOR_slow mobility route
D_POT_SPA-MOR_riverside open spaces
D_PRB_SOC-ECN_invisible underground canal
D_PRB_SOC-ECN_unattractiveness
D_POT_SOC-ECN_economic attractor
D_PRB_ENV-ECO_poor water quality
D_PRB_SPA-MOR_no contact with water
D_POT_SOC-ECN_identity
D_POT_SPA-MOR_abandoned riverside structures
D_POT_SPA-MOR_the largest public space of the city
D_PRB_PLA-GOV_fragmented administration
D_POT_SOC-ECN_centrality
D_POT_SPA-MOR_connecting structure
D_POT_SPA-MOR_geomorphology
D_PRB_ENV-ECO_limited ecological function
D_PRB_ENV-ECO_the natural system of the river valley...
D_PRB_PLA-GOV_lack of integrated/complex planning
D_PRB_SPA-MOR_lack of control over the ends
D_PRB_SPA-MOR_lack of public spaces along the river
D_PRB_SPA-MOR_the poor condition of the technical...
D_POT_SPA-MOR_sequentiality
D_PRB_SOC-ECN_lack of social activities
D_POT_SOC-ECN_recreation
D_PRB_PLA-GOV_lack of a general vision
D_POT_ENV-ECO_ecology
D_POT_ENV-ECO_microclimate regulation
D_POT_SOC-ECN_touristic route
D_PRB_SPA-MOR_poor visibility
D_POT_SPA-MOR_the canal and port downstream
D_PRB_ENV-ECO_does not function as a green corridor
D_PRB_PLA-GOV_lack of a strategy
D_PRB_SPA-MOR_riverside spaces out of scale
D_POT_ENV-ECO_the right valley edge
D_POT_ENV-ECO_water resource
D_POT_SOC-ECN_an alternative kind of consumption
D_POT_SOC-ECN_IT/Tech industry
D_POT_SPA-MOR_historical urban fabric
D_PRB_PLA-GOV_stagnating riverside urban...
D_PRB_SOC-ECN_lack of resident population
D_PRB_SPA-MOR_deterioration during the transition...
D_PRB_SPA-MOR_fragmented image

Appendix E Indicators selected for the assessment of Bucharest's URCs

The following pages present the indicators selected for the assessment of URC Dâmbovița and URC Colentina in Chapter 6, as summarised in Table.App.E.1. Each indicator includes: a definition, the results on the scale of the URC, an illustration of a corridor segment, and data- or implementation-specific notes.

	SELECTED INDICATORS	URC
Connectivity		
Longitudinal		
Social	A.1.1.1a Slow mobility routes - continuitiy	URC Dâmbovița
	A.1.1.1b Slow mobility routes - %	URC Dâmbovița
Ecological	A.2.1.1a Landscape connectivity - connected components	URC Dâmbovița
Lateral		
Social	A.1.2.1a Accessibility - network	URC Dâmbovița, URC Colentina
	A.1.2.1c Accessibility - visitors	URC Dâmbovița
	A.1.2.3a Crossability - linear density of crossings	URC Dâmbovița
	A.1.2.3b Crossability - river width	URC Dâmbovița
Ecological	A.2.2.1 Presence of transversal corridors	URC Dâmbovița
	A.2.2.3 Sinuosity	URC Dâmbovița
Vertical		
Social	A.1.3.1a Contact with water - points	URC Dâmbovița
Ecological	A.2.3.1 Presence of ecotones	URC Dâmbovița
Spatial capacity		
Diversity		
Social	B.1.1.1a Diversity of land uses—patch richness density	URC Dâmbovița
Ecological	B.2.1.1 Biodiversity—presence of species-rich areas	URC Dâmbovița
Quality		
Social	B.1.2.1a Visual permeability - % of visible river space	URC Dâmbovița
Ecological	B.2.2.4 Respect of natural dynamics	URC Dâmbovița
Porosity		
Social	B.1.3.2a Waterfront constitutedness - configuration	URC Dâmbovița
Ecological	B.2.3.1a Coverage - % open space	URC Dâmbovița
	B.2.3.1b Coverage - % green space	URC Colentina

TABLE APP.E.1 Indicators selected for the assessment of URC Dâmbovița and URC Colentina.

Continutiy of riverside slow mobility routes (A.1.1.1a)

Definition:
The presence and continuity of slow mobility routes along the river is measured at the scale of the corridor segment as **[1] absent**; **[2] discontinuous**; **[3] continuous**.

Input data:
- Corridor segment boundary
- Bike path network within the corridor segment (OSM)[79]
- Water polygon within the corridor segment (OSM)
- Buffer distance[80]

Implementation:
1. A buffer of 25m from the river polygon is created. To isolate the riverside slow mobility routes, the bike path network is clipped with the 25m buffer. If the clipped network is empty (NULL), then the value **[1] absent** is assigned to the corridor segment and the following steps are skipped.
2. Another buffer of 25m is created from the end edges of the water polygon, i.e. the edges which intersect the corridor segment boundary. To check the continuity of the bike path network across the corridor segment, the clipped bike path network is intersected with the end segment buffers. If at least one of the two end buffers does not intersect the bike path network, than the value **[2] discontinuous** is assigned and the following step is skipped.
3. If both end segments intersect the bike paths, then the network is checked for the number of connected components. If the number of components is >1, then the value **[2] discontinuous** is assigned. Otherwise, the bike path network is considered to be **[3] continuous**.

Results CS03:
- Geometry: **NOT NULL**
- No. of connected components: **1**
- No. of connected ends: **1**/2
- Continuity of riverside slow mobility routes: **discontinuous**

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79 The OSM data used in this assessment needs to be confronted with the real-world situation, as some bike ways may not be in fact usable.

80 In case of River Dâmbovița, a buffer distance of 25m was considered to be sufficient for the selection of riverside bike paths. A larger buffer might be needed in other cases, therefore it needs to be determined according to the specific configuration of the riverfront that is being assessed.

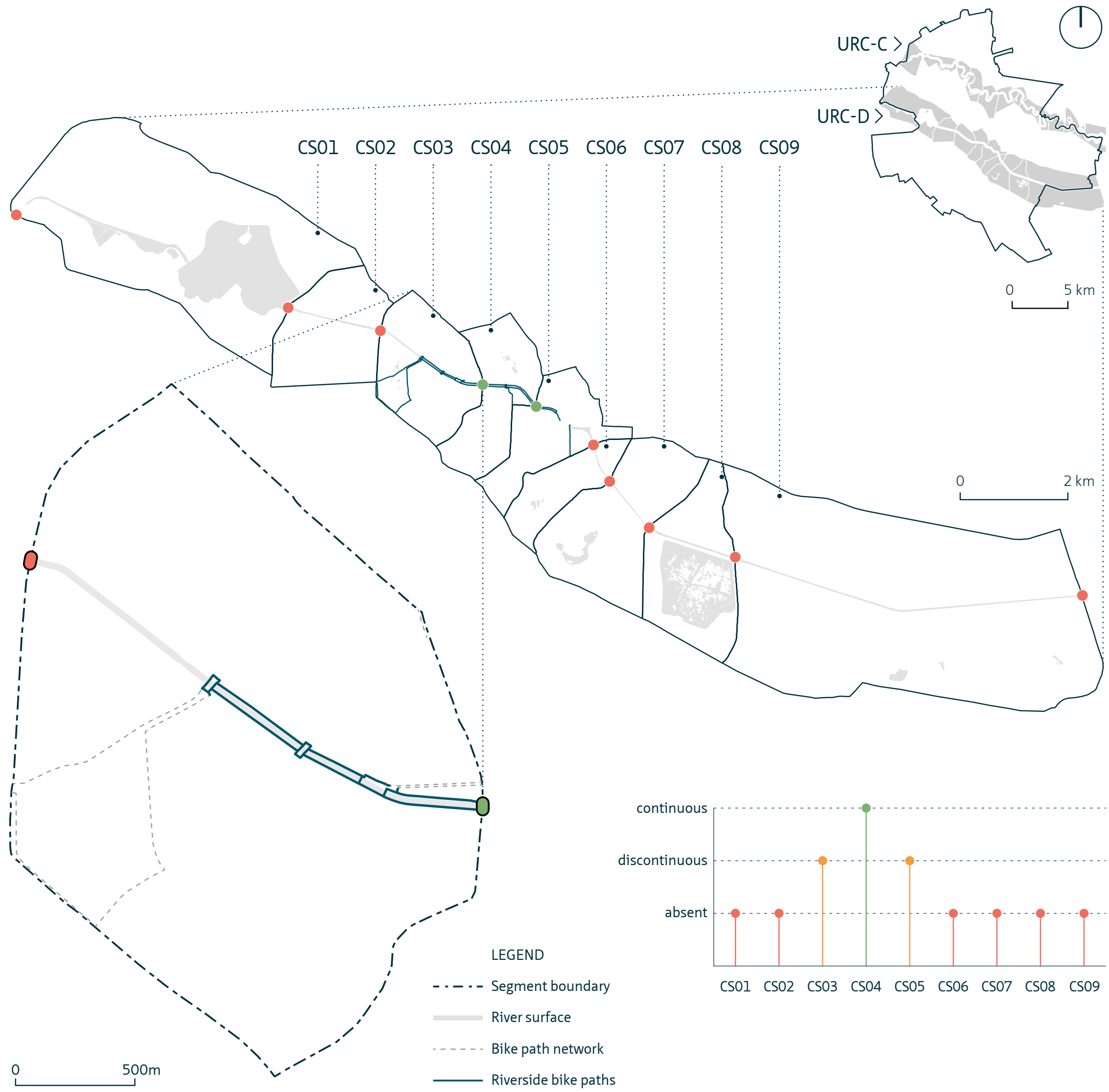


FIGURE APP.E.1 Continuity of slow mobility routes along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	absent	1
CS02	absent	1
CS03	discontinuous	2
CS04	continuous	3
CS05	discontinuous	2
CS06	absent	1
CS07	absent	1
CS08	absent	1
CS09	absent	1

TABLE APP.E.2 Results of indicator A.1.1.1a.

Percentage of riverside slow mobility routes (A.1.1.1b)

Definition:

This indicator measures the percentage of waterside slow mobility routes out of the total length of the riverside paths. The following three-point scale is used: **[1] <50%**; **[2] ≥50** or **<75%**; **[3] ≥75%**.

Input data:

- Corridor segment boundary
- River polygon (OSM: nature=water + waterway=riverbank)[81]
- Road network within the corridor segment (OSM: highway=*)
- Bike path network within the corridor segment (OSM: highway=cycleway OR highway=pedestrian OR highway=path OR highway=footway OR highway=bridleway)
- Buffer distance[82]

Implementation:

1. A buffer of 25m from the river polygon is used to clip the road segments.
2. In order to outline the riverbanks, the river polygon is transformed into lines and the end segments—that is, the lines intersecting the corridor segment boundary— are removed.
3. The bike paths are extracted from the clipped road segments. Both the clipped road segments and the extracted bike paths are buffered with 5 meters. The two buffers are then intersected with riverbanks.
4. The percentage of slow mobility routes is calculated from ratio between the lines resulted from the intersection of the clipped road buffer with the riverbanks ($\mathbf{L_R}$) and from the clipped bike path buffers with the riverbanks ($\mathbf{L_{BP}}$) respectively.

Results CS03:

- L_R = **4066,7m**
- L_{BP} = **2222,8m**
- Percentage of riverside slow mobility routes: **55%**

81 If the river polygon is interrupted by bridges, the polygon needs to be completed before it can be used as an input.

82 In case of River Dâmbovița, a buffer distance of 25m was considered to be sufficient for the selection of riverside bike paths. A larger buffer might be needed in other cases, therefore it needs to be determined according to the specific configuration of the riverfront that is being assessed.

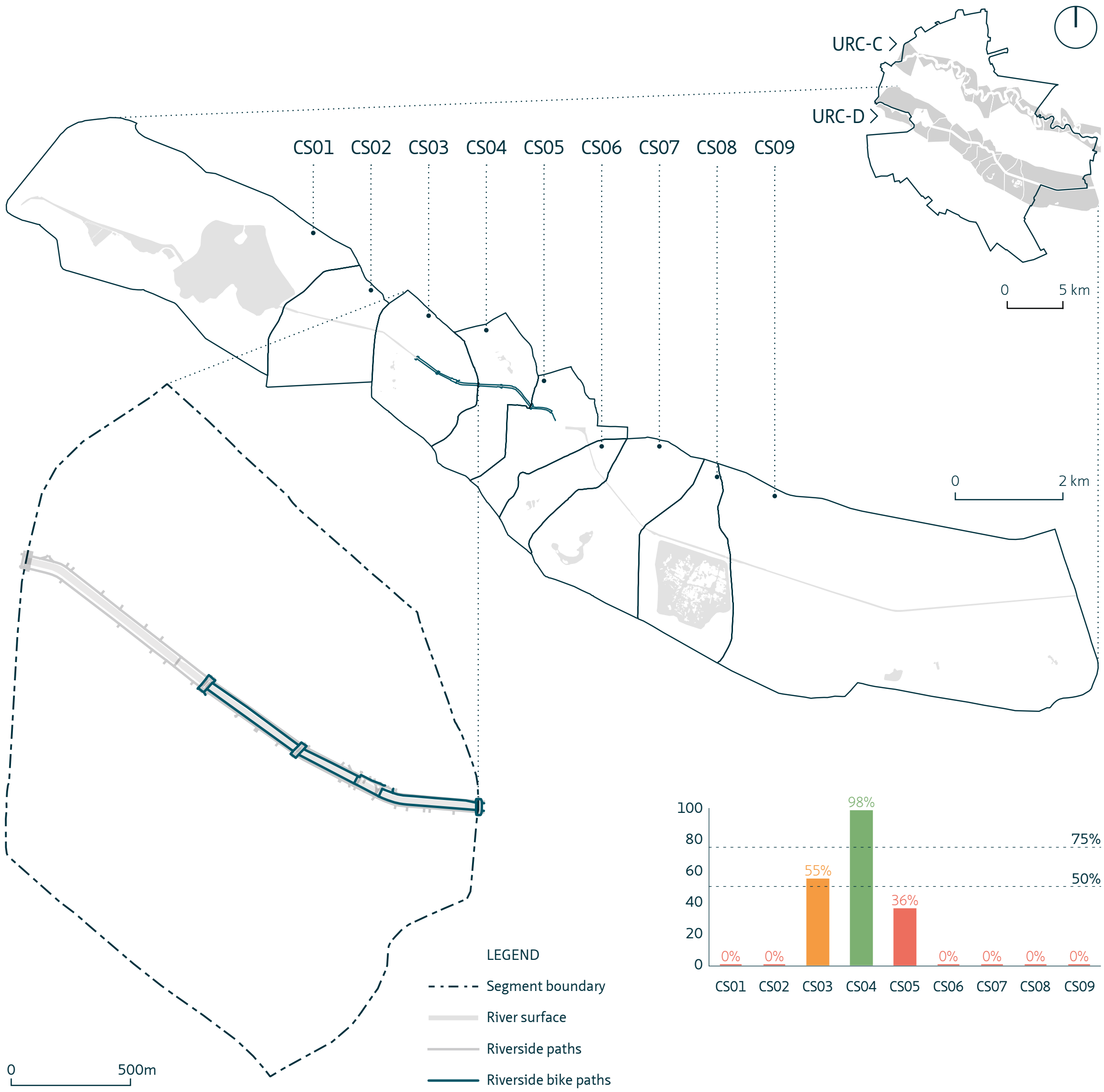


FIGURE APP.E.2 Percentage of slow mobility routes along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	0.00%	1
CS02	0.00%	1
CS03	54.66%	2
CS04	98.25%	3
CS05	35.72%	1
CS06	0.00%	1
CS07	0.00%	1
CS08	0.00%	1
CS09	0.00%	1

TABLE APP.E.3 Results of indicator A.1.1.1b.

Network accessibility (A.1.2.1a)

Definition:

Network accessibility[83] is indicated by the percentage of the total length of riverside segments classified into low, medium and high local integration (R500m), compared to local integration (R500m) of the road network of the whole city. Values: **[1] low**, when medium and high values of local integration are below city low values; **[2] medium**, when medium values are higher than city values, and high values are lower than city values; **[3] high**, when high values are higher than city values.

Input data:

- Corridor segment boundary
- River polygon (OSM: nature=water + waterway=riverbank)[84]
- Road network of the city (OSM: highway=*)
- Buffer distance[85]

Implementation:

1. Before performing the analysis on the road network on city scale, isolated components are excluded from the network and the OSM road centrelines are simplified using the ArcGIS tools for Topological Inconsistency and Line Simplification proposed by Kimon Krenz (2017).[86]
2. Space Syntax analysis of local integration R500m is performed for the city with the *SS toolkit* in QGIS.
3. The result of the analysis is classified in quantiles into [1] low; [2] medium; and [3] high values.
4. A buffer of 25m from the river polygon is used to isolate riverside paths from the classified network.[87]
5. Network accessibility in the corridor segment is evaluated as follows:

- If the total percentage of the total length of riverside paths classified as high is more than the percentage of all road segments of the city with high value, than the score is **[3] high**;
- Else if the total percentage of the total length of riverside paths classified as medium is more than the percentage of all road segments of the city with medium value, than the score is **[2] medium**;
- Else the score is **[1] low**.

Results for CS03:

- Percentage of road segments with high value: **8,68%** < city high value 15,50%
- Percentage of road segments with medium value: **43,63%** > city medium value 23,95%
- Percentage of road segments with low value: **47,69%** < city low value 60,56%
- Network accessibility: **2**

83 In Space Syntax theory integration is a measure of accessibility (e.g. Hillier, 2012).

84 If the river polygon is interrupted by bridges, the polygon needs to be completed before it can be used as an input.

85 In case of River Dâmbovița, a buffer distance of 25m was considered to be sufficient for the selection of riverside bike paths. A larger buffer might be needed in other cases, therefore it needs to be determined according to the specific configuration of the riverfront that is being assessed.

86 The workflow presented by Krenz (2017) includes two more steps: Dual Line Removal and Road Detail Removal. The algorithms used in those steps haven't given satisfying results and were excluded from this workflow. On the other hand, the algorithms addressing Topological Inconsistency and Line Simplification have reduced considerably the amount of road segments without altering the results of the analysis.

87 In case of River Dâmbovița, a buffer distance of 25m was considered to be sufficient. The buffer is case specific and needs to be determined according to the specific configuration of the riverfront that is being assessed.

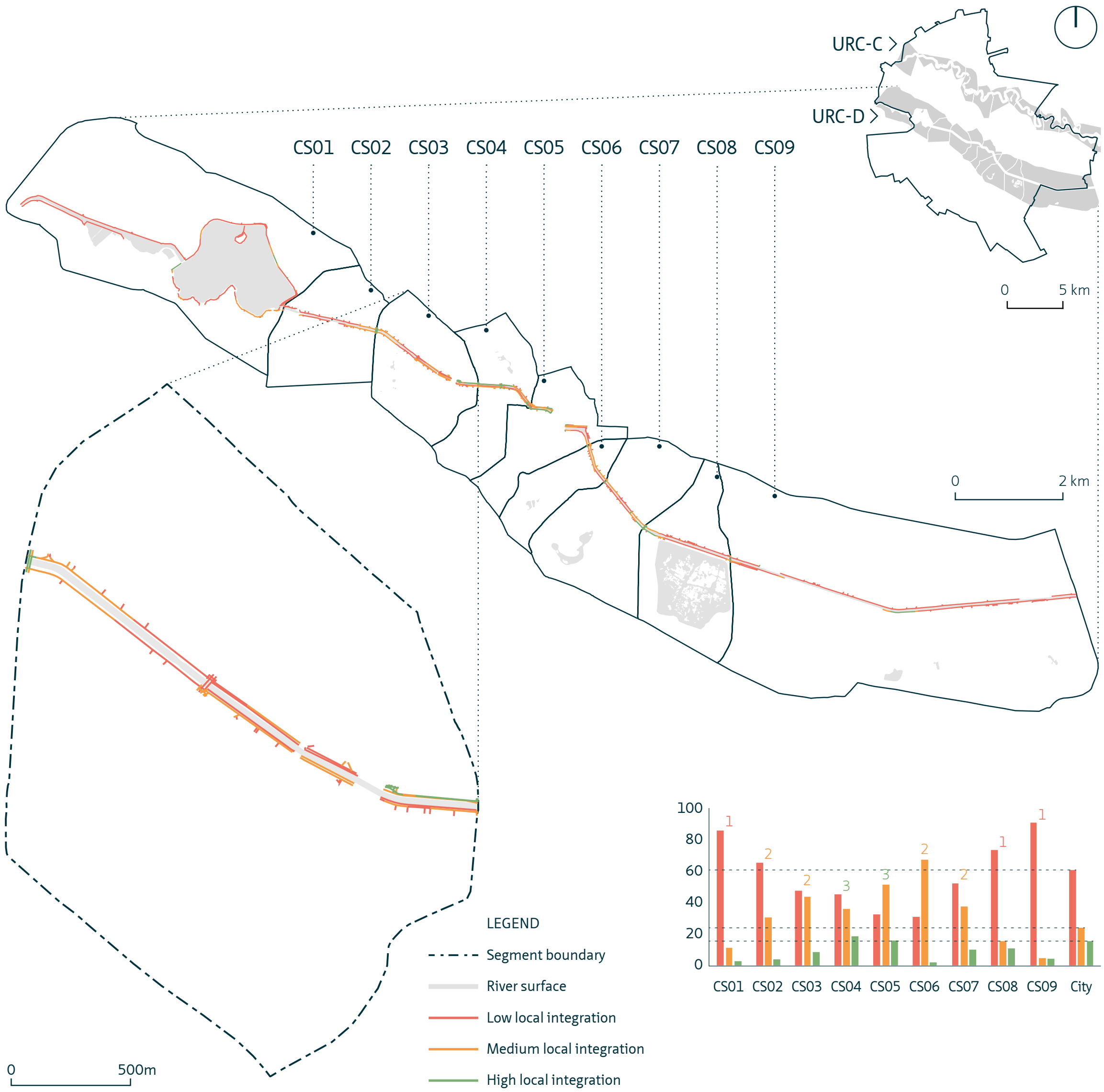


FIGURE APP.E.3 Network accessibility along URC Dâmbovița, with detail of CS03.

SEGMENT	PLEN1	PLEN2	PLEN3	INDEX
CS01	85.86%	11.39%	2.75%	1
CS02	65.36%	30.70%	3.94%	2
CS03	47.69%	43.63%	8.68%	2
CS04	45.31%	36.15%	18.54%	3
CS05	32.71%	51.46%	15.82%	3
CS06	30.90%	67.10%	2.00%	2
CS07	52.26%	37.51%	10.23%	2
CS08	73.54%	15.41%	11.05%	1
CS09	90.84%	4.72%	4.45%	1

TABLE APP.E.4 Results of indicator A.1.2.1a.

Public transport accessiblitiy (A.1.2.1c)

Definition:
Accessibility of the river space by pedestrians from public transport stops (bus, tram, metro) per corridor and river segment. This indicator shows the percentage of the total river length accessible by public transport in a 500m distance. Values: **[1] below 50%**; **[2] medium 50%-75%**; **[3] above 75%**.

