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A Cross-case Comparison of Dispersed Urban Development in Europe

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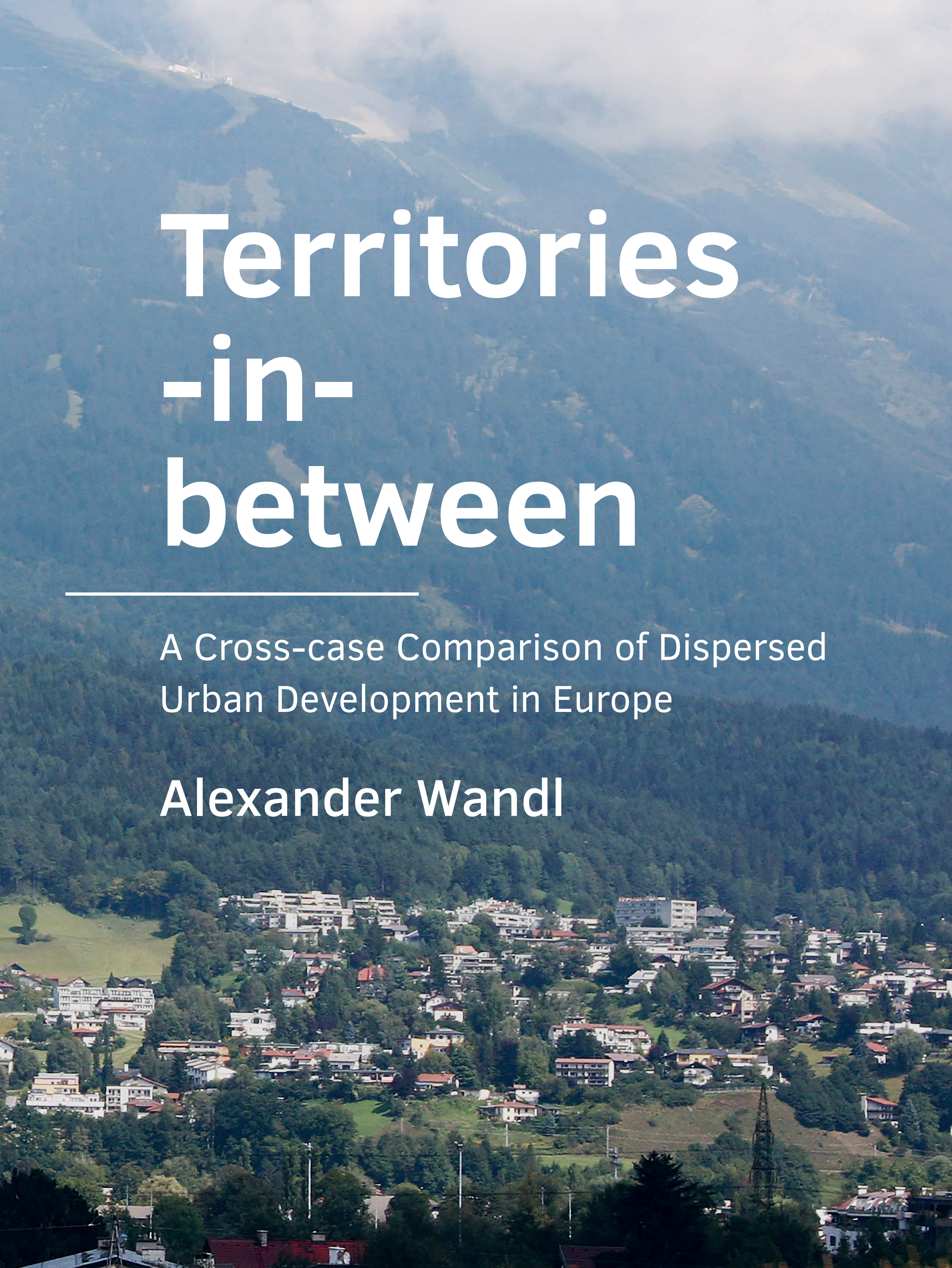

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Territories-in-between

A Cross-case Comparison of Dispersed Urban Development in Europe

Dissertation

for the purpose of obtaining the degree of doctor
at Delft University of Technology
by the authority of the Rector Magnificus, prof.dr.ir. T.H.J.J. van der Hagen
chair of the Board for Doctorates
to be defended publicly on
Wednesday, 22 January 2020 at 10:00 o'clock

by

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This dissertation has been approved by the promotors.

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To Birgit for sharing a passionate journey through life and urbanism with me.

Preface

The research in this dissertation was spurred by two observations I made early on during my master studies, in the 1990ies: There is a network - or better a landscape of villages and towns and related open spaces - outside of large cities, which are more than suburbs. Areas that have their own way of life that form economic networks have their own culture and after all form spatial structures that are not necessarily related to a rural economy or lifestyle.

At the time, I was surprised that in most urban and regional plans I came across, these landscapes did not play a role at all. They were either simply seen as a space for further urban extension or called 'zersiedelt' (dispersed), without further qualification.

Reading Thomas Sievert's Zwischenstadt: Zwischen Ort und Welt, Raum und Zeit, Stadt und Land (1997), a book that I still often carry with me, was a revelation for me. The book provides ways to understand what I call territories-in-between, from a descriptive but also a planning perspective, in a complementary way to how we plan the compact European city. And it confirmed my feeling that when talking about sustainable development, territories-in-between play a crucial role and deserve special and spatial attention.

This idea of understanding and developing the potentials of territories-in-between has been the red thread through my academic work in the last twenty years, starting with my Master thesis that looked at the area between Vienna and Bratislava from the landscape planning perspective, mentored by Werner Kvarda.

After practising landscape architecture and planning in Vienna, I returned back to academia to join the post-graduate program European Master of Urbanism at the TU Delft. Ten years after my master thesis, my EMU thesis mentored by Bernardo Secchi and Daan Zandbelt focussed on comparing two different cases of dispersion, the Tyrol in Austria and Zuid-Holland in The Netherlands from a more integrated perspective. This work was the ideal preparation for my dissertation, which further advanced, deepened and sharpened the concepts I developed during my studies.

Parallel to my dissertation, I have been working on several national and international research projects. Most important, the work within the European Horizon2020 research project Resource Management in Peri-urban Areas (REPAiR), which looks at the peri-urban from a metabolic perspective, gives a preview of where I want to head the coming years.

Acknowledgements

This dissertation would not have been possible without the support of the many people who were involved in it in direct or indirect ways. Many people contributed in different ways to this long journey. I owe them many thanks, and I would like to acknowledge them here.

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I want to thank Wil for his academic rigour his concise and critical comments and questions, which always came from an open-minded point of view. I am extremely grateful to Remon, for finding the right approach to supporting me between giving me my independence and being rigorous when needed. Thank you for the hour-long and detailed discussions on many, many draft versions of the papers of this dissertation as well as for your always positive way of coaching me.

I am thankful to Thomas Sieverts for encouraging me, to include an alpine case into my comparison, when I presented the first ideas of my dissertation at a conference in Haifa. My gratitude goes to Paola Viganò and Bernardo Secchi for providing the possibility to learn from them while jointly exploring the future of Le Grand Paris and introducing me to the wide field of academic peers working on the dispersed.