Input data:
- Corridor segment boundary
- River polygon (OSM: nature=water + waterway=riverbank)[88]
- Road network within the corridor segment (OSM: highway=*)
- Metro, bus and tram stops (OSM: railway=station + highway=bus_stop + railway=tram_stop)
- Radii for bus/tram stops and metro stations
- Buffer distance[89]

Implementation:
1. Metro stops in a search distance of 500m and bus/tram stops in a search distance of 250m around the corridor segment boundary are selected as potential access points from the public transport network to the river.[90]
2. Riverside paths are clipped from the road network with a buffer of 25m from the water polygon.
3. Service areas are calculated from the bus and tram stops (250m) and from the metro stops (500m). The two service areas are merged. The percentage of the riverside paths which are included in the merged service area provides the value of this indicator, as follows: **[1] < 50%**; **[2] 50-75%**; **[3] > 75%**.

Results for CS03:
- Length of riverside paths inside the compond service area: **4066,7m**
- Length of riverside paths inside the compond service area: **4066,7m**
- Public transport accessibility: **100%**

88 If the river polygon is interrupted by bridges, the polygon needs to be completed before it can be used as an input.

89 In case of River Dâmbovița, a buffer distance of 25m was considered to be sufficient for the selection of riverside bike paths. A larger buffer might be needed in other cases, therefore it needs to be determined according to the specific configuration of the riverfront that is being assessed.

90 These values represent distances that people are willing to walk to/from public transport stops. Search distances outside the boundaries of the corridor segment were selected accordingly.

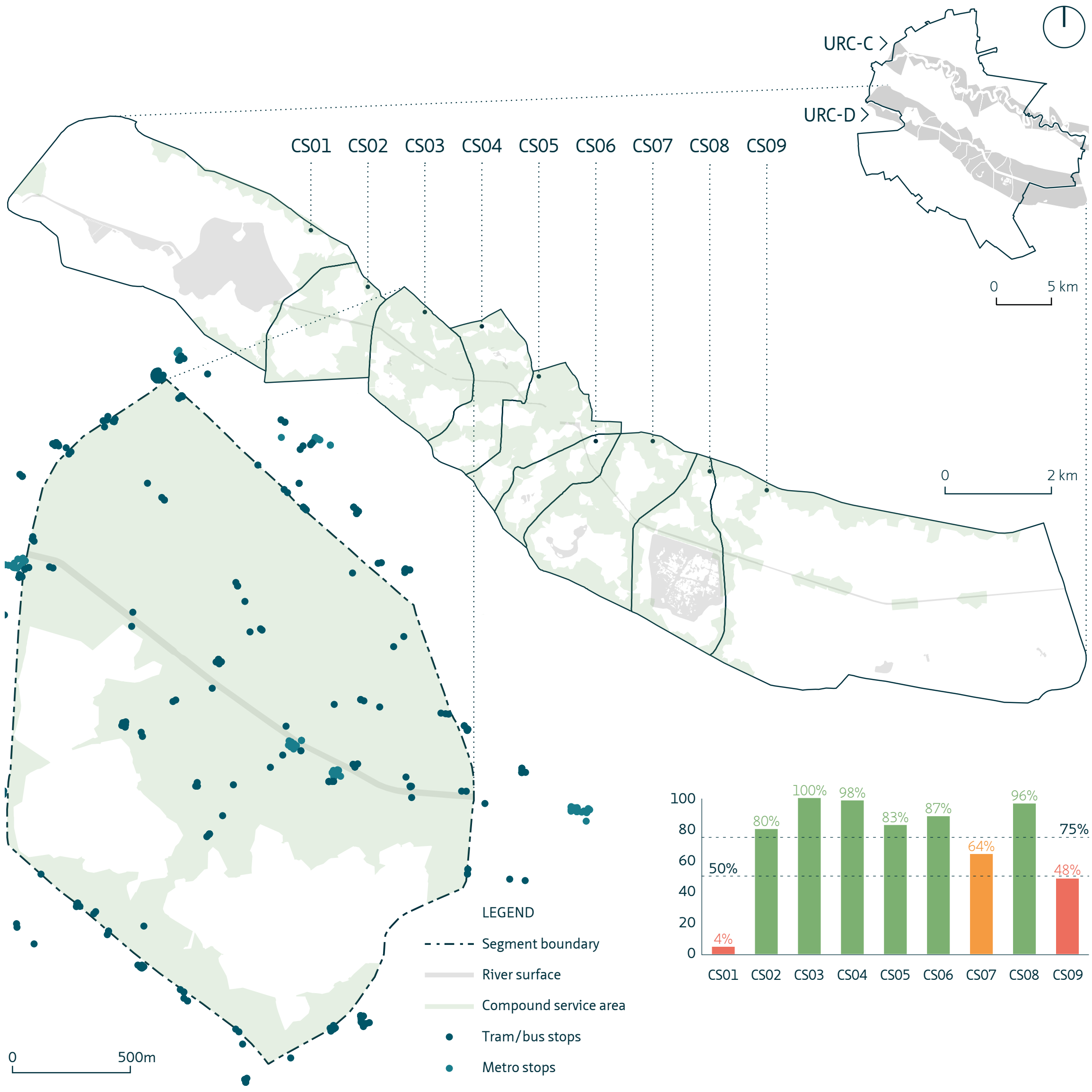


FIGURE APP.E.4 Public transport accessibility along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	3.674%	1
CS02	79.94%	3
CS03	100.00%	3
CS04	98.49%	3
CS05	82.57%	3
CS06	86.96%	3
CS07	63.89%	2
CS08	96.45%	3
CS09	48.36%	1

TABLE APP.E.5 Results of indicator A.1.2.1c.

Crossability - linear density of bridges (A.1.2.3a)

Definition:
The linear density of pedestrian/bike bridges (number of crossings/km) (Silva et al., 2004; 2006; 2013) indicates to what extent the river is perceived as a barrier to transversal movement. The scale is determined based on the minimum plausible and maximum plausible number of pedestrian bridges per corridor segment. Silva et al. use a maximum plausible value of 4 bridges/km. Values: **[1] 0-1 bridge/km**; **[2] 2-3 bridges/km**; **[3] ≥4 bridges/km**.

Input data:
- Corridor segment boundary
- River centreline (OSM: waterway=river)[91]
- Bridge lines (OSM: bridges=yes)

Implementation:
1. To obtain the length of the river (L_R), the river centreline is dissolved and clipped to the corridor segment boundary.
2. The bridges are obtained from the OSM data as follows:
- In order to simplify multi-lane roads the OSM road segments labeled with 'bridge=yes' are merged with the ArcGIS tool Merge Divided Roads. A merge distance of 5 meters is used.
- The merged road lines are intersected with the river centreline. The resulting intersection points represent the bridges across the river. The number of bridges (**B**) is obtained by counting the bridges within the corridor segment boundary. Bridges on shared corridor segment boundaries are counted in both corridor segments.
3. The linear density of crossings is $\mathbf{B / L_r}$.

Results for CS03:
- B = **6**
- L_r = **2,2km**
- Linear density of crossings = **2,72 bridges/km**

91 In some cases the definition waterway=stream may need to be added to the selection. The river line must be dissolved before used as an input.

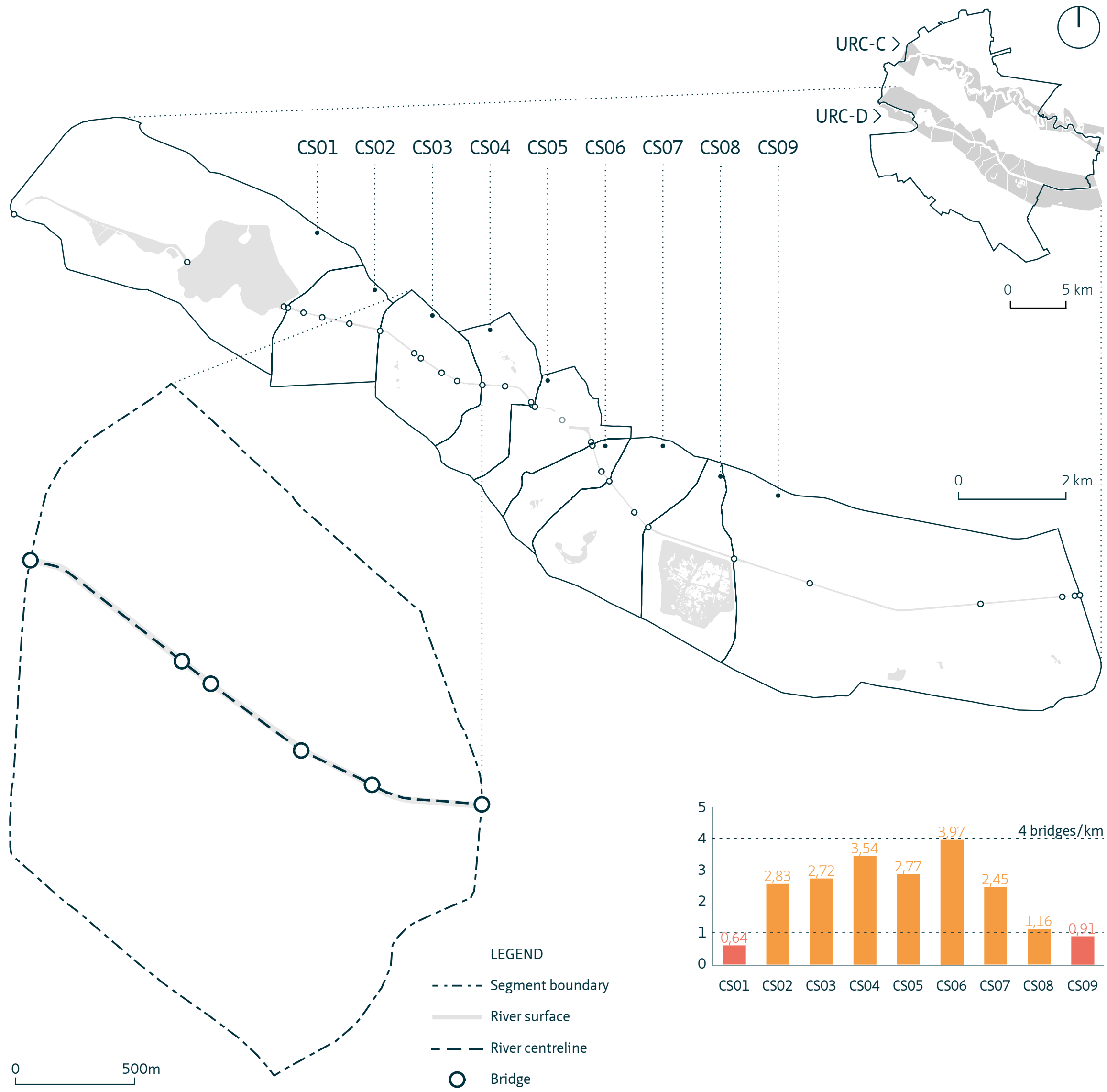


FIGURE APP.E.5 Crossability - linear density of bridges along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	0.64	1
CS02	2.83	2
CS03	2.72	2
CS04	3.54	2
CS05	2.77	2
CS06	3.97	2
CS07	2.45	2
CS08	1.16	2
CS09	0.91	1

TABLE APP.E.6 Results of indicator A.1.2.3a.

Crossability - river width (A.1.2.3b)

Definition:
Crossability is measured in function of the width of the river: **[1] rarely bridged** above 400m; **[2] hard to bridge** between 50-400m; or **[3] easily bridged** below 50m.

Input data:
- Corridor segment boundary
- River polygon (OSM: nature=water + waterway=riverbank)[92]
- River centreline (OSM: waterway=river)[93]
- Disaggregation step for width assessment: 50 m

Implementation:
1. The tool *Fluvial Corridor* for ArcGIS[94] is used to calculate perpendicular distances from the river centreline to the edge of the river polygon. The distances are recorded in points on the river centreline with a disaggregation step of 50m (i.e. river widths are calculated every 50 meters).
2. Each point is then classified on the three-point scale of the indicator. If all values are in one of the three classes, the corridor segment is classified accordingly. If the points are not in the same class (variable river width), then the average width (MEAN) determines the class of the corridor segment.

Results for CS03:
- MEAN: **27,19 m**

92 If the river polygon is interrupted by bridges, the polygon needs to be completed and dissolved before it can be used as an input.

93 In some cases the definition waterway=stream may need to be added to the selection. The river line must be dissolved before used as an input.

94 The tool is available at http://umrevs-isig.fr/node/34 Source: Roux, C., Alber, A., Bertrand, M., Vaudor, L., Piegay, H., submitted. "FluvialCorridor" : A new ArcGIS package for multiscale riverscape exploration. Geomorphology

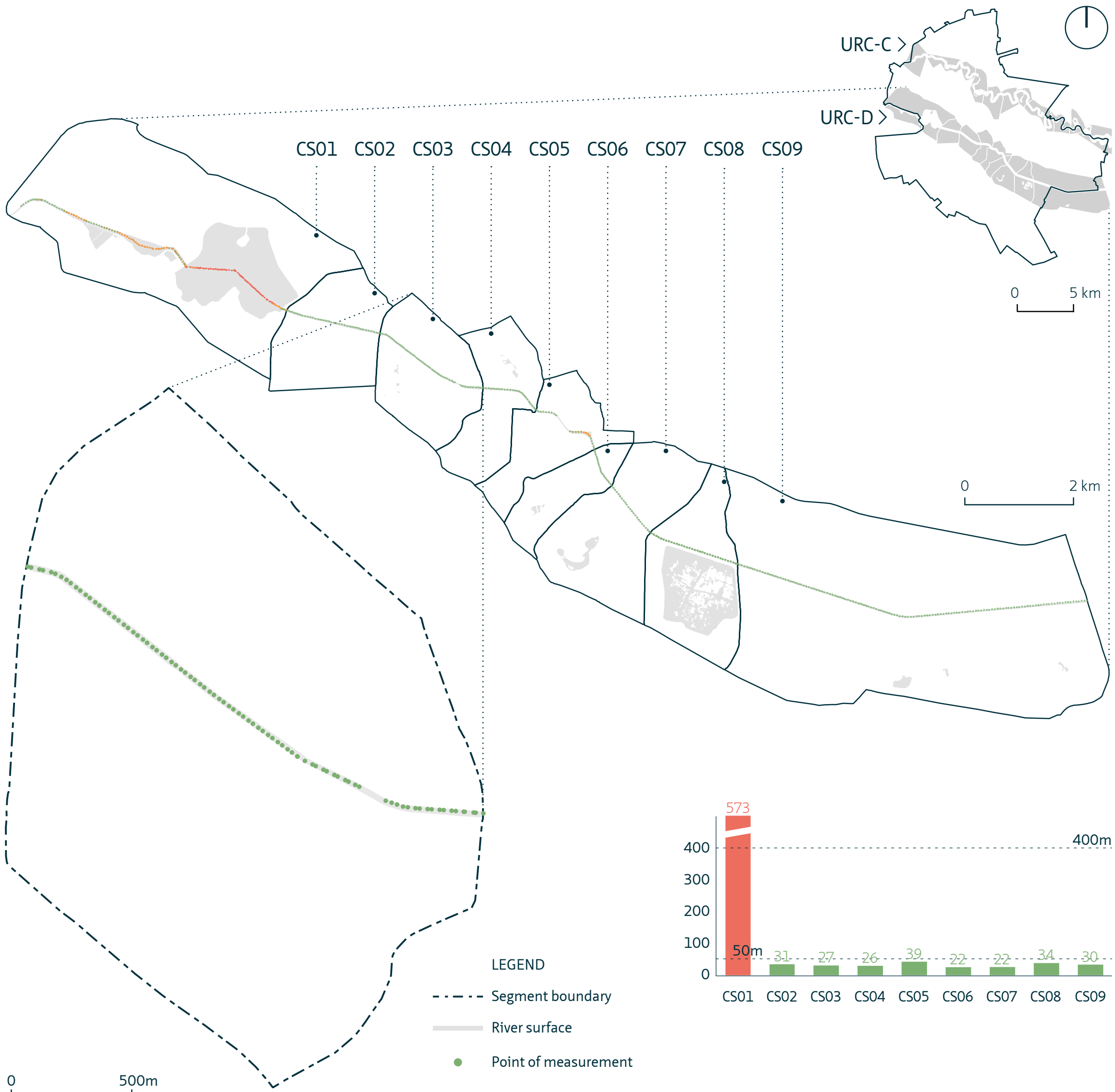


FIGURE APP.E.6 Crossability - river width along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	572.596	1
CS02	30.989	3
CS03	27.192	3
CS04	26.084	3
CS05	39.150	3
CS06	21.939	3
CS07	22.067	3
CS08	34.398	3
CS09	29.890	3

TABLE APP.E.7 Results of indicator A.1.2.3b.

Contact with water - linear density of points of contact with water (A.1.3.1a)

Definition:
This indicator measures the number of points of access to water (e.g. stairs, beaches, piers). Values: **[1] < 2 contact points per km**; **[2] 2-4 contact points per km**; **[3] >4 contact points per km**.

Input data:
- Corridor segment boundary
- River polygon (OSM: nature=water + waterway=riverbank)[95]
- River centreline (OSM: waterway=river)[96]
- Points of contact with water (Manually traced on satellite base map or collected via survey)

Implementation:
1 Using a satellite base map or a site survey, points of contact with water are located on open (uncovered) riverbank lines. The value of the indicator is given by the ratio of the total number of contact points (**P_C**) divided by the total length of open riverbanks (**L_{RB}**).

Results for CS03:
- P_C = **2**
- L_{RB} = **4,07km**
- Points of contact per km: **0,49**

95 If the river polygon is interrupted by bridges, the polygon needs to be completed and dissolved before it can be used as an input.

96 In some cases the definition waterway=stream may need to be added to the selection. The river line must be dissolved before used as an input.

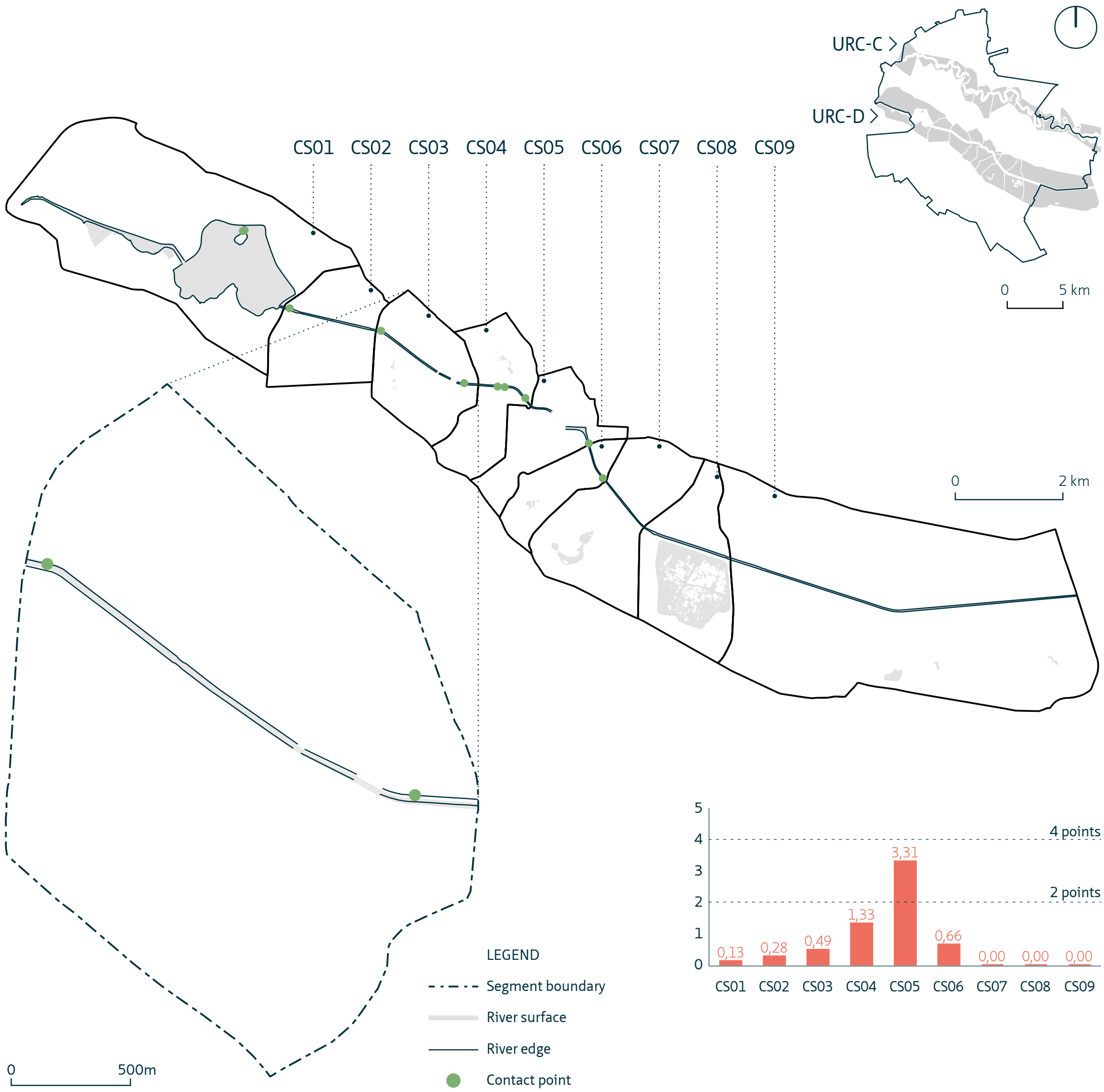


FIGURE APP.E.7 Linear density of points of contact with water along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	0.13	1
CS02	0.28	1
CS03	0.49	1
CS04	1.33	1
CS05	3.31	2
CS06	0.66	1
CS07	0.00	1
CS08	0.00	1
CS09	0.00	1

TABLE APP.E.8 Results of indicator A.1.3.1a.

Landscape connectivity - actual (A.2.1.1a)

Definition:
Landscape connectivity is indicated by the number of connected components formed by existing patches in the corridor. Values: **[1] disconnected**; **[2] fragments**; **[3] connected**.

Input data:
- Urban river corridor boundary
- Corridor segment boundary
- Land use data[97] (OSM: landuse=aeroway_polygon, amenity_polygon, landuse_polygon, leisure_polygon, natural_polygon, sport_polygon, and waterway_polygon)
- Edge-to-edge (EE) distance: 200m

Implementation:
The tool *MatrixGreen* for ArcMap is used to perform the component analysis (overall patch network performance), as follows:

1. Vegetated (ecologically functional) and non-vegetated (potential) patches are extracted from the following OSM layers: aeroway_polygon, amenity_polygon, landuse_polygon, leisure_polygon, natural_polygon, sport_polygon, and waterway_polygon. Isolated buildings and overlaps are removed.
2. The resulting patches are merged and converted into a patch set in MatrixGreen. Links with a maximum edge-to-edge (EE) distance of 200m[98] are created.
3. A component analysis of the resulting patch set and links determines the number of connected components in the corridor. If there is one major component crossing the whole corridor the URC is classified as **[3] connected**; if up to 5 largest components which do not cross the corridor could be connected if the EE distance would be increased to 300m, the corridor is classified as **[2] disconnected**; if the corridor is still disconnected after the EE distance is increased, it is classified as **[1] fragmented**.

Results for CS03:
- Number of actual connected components: **1**

97 Land cover data is currently only implied by other tags, such as some types of landuse=*, surface=* and natural=*. Landcover=* to directly tag land cover types is among the proposed features in OpenStreetMap. (Source: http://wiki.openstreetmap.org/wiki/Landcover)

98 The maximum distance of 200 m is based on Andersson, E, Bodin, O, "Practical tool for landscape planning? An empirical investigation of network based models of habitat fragmentation", in Ecography 32: 123-132, 2009.

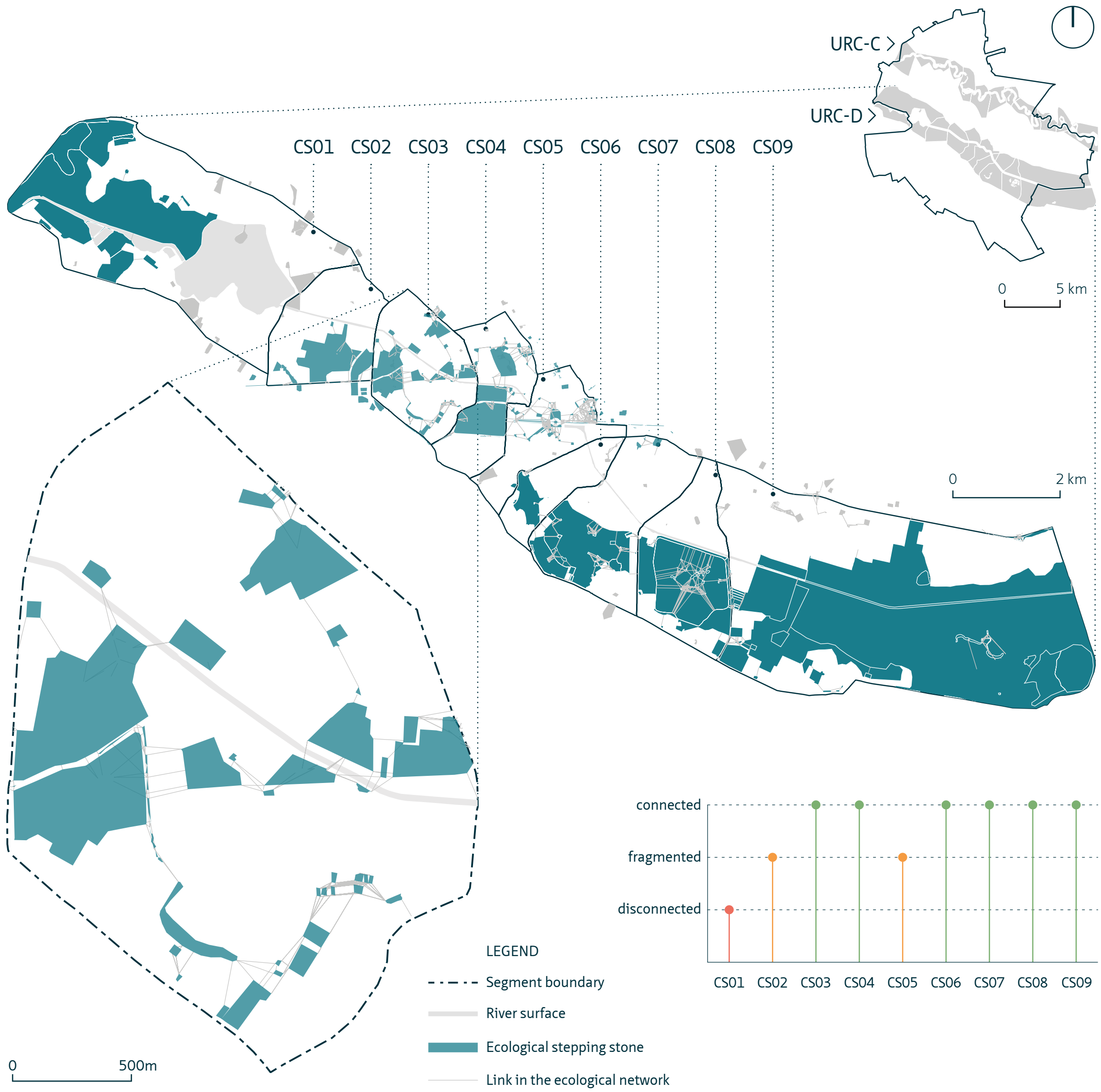


FIGURE APP.E.8 Landscape connectivity along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	disconnected	1
CS02	fragmented	2
CS03	connected	3
CS04	connected	3
CS05	fragmented	2
CS06	connected	3
CS07	connected	3
CS08	connected	3
CS09	connected	3

TABLE APP.E.9 Results of indicator A.2.1.1a.

Presence of transversal corridors (A.2.2.1)

Definition:
Lateral connectivity is measured through the presence of transversal corridors connecting the riverside vegetation to the surroundings. The vegetation on transversal corridors, from the river to the URC edge are mapped and classified into: **[1] absent**; **[2] intermittent**; or **[3] continuous**.

Input data:
- Corridor segment boundary
- Road network within the corridor segment (OSM: highway=*)
- Green spaces

Implementation:
1. All side streets that intersect riverside paths within the corridor segment are selected as follows:
   - before running the analysis, create natural roads using *Axwoman* for ArcGIS;[99]
   - all streets which partially overlap the streets clipped to the 25m buffer around the river polygon are selected, while streets which completely overlap are considered to be riverside streets and are excluded.
2. A buffer of 25m is created around green spaces in the corridor segments.
3. The length of transversal corridors is determined by intersecting the transversal roads (step 1) with the buffered green spaces (step 2).
4. The presence of transversal corridors is expressed as a percentage of the total length of transversal green corridors ($\mathbf{L_{tgc}}$) out of the total length of transversal roads ($\mathbf{L_{tr}}$).

Results for CS03:
- L_{tgc} = **6125 m**
- L_{tr} = **14597 m**
- Transversal green corridors: **42%**

99 Axwoman 6.3 for ArcGIS 10.3.1 was used. Source: Jiang B. (2015), Axwoman 6.3: An ArcGIS extension for urban morphological analysis, http://fromto.hig.se/~bjg/Axwoman/, University of Gävle, Sweden.

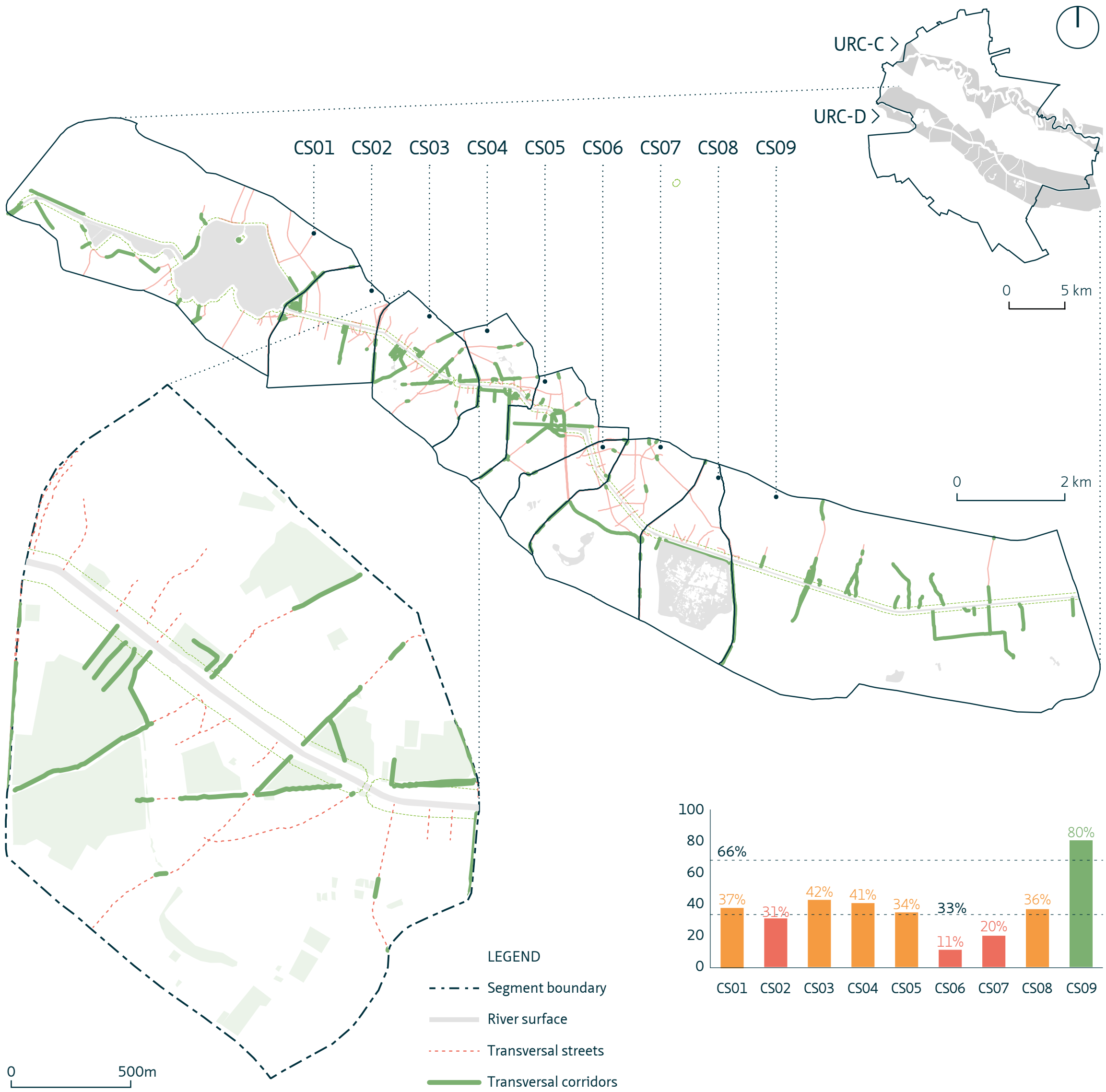


FIGURE APP.E.9 Presence of transversal corridors along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	36,86%	2
CS02	30,61%	1
CS03	41,96%	2
CS04	40,50%	2
CS05	34,38%	2
CS06	10,98%	1
CS07	19,97%	1
CS08	36,19%	2
CS09	80,35%	3

TABLE APP.E.10 Results of indicator A.2.2.1.

Sinuosity (A.2.2.3)

Definition:
Sinuosity is a measure of channel form complexity which may be used, within lateral connectivity, as an indicator of (not the presence of, but the spatial conditions for) biodiversity. Sinuosity is "the existence or absence of a meandering pattern in the landscape." (Silva et al., 2004, pp.34-6) Sinuosity can be determined by dividing channel length (L_r) with down-valley length (L_v). Values: **[1] almost straight** between 1,00-1,05; **[2] sinuous** between 1,05-1,50, and **[3] meandering** above 1,50.

Input data:
- Corridor segment boundary
- River centreline (OSM: waterway=river)[100]

Implementation:
1. The river centreline is clipped to the corridor segment boundary.
2. The down-valley length is determined by river centreline.
3. The sinuosity is determined with the formula L_r / L_v.

Results for CS03:
- L_r = **2,19km**
- L_v = **2,15km**
- Sinuosity: **1.02 (almost straight)**

100 In some cases the definition waterway=stream may need to be added to the selection. The river line must be dissolved before used as an input.

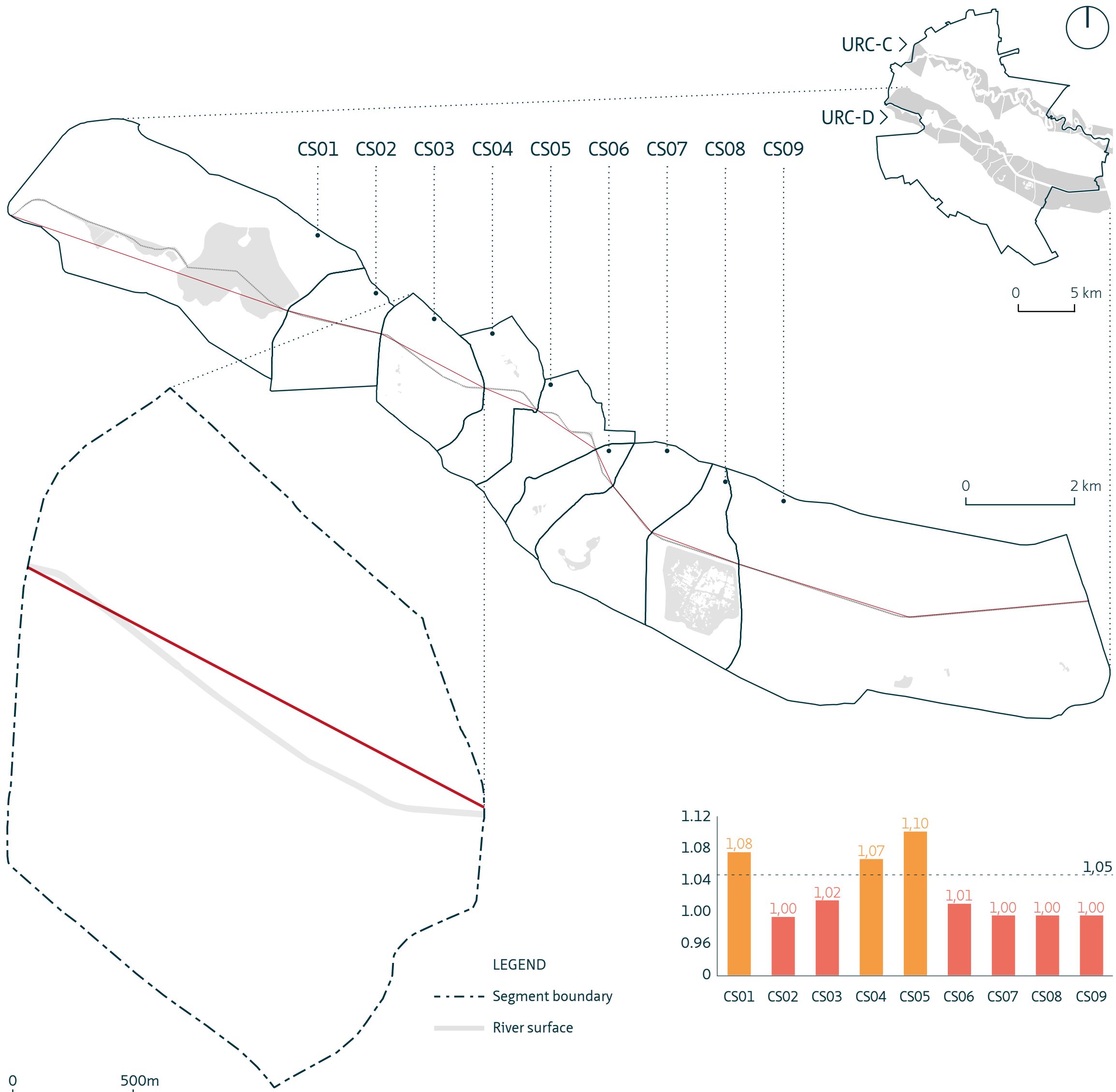


FIGURE APP.E.10 Sinuosity along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	1.08	2
CS02	1.00	1
CS03	1.02	1
CS04	1.07	2
CS05	1.10	2
CS06	1.01	1
CS07	1.00	1
CS08	1.00	1
CS09	1.00	1

TABLE APP.E.11 Results of indicator A.2.2.3.

Presence of ecotones (A.2.3.1)

Definition:

The presence of ecotones is determined on the edges of the river and it is expressed as a percentage of the total length of ecotones ($\mathbf{L_{ec}}$) out of the total length of river edges ($\mathbf{L_{re}}$). Values are classified as follows: **[1] low** for values below 25%; **[2] medium** for values greater than 25% but lower than 50%; and **[3] high** for values higher than 50%.

Input data:

- Corridor segment boundary
- Classified riverbanks[101]

Results for CS03:

- % L_{ec}/L_{re} = **0%**
- Presence of ecotones: **low**.

101 The present assessment is based on classification of the presence of ecotones on riverbanks as seen on satellite imagery and in photos. For a detailed and accurate classification of the riverbanks, a survey must be carried out.

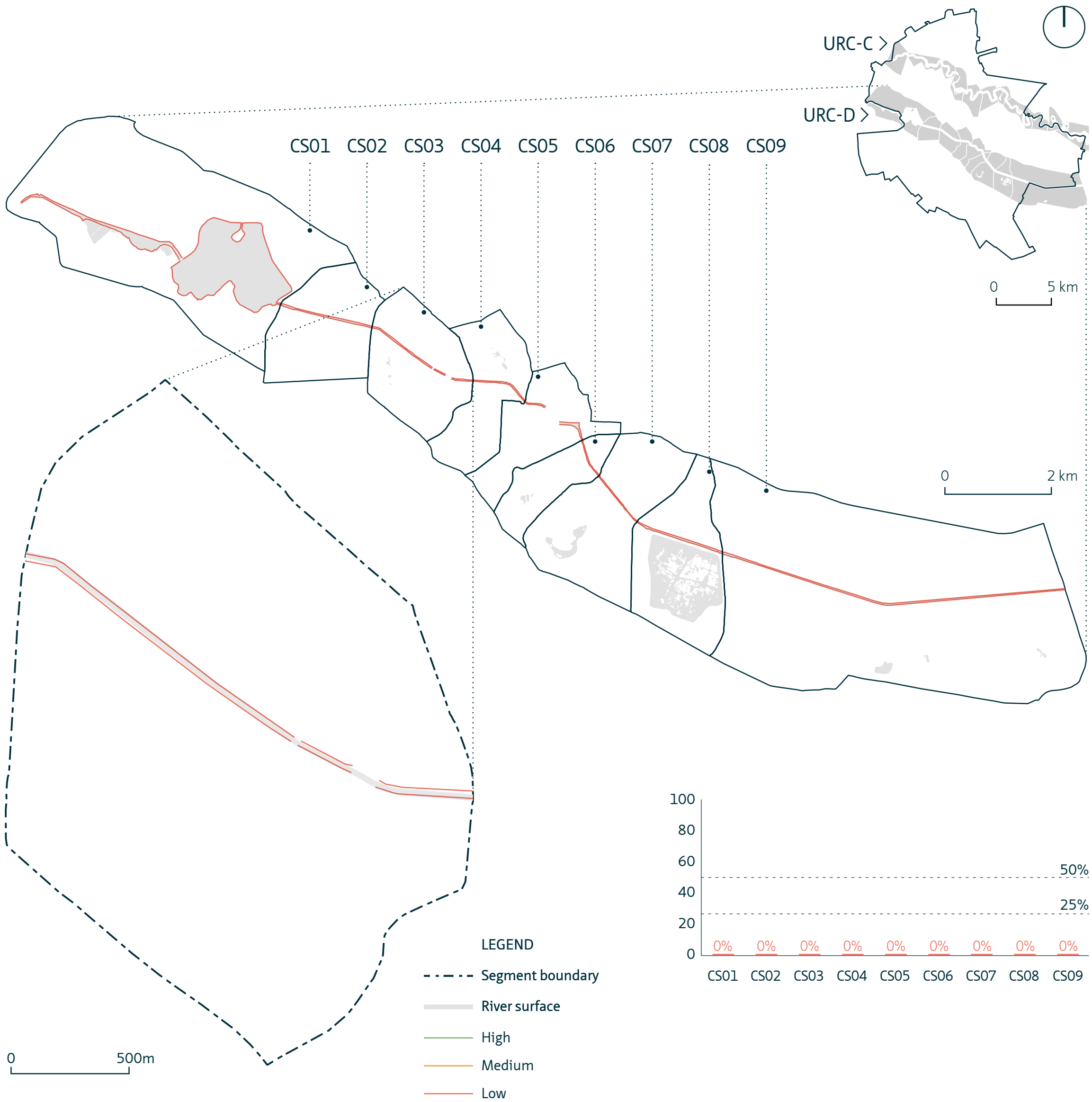


FIGURE APP.E.11 Percentage of ecotones along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	0%	1
CS02	0%	1
CS03	0%	1
CS04	0%	1
CS05	0%	1
CS06	0%	1
CS07	0%	1
CS08	0%	1
CS09	0%	1

TABLE APP.E.12 Results of indicator A.2.3.1.

Diversity of land uses—patch richness density (B.1.1.1a)

Definition:

Patch richness density (PRD),[102] representing the number of different land use classes per 100 hectares within the study area, is used as a measure of land use diversity. Values: **[1] PRD < 0,25**; **[2] 0,25 ≤ PRD < 0,75**; **[3] PRD ≥ 0,75**.

Input data:

- URC and corridor segment boundaries
- Urban Atlas data for the study area[103]

Implementation:

1. Urban Atlas data is reclassified as shown in Table.App.E.13.
2. To isolate land uses interacting with the river space, polygons within a buffer of 150m from the river are selected from the Urban Atlas data.
3. The number of different classes (**n**) is recorded for each corridor segment.
4. The PRD values assigned to the corridor segments are given by the ratio $\mathbf{PRD = n / A_{rs} * 100}$, i.e. the number of different classes per 100 hectares.
5. Final values are normalised[104] and classified as follows: **[1] PRD < 0,25**; **[2] 0,25 ≤ PRD < 0,75**; **[3] PRD ≥ 0,75**.

Results for CS03:

- Number of different classes: **4**
- PRD = 4 / 123,77ha * 100 = **3,232 classes/100 ha**
- Normalised PRD = **0,413** > 0,25 **[class 2]**

CLASS	NAME	UA CODE	SEALING
C1	Continuous urban fabric areas	11100	80-100%
C2	Discontinuous dense urban fabric	11121	50-80%
C3	Discontinuous urban fabric	11220, 11230, 11240, 11300	< 50%
C4	Industrial/commercial areas	12100	
C5	Transport infrastructure	12210, 12220, 12230, 12300,12400	
C6	Mine/Dump sites, Construction/Land without use	13100, 13300, 13400	
C7	Green areas and sport facilities	14100, 14200	
C8	Agriculture, Forest, Water	20000, 30000, 50000	

TABLE APP.E.13 Reclassification of Urban Atlas data (based on Prastacos et al., 2017).

102 PRD is a diversity measure of landscape composition.

103 Urban Atlas data is available for the Large Urban Zones of Europe (all urban areas above 100.000 inhabitants, according to the Urban Audit). Source: https://www.eea.europa.eu/data-and-maps/data/urban-atlas#tab-gis-data

104 In absence of a reference (maximum) value, PRD values of all corridor segments of the corridor are normalised, with the highest PRD value equal to 1.