I would particularly like to thank my co-authors Birgit Hausleitner and Roberto Rocco for their contributions and discussion of the papers we jointly wrote. The papers would have not been possible without them. I would also like to thank the reviewers of the papers and the editors of the journals who all provide excellent feedback that proved essential for improving the papers. I am thankfull to the members of the defence committee for their questions and feedback.

My gratitude goes to Arjan van Timmeren and Amber Leeuwenburgh for believing in me and providing me with the possibility to stay in academia and at TU Delft against the odds. A special thank to you, Arjan, for providing the environment that allowed me to develop and grow.

I would like to offer my special thanks to all my current and former colleagues from the Department of Urbanism for the many discussions and comments which were very helpful along the way, specifically, Birgit Hausleitner, Frank van der Hoeven, Egbert Stolk, Jorge Gil, Akkie van Nes, Wendy Tan, Evert Mijers, Diego Sepulveda, Qu Lei, Verena Balz, Ulf Hackauf, Bardia Mashhoodi, Dominic Stead, Roberto Rocco, Steffen Nijhuis, Nico Tillie, Daniela Maiullari, Cecilia Furlan, Ken Arroyo Ohori, Stephen Read and Daan Zandbelt.

I also wish to thank my paranymphs, Birgit Hausleitner and Ulf Hackauf as well as Karin Visser for their support in the preparation of the defence; I am also grateful for the assistance provided by Daniela Maiullari and Emma Flores Herrera for some of the maps and the final layout. I want to extend my gratitude to Annemieke Berger and the support staff of the Department of Urbanism and the Faculty. A special thanks deserves the urbanism secretariat with Linda van Keeken, Margo van der Helm, Karin Visser, Chiara Termini, and Danielle Hellendoorn for the necessary troubleshooting and the continuous patience along the way.

My utmost gratitude goes to my family, to my mother Margit, my father Otto, and my brother Christian. Not only did they always support me with more than their love throughout my career, which more often than once had radical and surprising changes. More than that, they showed me through their daily life and professional practise that caring about our planet and our species' future makes a difference, that this care is worth pursuing against the economic mainstream and that it can be successful. My gratitude extends to my uncle Toni for being an inspiration as a pioneer in a circular economy and for making me aware of the limits of our planet already in my early childhood.

Most grateful I am to Birgit, my partner in life and in urbanism. I want to thank you for our inspiring discourses, for your sharp criticism and for your endless passion for sharing with me your knowledge and observations. Without you, this thesis would not have been possible.

Contents

Summary

There is an increasing body of literature suggesting that the conventional idea of a gradual transition in spatial structure from urban to rural does not properly reflect contemporary patterns of urban development and their potential for sustainable development. Furthermore, it is argued that large parts of the dispersed urban areas of Europe are neglected in urban and spatial planning policies. Such areas tend to be labelled simply as sprawl, though there is little evidence about whether such dispersed development is more or less sustainable than other forms of urban development. Moreover, evidence points in the direction that a large amount of dispersed urban development also asks for different planning approaches and instruments, which reflect the complexity and network structure of theses specific settlement patterns.

The research introduces the concept of territories-in-between (TiB) to address the issues surrounding dispersed urban development and to contribute to the understanding of sustainable urbanisation. TiB is an umbrella term that avoids the simple dichotomy of spatial structure into ‘urban’ and ‘rural’. It also avoids the notion of an urban-rural continuum, and is not limited by cultural connotations that come with some other terms like *Zwischenstadt, Città diffusa* or *Tussenland*, because those terms belong to a specific place and are not generic.

A cross-case comparison research design was chosen to avoid an approach that is too context-specific and solution-oriented but which is able to develop methods and principles that can be transferred to other geographical contexts. Ten cases in five countries were studied with the aim to answer the following questions:

- What spatial structures characterise dispersed urban areas in Europe?
- Which morphological and functional structures of dispersed urban areas offer the potential for more sustainable development? If so, how can this potential be mapped and measured to inform regional planning and design?
- Are there similarities and dissimilarities concerning potentials of dispersed urban areas in different locations, planning cultures, topographies and histories?

These questions were answered in detail in four papers, which are summarised below.

Beyond urban-rural classifications: characterising and mapping territories-in-between across Europe

Much of the physical territory of Europe does not fit classic ‘urban-rural’ typologies but can best be described as ‘territories-in-between’ (TiB). There is considerable agreement that TiB is pervasive and very significant. However, typologies of territory or spatial development continue to employ only degrees of either urban or rural. Similarly, spatial planning and territorial development policies rarely make use of the notion of in-between areas but tend instead to divide the territory into urban and rural zones. Questions have been raised therefore, about the lack of understanding of territories-in-between and the lack of attention given to them in planning policy. This paper contributes to a better understanding of TiB, by proposing a method for their characterisation and mapping. It asks if there can be a common definition of TiB that reflects consistent and distinctive

characteristics across the great variety of spatial development contexts in Europe. It proposes spatial and demographic criteria for their definition, mapping and comparison. The comparison with widely used urban-rural classifications shows that the notion of TiB has three advantages: (i) it maps the complexity of the spatial structure of urbanised areas on a regional scale, and thereby helps to overcome the prevalent idea that urbanised regions are characterised by a spatial gradient from urban centre(s) to rural periphery; (ii) it emphasises the network structure of territories-in-between and the underlying connectivity of places with different functions; and (iii) it raises awareness that in some parts of Europe a settlement pattern has developed that cannot be understood as either urban or rural.

Towards sustainable territories-in-between: a multidimensional typology of open spaces in Europe

The improvement of ecosystem services provided by open spaces in dispersed urban areas is a crucial challenge for sustainable spatial development in Europe. The typology presented in this article illustrates the different potentials that open spaces in territories-in-between have across ten cases in Europe. Unlike other typologies, neither function nor form is used for the classification, but the potential interaction of open spaces with social, technical and ecological networks. Therefore, the typology informs regional spatial planning and design about the potential ecosystem services in networked urban regions. Consequently, the importance of territories-in-between, which are often neglected by mainstream spatial planning and design, for sustainable development is highlighted.

Comparing the landscape fragmentation and accessibility of green spaces in territories-in-between across Europe

The positive effects provided by green spaces on human well-being in dispersed urban areas is a potential advantage in urban development and a key challenge for sustainable spatial development in Europe. This article presents a methodology that allows for the comparison of the potential of green spaces in territories-in-between across Europe, in a way that crosses the fields of urban ecology and urbanism. The article adds to the existing knowledge and understanding of the relation between the spatial organisation of systems of green spaces and their accessibility to biodiversity and human well-being. First, it adapts a green space fragmentation index in a way that it can be applied to the specific spatial characteristics of territories-in-between. Second, it combines the fragmentation index with an indicator for the accessibility of green spaces in order to integrate aspects of ecology, human well-being and the spatial heterogeneity of the relation between them. The methodology is applied to ten areas across western Europe in order to inform decision and policy makers including urban planners, designers and environmental agencies. The approach enables assessment of the potential of the system of green spaces for biological diversity and human well-being in an integrated manner.