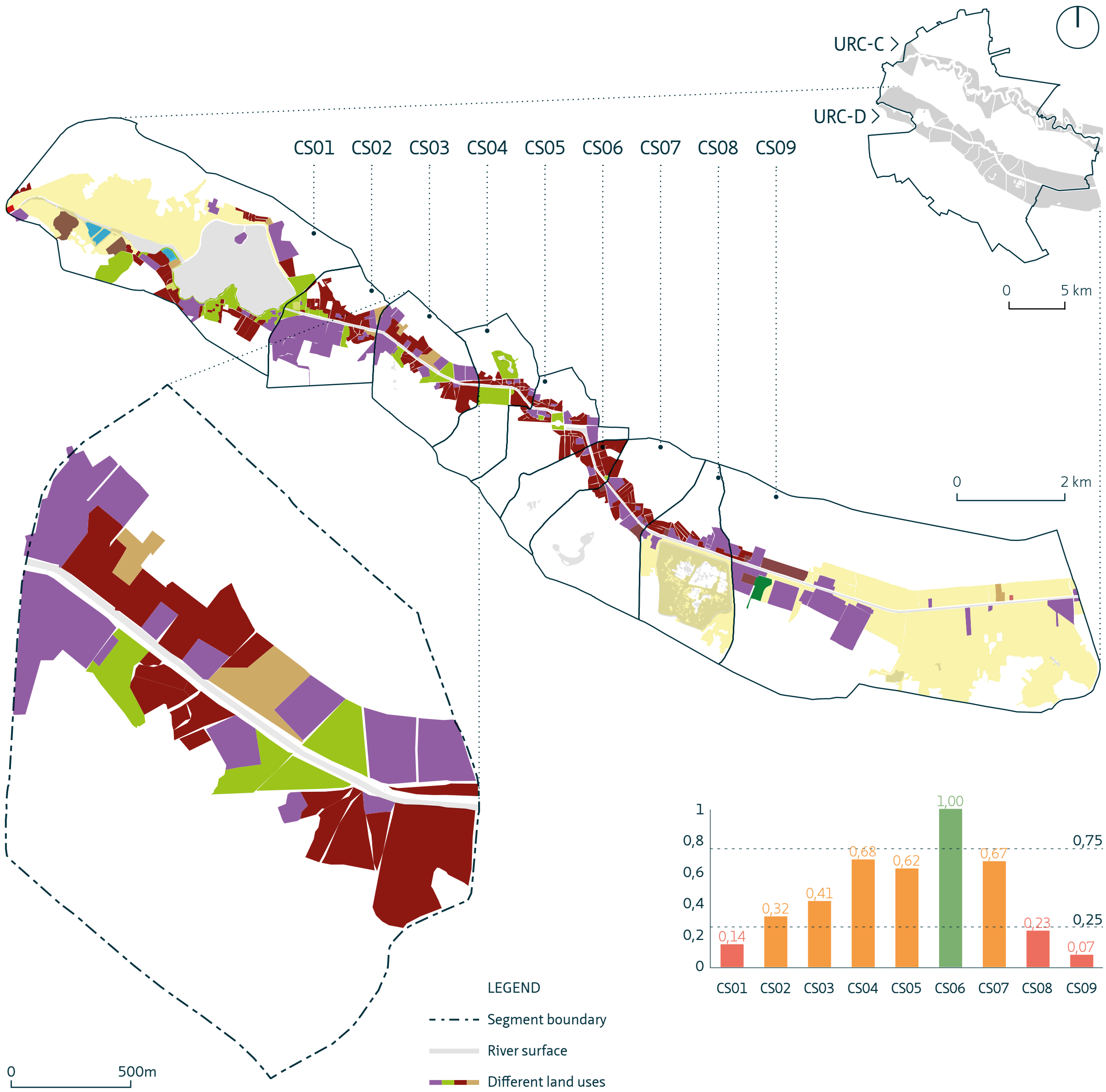


FIGURE APP.E.12 Diversity of land uses - patch richness density along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	0.138	1
CS02	0.316	2
CS03	0.413	2
CS04	0.678	2
CS05	0.620	2
CS06	1.000	3
CS07	0.667	2
CS08	0.225	1
CS09	0.071	1

TABLE APP.E.14 Results of indicator B.1.1.1a.

Visual permeability—% visible river space (B.1.2.1a)

Definition:

Visual permeability is an indicator of spatial quality that shows the percentage of visible open space within the river space. Values: **[1] low visibility**, when lower than 25%, **[2] medium visibility** between 25% and 75%, and **[3] high visibility** above 75%.

Input data:

- Corridor segment boundaries
- Digital elevation model[105]
- Buffer from river edges: 150m
- Buildings (OSM)

Implementation:

1. A digital elevation model (DEM) and buildings within the corridor are used as input to a viewshed analysis. The viewshed analysis is performed from the river edges.
2. A 150m buffer is created along the river edges.
3. The percentage of visible open space is given by dividing the total visibility area (A_{vis}) by the total area of the buffer (A_{tot}) within the corridor segment. Values are classified as **[1] low visibility**, when lower than 25%, **[2] medium visibility** between 25% and 75%, and **[3] high visibility** above 75%.

Results for CS03:

- A_{vis} = **331.866 m^2**
- A_{tot} = **666.947 m^2**
- Visible river space: **49,8%**

105 For the digital elevation model, 30m resolution SRTM data was used. (USGS, 2017)

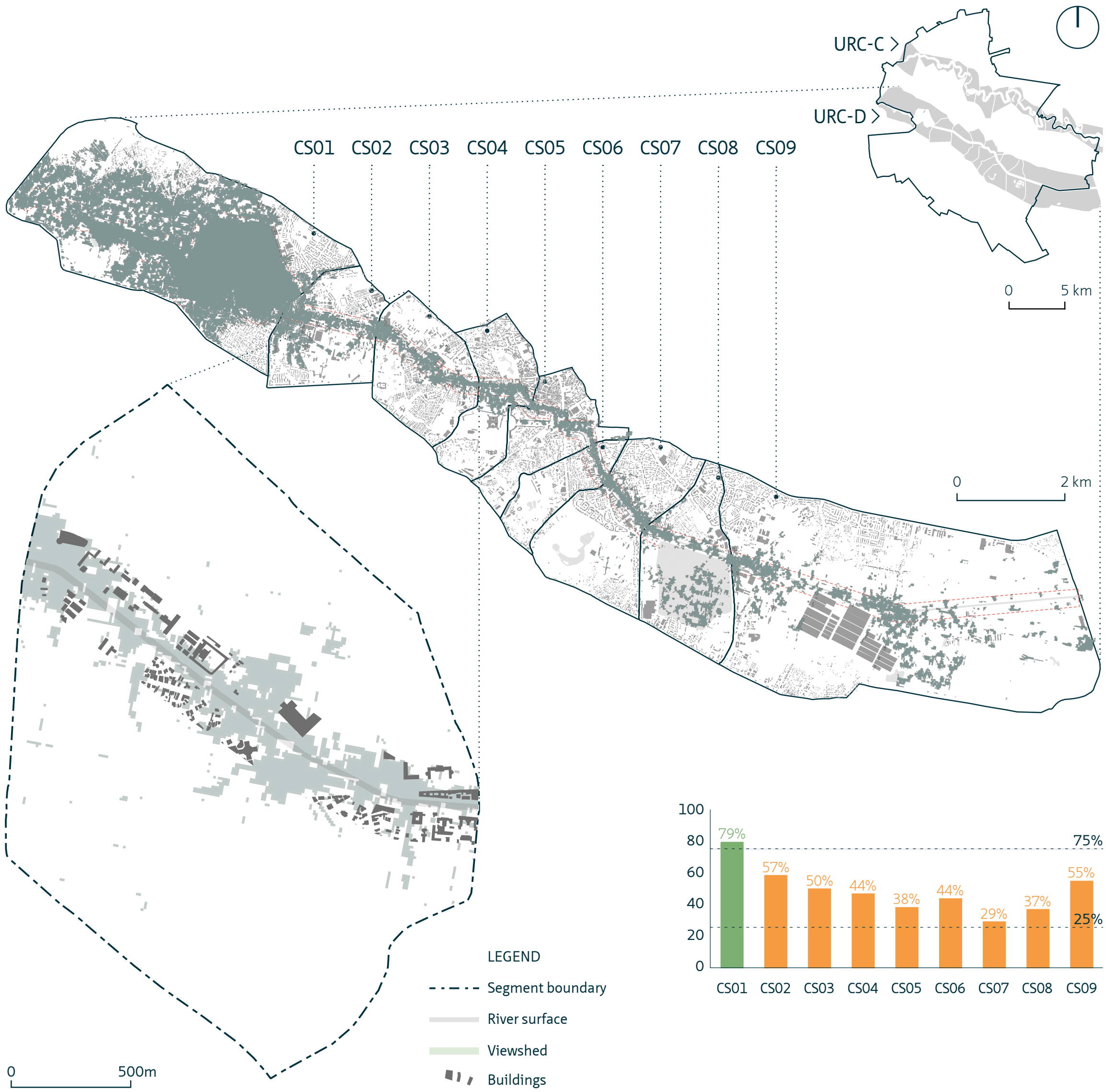


FIGURE APP.E.13 Visual permeability—% visible river space along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	79.198%	3
CS02	57.286%	2
CS03	49.759%	2
CS04	44.412%	2
CS05	37.922%	2
CS06	43.536%	2
CS07	28.944%	2
CS08	36.684%	2
CS09	54.605%	2

TABLE APP.E.15 Results of indicator B.1.2.1a.

Waterfront constitutedness—configuration (B.1.3.2a)

Definition:
Waterfront constitutedness is indicated by the percentage of the total length of built fronts projected on the river edges out of the total length of the river edges, corrected with a coefficient of fragmentation (standard deviation from maximum potential constitutedness). Values are standardized and classified as: **[1] value <= 50%**; **[2] 50% < value <= 75%**; **[3] value > 75%**.

Input data:
- River edges (obtained from OSM river polygon)
- Buildings (OSM)
- URC boundary (traced on OSM road network)
- RS boundaries (traced on OSM road network)

Implementation:[106]
1. Perpendicular lines of 150m are generated every 10m from the river edges.
2. To determine the distance of the built front from the river, the perpendicular lines are intersected with the buildings in the river front (i.e. buildings selected within a buffer of 150m from the river edges). Lines with a length equal to 150m, indicating absence of a waterfront, are excluded.
3. The remaining lines are aggregated into polygons with a dissolved buffer of the lines comprised between 45 and 50 meters (47.5 m). This has to be done when a distance of 100 m as considered to be a break in the waterfront. The resulting polygons are cut using the first and the last perpendicular lines of each waterfront.
4. The buffers are intersected with the riversides to calculate the length of each riverfront. The intersected lines and the perpendicular ones are spatially joined, summarizing the Standard Deviation (STD). A coefficient (c) is assigned as follows: 1 if the STD is below 30 (this means that the waterfront is constituted), 0.5 if the STD is more than 30.
5. Waterfront constitutedness for each corridor segment is calculated with the formula:

$$\frac{\sum\left(L_{wf} \times c\right)}{L_{tot}} \times 100$$

where $\mathbf{L}_{wf}$ is the length of each waterfront, $\mathbf{L}_{tot}$ is the total length of the riversides in each segment, and **c** is the coefficient described at point 4. The final score is determined by classifying the value using the following breaks: **[1] value <= 50%**; **[2] 50% < value <= 75%**; **[3] value > 75%**.

Results for CS03:
- Waterfront constitutedness: **76%**

106 For the following workflow ArcGIS 10.5.0 was used. All features must be in the ETRS89_LAEA_Europe coordinate system.

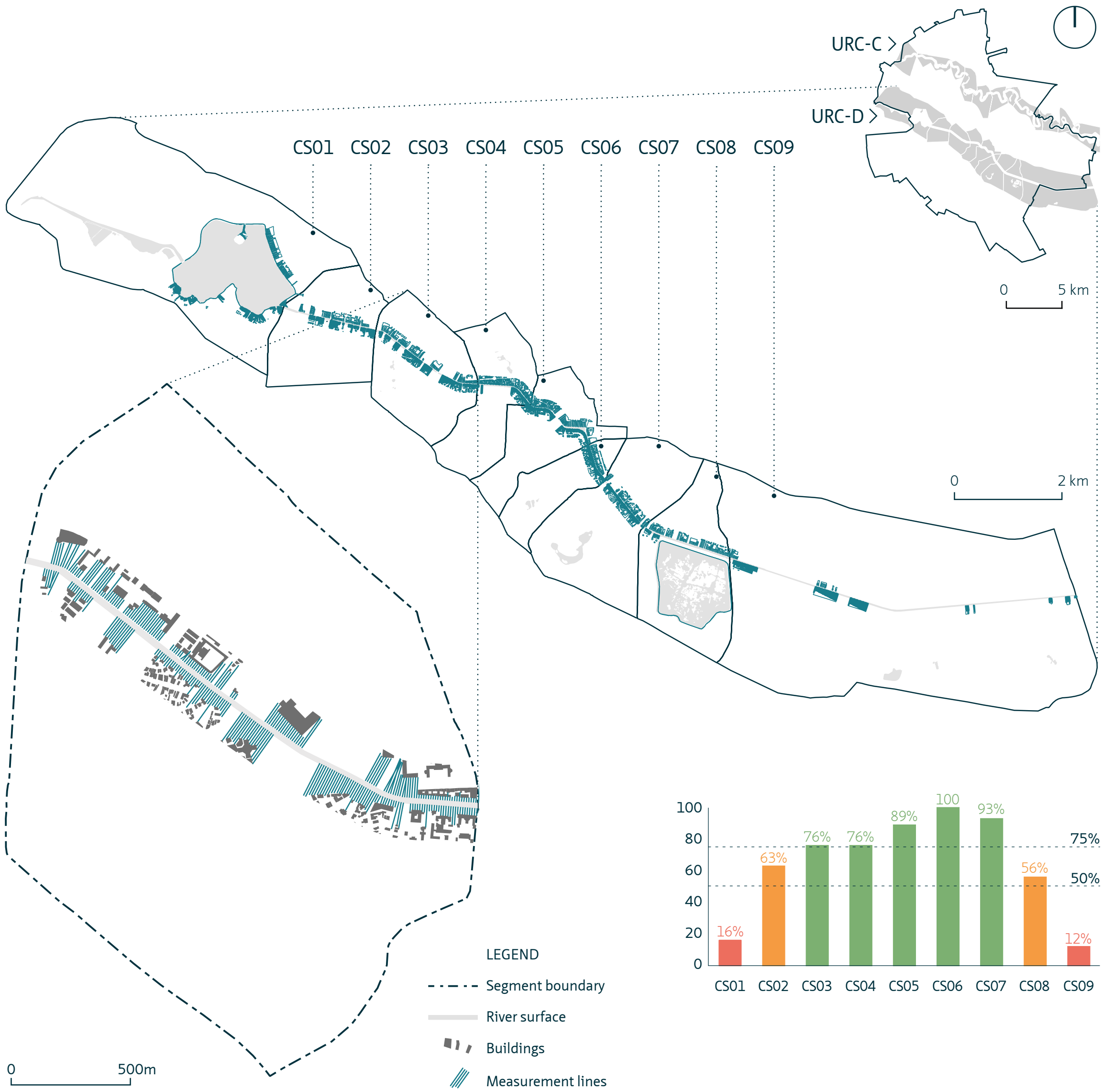


FIGURE APP.E.14 Waterfront constitutedness along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	16%	1
CS02	63%	2
CS03	76%	3
CS04	76%	3
CS05	89%	3
CS06	100%	3
CS07	93%	3
CS08	56%	2
CS09	12%	1

TABLE APP.E.16 Results of indicator B.1.3.2a.

Biodiversity—presence of species-rich areas (B.2.1.1a)

Definition:

Species-rich areas in the corridor are mapped and classified as follows: **[1] low**, when no such area is present, **[2] medium**, when they are present in the proximity of the river, or **[3] high,** when species-rich areas are in direct contact with the river, i.e. they constitute part of the riparian space.

Input data:

- Corridor segment boundary
- Species-rich areas[107]

Results for CS03:

- Biodiversity—presence of species-rich areas: **low**.

107 The present assessment is based on satellite imagery, literature and interviews. For a detailed and accurate inventory of species-rich areas, this classification must be confronted with local biodiversity studies. In this case, only areas with potential for biodiversity or direct contact with the landscape surrounding the city were taken into consideration.

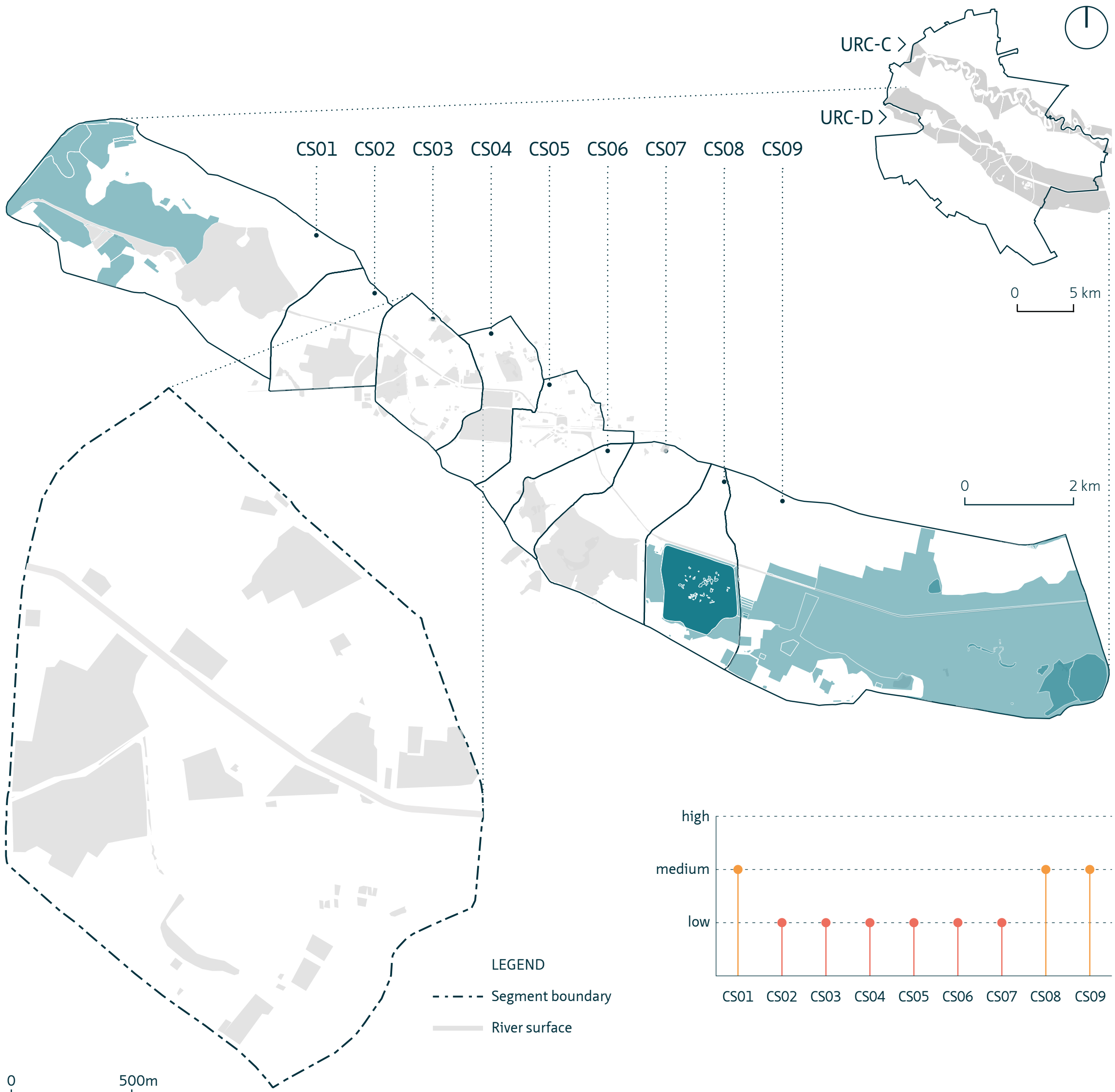


FIGURE APP.E.15 Presence of species-rich areas along URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	medium	2
CS02	low	1
CS03	low	1
CS04	low	1
CS05	low	1
CS06	low	1
CS07	low	1
CS08	medium	2
CS09	medium	2

TABLE APP.E.17 Results of indicator B.2.1.1a.

Respect of natural dynamics[108] (B.2.2.4)

Definition:

The degree of disturbance to natural dynamics is indicated by the classification of river banks: **[1] highly disturbed** , i.e. very artificial, channelised, concrete bed and banks, **[2] moderately disturbed** i.e. artificial, channleised, concrete bed or banks, or **[3] undisturbed**, i.e. close to natural conditions.

Input data:

- Corridor segment boundary
- Classified riverbanks[109]

Results for CS03:

- Respect of natural dynamics: **highly disturbed**.

108 This indicator is based on Silva et al. (2004, p.34).

109 The present assessment is based on satellite imagery. For a detailed and accurate classification of the degree of disturbance on the riverbanks, a survey must be carried out.

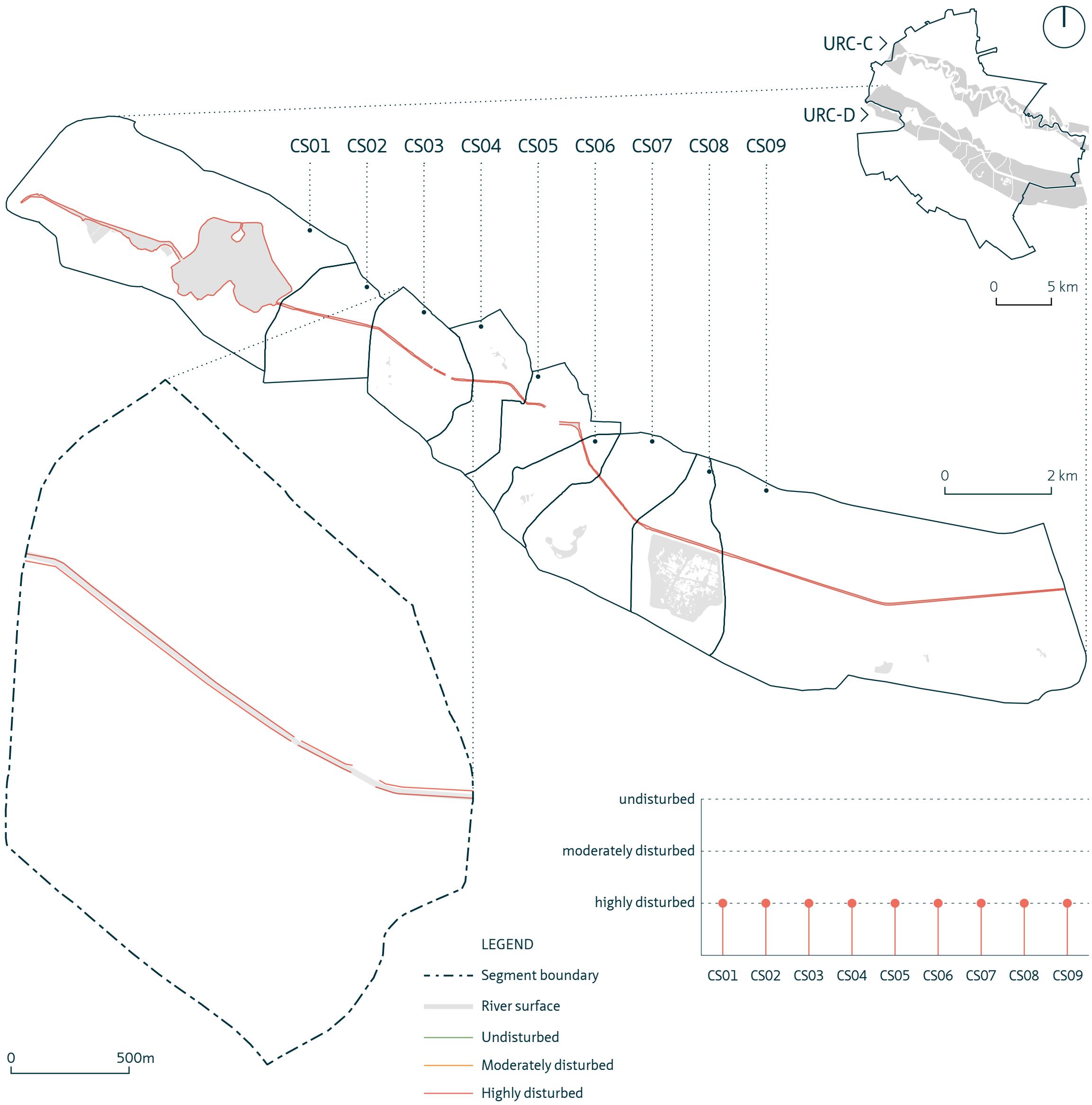


FIGURE APP.E.16 The degree of disturbance along the banks of URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
CS01	highly disturbed	1
CS02	highly disturbed	1
CS03	highly disturbed	1
CS04	highly disturbed	1
CS05	highly disturbed	1
CS06	highly disturbed	1
CS07	highly disturbed	1
CS08	highly disturbed	1
CS09	highly disturbed	1

TABLE APP.E.18 Results of indicator B.2.2.4.