Territories-in-between: investigating forms of mixed-use in Europe’s dispersed urban areas

A large part of Europe’s population lives in dispersed urban settlements, much of it labelled as sprawl: monofunctional low-density urbanisation. There is increasing evidence though that this may be a too simplistic way of describing them, as some of these territories-in-between (TiB) urban and rural have undergone a process of densification and diversification. This paper investigates whether and how mixed-use appears in TiB. The paper uses data on the location of economic activities and the residential population at a 500 m by 500 m resolution. It concludes that in the eight cases in four European countries mixed-use is widespread and that more than 65 per cent of the area is mixed. Moreover, the paper demonstrates, by developing a multi-scalar typology of settlement characteristics including measures of grain, density, permeability and centrality, that local and regional settlement characteristics can explain the location and intensity of mixed-use areas. Although the building types and form of local urban tissue vary significantly in mixed-use areas, we conclude that across all four countries, the cross-scale settlement characteristics are similar.

Atlas of territories-in-between

The four papers are completed by an Atlas of Territories-in-between and a meta-analyses across all papers and cases. The Atlas presents a rich compendium of original maps illustrating the morphological, functional and relational properties of TiB, and the resulting potentials for present and future sustainability. The cross-case comparison of the ten dispersed urban areas across Europe uses 25 indicators to assess the current state and potentials for the future sustainability of these areas. The indicators cover the aspects of the provision of different ecosystem services, multi-functionality and mixed-use. The methods developed to assess the potential for future sustainable development combine both regional and systemic aspects with local and place-specific elements. It does so drawing on extensive modelling and spatial analyses of the settlement patterns, systems of built and unbuilt open spaces as well as on demographic and economic location patterns.

Conclusions

Do dispersed urban areas have distinct characteristics? In sum, the findings show that dispersed urban areas in Europe are quite distinct from urban and rural areas and that they share characteristics from one place to another. The findings also show that the well-worn notion of a continuum from urban to rural does not stand up to the evidence, and is a crude simplification of the complexities and socio-ecological systemic relations which characterise TiB. It follows that effective spatial planning for such areas needs to be built on a more careful analysis of characteristics and potential for sustainable development.

The research investigated three aspects of sustainable spatial development, the potential of multi-functionality, the provision of ecosystem services and the presence and potential for mixed-use. The potentials for multi-functionality in TiB go beyond the buildings. Especially grey open spaces provide a significant potential for multifunctionality. Greenspaces have an inherent potential through multifunctional use to not only lessen the negative impact of climate changes but also to provide a positive effect on the liveability of citizens.

The maps presented in this study show that the most common green spaces, but also significant parts of grey spaces in TiB have the potential for multiple ecosystem services. The form of the potential is very distinct according to the spatial relation of a specific open space to its centrality as a resulting characteristic of the street network, accessibility to and connectivity of services as well as densities of services, production and consumption.

Mixed-use, preferably integrated into a pedestrian-oriented environment, is a further aspect of sustainability. The research shows that TiB are more mixed than commonly referred to. The typology presented in this paper shows that mixed-use in TiB could be related to specific settlement characteristics. The characteristics investigated were: grain, density, permeability, centrality and closeness to transit stations and motorway entries.

This leads to a generalised conclusion: the networks of small towns and cities form a robust spatial structure that can facilitate multi-functionality, mixed-use and ecosystem services, on both local and regional scales. But these qualities are under pressure by one-dimensional planning approaches which tend to focus on densification only. There is a significant potential to develop green and grey open spaces along with the network of grey infrastructures to provide ecosystem services and also facilitate multi-functionality.

Samenvatting

Er zijn steeds meer aanwijzingen in de literatuur dat het conventionele concept van een geleidelijke overgang in de ruimtelijke structuur van urbaan naar ruraal geen correcte afspiegeling vormt van hedendaagse patronen van stedelijke ontwikkeling en hun potentieel voor duurzame ontwikkeling. Bovendien worden grote delen van de diffuse stedelijke gebieden in Europa in het stedelijke en ruimtelijke ontwikkelingsbeleid over het hoofd gezien. Dergelijke gebieden worden vaak simpelweg beschouwd als suburbanisatie (sprawl) en er is weinig bewijs of deze diffuse ontwikkeling duurzamer of juist minder duurzaam is dan andere vormen van stedelijke ontwikkeling. De feiten lijken daarbij te suggereren dat een grote mate van diffuse stedelijke ontwikkeling ook andere planmatige benaderingen en instrumenten vereist, die tegemoetkomen aan de complexiteit en de netwerkstructuur van deze specifieke vestigingspatronen.

In dit onderzoek wordt het concept territories-in-between (TiB) [tussengebied] geïntroduceerd voor het aanpakken van kwesties in verband met diffuse stedelijke ontwikkeling en een bijdrage te leveren aan een beter inzicht in duurzame verstedelijking. TiB is een overkoepelend begrip dat de harde tegenstelling in de ruimtelijke structuur tussen ‘urbaan’ en ‘ruraal’ overstijgt. Ook helpt het om het idee van een continuüm van urbaan naar ruraal te vermijden en wordt het niet beperkt door culturele connotaties die bepaalde andere begrippen met zich meebrengen, zoals Zwischenstadt, città diffusa of tussenland, omdat die begrippen bij een specifieke plaats horen en niet generiek zijn.

Het onderzoek is opgezet als cross-case research om een aanpak te voorkomen die te contextspecifiek en oplossingsgericht is zodat er juist methoden en beginselen worden ontwikkeld die kunnen worden overgenomen in andere geografische kaders. Er zijn tien cases in vijf landen onderzocht om antwoord te vinden op de volgende vragen:

Welke ruimtelijke structuren zijn kenmerkend voor diffuse stedelijke gebieden in Europa?

Welke morfologische en functionele structuren van diffuse stedelijke gebieden bieden mogelijkheden voor meer duurzame ontwikkeling? Hoe kan dit potentieel in kaart worden gebracht en gekwantificeerd ten behoeve van regionale plannen en ontwerpen?

Zijn er overeenkomsten en verschillen in het potentieel van diffuse stedelijke gebieden naargelang hun plaats, plancultuur, topografie en geschiedenis?

Deze vragen zijn uitvoerig beantwoord in vier artikelen, die hier worden samengevat.

Voorbij urbaan-rurale classificaties: karakterisering en indeling van tussengebieden in Europa

Veel van het fysieke grondgebied van Europa past niet in klassieke ‘urbaan-rurale’ typologieën maar laat zich beter omschrijven als territories-in-between (TiB), of tussengebieden. Er bestaat aanzienlijke consensus dat tussengebieden alomtegenwoordig en belangrijk zijn. Toch blijft het zo dat in typologieën van een grondgebied of ruimtelijke ontwikkeling nog altijd alleen maar gradaties van hetzij urbaan, hetzij ruraal worden gehanteerd. Evenzo wordt in het beleid voor ruimtelijke planning en ontwikkeling slechts zelden gebruikgemaakt van het idee van tussengebieden; grondgebied wordt meestal onderverdeeld in urbane en rurale zones. Zowel het gebrek aan inzicht in tussengebieden als het gebrek aan aandacht dat eraan besteed wordt in het ruimtelijk beleid hebben vragen doen rijzen. Dit artikel moet meer inzicht verschaffen in tussengebieden door een methode te formuleren waarmee ze gekarakteriseerd en ingedeeld kunnen worden. De vraag wordt gesteld of er een definitie van tussengebieden bestaat die recht doet aan de gemeenschappelijke en onderscheidende kenmerken van alle uiteenlopende contexten van ruimtelijke ontwikkeling in Europa. Het bevat voorstellen voor ruimtelijke en demografische criteria voor het definiëren, indelen en vergelijken van tussengebieden. De vergelijking met veelgebruikte urbaan-rurale classificaties laat zien dat het TiB-concept drie voordelen biedt: (i) het geeft inzicht in de complexiteit van de ruimtelijke structuur van verstedelijkte gebieden op regionale schaal en helpt daarmee het overheersende idee te ondervangen dat verstedelijkte regio's worden gekenmerkt door een ruimtelijke schaal die van urbane centra naar rurale periferieën loopt, (ii) het benadrukt de netwerkstructuur van tussengebieden en de onderliggende verbondenheid van plaatsen met verschillende functies, en (iii) het vergroot het bewustzijn dat zich in bepaalde delen van Europa een vestigingspatroon heeft ontwikkeld dat niet kan worden getypeerd als hetzij urbaan, hetzij ruraal.

Op weg naar duurzame tussengebieden: een multidimensionale typologie van open ruimten in Europa

De verbetering van de bijdragen die open ruimten aan het ecosysteem in diffuse stedelijke gebieden leveren is een cruciale uitdaging voor duurzame ruimtelijke ontwikkeling in Europa. De in dit artikel gepresenteerde typologie illustreert in tien casestudy's in verschillende Europese landen het gevarieerde potentieel die open ruimten in tussengebieden hebben. Anders dan in andere typologieën wordt niet de functie of de vorm als classificatiecriterium gebruikt, maar de interactie die open ruimten met sociale, technische en ecologische netwerken kunnen hebben. Daardoor levert deze typologie input op voor het regionale ruimtelijke planning- en ontwerpbeleid met betrekking tot de potentiële bijdrage aan het ecosysteem in netwerken van stedelijke regio's. Het gevolg is dat het belang van de tussengebieden, dat in conventionele ruimtelijke plannen en ontwerpen zo vaak over het hoofd wordt gezien, voor duurzame ontwikkeling wordt onderstreept.

Comparing the landscape fragmentation and accessibility of green spaces in territories-in-between across Europe (Een vergelijking van de landschappelijke versnippering en toegankelijkheid van de groene ruimte in tussengebieden in Europa)

De positieve effecten op het menselijk welzijn van groene ruimtes in diffuse stedelijke gebieden bieden een potentieel voordeel voor stedelijke ontwikkeling en vormen een belangrijke uitdaging voor duurzame ruimtelijke ontwikkeling in Europa. In dit artikel wordt een vakgebiedoverschrijdende methodologie gepresenteerd waarmee het potentieel van groene ruimten in tussengebieden in verschillende delen van Europa kan worden vergeleken die elementen van stedelijke ecologie en stadsplanning bevat. Het artikel levert aanvullende nieuwe kennis en inzichten op over de relatie tussen de ruimtelijke ordening van stelsels van groene ruimten en hun toegankelijkheid voor biodiversiteit en menselijk welzijn. Ten eerste wordt een versnipperingsindex van de groene ruimte zodanig aangepast dat deze op de specifieke ruimtelijke kenmerken van tussengebieden kan worden toegepast. Ten tweede wordt de versnipperingsindex met een indicator voor de toegankelijkheid van groene ruimten gecombineerd om aspecten van de ecologie en het menselijk welzijn en de ruimtelijke heterogeniteit van de relatie tussen die aspecten te integreren. De methodologie wordt toegepast op tien gebieden in West-Europa om informatie aan besluitvormers en beleidsmakers te verschaffen, waaronder stedenbouwkundigen, ontwerpers en milieu-instanties. Deze aanpak maakt het mogelijk om integraal te beoordelen welk potentieel het stelsel van groene ruimten heeft voor biodiversiteit en menselijk welzijn.

Tussengebieden: onderzoek naar gemengd gebruik in de diffuse stedelijke gebieden van Europa

Een groot deel van de Europese bevolking woont in diffuse stedelijke gebieden, waarvan er vele worden getypeerd als suburbaan: monofunctionele urbanisatie met een lage dichtheid. Er is echter toenemend bewijs dat deze beschrijving wellicht te simplistisch is, omdat een aantal van deze urbane en rurale tussengebieden een proces van verdichting en diversificatie hebben ondergaan. In dit artikel wordt onderzocht of en hoe gemengd gebruik in de tussengebieden voorkomt. Daarbij wordt gebruikgemaakt van locatiedata van economische activiteiten en bewoning met een resolutie van 500 bij 500 meter. De conclusie is dat gemengd gebruik in acht casestudy's in vier Europese landen wijdverspreid is en dat meer dan 65 procent van het gebied een gemengde functie heeft. Bovendien wordt, met een multiscalaire typologie van vestigingskenmerken zoals de mate van granulariteit, densiteit, permeabiliteit en centraliteit, aangetoond dat lokale en regionale vestigingskenmerken de locatie en intensiteit van gebieden met gemengd gebruik.kunnen verklaren. Hoewel de typen bebouwing en lokaal stedelijk weefsel aanzienlijke verschillen vertonen in gebieden met gemengd gebruik, concluderen wij dat in alle vier de landen de vestigingskenmerken op verschillende schalen soortgelijk zijn.

Atlas van tussengebieden

De vier artikelen worden gecompleteerd met een Atlas of Territories-in-between en een meta-analyse van alle artikelen en casestudy's. In de atlas wordt een rijk compendium gepresenteerd van oorspronkelijke kaarten die de morfologische, functionele en relationele kenmerken van tussengebieden illustreren en het potentieel dat ze daardoor hebben voor huidige en toekomstige duurzaamheid. Voor de cross-case-vergelijking van de tien diffuse stedelijke gebieden in Europa is gewerkt met 25 indicatoren om hun huidige staat en toekomstig potentieel ten aanzien van duurzaamheid te beoordelen. De indicatoren hebben betrekking op aspecten van verschillende bijdragen aan het ecosysteem, multifunctionaliteit en gemengd gebruik. De methoden die zijn ontwikkeld om het potentieel voor toekomstige duurzame ontwikkeling vast te stellen, combineren regionale en systemische aspecten met lokale en plaatsgebonden elementen. Hiervoor zijn extensieve modellen en ruimtelijke analyses van de vestigingspatronen gebruikt, stelsels van bebouwde en onbebouwde open ruimten, en demografische en economische locatiepatronen.

Conclusies

Hebben diffuse stedelijke gebieden onderscheiden kenmerken? De uitkomsten als geheel laten zien dat diffuse stedelijke gebieden in Europa zich duidelijk onderscheiden van urbane en rurale gebieden en dat ze kenmerken gemeen hebben. De uitkomsten laten ook zien dat het veelgebruikte idee van een continuüm van urbaan naar ruraal geen stand houdt in het licht van het bewijsmateriaal en een grove versimpeling is van de complexiteiten en sociaaleconomische systeemrelaties die kenmerkend zijn voor tussengebieden. Hieruit volgt dat doeltreffende ruimtelijke planning voor dergelijke gebieden gebaseerd moet zijn op een zorgvuldiger analyse van de kenmerken ervan en het potentieel voor duurzame ontwikkeling.