Coverage - % total open space (B.2.3.1a)

Definition:
The percentage of the total area of open spaces (P_{os}) in the corridor segment out of the total area of the corridor segment (A_{rs}). Open spaces are all unbuilt spaces (A_{rs} - A_b), excluding the area occupied by road infrastructure (A_r) and water (A_w). Values: **[1] below 50%**; **[2] medium 50-75%**; **[3] above 75%**.

$$P_{os} = \frac{A_{rs} - A_b - A_r - A_w}{A_{rs}} \times 100$$

Input data:
- Corridor segment boundary
- Buildings in the corridor segment (OSM: buildings=*)[110]
- Street polygons (UrbanAtlas)

Results for CS03:
- Built area: **97,2 ha**
- Open space: **282,1 ha**
- Coverage: **74%**

110 Buildings obtained form the OSM dataset may be incomplete. For a more accurate result, the analysis must be performed with municipal data sources.

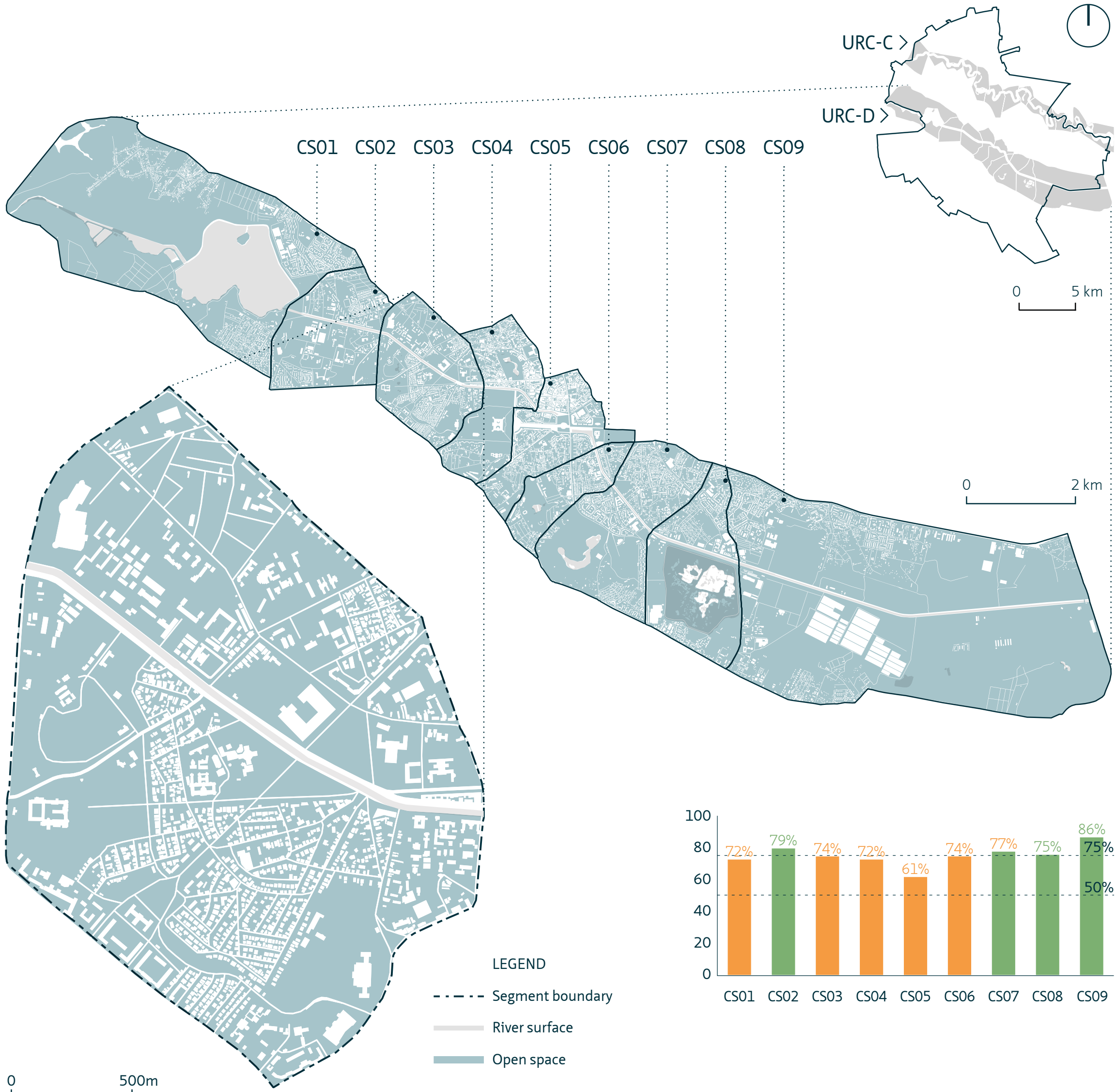


FIGURE APP.E.17 Open space coverage in URC Dâmbovița, with detail of CS03.

SEGMENT	VALUE	INDEX
RS01	72%	2
RS02	79%	3
RS03	74%	2
RS04	72%	2
RS05	61%	2
RS06	74%	2
RS07	77%	3
RS08	75%	3
RS09	86%	3

TABLE APP.E.19 Results of indicator B.2.3.1a.

Coverage - % total green space (B.2.3.1b)

Definition:

Green space coverage is indicated by the percentage (**P_{gs}**) of the total area of green spaces (**A_{gs}**) out of the total area of the corridor segment (**A_{cs}**):

$$P_{gs} = \frac{A_{gs}}{A_{cs}} \times 100$$

and it is classified as follows: **[1] low** below 20%; **[2] medium** between 20% and 40%; **[3] high** above 40%.

Input data:

- Corridor segment boundary
- Land cover from classified multispectral satellite image[111]

Results for CS04:

- A_{gs} = 1,71 **km²**
- A_{cs} = 4,05 **km²**
- Coverage: **42%**

Results for CS08:

- A_{gs} = 0,84 **km²**
- A_{cs} = 5,16 **km²**
- Coverage: **16%**

SEGMENT	VALUE	INDEX
CS01	33%	2
CS02	32%	2
CS03	29%	2
CS04	42%	3
CS05	29%	2
CS06	30%	2
CS07	27%	2
CS08	16%	1
CS09	22%	2
CS10	26%	2
CS11	28%	2

TABLE APP.E.20 Results of indicator B.2.3.1b.

111 For the classification, Sentinel-2 satellite imagery (Copernicus Sentinel data, 2017) was used. The land cover classification was carried out with the *Semi-Automatic Classification Plugin (SCP)* for *QGIS*. Out of the land cover classes used in the classification—'built-up', 'water', 'vegetation', and 'bare soil'—, the class 'vegetation' was used in this indicator.

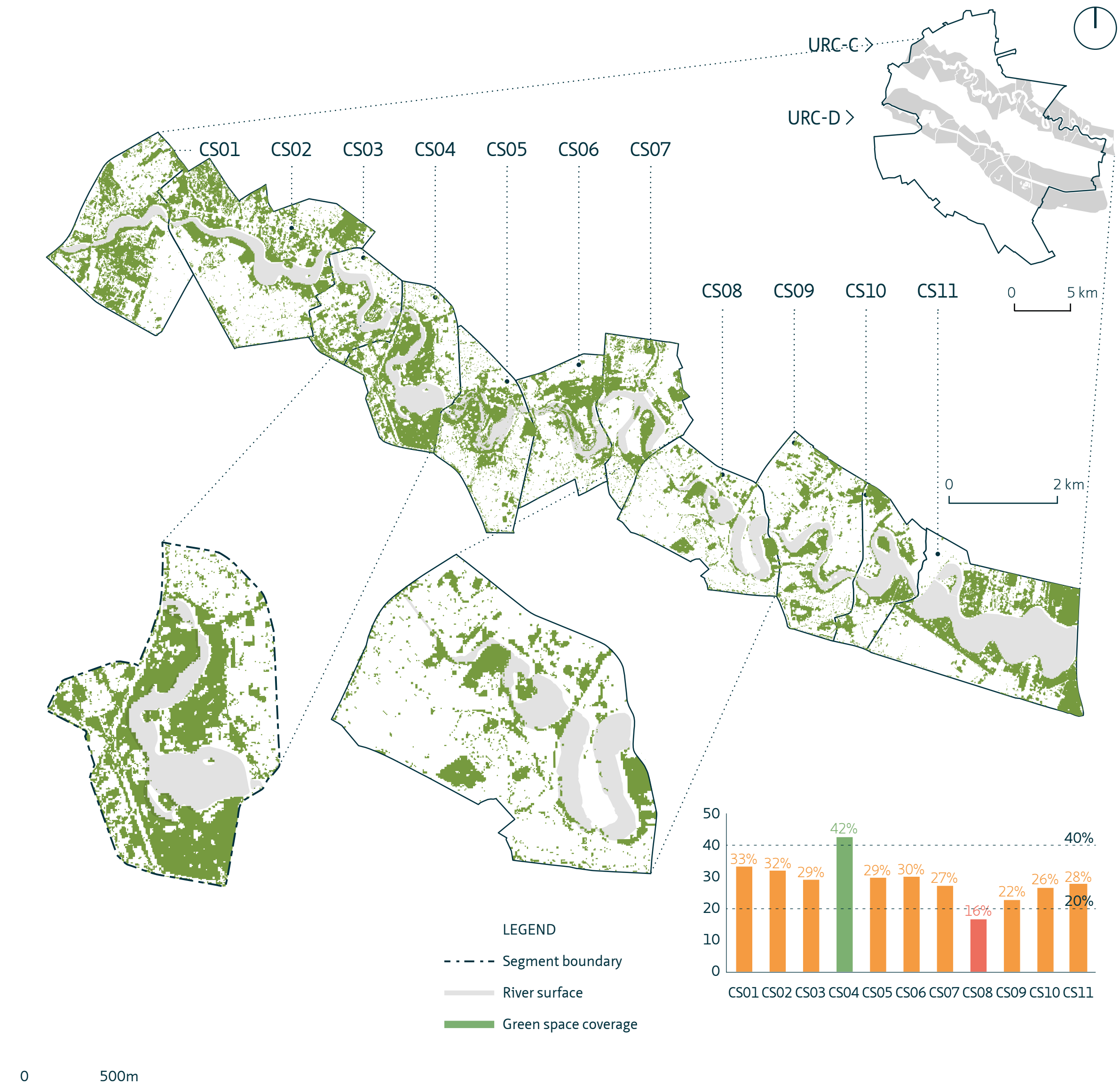


FIGURE APP.E.18 Green space coverage in URC Colentina, with detail of CS04 and CS08.

Appendix F Application procedure published on the workshop website

Workshop website: https://urcb.weblog.tudelft.nl/

Application deadline: 15 January 2017

Who can apply?
Application is open for young professionals, master students and doctoral candidates in the fields of urban design and planning, landscape architecture, and architecture, who are familiar with the context of Bucharest. Given the multi-disciplinary character of the workshop, young professionals or students from connected fields, such as sociology, anthropology, geography, hydrology, civil engineering and environmental studies are also encouraged to submit their application.

How to apply?
Please complete your application by filling in the online application form and by sending the following three documents in PDF format to C.Forgaci@tudelft.nl:

- A letter of motivation (in English or Romanian), no longer than two A4 pages, answering the following questions:
  - Why do you want to join the workshop?
  - In case you are not from a design-related field (urban design and planning, landscape architecture or architecture), have you had any design experience before?
  - What is your experience with working in multi-disciplinary teams?
  - Have you had any professional experience connected to the rivers of Bucharest? If so, please describe it.
  - What do you think are the main challenges that the two rivers of Bucharest face?
  - How do you see the future of the two rivers?
- A CV, no longer than two A4 pages.
- A sample, no longer than one A4 page, of your work that can be any form of creative or professional work (a project sample, a rendering, a research finding, etc.), including a brief description (one or two sentences), that is representative for your interests, skills and knowledge. Please make sure that the sample contains only one item.

The application will be complete when the online application form has been filled in and the required documents have been submitted.

Selection criteria
There is a limited number of places, therefore the applications will go through a selection process, which will take into consideration the following criteria:

- The motivation and background of the applicant.
- The mix of disciplines required for the composition of the teams. At least 50% of the selected participants need to be trained designers (urban designers or planners, landscape architects, architects) and at least 20% need to be from a different discipline.
- The availability of the applicant throughout the days of the workshop.
- A good command of English.

The selection will be made by the URCB steering committee at TU Delft.

Fees

Participation is free of charge. Lunch will be provided during the week to the workshop participants.

Outcomes

On the last day of the workshop, the workshop outcomes will be exhibited and discussed with local experts and the international guests. The participants will receive a Certificate of Attendance.

Questions?

For any further questions, feel free to contact Claudiu Forgaci, C.Forgaci@tudelft.nl (in English or in Romanian).

Appendix G List of selected participants

LIST OF SELECTED PARTICIPANTS				
No.	**Name**	**Occupation**	**Affiliation**	**Profession**
1	Alexandra Mirona Man	young professional	graduated UT Cluj	architect
2	Alexandru Mexi	PhD candidate	UB, graduate of USAMV	landscape architect
3	Anca-Ioana Crețu	young professional	graduate of UAUIM	architect
4	Andreea Toma	master student	UAUIM-U	urbanist
5	Anita Stamatoiu	young professional	graduate of UAUIM	architect, economist
6	Bianca-Melitta Tămășan	young professional	graduated TUD & TU Vienna	architect
7	Cezar Contiu	young professional	UAUIM-U	landscape architect
8	Christian Patriciu Popescu	young professional	graduate of UAUIM	landscape architect
9	Cristina Stefan	young professional	graduate of UAUIM-urbanism	visual artist
10	Cristina Wong	post-master student	EMU, TU Delft	architect, urbanist
11	Cristina-Mihaela Iordache	master student	UAUIM	architect
12	Daneiele Caruso	PhD candidate	Federico II, Naples	urban planner
13	George Bouroș	PhD candidate	UB / biology	conservation officer
14	Gertie van den Bosch	post-master student	EMU, TU Delft	engineer-architect, urbanist
15	Giuliana Gritti	post-master student	EMU, TU Delft	architect, urbanist
16	Iarina Tava	young professional	graduate of UAUIM	architect
17	Ioana Eveline Raduta	bachelor student	UAUIM-U	urbanism student
18	Irina Mateescu	master student	UAUIM-A	architect
19	Iulia Dana Baceanu	young professional	graduated UAUIM	architect
20	Jean-Baptiste Peter	post-master student	EMU, TU Delft	architect, urbanist
21	Johanna Jacob	young professional	graduate of EMU, KUL	urban designer
22	Karina Pitis	master student	Royal College of Art, London	architect
23	Lucian-Ștefan Călugărescu	master student	UAUIM-A	architect
24	Magda Baidan	young professional	PhD at TVES, Univ. of Lille 1, graduate of UB	geographer
25	Marcela Doina Dumitrescu	master student	UAUIM-U	structural engineer, urban mobility expert
26	Maricruz Gazel	post-master student	EMU, TU Delft	architect, urbanist
27	Monika Novkovikj	post-master student	EMU, TU Delft	architect, urbanist
28	Ruxandra Grigoraș	young professional	UAUIM	architect
29	Silvia Cazacu	young professional	graduated UAUIM	architect
30	Simona Dolana	master student	UAUIM-U	urban planner student
31	Uchil Rajat	post-master student	EMU, TU Delft	architect, urbanist
32	Zhouyiqi Chen	post-master student	EMU, TU Delft	landscape architect, urbanist

Appendix H Workshop calendar

The Urban River Corridors of Bucharest I A design workshop I March 5th-10th 2017

Calendar

Sat | March 4	**Sun** | March 5		**Mon** | March 6	**Tue** | March 7	**Wed** | March 8	**Thu** | March 9	**Fri** | March 10
Site	Site / La Firul Ierbii		La firul ierbii / UAUIM	La firul ierbii / UAUIM	La firul ierbii / UAUIM	La firul ierbii	La firul ierbii
		08:30	Welcome & coffee	Check in & coffee	Check in & coffee	Check in & coffee	Check in & coffee
Guided tours on Colentina (Colentina teams)	Guided tours on Dâmbovița (Dâmbovița teams)	**09:00**	**Seminar: spatial morphology** **Angelica Stan** **Matei Bogoescu**	**Seminar: water and the city** **Liliana Zaharia** **Constantin Radu Gogu**	**Seminar: environment and the city** **Cristian Iojă** **Cristian Tetelea**	**Seminar: scales and the city** **Gabriel Pascariu** **Liviu Ianăși**	**Public presentations (8 teams - 2 hours)**
		10:45	Coffee break	Coffee break	Coffee break	Coffee break	Coffee break
		11:00	**Instrument 1**	**Instrument 2**	**Instrument 3**	**Instrument 4**	**Discussion (1,5h) with guests, partners, and local experts**
		12:00					
		12:30	Lunch	Lunch	Lunch	Lunch	Lunch (buffet)
		13:30	**Team work (design)**	**Team work (design)**	**Team work (design)**	**Team work (design)**	Free afternoon
		14:00					
		15:00					
		16:00					
		17:00	Daily evaluation	Daily evaluation	Daily evaluation	Daily evaluation	
	Intro at La Firul Ierbii	**17:30**	Walk/Metro to UAUIM	Walk/Metro to UAUIM	Walk/Metro to UAUIM	**Teams prepare for presentations**	
		18:00	Evening lectures: Welcome by the **Marian Moiceanu,** Rector of UAUIM and **Claudiu Runceanu**, Dean of the Faculty of Urbanism **Birgit Hausleitner** Morphology and economy **Taneha Kuzniecow Bacchin** Morphology and water	Evening lectures: **Machiel van Dorst** Generic and specific behavior in generic and specific space **Bogdan Suditu** Bucharest and its inhabitants **Ștefan Ghenciulescu** Democratic urbanism in post-comunist Bucharest	Evening lectures: **Arjan van Timmeren** Resilient urban systems in research and practice **Tiberiu Florescu** The Dynamic GUP of Bucharest **Șerban Țigănaș** Designing with rivers in the city. Raising awareness and implementing a method		
		20:00					

Appendix I Example of a workshop handout: Day 1

THE
URBAN
RIVER
CORRIDORS
OF BUCHAREST

DESIGN WORKSHOP, BUCHAREST, 4-10 MARCH 2017

DAY 1

Spatial morphology
Interconnectedness
The Connector

Day 1, Monday 6 March

Topics: Spatial morphology / Interconnectedness / The Connector

Location: La Firul Ierbii, Splaiul Unirii 160, Bucharest

8:30 - 9:00	Check in and coffee
9:00 - 10:45	**Seminar: the morphology of Bucharest**
	Lecture by Angelica Stan: Bucharest, a landscape between two rivers.
	Lecture by Matei Bogoescu: Bucharest Collage - 6 images of the city - 1700-2000
	Discussion
10:45 - 11:00	Coffee break
11:00 - 12:30	**Instrument 1: The Connector**
	Introduction by Claudiu Forgaci
	Application (see pages 6-7)
12:30 - 13:30	Lunch
13:30 - 16:00	**Design session**
16:00 - 16:30	**Scale up!** - group work on corridors
16:30 - 17:00	Presentations, reflection, and evaluation
17:00 - 18:00	Break / Change location to UAUIM
18:00 - 20:00	**Welcome** by UAUIM and **Lecture** by Birgit Hausleitner & Taneha Kuzniecow Bacchin - A systemic approach to urban morphology: morphology and economy / morphology and water
	Discussion moderated by Angelica Stan

2

Seminar speakers

assoc. prof. dr. arch. urb. Angelica Stan
Department of Urban and Landscape Design, Faculty of Urbanism, "Ion Mincu" University of Architecture and Urbanism, Bucharest

Angelica Stan holds a Ph.D. in urbanism with a thesis entitled "The Landscape of Peripheries." Currently, she gives a course on Urban Typo-Morphological Analysis at "Ion Mincu" University of Architecture and Urbanism. In her lecture during the seminar, she will give an introduction about the morphology of Bucharest in relation to the two rivers. (See website, Lectures section, for an extended bio)

arch. urb. Matei Bogoescu
4B Arhitectura, BAZA

Matei Bogoescu is an architect and urban planner . He earned the MSc degree in Urbanism in the EMU programme in 2010 with the Thesis: "Bucharest 2025 - A New Paradigm". From 2010 he opened his own practice in Bucharest (4B Arhitectura) together with Mara Vergu-Bogoescu, being involved in Residential and Commercial Projects as well as Master plans and Urban Design Projects. He was part of the team of experts, which ideated the UAUIM Proposal for the new Master plan of Bucharest 2018.

Guest tutor

dr. arch. Alexandru Belenyi
Doctoral School Architecture, "Ion Mincu" University of Architecture and Urbanism, BAZA

Alexandru Belenyi is an architect, urban planner and educator. He defended his Ph.D. thesis in 2015 (*Education for architects*) and was awarded the Ph.D. title by Ion Mincu University, Bucharest (Romania). He studied at the TUDelft (The Netherlands) and Ion Mincu University. Previous to establishing his own architecture company he worked for Aecom Bucharest and Chora Architecture & Urbanism, London. He was involved in large scale planning and architecture projects such as the General Urban Plan for Bucharest, Multipurpose Hall in Bucharest (Aecom) Taiwan Strait Climate Incubator (Chora UK).

3

EXCERPTS*
Connectivity and interconnectedness in urban river corridors

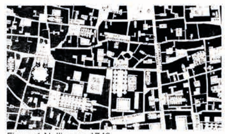


Figure 1 Nolli map, 1748

The space of movement

In *The Social Logic of Space*, Bill Hillier (1984) described the ordering of space, both on architectural and urban scale, is determined by the way social relationships have christalised through time. In other words, as his book's title suggests, there's a social logic that precedes and determines spatial configurations.

In explaining this logic, Hillier in a later publication describes space in terms of two generic human activities: occupation and movement (Hillier, 2007, p.248). *Occupied space* is the space of activities that are mainly static or where movement is localised within the occupied space. *The space of movement* is shaped by movement between occupied spaces or in and out of an occupied space.

The 18th c. Nolli map (Figure 1) is a classical example of a figure-ground representation following the same principles. In a more contemporary interpretation, Bernardo Secchi's *Progetto di Suolo* depicts urban space as the ground floor of the city, thus representing both private and publicly accessible space to capture the interaction between public and private space with more accuracy.

Three-dimensional connectivity

According to G.M. Kondolf and P.J. Pinto (2017, p.182), the social connectivity of urban rivers, or the way people, goods, ideas, and culture move along and across rivers, can be described in terms of "three-dimensional connectivity", that is, through (1) longitudinal, (2) lateral, and (3) vertical connectivity (Figure 2).

Longitudinal connectivity characterizes the activities that run along the river, such as navigation or riverside traffic corridors. The scale of this type of connectivity is large, up to the scale of the watershed.

Lateral connectivity refers, on one hand, to connections across the river and, on the other hand, to the way the river is connected transversally to the surrounding urban fabric. This type of connectivity can be observed on the scale of waterside urban districts and it has a key role in the connectivity of the urban river corridor as a whole.

Vertical connectivity refers to the direct interaction between people and water, such as swimming, walking along the embankments and the dynamic use of floodable areas. This is the smallest in scale of all three types of connectivity.

4


Figure 2 Vertical and laterral connectivity. Kondolf and Yang, 2008

Figure 3 The Urban River Corridor as an interconnected structure.

Interconnectedness

Considering that the areas along urban river corridors are mainly public and have a central character, their accessibility by pedestrians within and towards the corridor is very important. In this sense, interconnectedness is considered to be an important quality of urban river corridors.

The property *interconnectedness* is used here to characterise the density of reciprocal connections in the urban fabric along, across and within (vertical connectivity) an urban river corridor. In this sense, the qualities of urban river corridors must be understood as mutually beneficial for the river valley and the urban fabric. For instance, accessibility of the waterfront can be expressed also in terms of permeability of the surrounding urban fabric (Figure 3).

*This text is an excerpt from the Ph.D. thesis manuscript of Claudiu Forgaci.

References:

Hillier, B. (2007). Space is the machine (2nd electronic ed.). Cambridge: Cambridge University Press.

Hillier, B. & Hanson, J. (1984). The social logic of space. Cambridge: Cambridge University Press.

Kondolf, G. & Pinto, P. (2017). The social connectivity of urban rivers. Geomorphology, 277, 182-196.

In today's exercise we will focus on the space of movement in urban space as *a field of possibilities*. The instrument *Connector* in the following exercise is built on this field of possibilities.

5

Instrument 1:

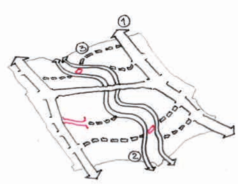
The Connector

The Connector is a tool that highlights and enforces the base structure of the city, that is both the natural and the urban space for movement. As illustrated below, the tool has the following three topological components:

(1) The *explorer* highlights the main urban structure parallel to the river;

(2) The *enforcer* follows the edge of the river as closely as possible and in a continuous way;

(3) The *gatherer* is a transversal link that connects the two other components following important transversal links.



1.a Draw individually the three components of the connector on the A4 sheets. - 5 minutes

1.b Discuss your connector with the rest of the team, agree on a configuration, and transfer it on the large basemap of the study area. - 10 minutes

2.a Brainstorm with your team about problems and/or potentials related to connectivity which you identified during the site visit. Write down as many aspects you remember on post-its. - 10 minutes

2.b Choose 3 problems and 3 potentials out of all aspects written down during the brainsotrming session. - 5 minutes

3.a Draw the connector on the detail map.

3.b Represent the 3 problems and 3 potentials on the detail basemap with symbols. 10 minutes

3.c Represent them on the section too. - 10 minutes

4.a Based on the problems and potential identified in the previous steps formulate a problem statement (1 sentence) and a design objective (1 sentence). - 10 minutes

6

7

FIGURE APP.I.1 Spreads from the handout given to the participants on Day 1 of the workshop.

Appendix J Example of base maps: site D3

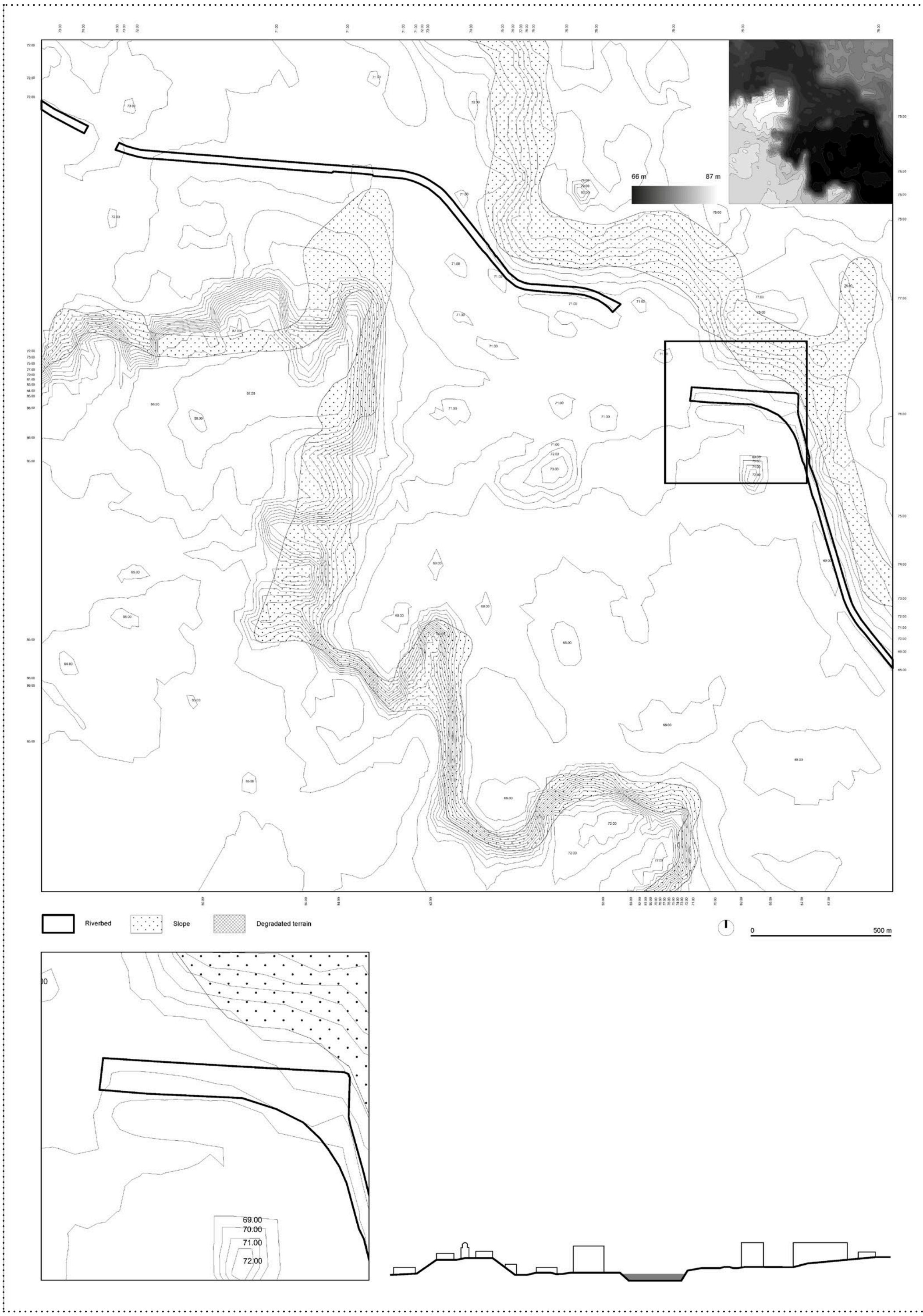


FIGURE APP.J.1 Base maps for the Connector and the Sponge (reverse) and the Integrator on site D3. Original size: A1.

TOC

Appendix K Example of a daily evaluation form: Day 1

I. The workshop

1. What did you find most interesting today?

2. What did you find most difficult today?

3. Were you missing something during today's sessions?

4. How would you evaluate the workload today?
   Not enough – The right amount of work – Too much

5. Please rate today's activities from 1 to 10:

- Morning seminar: 1-2-3-4-5-6-7-8-9-10
- Instrument training: 1-2-3-4-5-6-7-8-9-10
- Design session: 1-2-3-4-5-6-7-8-9-10
- Scale up! session: 1-2-3-4-5-6-7-8-9-10
- Reflection: 1-2-3-4-5-6-7-8-9-10

II. The theme of the day

1. How clear was the theme of the day connectivity?
   1-2-3-4-5-6-7-8-9-10

2. To what extent did you understand the property of interconnectedness?
   1-2-3-4-5-6-7-8-9-10

3. How useful was the theoretical introduction on today's topic?
   1-2-3-4-5-6-7-8-9-10

III. The seminar

1. Did you find the seminar useful for approaching your design assignment?
   Not at all – Somehow – Very useful

2. Please rate the seminar lectures from 1-10.

- Lecture 1: 1-2-3-4-5-6-7-8-9-10
- Lecture 2: 1-2-3-4-5-6-7-8-9-10

IV. Today's instrument: The Connector

1. Was the instrument easy to use?
   (not at all) 1-2-3-4-5-6-7-8-9-10 (very easy to use)

2. Was the instrument useful?
   (not at all) 1-2-3-4-5-6-7-8-9-10 (very useful)

3. What would you improve?

V. The design session

1. How would you rate the afternoon design session of today?
   1-2-3-4-5-6-7-8-9-10

VI. The team

1. How would you rate team work today?
   1-2-3-4-5-6-7-8-9-10

2. Do you have any other recommendations or observations?

Example of a summary of daily evaluation results

Day 1 - Spatial morphology / Interconnectedness / The Connector

# of responses: 31/32
Response rate (%): 97%

		Response 1	Response 2	Response 3	Response 4	Response 5	Response 6	Response 7	Response 8	Response 9	Response 10	Response 11	Response 12	Response 13	Response 14	Response 15	Response 16	Response 17	Response 18	Response 19	Response 20	Response 21	Response 22	Response 23	Response 24	Response 25	Response 26	Response 27	Response 28	Response 29	Response 30	Response 31	Response 32	Avg.
I. The workshop	**1. Most interesting**	i	s-MB	t	i	d	s, t	i	s	C	i, BS	t, i	t	s, C	C	C	s	*	s, C	s	i, s	s	i	d	s, i	*	C	*	i	i	s	C, s		
	2. Most difficult	C	i	t	T	s-AS	BS	C	C	d	C		d		T	t	T	t	C	t	C	C	?	?	C	*	i	?	C	C	C	C		
	3. Missing	C	-	cold	-	s	-	-	intro	-	-	g			W	g	F	?	i	i	-				-	-	break	-	cold	i	bm	s		
	4. Workload				n/a	not enough			the right amount of work						too much																			
	5. Activities: Seminar	9	8	8	9	6	9	8	10	9	7	5	8	7	8	9	10	8	9	8	10	8	10	8	9	9	8	9	10	7	9	9		**8,42**
	Instrument	10	8	9	9	8	10	8	9	10	8	10	9	8	8	8	10	9	10	7	10	6	10	8	9	9	10	10	9	9	9	10		**8,94**
	Design	10	9	3	8	9	10	10	8	9	9	9	10		10	9	8	10	9	9	10	7	8	9	10	8	8	9	10	7	7	10		**8,73**
	Scale up!	8						8			6		10	9									8			8			8		7			
	Reflection	10	9			8	10	9		8	5		9						10				8	8		8		10	10		8	9		
II. Theme of the day	**1. Theme - clarity**	9	8	7	10	8	9	10	9	10	7	10	9	8	8	10	10	8	9	8	10	8	10	8	10	10	10	10	10	10	9	10		**9,10**
	2. Property - clarity	9		9	10	8	9	9	9	8	8	9		8	8	8	9	6	9	9	9	5	10	7	8	10	10	10	8	8	7	8		**8,45**
	3. Theory - usefulness	10	10	8	10	5	10	10	9	10	9	8	8	5	8	9	10	7	10	10	10	8	0	7	10	10	10	10	9	9	8	10		**8,61**
III. Seminar	**Useful for design**																	somehow		very useful														
	Lecture 1: M. Bogoescu	10	9	10	9	9	10	9	10	10	9	10	9	9	8	9	10	9	10	10	20	9	10	9	10	9	10	10	10	8	9	10		9,77
	Lecture 2: A. Stan	7	6	6	7	6	8	8	9	9	6,5	3	10	4	8	7	8	7	9	8	8	7	5	5	8	8	7	7	6	8	9	8		7,18
IV. Instrument	**1. Easy to use**	10	7	9	10	7	9	10	9	9	8	10	8	8	9	8	9		9	8	9		10	9	8	9	10	10	9		6	9		**8,79**
	2. Usefulness	10	7	8	10	7	10	10	9	9	9	7	10	8	8	9	9		9	8	10		10	8	8	8	10	9	8		5	9		**8,64**
	3. What to imporve												?																					
V. Design session	**1. Afternoon design session**	9	9	9	10	9	10	9	8	8	8	9			9	9	9		8	9	9		8	9	8	8	8	10	9		7	10		**8,77**
VI. Team	**1. Team**	9	9	10	9	9	10	10	10	9	6	8	10	8	9	8	10		9	8	8		8	10	9	8	7	10	7		9	10		**8,82**
Other	**2. Recom. or obs.**																																	

		Conclusions / Observations
I. The workshop	**1. Most interesting**	1. Matei Bogoescu's lecture (12); 2. the instrument (10); 3. the collage exercise (7)
	2. Most difficult	1. the collage (12); 2. team/group work (4); 3. lack of time (3)
	3. Missing	1. nothing missed(10); 2. in depth explanation of instrument (3)
	4. Workload	The right amount of work.
	5. Activities: Seminar	Overall, the seminar, the instrument testing session, and the design session were appreciated and considered useful.
	Instrument	
	Design	
	Scale up!	Scale up session was cancelled due to time constraints.
	Reflection	Group reflection was cancelled due to time constraints. Instead, there was a brief presentation session.
II. Theme of the day	**1. Theme - clarity**	The theme, property and theory were briefly introduced. A more in-depth presentation would have provided the participants a better base to work with the instrument. Try sending the material one day in advance and give a more detailed presentation.
	2. Property - clarity	
	3. Theory - usefulness	
III. Seminar	**Useful for design**	Very useful (18); Somehow (13)
	Lecture 1: M. Bogoescu	Very much appreciated by the participants.
	Lecture 2: A. Stan	The lecture was not so clear and partially repeated the previous lecture.
IV. Instrument	**1. Easy to use**	
	2. Usefulness	
	3. What to imporve	
V. Design session	**1. Afternoon design session**	
VI. Team	**1. Team**	
Other	**2. Recom. or obs.**	

i instrument
s seminar
t team work
d design
C The Utopian Collage exercise
BS the brainstorming session

***** everything
? uncommon remark
T time
F feedback from tutors
g group interaction
W water

(pink) Unanswered or not applicable

Appendix M Post-workshop evaluation form

The following questionnaire is included as it was originally administered via the online surveying platform Qualtrics. Some adjustments have been made to interactive elements to improve their readability on paper.

Q1 Dear workshop participant,

As a follow up to The Urban River Corridors of Bucharest design workshop that you attended between 4-10 March in Bucharest and in addition to the daily evaluation forms that you filled in during the workshop, we prepared a final questionnaire, which is meant to collect your opinion on the whole set of instruments. By filling in this questionnaire, you will complete the evaluation of the instruments.

The questionnaire is anonymous and it takes approximately 10-15 minutes to complete. Your progress will be saved, so you may stop anytime and resume later. The questionnaire will be available until the 24 March, so please make sure you fill it in by that date.

Press the next button below to proceed to the questionnaire.

Q2 In this section you will evaluate the instrument Connector. As introduced in the workshop, the Connector is an instrument which highlights and enforces the base structure of the city, that is, both the natural and the urban space for movement. The tool has the following three topological components: the explorer, which highlights the main urban structure parallel to the river; the enforcer, which follows the edge of the river as closely as possible and in a continuous way; and the gatherer, which is a transversal link that connects the two other components following important transversal links. Based on this definition, the designer chooses where to place the three elements of the Connector on a map of the existing space for movement, that is, the network of roads, alleys, walkways and walkable surfaces of the urban area in question. Possible future connections are added to the map too.

Q3 Please rate from 1 to 10 the following statements: The Connector...
...was easy to use. (1)
...was useful for my team's design proposal. (2)

Q4 Please rate the difficulty of the three elements of the Connector:
Difficult to use (1); Neither difficult nor easy to use (2); Easy to use (3).

The explorer	1-2-3
The enforcer	1-2-3
The gatherer	1-2-3

Q5 What did you like about the Connector?

Q6 What did you dislike about the Connector?

Q7 What would you improve in the Connector?

Q8 Please write down if you have any other observations or recommendations for the instrument Connector.

Q9 In this section you will evaluate the instrument Sponge. As introduced in the workshop, the Sponge is an instrument that maximises the spatial capacity of the study area by: finding more space for water; identifying and connecting ecological patches; integrating (1) and (2) with a network of public spaces. The team maps all patches in the study area. Patches include green spaces, such as parks and gardens, but also impervious surfaces, such as parking lots, industrial platforms, and brownfields. The team discusses problems and potentials in the spatial configuration of the mapped patches.

Q10 Please rate from 1 to 10 the following statements: The Sponge...
...was easy to use. (1)
...was useful for my design proposal. (2)

Q11 Please rank the three aspects of the Sponge in the order of their difficulty:
Difficult to use (1); Neither difficult nor easy to use (2); Easy to use (3).

Space for water	1-2-3
Ecological patches	1-2-3
Public space	1-2-3

Q12 What did you like about the Sponge?

Q13 What did you dislike about the Sponge?

Q14 What would you improve in the Sponge?

Q15 Please write down if you have any other observations or recommendations for the Sponge.

Q16 In this section you will evaluate the instrument Integrator. As introduced in the workshop, The Integrator combines the maps of the previous two instruments - The Connector and The Sponge - in order to identify spaces of strategic integration, answering to the following questions: Where do The Connector and The Sponge overlap? - potential for integration Where are The Connector and The Sponge missing? - need for integration How do the two layers interact with geomorphology? The designer overlaps the results of The Connector and The Sponge on a base map of geomorphology and identifies spaces of strategic social-ecological integration.

Q17 Please rate from 1 to 10 the following statements: The Integrator...
...was easy to use. (1)
...was useful for my design proposal. (2)

Q18 Please rate the following three aspects of the Integrator according to their difficulty:
Difficult to use (1); Neither difficult nor easy to use (2); Easy to use (3).

Identifying overlaps between The Connector and The Sponge	1-2-3
Identifying key areas where The Connector and The Sponge are missing or do not overlap	1-2-3
The overlap with geomorphology	1-2-3

Q19 What did you like about the Integrator?

Q20 What did you dislike about the Integrator?

Q21 What would you improve in the Integrator?

Q22 Please write down if you have any other observations or recommendations for the instrument Integrator.

Q23 In this section you will evaluate the instrument Scaler. As introduced in the workshop, the Scaler is an instrument which has two functions: it evaluates the use of scales in the project and it looks for scalar problems in the area of study. The designer reflects back and lists all the scales used in the design process. The list then is classified in scale(s) of context (which explain the wider implications of the project), scale(s) of focus (the scale(s) of the actual intervention), and scales of detail (which illustrate and explain the way the intervention works). Scalar problems (lack of human scale in urban space, scalar mismatches, etc.) are then discussed and integrated in the design proposal. Any adjustments that The Scaler might require can be made to The Connector, The Sponge, and The Integrator retroactively.

Q24 Please rate from 1-10 the following statements: The Scaler...
...was easy to use. (1)
...was useful for my design proposal. (2)

Q25 Please rank the following three aspects of the Scaler in the order of their difficulty:
Difficult to use (1); Neither difficult nor easy to use (2); Easy to use (3).

Listing and classifying the scales of the project	1-2-3
Identifying scalar problems on the site	1-2-3
Adjusting the design proposal to the scalar issues identified on the site	1-2-3

Q26 What did you like about the Scaler?

Q27 What did you dislike about the Scaler?

Q28 What would you improve in the Scaler?

Q29 Please write down if you have any other observations or recommendations for the instrument Scaler.

Q30 In this section you will evaluate the whole set of instruments. Please think of the way the four instruments worked together.

Q31 Please rank the four instruments according to your preference (with the 1st as the most liked and the 4th as the least liked). Drag the instruments to reposition them in the list.

______ The Connector (1)
______ The Sponge (2)
______ The Integrator (3)
______ The Scaler (4)

Q32 Can any of the four instruments be left out? If yes, which one?

Q33 Is there something missing from the set of instruments?

Q34 Did you find the order of the instruments correct? If not, please rearrange them below in the order that you think it would have worked better. If you agree with the proposed order, leave the list below unchanged.

______ The Connector (1)
______ The Sponge (2)
______ The Integrator (3)
______ The Scaler (4)

Q35 If you have any final remarks or recommendations related to the set of instruments, please write them below.

Appendix N Summary of the interviews with the workshop participants

FIGURE APP.N.1 Team C2 during the interview. Photo credit: Sebastian Apostol.

TABLE APP.N.1 Interviews with the teams working on URC Dâmbovița in the design workshop.

QUESTION	D1 MORII LAKE	D2 BASARAB-IZVOR SITE	D3 NATIONAL LIBRARY	D4 VĂCĂREȘTI LAKE
1. Which do you consider to be the greatest quality/ potential of your team?	– diversity of expertise and educational backgrounds, international team; – we consider each other's' ideas; – we might miss the leader;	– diversity of backgrounds, we have architects, urban planners, engineers, landscape architects;	– the variety, even our backgrounds are close, we have different approaches;	
2. Which do you consider the difficult parts about your teamwork?	– the concepts are new to us and we tend to interpret them differently due to our different expertise;	– diversity of expertise slows down the process sometime; also, the different educational backgrounds and approaches (makes it good and difficult at the same time);	– not really, maybe at first; – the language, none of us is an English native speaker; – the different approaches, clashes in working through scales (too much in detail or too zoom out); people who know the site better, go into detail (not always bad);	
3. Which do you consider the best part about working together?	– the diversity of ideas filtered and shaped through good debate;	– the diversity of backgrounds and approaches;	– work pretty well together, we have different educational backgrounds; we brainstorm and then choose the best ideas; we are devoted, engaged and we have imagination!	– pretty well, we also relate well to other groups to discuss design on larger scales;
4. How do you work together?	– well	– smoothly, ideas come well together;	– very well;	– there are debates, we don't know each other at all, that was not necessarily bad;
5. What do you consider to be most challenging about your site?	– there is no relation between people and their surroundings; – renaturalisation and how to make the strategy transferable downstream by using the scalar;	– the site complexity and its understanding at different scales;	Same as 7.	Same as 7.
6. What do you consider to be the highest potential of your site?	– the massive surface of water; – there is high potential but there is nothing to enhance it, nothing around it;		– the central location, very crossed, high traffic, there are many heritage landmarks, important institutions; – close to vibrant places (Unirii Square, The Historical City Centre), but no connection to the water as there is no culture of public space near water in Bucharest;	
7. What do you consider most challenging in working on the corridor?	– working through scales, understanding the relation of smaller project interventions with the corridor;	– tackling with scales, designing through scales; coping with diversity and complexity of the site; instruments helped cope with both, revealing the site's potential and problems; turning mapping into the strategy;	– the river is a concrete tube; extremely systemized; – rebuild the connection between city and water as the city turned its back to the water, the river is invisible to the inhabitants (in the city center); nature was mastered;	– Romanians and Bucharestians completely turn their back to the river, that is different from what I know; As a Bucharestian, I never realized the importance and potential of the River; I wish I was aware about Dâmbovița as a child, children dream a lot, now I am too practical in my approach;

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TABLE APP.N.1 Interviews with the teams working on URC Dâmbovița in the design workshop.