Tijdens het onderzoek zijn drie aspecten van duurzame ruimtelijke ontwikkeling bestudeerd: de mogelijkheden voor multifunctionaliteit, de bijdrage aan het ecosysteem en het potentieel voor en de aanwezigheid van gemengd gebruik. De mogelijkheden van multifunctionaliteit in tussengebieden gaan verder dan alleen de bebouwing. Met name de grijze open ruimten bieden significante mogelijkheden voor multifunctionaliteit. Groene open ruimten kunnen intrinsiek door multifunctioneel gebruik niet alleen de negatieve gevolgen van klimaatverandering verminderen, maar ook een positieve uitwerking hebben op de leefbaarheid voor de mens.

De in deze studie gepresenteerde kaarten laten zien dat de meeste gemeenschappelijke groene ruimten en grote delen van de grijze ruimten in tussengebieden potentieel op meerdere manieren kunnen bijdragen aan het ecosysteem. De vorm van dit potentieel is heel duidelijk afhankelijk van de ruimtelijke relatie van een bepaalde open ruimte met haar centrale punt als resulterend kenmerk van het wegennet, de toegankelijkheid van en verbindingen met diensten, alsook de dichtheid van diensten, productie en consumptie.

Gemengd gebruik, bij voorkeur geïntegreerd in een op voetgangers gerichte omgeving, is een ander aspect van duurzaamheid. Uit het onderzoek blijkt dat tussengebieden meer gemengd zijn dan gewoonlijk wordt aangenomen. De hier gepresenteerde typologie laat zien dat gemengd gebruik in tussengebieden mogelijk verband houdt met specifieke vestigingskenmerken. De onderzochte kenmerken zijn granulariteit, densiteit, permeabiliteit, centraliteit en de nabijheid van haltes voor het openbaar vervoer en op- en afritten van snelwegen.

Dit alles leidt tot een algemene conclusie: de netwerken van kleine plaatsen en steden vormen een robuuste ruimtelijke structuur die bevorderlijk kan zijn voor multifunctionaliteit, gemengd gebruik en bijdragen aan het ecosysteem op zowel lokale als regionale schaal. Maar deze kwaliteiten staan onder druk van eendimensionale vormen van planologisch beleid waarin de focus vaak alleen op verdichting ligt. De ontwikkeling van groene en grijze open ruimten langs het netwerk van grijze infrastructuur biedt significante mogelijkheden om bij te dragen aan het ecosysteem en de multifunctionaliteit te bevorderen.

1 Introduction

1.1 Territories-in-between

This dissertation aims to better understand the phenomenon of dispersed urbanisation across Europe. Although European countries have distinctive historical development patterns, a common phenomenon that occurred since the middle of the last century is that, 'most of Europe has been characterised by spreading of cities and increased population numbers, with people choosing to move out of inner cities to suburban and peri-urban areas (hybrid areas of fragmented urban and rural characteristics); this has resulted in the divide between urban and rural areas becoming increasingly blurred' (EUROSTAT, 2016). This change has resulted in more than half of the European population to reside outside of densely populated cities.

The following paragraphs explain why the term territories-in-between (TiB) was chosen for this dissertation and positions it within key discussions on sustainable urbanisation from the last couple of decades. Is there a need for a new and different term to describe the contemporary city or parts of it? Why not use terms like fringe, suburb, periphery, peri-urban? Despite the dominance in Europe of territories which blend both urban and rural characteristics, there is a widespread agreement that public policy mainly divides the world into simple 'urban' or 'rural' categories (Healey, 2007; Allmendinger and Haughton, 2009; Shane, 2005; Weber, 2010). Concepts which separate urban and rural, like sprawl, urban-rural relationships, suburbanization or peri-urban, do not reflect the diversity and complexity of dispersed urbanisation across Europe. Most concepts imply that there is only a gradient from urban towards rural or vice-versa, which are based on the dichotomy of both. In the highly urbanised and interconnected regions of Europe, the idea of a gradual transition from urban to rural is no longer sufficient to understand urban forms, processes and performances.

Dispersed urban areas have been forgotten and neglected by planners (Andexlinger et al., 2005).. (2013) Based on (Shucksmith 2010) Scott et al. describe the disintegration of planning as a critical characteristic of territories-in-between. This is partly due to the lack of analytical planning, design methods and related theories. One specific aspect of this problem is that most methods which assess the effects of urban growth and transformation towards sustainability either use administrative boundaries as analysing units or raster or grid cells (Laidley 2016; Oueslati, Alvanides, and Garrod 2015). Those boundaries omit crucial planning and design elements, such as landscape, urban morphology and other structuring spatial components.

All of the above terms have in common that they describe spatial phenomena, that evolves around and have close spatial and functional relationships and dependencies with cities or urban cores. Therefore, they represent the core-periphery model of urbanisation. While larger parts of dispersed urban areas may have developed in close relation with compact city cores, there is growing evidence that this model falls short in describing reality. Thus, the model also falls short in supporting spatial planning and policymaking. This observation is not new. As a consequence, city and related planning concepts have been adapted over the last century.

Geddes (1915) referred to the continuity of cities when talking about the Randstad area in the Netherlands. Peter Hall (1966) included in his 'World Cities', a 'polycentric type of metropolis'. Referring again to the Randstad and the Rhine-Ruhr area, the leading model of a polycentric metropolis was born, specifically in the multinational and multipolar EU. The polycentric model acknowledges that metropolitan regions are formed by a network of centres defined by a variety of different economic activities. They are the result of the processes of globalisation and a liberal market economy that relocated production and companies outside dense historic city cores.

Even though there are many representations of polycentric urban systems which are related to global networks, they fail to acknowledge the networked or relational nature and complexity of urban development within the metropolitan system(s). One centre with one periphery was just replaced by several centres with numerous peripheries, or a joined periphery around multiple centres, as seen in figure 1.1. In other words, a functional and zoning-oriented understanding of cities, urbanisation and urban planning has persisted. The countless, and often uncritical references to the UN (2011) World Urbanization Prospects, 'that more than 50 per cent of the world's population is living in cities', can also be taken as an example of a persistent city countryside dichotomy. The more recent shift, to overcome the urban-rural divide, by looking at urban-rural relations (Arango et al. 2017) and a related urban-rural continuum, as advocated by the United Nations New Urban Agenda, acknowledges that it's crucial to overcome the urban-rural dichotomy and work across the complete spatial planning continuum from the neighbourhood to the supranational level.

Nevertheless, the continuum is often replaced by a gradient from urban to rural, with the dominating idea of having an urban core and a rural hinterland. The persistence of the dichotomist way of thinking can be seen in the illustration used in the report with the title: implementing the new urban agenda by strengthening urban-rural linkages (Arango et al. 2017), as shown in figure 1.1. The report identifies on one hand, one way towards sustainable development by 'developing an idea of mixed spaces, combining urban and rural characteristics 'and on the other hand, examples like urban agriculture or rural manufacturing are either simplistic transfer from typical rural/urban to the other and neglect, at least for the European case, the already existing complexity of functional mix in territories-in-between.

To a certain extent, all of this is quite surprising, as already in 1902, Wells stated that the general 'distribution of the population in a country must always be directly dependent on transport facilities'. Therefore, he questioned if the urbanisation process would further lead to higher concentrations of people and further densification of large cities, or if a different, diffused form of population distribution would prevail. He also described the city countryside diffusion and the idea of a continuous urbanised landscape or landscape city: 'The city will diffuse itself until it has taken up considerable areas and many of the characteristics, the greenness, the fresh air, of what is now country and this leads us to suppose also that the country will take to itself many of the qualities of the city' (ibid).

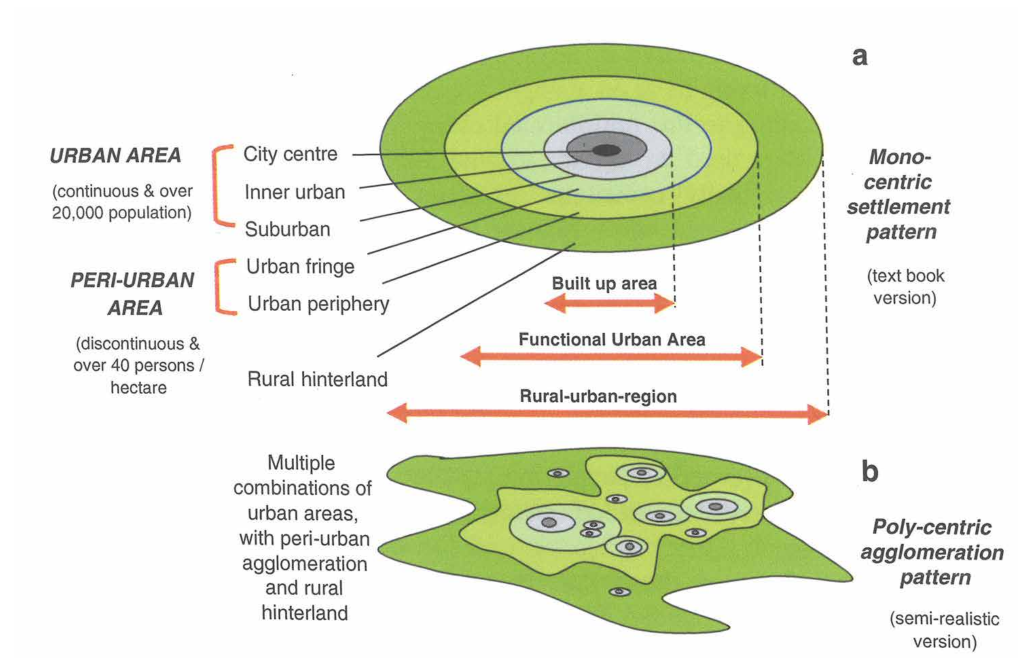


FIG. 1.1 The polycentric representation of a metropolitan area and its hinterland by the PLUREL project (2007)

The choice of the term ‘territory’ in territories-in-between was made to emphasise the relational nature of dispersed urban areas, which are the result of systems of relations. They sometimes interact with each other and sometimes operate in complete ignorance of each other. On the other hand, a territory cannot be thought of without boundaries or control over geographic spaces. This means that it allows us to locate, map and understand the interaction of different systems within boundaries. And it also allows us to identify, plan and design them based on physical structures as a territory and even as an artefact of past interactions of relational systems.

The choice of the term ‘in-between’ is an apparent reference to Sieverts’(2001) Zwischenstadt, for the author culturally the closest of the many concepts dealing with dispersed urbanisation at the end of the last century. Sieverts described the Zwischenstadt as a new form of urbanisation, which resulted from the above-described interrelation of global and local systems and through time and space. It exists independently and differs from the traditional European dense city and countryside. He proposes that the Zwischenstadt, not the compact city nor the countryside, is better understood and planned as an ‘urbanised landscape’.

Sieverts advocated that this new form of urbanisation also requires new ways of regional planning, which contrasted, for example, Koolhaas (1995), who postulates that planning had become irrelevant for the generic city. Sieverts, argues that the Zwischenstadt (Cities without Cities) can be understood and designed to be a structured whole through ‘a re-articulation of development strategies that take into account the plurality of factors, all that are in some way correlated: from the realignment of economic opportunities between city centres and peripheral areas, to the prospect of renewing policies for the preservation of natural areas towards forms of mediation between economic development expectations of local populations and safeguarding requirements of environmental resources and the stewardship of natural capital, to a more efficient articulation of administrative functions and competencies between different levels of government in the region’ (Giecillo, 2004).

Precisely due to this conviction that a new form of planning requires a better kind of understanding, describing and designing territories in-between is the crucial driving thought behind this dissertation. Therefore, the four papers that build this dissertation present new or adapted ways of analysing and understanding TiB and the processes forming them. The aim is to contribute to a non-dichotomist way of understanding of 'where we live now', to cite the later and better translation of Zwischenstadt (Sieverts 2008), and to understand which sustainable urban development potentials are within TiB. The quest is not to find out whether the compact city or the dispersed city is more sustainable, but how to develop both of them to be more sustainable, or even better how to develop the systems both of them are part of, towards sustainability.

Before presenting the research design in chapter 2, three subsections are introduced in the dissertation. The scientific and societal relevance is shown through: (i) introducing key concepts developed at the end of the last century, which deals specifically with the challenges of dispersed urban development in Europe, (ii) demonstrating the sheer extension of dispersed urban development in Europe and its relational nature, (iii) presenting the widespread call for new planning approaches in spatial planning and related disciplines in order to overcome the compact city versus sprawl discussion. All three subsections are kept brief in order to avoid too much overlap with the articles that form the body of this dissertation.

1.2 Netzstadt, Horizontal Metropolis and Zwischenstadt - key concepts of an understanding of dispersed urban development

The three ideas presented in this section are examples of non-mainstream approaches of sustainable urban planning and design, which all overcame the urban-rural divide. They aim at connecting spatial planning with an ecosystem approach or with an industrial ecology approach, and they all acknowledge the relational nature of the contemporary urbanisation pattern.

In Europe, the spatial focus of this dissertation, the majority of the urbanisation of the second half of the last century did not take place in the traditional compact city cores but in different forms of dispersed (Kasanko et al. 2006) urban development. Therefore, it is not surprising that ideas of multi-functionality and overlapping of functions on the same location became more and more common in Europe starting in the 1980s and 1990s. Only later on, ideas like the Patchwork Metropolis (Neutelings, 1994) show a first dissolution of thinking about city and countryside as opposites. Neutelings demonstrated that functional arrangements in the Dutch province of South-Holland, are more diverse and, from the functional zoning perspective, sometimes even paradoxical.

Three concepts stand out, because they influenced both planning and design practice and research: Netzstadt (Baccini & Oswald, 2008a; Oswald, Baccini, & Michaeli, 2003; Campi et al., 2000), "territories of dispersion" which developed into the Horizontal Metropolis (Viganò 2012; Viganò et al. 2017; Viganò, Cavalieri, and Barcelloni Corte 2018) and Zwischenstadt (Sieverts 2001, 2003, 2008; Sieverts and Bölling 2004). All three have in common a shared understanding of the design and planning of the territory, based on seeing the 'urban landscape as a large interlocking system rather than as a set of discrete cities surrounded by countryside' (Bruegmann, 2005). All three have also in common that they cross what Scott et al. (2013) call 'the alternative paradigms of spatial planning and ecosystem approach' for policy decisions. All three should also be understood as both metaphors and models, which provide ways to perceive, analyse and interpret basic patterns of spatial organisation. But they go beyond observation and analysis as they also propose urban design and planning strategies and interventions.