QUESTION	D1 MORII LAKE	D2 BASARAB-IZVOR SITE	D3 NATIONAL LIBRARY	D4 VĂCĂREȘTI LAKE
8. What was your favorite instrument?	– 2x sponge: you can read beyond appearance and it merges the social with natural; - 1x scalar; – 1x all of them; concepts were abstract at first, but as we apply them, we understand how they work; instruments helped to work through scales and helped strategic thinking;	– 2x the sponge; – 2x the scalar;	– 2x the connector; – 1x the sponge; – 1x the integrator;	– 4x the sponge;
9. Name one word to describe your river corridor.	autistic; separation; potential; ignorance;	barrier; invisible; division (north and south are very different); contrast;	distance (the distance between me, city inhabitants and the river); a machine (to conquer floods, but not part of the city life); artificial; challenge and a monument of shame (the city doesn't rise up to the challenge);	connection; potential; porosity; invisible;
10. Name one word to describe Bucharest.	beautiful; potential; concrete; hectic;	distractive; 3x contrast;	contrast; complex; beautiful chaos; unique (all historical 'scars' are visible and beautiful);	unfinished; dynamic; chaos; angry;
11. What was your favorite workshop moment?	– 2x the scale up session- interesting discussions and discoveries for all teams; – 2x lectures and seminars to complete knowledge, and the mix of experts from the lectures, uncovering knowledge from different backgrounds on the same topic;	– 2x the collage- the utopian exercise; all design sessions were always nice; – the final part when our solution comes together;		– the interview (laughing), the site visits, lectures, lunch, Cristian Tetelea's lecture (the ecologist); – the whole configuration – lunch also brought us all together;

TABLE APP.N.2 Interviews with the teams working on URC Colentina in the design workshop.

QUESTION	C1 GRIVIȚA LAKE	C2 HERĂSTRĂU LAKE	C3 FUNDENI LAKE	C4 PANTELIMON LAKE
1. Which do you consider to be the greatest strength of your team?	– our different backgrounds, the mixed team (from Bucharest and international) helped to understand the site from different perspectives;	– different views on the site: coupling in-depth knowledge about the site with the objectiveness, when reading the site for the first time;	– very diverse experience in education, expertise and types of projects;	– different educational background, different experience stages;
2. Which do you consider the difficult parts about your teamwork?	– it's hard to bring together the different perspectives and methods, we have different understanding of concepts, such as the notion of scale, we are all familiar with these notions, but we have to explain that to the team; and we start designing from different angles;	– didn't find any difficulty;	– different visions; – communication problems, English is not mother language for none of us;	– different understanding of the site; – hard to bring together the different approaches;
3.Which do you consider the best part about working together?	– despite difficulties, we have a final project put together;	– the understanding and the good work through scales; – the two main backgrounds in our team: architecture and urbanism made working through scales an interesting experience;		– too early to tell;
4. How do you work together?	– ok	– well, 'super cooperation'	– it's ok	– it's hard
5. What do you consider to be most challenging about your site?	– how to work with the social, the gated communities, which are completely enclosed from their surrounding environment and the lake, there is no relationship with the water; – hard to decide how much to intervene and how to create a balance between nature and people through design, make it accessible vs. protect it;	– our site is the centre of the corridor; the site is overused, too popular as an urban destination, but 'isolated' from the lake natural system; – we are trying to spread people on the corridor, make our site a gate to the other lakes in the chain; – relink our site to the natural system;	– the diversity and complex identities; – how to preserve and repair?	– the lack of utilities and unplanned development; – the urban expansion; – bringing together unstructured parts;
6. What do you consider to be the highest potential of your site?	– the empty natural land, that can be used to turn around the negative parts; – raise awareness, prove the value of nature;	– our site is a popular destination in the city;	Same as 5.	
7. What do you consider to be most challenging in working on the corridor?	– the lakes were an unfinished project, development and occupation on its shores was loose, organic, uncontrolled, so the site rewilded naturally due to indifference, we fear that connectivity can destroy the site;	Interscalarity, linking to the other sites to release the pressure put on our site; the synthesis;	Same as 5.	– the conflicting views and opinions that different stakeholders and specialists have about the lakes; – the fragmented land ownership and private properties next to the lake;

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TABLE APP.N.2 Interviews with the teams working on URC Colentina in the design workshop.

QUESTION	C1 GRIVIȚA LAKE	C2 HERĂSTRĂU LAKE	C3 FUNDENI LAKE	C4 PANTELIMON LAKE
8. What is your favorite instrument?	– 2x connector; – 2x sponge; – the connector provides very fast understanding of the site and best to approach a complex unknown context; – the sponge, it helps you understand how the site will integrate your proposal; – the sponge, also used in ecology, is a great idea to think about it as having a mixed use: connect people and nature at the same time; – connector- we applied it very differently;	– 4x sponge; – as we need to restore nature, the sponge was important; – the scaler was the most difficult at first, but became natural and central in our process further on;	– 2x the sponge; – 1x the connector; – 1x the integrator;	– 2x the sponge; – 2x the scaler; – the Scaler has the potential to put the river scape into a variety of contexts, that may otherwise remain hidden. It is not as obvious as the other instruments, which is precisely why it can produce surprising conclusions and outcomes.
9. Name one word to describe your river corridor.	fragmented; continuity; wild; relaxed;	contrast; diversity; huge potential; contrast;	openness; underworld; intimacy; diversity;	diversity; nature; unity; unexpected; mystery;
10. Name one word to describe Bucharest.	pollution; disorder; chaotic developments; fragmented;	dramatic; dynamic; colourful; city of all possibilities;	vibrant; home; Paris; grey; underdog;	palimpsest; noise; crowded; confusion; expanse;
11. What was your favorite workshop moment?	– the site visit x2; – the scale up session x2 – nice to see different observations and approaches coming together (diversity of approach between teams); – lunch; first drawings, the instruments; the site visits, fieldwork;	– the collage exercise; – the scale up session; – the evening talks;		

Appendix O

The design projects developed in the workshop

LIST OF THE DESIGN PROJECTS DEVELOPED IN THE WORKSHOP		
No.	**Project title**	**Authors**
C1	Reclaiming the Shore, Lake Grivița	Gertie van den Bosch, Ioana-Eveline Răduța, Karina Pitiș, George Bouros
C2	Opening the Gates: Decentralising, Re-orienting, Re-naturalizing Lake Herăstrău	Rajat Uchil, Simona Dolana, Anca-Ioana Crețu, Iulia Dana Băceanu
C3	The Amphibian Communities of Fundeni Lake	Johanna Jacob, Jean-Baptiste Peter, Andreea Toma, Iarina Tava
C4	The Hinge, Lake Pantelimon	Anita Stamatoiu, Giuliana Gritti, Silvia Cazacu, Christian Patriciu Popescu
D1	Reinvent by Design, Lake Morii	Monika Novkovikj, Ruxandra Grigoraș, Cezar Conțiu, Magda Baidan
D2	Dâmbovița From Barrier to Link, Mihai Vodă- Izvor site	Maricruz Gazel, Cristina Ștefan, Marcela Doina Dumitrescu, Alexandru Mexi
D3	Closing the Gap, The National Library site	Zhouyiqi Chen, Cristina-Mihaela Iordache, Alexandra Mirona Man, Lucian-Ștefan Călugărescu
D4	Linking Park, Lake Văcărești	Cristina Wong, Daniele Caruso, Irina Mateescu, Bianca-Mellita Tămășan

C1 Reclaiming the Shore, Lake Grivița

Authors : Gertie van den Bosch, Ioana-Eveline Răduța, Karina Pitiș, George Bouros

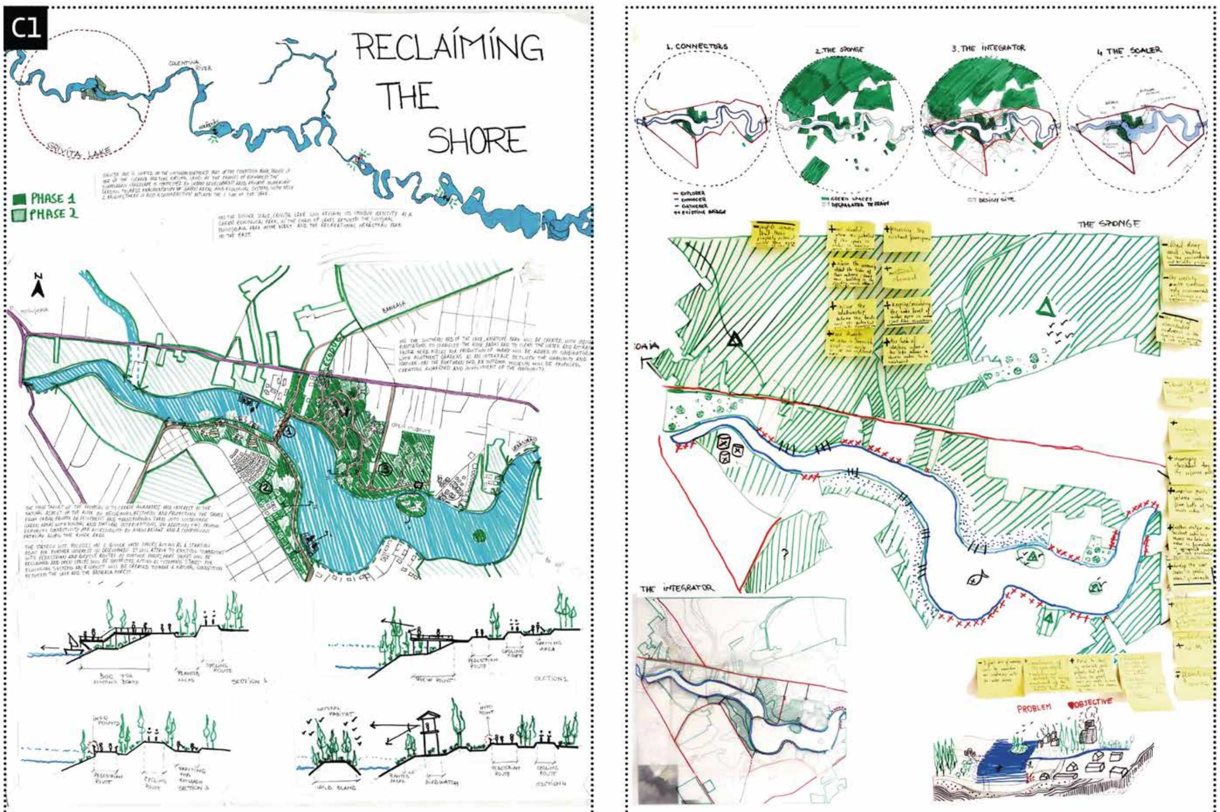

FIGURE APP.O.1 The project 'Reclaiming the Shore', Lake Grivița, team C1.

Grivița lake is located in the upstream northwest part of the Colentina river, making it one of the cleaner and more natural lakes at the fringes of Bucharest. The surrounding landscape is contested by urban development and private ownership leading towards fragmentation of green areas and ecological systems. With only two bridges, there is also a disconnection between the two sides of the lake. The proposal aims to create awareness and interest in the natural aspects of the Colentina river by reclaiming, restoring and protecting the shores from urban private development and transforming them into sustainable green areas with minimal and natural interventions. In addition, this project enforces connectivity and accessibility by a new bridge and a continuous pathway along the river beds.

The strategic site focusses on two big open spaces, acting as a starting point for further interest in development. It will attach to existing "connectors" with pedestrian and bicycle routes. In further phases, more shores will be reclaimed and open spaces will be connected, acting as "stepping stones" for ecological systems. An eco-duct will be created to make a natural connection between Grivița lake and Baneasa forest.

On the southern bed of the river, a nature park will be created, with indigenous plantations to stabilize the river banks, clean the water and attract fauna. Herb fields for the honey production will be added in combination with allotment gardens as an interface between nature and community. On the northern bed, an outdoor museum will be proposed, creating awareness and involvement of the community. On the bigger scale, Grivița lake will reclaim its unique identity as a green ecological park, in the chain of lakes between the cultural Mogoșoaia park and the recreational Herăstrău park.

The jury's feedback:

- The project includes many ideas, with a high level of complexity. It followed the workshop program and developed an own methodology for reclaiming the shores of Lake Grivița.
- A strong point is the emphasis on ecosystem services and how to build nature-based design ideas on this principle, while a missing aspect is the economic dimension and the overview of actors is missing the players of real estate.

C2 Opening the Gates: Decentralising, Re-orienting, Re-naturalizing Lake Herăstrău

Authors: Rajat Uchil, Simona Dolana, Anca-Ioana Crețu, Iulia Dana Băceanu

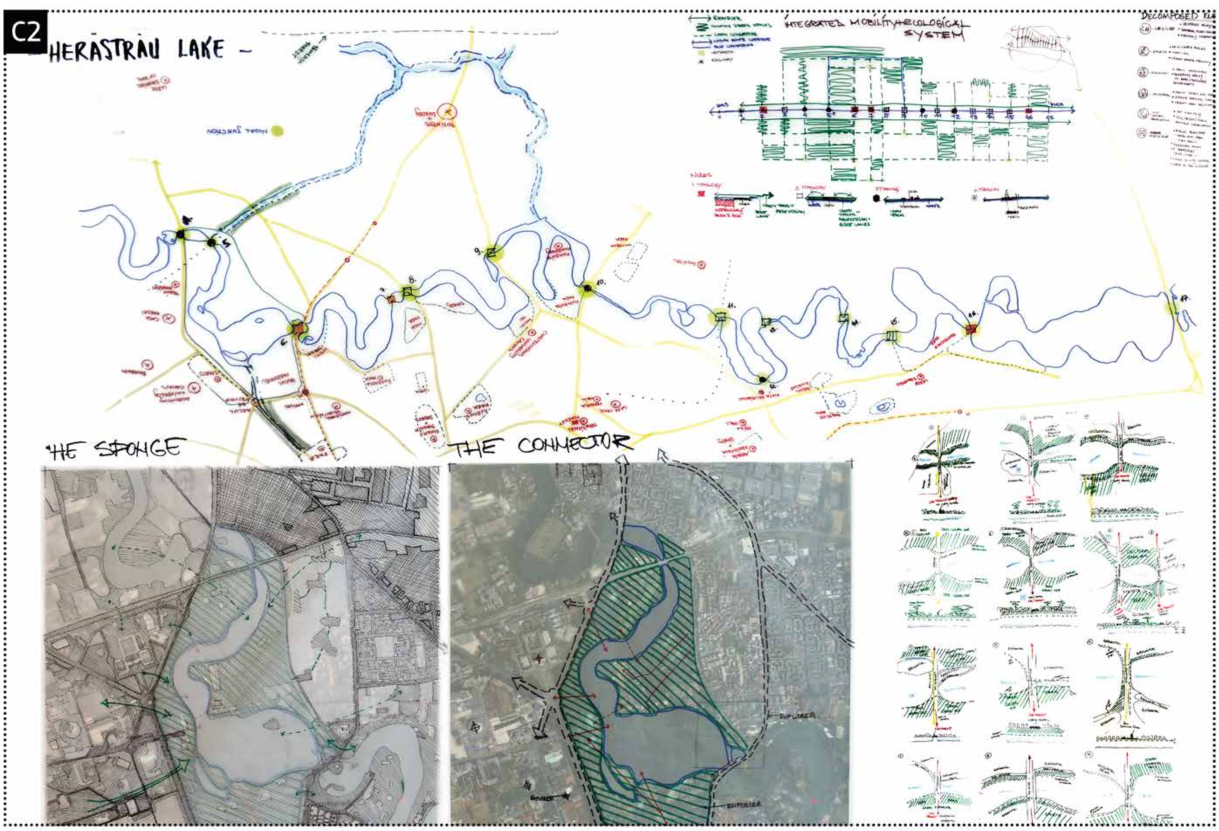

FIGURE APP.O.2 The project 'Opening the Gates: Decentralising, Re-orienting, Re-naturalizing Lake Herăstrău', team C2.

As a section of Colentina river, Lake Herăstrău is the most accessible, frequently visited and very popular in Bucharest. Though this is a strength of the site, it is leading to overcrowding, excessive human intervention, degradation of natural environment and thus, this lake does not mutually co-exist with the rest of the corridor. The gravity of this lake, caused by various factors (such as users' types, real-estate value towards it), is underutilizing the potential of the other lakes along Colentina corridor. In summary, isolation and lack of polarization of this lake park affects the economic, social and ecological system of the Colentina river corridor, as well as the neighbourhoods around it.

Through the analysis done via the design instruments (the sponge, the connector, the integrator, the scalar), the lecture series and site visits , we realise the importance of drawing on a strategy to re-orient the users, such as daily users, seasonal users to other parks via nodes. Apart from this, decomposing and re-distributing the elements of the park would enable a decentralised approach towards the corridor, and it can potentially bring integrated and cohesive development along the the river corridor, beyond our site. Finally, re-naturalising a submerged system layered by human interventions would allow for more balanced socio-ecological hierarchies along the corridor and at the larger scale lead to a better co-existence between the corridor and the city.

The jury's feedback:

- Since Herastrău lake is already strongly developed as a self-standing park with its own identity the team moved beyond the actual area of consideration and made a node analysis for the entire landscape of Colentina corridor.
- The approach is very conceptual and plays with the potential of green infrastructure for sustainable transport (cycling, pedestrian routes).
- A strong point is the integrated mobility concept which included the idea of an ecological network.
- The project is definitively scalable, but it lacked detailing.

C3 The Amphibian Communities of Fundeni Lake

Authors : Johanna Jacob, Jean-Baptiste Peter, Andreea Toma, Iarina Tava

Located on Colentina River, the Fundeni Lake offers a rich environment with an interesting diversity of fauna, flora and communities. By walking along the lake, you might experience the openness of your environment while finding yourself in an intimate relation with nature. This intimacy, which is the main asset we want to enhance in this project, is reinforced by the proximity of "rural" built areas (suburban areas), framed by the blocks perceived as a distant background of the surrounding landscape.

However, this strength is threatened by uncontrolled development, exaggerate privatization of land, and the degradation of natural environment. In addition, existing communities live disconnected from the natural environment. This is a result of lack of awareness, certain poverty and an exclusive understanding of nature and culture.

On the other hand, acknowledging how much health and happiness of human being is related to nature, we face this paradoxical situation with a vision to generate an amphibious place with a more symbiotic relation between the existing community and the River Corridor of Colentina. A system approach was selected to address these challenges by empowering and connecting local communities.

For instance, the strategy for Fundeni Lake proposes to initiate in the short-term bottom-up initiatives, which will create a sense of community. In the midterm, a set of actions will contribute to restore the natural environment and will set the ground to develop more proactive activities. In the long term the goal is to sustain a balanced relation between nature and the surrounding community.

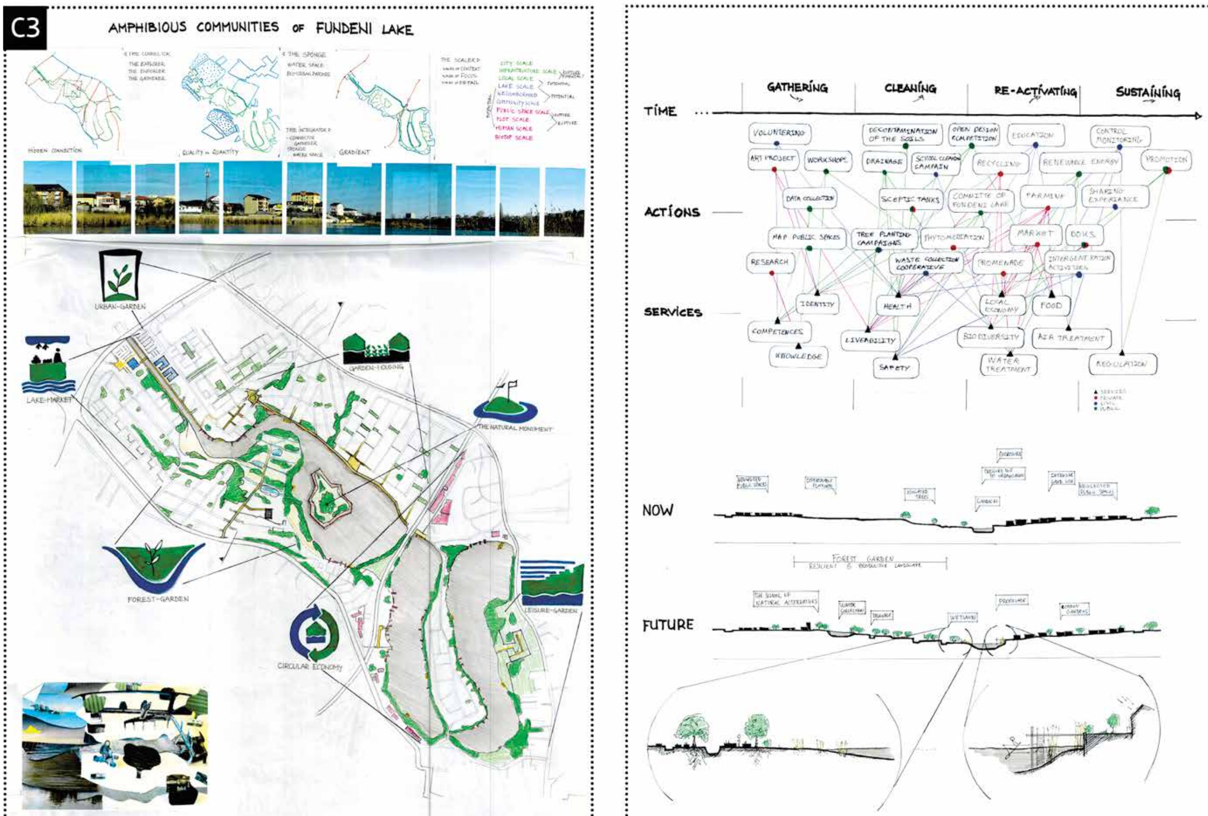

FIGURE APP.O.3 The project ' The Amphibian Communities of Fundeni Lake', team C3.