1.2.1 Netzstadt

Oswald, Baccini and collaborators (Baccini & Oswald, 2008b; Oswald et al., 2003) presented the idea of the Netzstadt (net-city), a framework for regional strategic planning that integrates, what they call 'architectural' morphological and 'scientific' physical disciplines. Perhaps, it is best interpreted as an extended urban metabolism approach (Kennedy, Pincetl and Bunje, 2011) that integrates aspects of urban planning and design with elements of industrial ecology. It was the result of the transdisciplinary research project called Synoikos. The framework is based on the understanding that the contemporary urbanised region is characterised and formed by a continuously changing and enormous amounts of flows of people, goods and information, which concentrate at the nodes of the net. The large system of nodes and paths of moving materials, people, information and capital results in new problems and a variety of scales and locations. Next to nodes and paths, they also define borders that delimit the network in a spatial, organisational and temporal manner.

The Netzstadt is proposed as a planning approach that presents five criteria of urban qualities (Oswald, Baccini, and Michaeli, 2003). Identification describes the capacity of a territory to provide images and icons of identification for its inhabitants. Diversity describes the morphological and functional variety of a territory. Flexibility represents the level of additivity and resilience towards changing circumstances. Self-sufficiency describes the dependency of a specific area on a hinterland for resource supply. Finally, resource efficiency describes the relationship between the benefits and efforts of human activities.

Netzstadt is also presented as a planning approach, which Aravot (2003) summarised in 'five methodological phases: first, the identification of the urban system in terms of the model. Then, three analytic steps structure the system into selected activities, shape it on the basis of key resources and represent it according to types of territories. The final stage is an evaluation. Following these steps are participatory cycles, and only after that the planning syntheses of projects rather than comprehensive modernist plans. For the evaluation step, Oswald and Baccini introduced four morphological indicators that describe density, coherence, fragmentation, grain size and accessibility.

The Netzstadt approach was, on the one hand, praised for its analytical and graphic quality, which were crucial to start the (Swiss) discussion about an urban system within an infrastructure steered regional landscape. On the other hand, it was explicitly criticised for the use of the quantitative morphological quality criteria. The developed indicators were normatively influenced by the authors. But this influence was not very transparent and made it difficult for the reader to draw the same conclusions as the authors did from the material presented (Bölling, 2007).

1.2.2 The Horizontal Metropolis

The Horizontal Metropolis (HM) is for Viganò (2018) ‘both an image and a conceptual device through which to criticise, apprehend and imagine the contemporary city and its future challenges’. The Horizontal Metropolis as a discursive project focuses on dispersed urban conditions and the related social, economic and environmental processes that generated it. The focus lies on those aspects, which can be understood as an asset or potentials for future sustainable development. In addition, understanding dispersed settlement patterns on a territorial scale, has a focus that contrasted mainstream planning and design, put on the ‘horizontality (as opposed to vertical centre-periphery relations) and on territorial complementarity (as opposed to dependency, dominion and submission)’ (Viganò, 2018) in order to go ‘beyond the idea of a centre and a periphery, but also beyond the idea of balanced regions where cells would live in a supposedly stable order’ (Viganò, 2018). The HM has been developed based on the understanding that it is the result of the (inter)action of many socio-technical and socio-ecological systems.

The aim is to requalify the relations between (i) urban morphological properties, such as open and built space, (ii) landscape morphological properties such as soil, water, forest, and (iii) physical-functional properties for example production, consumption and related flows (resources, goods, people and waste). In order to tackle the most pressing questions of urban development such as social justice, environmental degradation, climate change and increased mobility.

The following paragraph provides a brief review of the contribution of Secchi, Viganò and their team in the making of the vision for the Metropolitan Area of Brussels 2040. In addition, as the prototype of how the concept of HM is brought into planning practice. The fundamental hypothesis is that the Metropolitan Region of Brussels can be understood as a horizontal metropolis, which is an extended urbanised territory with an isotropic, but diversified typological structure. The diversification is generated by topography in which three valleys which cross the area, along with major train lines, several urban and spatial figures. Those spatial figures are for example historical and contemporary centralities, as well as parks and forest, which have identity providing functions.

The vision for the HM aims to manage a balanced development of the city of Brussels and its surrounding territory while developing more sustainable. Following the above-described reading of the HM, this vision starts from re-developing biodiversity in the three valleys and related river basins. At the same time, the vision aims to establish a system of green spaces that provides sufficient space for future and more frequent as well as intensive flooding events. Thereby, there is a proposal for additional eco-system services and high qualitative open spaces for poorer and disadvantaged parts of the population. Based on this structure of green and open spaces, a diversified transit system in the form of a fine mesh should be developed, which is not only a network for transportation of people and goods but its stations also become key locations that facilitate social and economic exchange. Thereby, these places are going to contribute to the identity of the HM. The combination of an isotropic transportation system, high qualitative open spaces and a mix of functions should ideally lead to a situation where cars eventually become obsolete as a primary means of transport.

The main criticism towards the HM, as Grosjean (2018) puts it, is the risk that it leads to the idea of a generic city as ‘we tend to highlight similarities rather than differences and to recognised it everywhere’. This is partly caused by using isotropy as an underlying concept, which should not be misinterpreted as homogeneity and stability, as this would not provide the dynamics of dispersed urban development justice.

1.2.3 Zwischenstadt

The final key concept was introduced earlier as Zwischenstadt. In his personal Rereading of the Book 'Zwischenstadt After Twenty Years' (in Viganò et al., 2018), Sieverts (2018) states that in our times of uncertainty, it is crucial to provide space for experiments which allow for the 'polycentric urban cultural landscape to become a personality, with a character, which speaks to you and which invites you to experience it with all your senses'. He, very humbly, stated that the International Bauaustellung (IBA) Emscherpark was the first modest example of such an experiment. Therefore, the following paragraphs are dedicated to the fundamental principles and projects that were developed and tested during the IBA Emscherpark. This was part of a ten year long (1989-1999) process to ecologically, socially and economic requalify a part of the Rurhrgebiet after decades of decline in the former mining area. Sieverts was one of the directors of the IBA, which was commissioned by the state of North Rhine-Westphalia.

The whole programme was organised around five aspects, two of which had a clear regional and systemic character to generate a shared understanding and a vision in an area with two million inhabitants, 17 towns and cities with a complex governance system. The other three were individual but related local projects.

First, the Emscher Landscape Park ha(s)d the aim to establish a, what we would call today, a regional green infrastructure. It connects the predominantly north-south oriented, large and disconnected existing areas of green space. Today, the landscape park is managed by 20 cooperating cities, which developed into the Masterplan Emscher Landschaftpark 2010. It set out for more than 300 projects which will be established until 2020.

The second regional and systemic project that was brought forward by the IBA Emscherpark was the ecological regeneration of the Emscher River system. During the IBA demonstration, projects were developed and implemented, which combined a new sewer system with the re-establishment of a river ecosystem and development of a regional leisure infrastructure. The legacy of the IBA is the systematic implementation of the same ideas and principles by the Emscher river management association with investments of more than 4.5 billion Euro, based on the 2006 developed Emscher-Zukunft master plan.

The other three critical aspects of the IBA Emscherpark, were (i) working in the park, which aimed at developing business parks with high ecological and architectural construction standards in derelict areas as incubators for future economic development. (ii) Housing and integrated urban development, which transformed traditional and abundant or substandard worker's housing into high-quality urban environments with higher environmental, social and design standards. (iii) New uses for industrial buildings and industrial monuments, which had the aim to preserve and put to new use many of the most famous buildings and monuments of the region's industrial past. Iconic transformation projects like the Landscape Park Duisburg-North (on a former blast furnace) or the Gasometer Oberhausen (an exhibition location in an old industrial Gasholder), the world heritage listed coal mine ensemble Zollverein and the conversion of a former steelworks gas-turbine-hall to the festival-hall (Jahrhunderthalle), are among these projects.