The jury's feedback:

- The project presents a very holistic approach grounded in the local actors and the diverse community around the Fundeni lake
- It is a very good idea to initiate a lake committee to develop a local governance scheme
- Actors and processes have been identified and included in a process-oriented design idea
- It remains open what circular economy can mean and the project lacks some spatial definition, due to its character

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C4 The Hinge, Lake Pantelimon

Authors : Anita Stamatoiu, Giuliana Gritti, Silvia Cazacu, Christian Patriciu Popescu

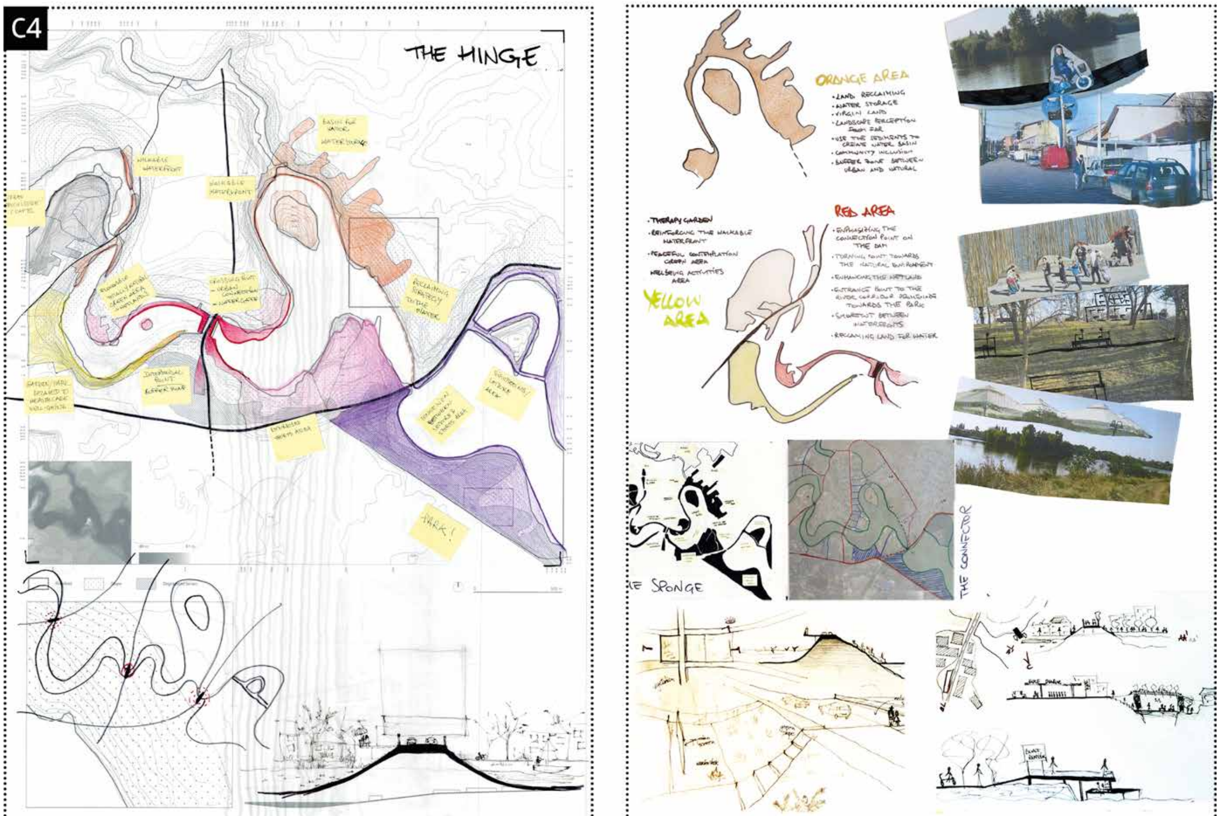

FIGURE APP.O.4 The project ' The Hinge', Lake Pantelimon, team C4.

The area around the Pantelimon Lake comprises a multitude of built environments, road types, green/open areas and water typologies, highly heterogeneous and weakly connected. The lack of planning in the past decades translates into uncontrolled sprawl that fails to integrate with both the urban setting and the green/blue landscape situation. Incoherent infrastructure development or the very lack of it resulted in a non-hierarchical spatial organization, as well as difficulty in accessing the waterfront. The extra spatial capacity of empty/abandoned land is not used to its potential. Most of the unused areas are in connection to the water, highlighting the absence of a true vision for the river.

Based on the diversity identified, the project envisions extracting a vocation for each area based on its topography, urban/architectural and ecological characteristics. This not only brings clarity in terms of the different types of interventions suitable, but also creates the premises for prioritization of the projects in different space-time scenarios.

The starting point is the dam at the center of the Dobroești Lake. This specific site works as an articulation between a wetland-like river environment in the West and a clear lake in the East, as well as between a dense urban area in the South and an almost rural settlement in the North. This point

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is therefore also a dam and a bridge/gate into the city connecting to an important urban junction where various mobility modes and activities are available. The project takes advantage of the good connectivity and density which create the premises for initial development and afterwards radiating towards the other vocational areas. The Hinge is an articulation point emanating urban activity emerged in a resilient river environment.

The jury's feedback:

- The project is a kind of manifesto for the hinge, which could have been even more articulated
- The presentation lost a time with the profound elaboration on the context
- The project presented a very good analysis and the use of scenarios is constructive
- However, the Pantelimon lakes have a huge potential for the development of green infrastructure and open spaces, probably in combination with urban pastures. This potential has not been articulated in the project.

D1 Reinvent by Design, Lake Morii

Authors : Monika Novkovikj, Ruxandra Grigoraș, Cezar Conțiu, Magda Baidan

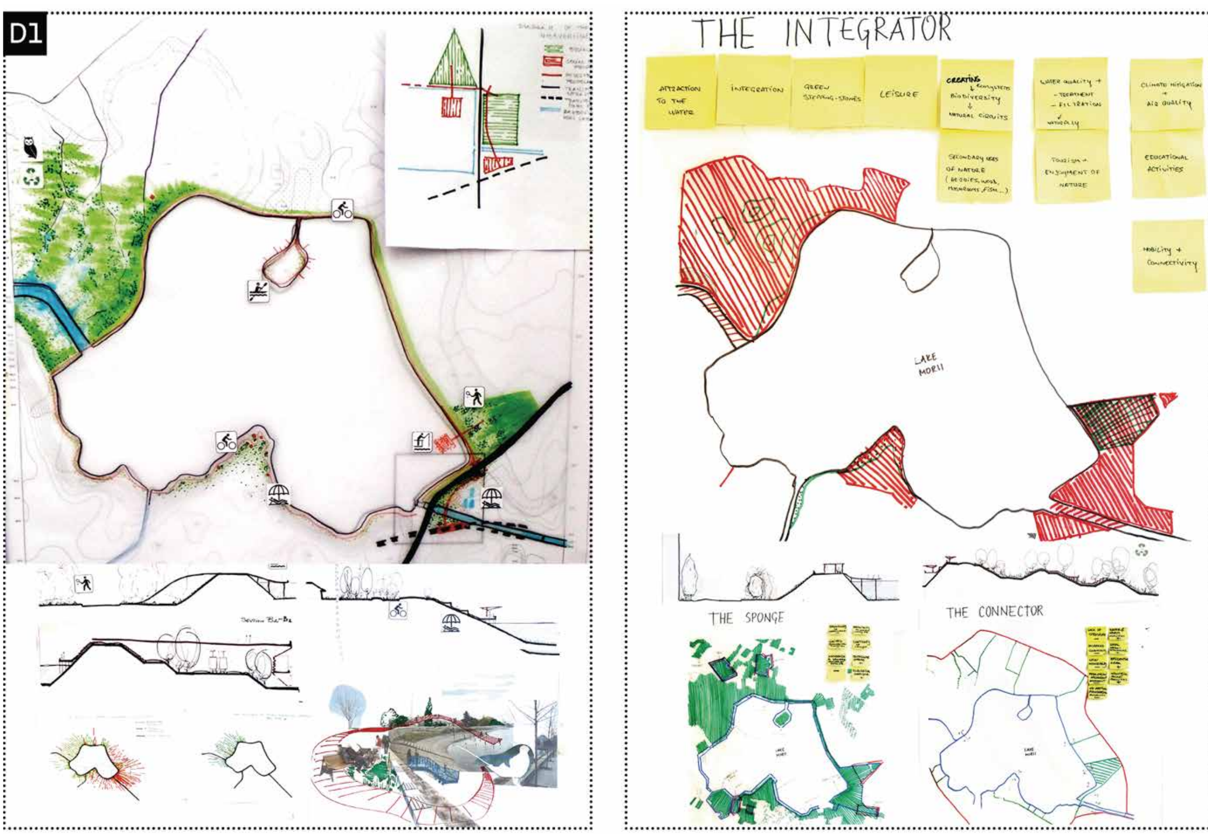

FIGURE APP.O.5 The project 'Reinvent by Design', Lake Morii, team D1.

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Lake Morii is a space which is highly disconnected from the surrounding Bucharest area. It is inevitable for the lake to coexist with its environment at various scales and begin to matter in the general perception of the people of Bucharest. We propose an integrated approach based on two notions: 1) The necessity to connect vertically, horizontally and through several scales, with the water body and its surroundings and 2) The area's important ecological and green potential enhanced by a healthy and extensive ecosystem, as much as the urban context allows.

Our proposal includes three sites: 1) a wetland/natural dendrology reserve with accompanying amenities, 2) a locally important park with sufficient greenery and activities-generating potential, 3) a non-motorized spatial mobility solution accompanied by social/leisure facilities. This circular solution should improve both the ecological and social features of the chosen sites with regards to the lake and integrate Morii with the city on a micro-/meso- scale. The design concept, constituted of three parts, could represent an initiating strategy/model to be later applied to other problem areas of the Dâmbovița river corridor, as well as other locations facing similar issues. The proposal envisions a tentacular development process which would grow through scales in time and catalyse the reactivation of the lake and its surrounding. As it provides socially attractive entry points towards the main focus area (A), this design solution is particularly replicable and it is in-tended to become not only an ecological site but also a mentality-changing 'gateway' towards a more integrated urban space and perception, hence its social and educational functions.

The jury's feedback:

- The team used the suggested method in a coherent was and worked at both the micro and the macro scale.
- The design visualizations are inviting and vivid, the make sure that the 'social entry points' to this lake need to be defined
- However, Lake Morii was in itself a very strong urban statement, which certainly requires a strong answer. A response to the urban articulation of the urban-water interface, which is still lacking, has not been given, which was a missed opportunity, still, the project provides beautiful details.

D2 Dâmbovița From Barrier to Link, Mihai Vodă- Izvor site

Authors: Maricruz Gazel, Cristina Ștefan, Marcela Doina Dumitrescu, Alexandru Mexi

High disregard for the river and an unbalanced use of space is the result of lack of institutional cooperation and integrated public policies. Dâmbovița River should become an attractive element to diversify and connect activities through the corridor and surrounding areas. The goal of this strategy is to increase awareness and promote a new collective image for the river as an integrated and attractive part of the city. It will be achieved by developing multiple activating connections across the river on a horizontal level and enhance coherence at a longitudinal level. In order to achieve the design objective a multi-phase process was developed. The focus of each intervention will be a platform, followed by informal connections between platforms and subsequently the two banks. A total of 5 potential intervention areas were identified in the segment between the Botanical Garden and Izvor Park. The main criteria for selecting the sites was their particular character and potential. Several platform types can be used and placed in the middle of the river or adjacent to the banks and connected through informal footbridges. The platform works as a stich. The detailed intervention connects the Botanical Gardens with the campus in several steps. The first phase of the project brings the students to the river and over it by inserting a main vegetation stich to the garden and a smaller one on the campus bank. It will be complemented with measures to change mobility behavior. The second phase implies extending the stiches and diverting the traffic one shore by improving the connection between the campus and the river and extending the area influenced by the connections. The process can be recreated in all selected areas with an experimental component and flexibility towards changes in location and activities.

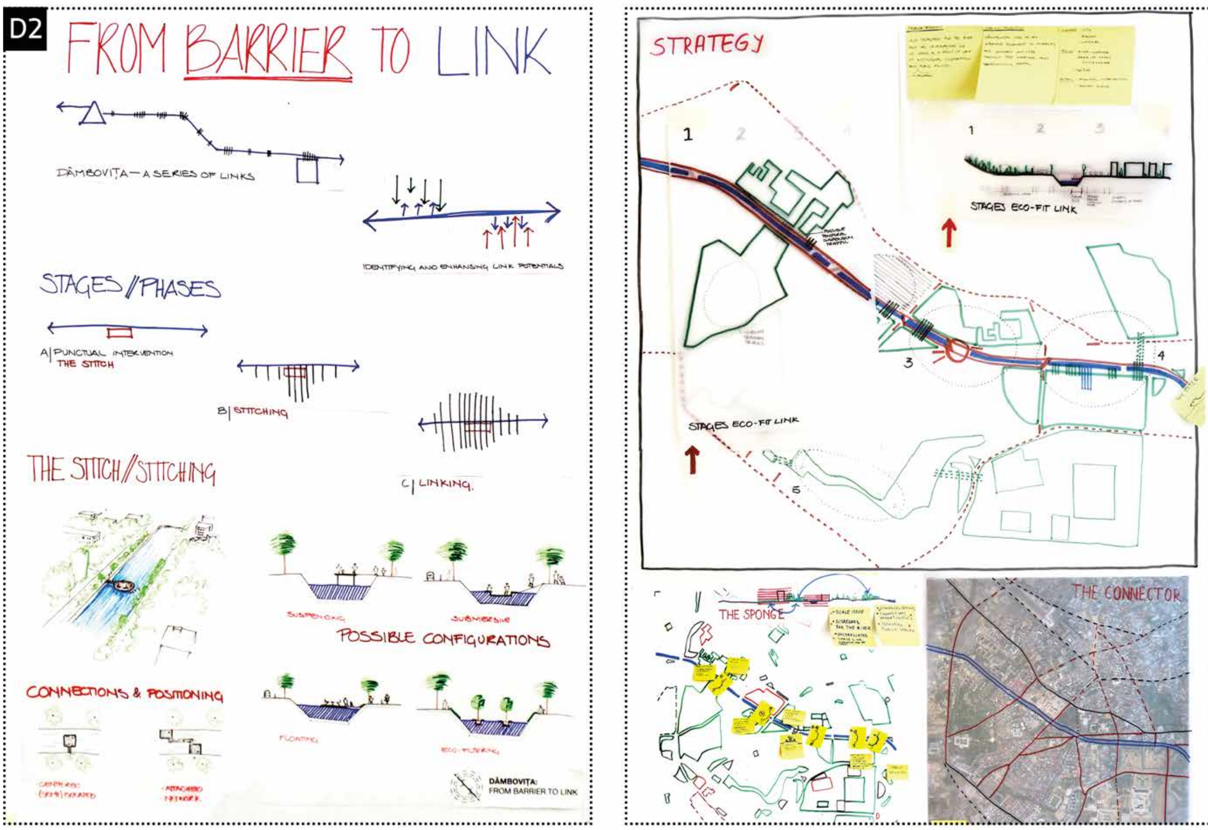

FIGURE APP.O.6 The project 'Dâmbovița From Barrier to Link', Mihai Vodă- Izvor site, team D2.

The jury's feedback:

- The project makes good use of the local potential and tries to find a coherent strategy, moving the river to a central position. The concept is definitively scalable, and the urban context of this project was very difficult and complex.
- However, the project lacks answers to the systemic problems of this area. For example, some suggestion on how the traffic pressure could be minimized in the future could have been given (such as public transport strategies, cycling routes).

D3 Closing the Gap, The National Library site

Authors : Zhouyiqi Chen, Cristina-Mihaela Iordache, Alexandra Mirona Man, Lucian-Ștefan Călugărescu

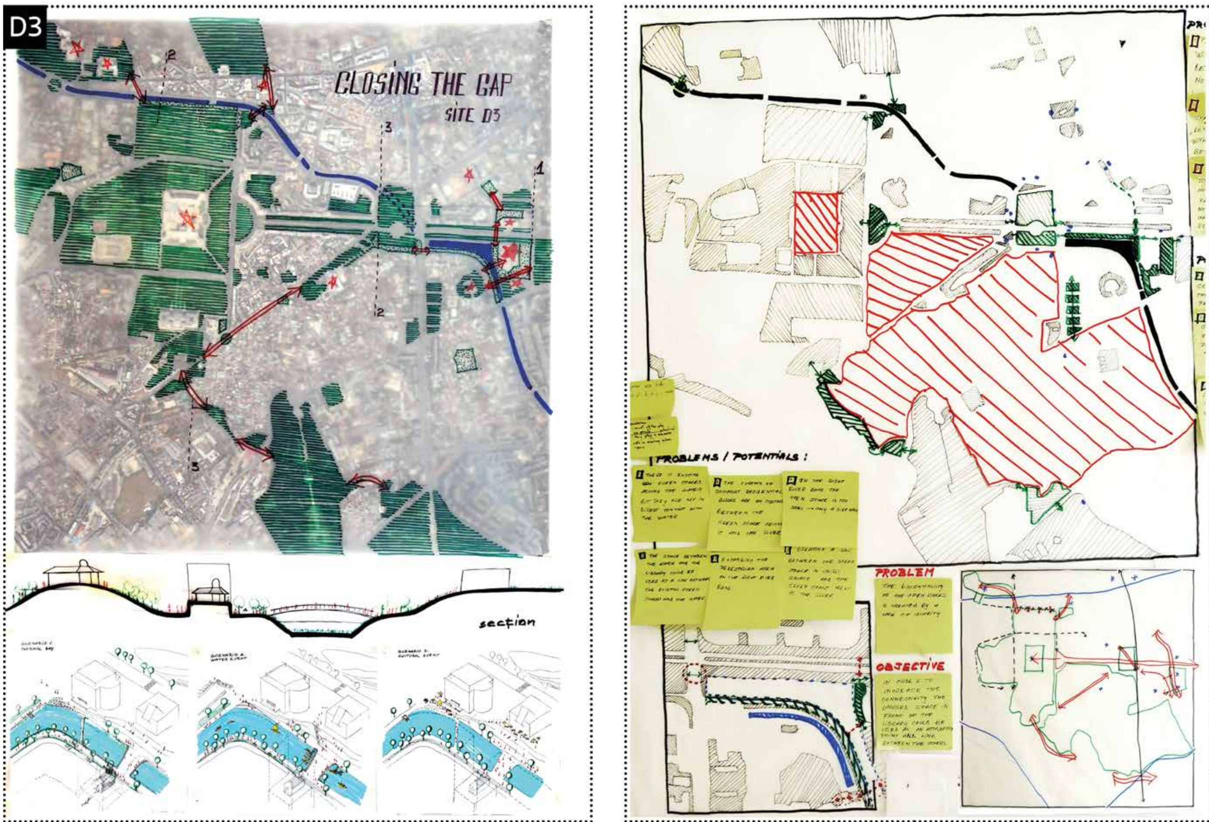

FIGURE APP.O.7 The project 'Closing the Gap', The National Library site, team D3.

The assigned site is located in one of the most central areas of Bucharest, next to an important transport hub and also on the central axis of the new civic center developed in the Socialist Era. The site has a big potential as it is surrounded by a number of important public functions, among them the most iconic being the National Library, The Comic Opera, Unirii Shopping Center and the Court House.

All these factors result in an area that is an essential place for social and cultural activities, as well as for the mobility system. However, the place is not used at its full potential because of social and ecological disconnections. Poor quality of open space, lack of accessibility and mismatched human scale end up with disconnections on social aspect. Most of the green areas are not continuously linked and the considerable gap between the river and the green space accentuates the ecological dysfunction.

Our design objective is to transform the river corridor of Dâmbovița in an attractive, livable, sustainable environment in the center of the city. The unused space around the library will be transformed into an attractive area that will create a link between the historical monastery and the potential park, which could develop on the unfinished construction site.

The jury’s feedback:

- The team articulated the idea of an urban utopia which is certainly a good tool for presenting alternative futures
- How does the tube idea link to the overall project concept?
- It was also not clear how the funnel would work
- No reflection of the inherent systemic problems of the area caused by a poorly organized traffic system

D4 Linking Park, Lake Văcărești

Authors: Cristina Wong, Daniele Caruso, Irina Mateescu, Bianca-Mellita Tămășan

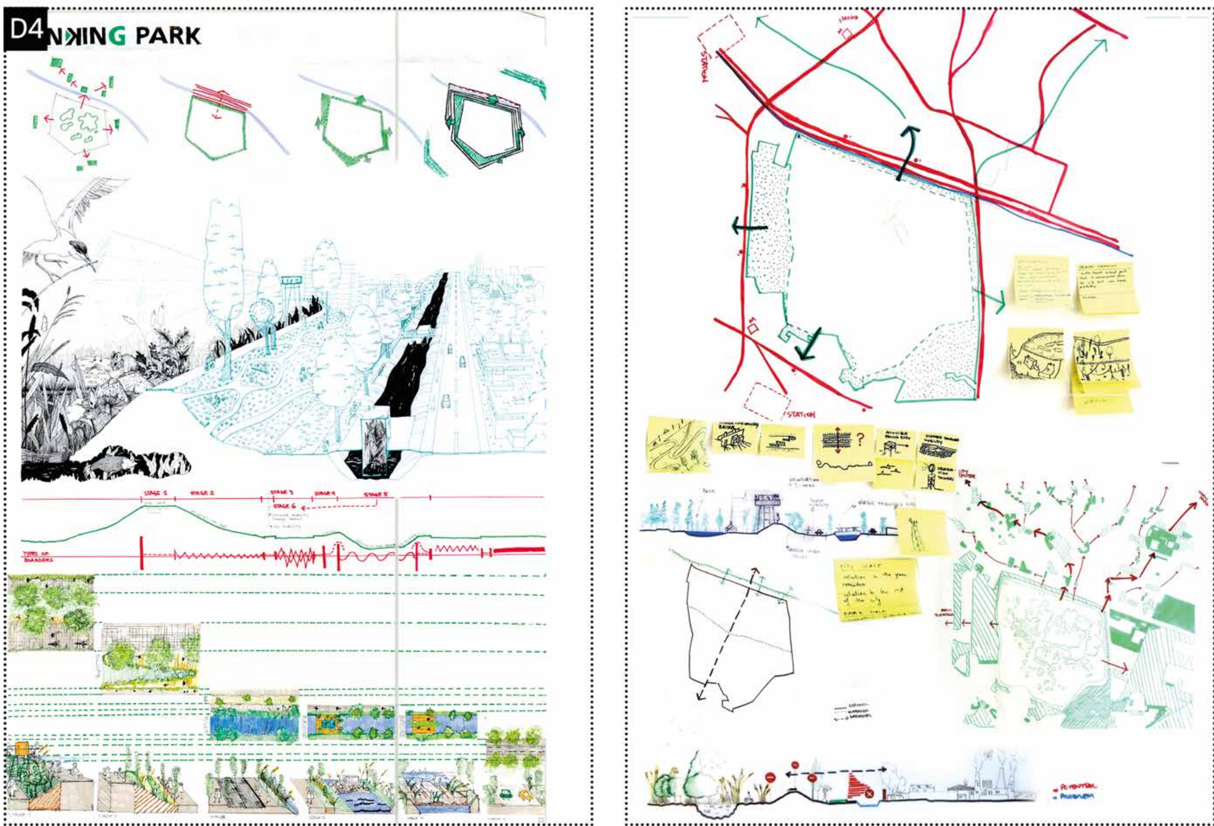

FIGURE APP.O.8 The project 'Linking Park', Lake Văcărești, team D4.

Our project focuses in a green buffer created between Lake Văcărești and the city. The proposal consists on taking advantage of the existing public spaces, residual areas and green zones of the city, considered ‘patches’, distributed along the city. These green patches will work as an extension of the ecological reserve, which will run throughout the city as green corridors connecting the lake with the city centre, Park Tineretului, Park Titan, and south Bucharest. Physical barriers encountered in the site will be removed in order to make a smooth transition among the existing city and the river.

The jury's feedback:

- Very good use of the sponge idea and transformation of the analysis result into the idea of a buffer zone around the nature protection zone
- However, it remained unclear how this zone would be maintained, this could be for example a form of urban agriculture or urban pasture
- The project developed very beautiful visualisations which are definitively a good approach towards communicating the value of the periphery to the general public.
- It remained open what would be the connection of the community to the sponge area

Appendix P

The jury's evaluation sheet for the final presentation

Evaluation Sheet Final Presentation, 10th of March 2017

Name of evaluator: Group number:

CRITERIA	COMMENTS	RANKING
		1 (lowest) - 5 (highest)
Communication (Presentation, Time Management, Visual Quality, Speech)		
Methodical Coherence (Consistence of structure and argumentation, logic, identifiable methods, innovative approach?)		
Social-ecological integration		
Scalability (The strategic relevance of the proposal on the scale of the corridor)		
Level of completion of the Task		
Further Observations		