Sieverts wrote Die Zwischenstadt (1997) partly based on his experience during the IBA and further developed the ideas on how to requalify the Zwischenstadt with a multi-disciplinary team during a research project from 2002 to 2005 which led to multiple publications (e.g. Bölling & Christ, 2005; Bormann, Koch, Schmeing, Schröder, & Wall, 2005; Körner, 2005). Bölling's (2007) dissertation, on decoding the image and identity of the Zwischenstadt and thereby contributing to the qualification of the Zwischenstadt, stays until present the most complete and complex work on the

Zwischenstadt. Key conclusions are that the Zwischenstadt is not at all faceless, but has a history of identity by providing ‘icons’ which are manifold and includes old cores of villages, infrastructure of agricultural production such as different forms of irrigation systems, leisure facilities from horse riding courts to golf courses and fun parks to various forms of shopping malls. He points out that with every increase in general affluence, a new urban expansion wave follows and that every wave has its own icons. The icons or their remains and ruins of the earlier waves are under discussion during all successive waves and contributes to the overall identity of the Zwischenstadt. This is crucial, considering that after the financial crisis of the last ten years, the beginning of such a wave of expansion is appearing again in many parts of Europe.

Although the concept and related theories of Zwischenstadt travelled and influenced planning theory and practices across Europe and beyond (Vicenzotti and Qviström, 2018), Sieverts himself stays rather critical: ’the practical impact of the book on politics, administration and the reality has been minimal: Neither has it led to — at least not in Germany — a political-administrative reform in the direction of regional governance, nor a cohesive development-policy for the urban-cultural landscape of this kind of polycentric city-landscape. The reality of the “ Zwischenstadt ” has not been turned into vital images and visions in the eyes of its inhabitants: the “ Zwischenstadt ” is still a cognitive abstraction!’

1.2.4 Learning from the three concepts

The three concepts described above have their similarities and dissimilarities, which are crucial as a starting point for this research. The terms state that the contemporary urbanisation processes are the result of interlinked dynamic systems, which can only be understood from an integrated physiological as well as a morphological perspective. The authors agree that it is crucial to understand urbanised territories through a multitude of scales that spans from a building or plot beyond the region. And that the dynamics in TiB are most influenced by what is connected to each other compared to what is next to each other. All state that dispersed forms of urbanisation have a distinct identity.

The three concepts also have distinctions, mainly in how to read the territory and, how to interpret the relation between landscape and technical infrastructure. The Netzstadt approach sees the network, related nodes and flows in the networks as the key characteristics of understanding and design, the horizontal metropolis instead understands the dialogue between the mesh of ideally isotropic infrastructure and crucial landscape features. Whereas, the Zwischenstadt focusses on a new figure that is developed between infrastructure and dense urban areas.

All three concepts also acknowledge what Grosjean (2018) identifies as two types of dynamics which ‘are true characteristics of these territories: 1. the important flows that run through them (people, goods, information); and 2. a form of instability over time, an organisational malleability'.

TOC

1.3 The vast extent and relational nature of dispersed urban development across Europe

This section illustrates the physical manifestation of the complexity of TiB at a continental scale because ‘it is important to understand - urbanised - territories not‘ as a container, and a bounded closed unit but instead conceptualise the city as a multi-scalar system which multiple highly specialised cross-border economic circuits circulate. This idea can be applied to cities and the environmental dynamic. In this case, the city is a multi-scalar system in which multiple specific socio-ecological circuits traverse. It is not a closed system. Cities are amalgamations of multiple “damage” circuits, “restoration” circuits and policy circuits’ (Sassen, 2009: 49).

Two maps, which were produced early in the dissertation research work, guide the discussion on the extent and relational nature of TiB. The first map depicts the continuous and discontinuous land cover according to the Coordination of Information on the Environment (CORINE) of the European Environmental agency, see Figure 1.2. The CORINE land cover classification distinguishes two types of land cover to characterise the urban (residential) fabric. The critical difference between the continuous (black) and discontinuous (red) is that the first is covered by more than 80% of impermeable surfaces, while the latter is covered by 30 to 80 per cent of impervious surfaces. Figure 1.2 clearly shows how much more widespread the discontinuous urban fabric is in larger parts of Europe. In comparison to the continuous urban fabric can only be found in the historical centres and some of the 19-century extensions of (large) cities.

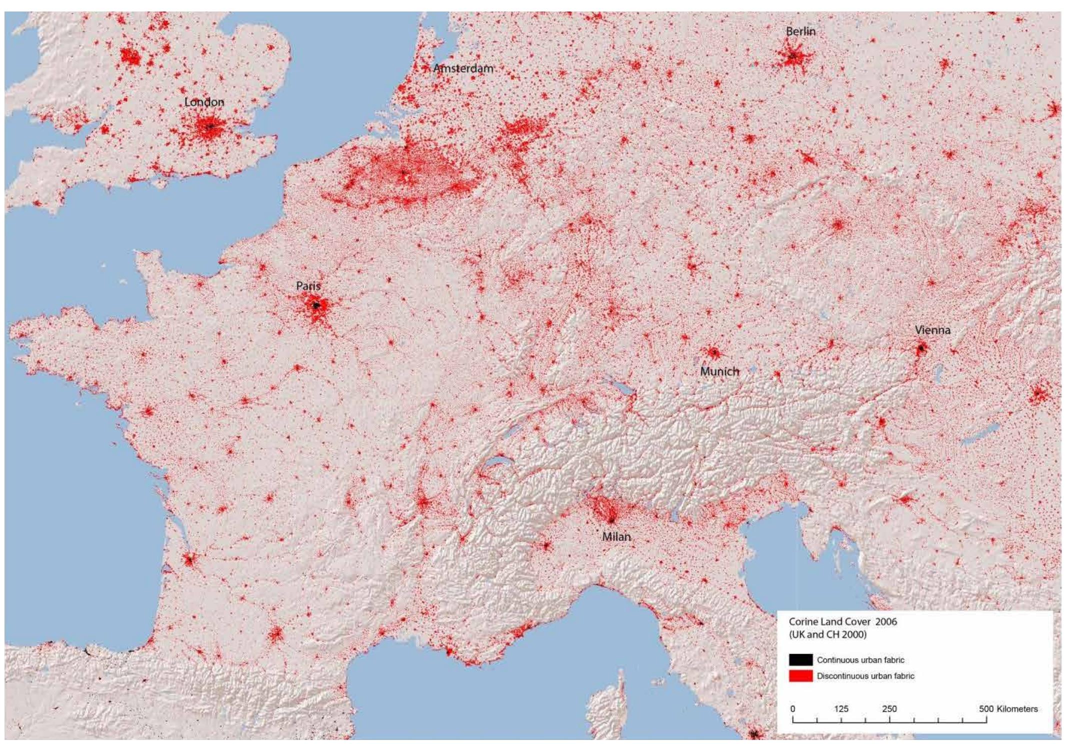


FIG. 1.2 Continuous and discontinuous urban fabric of parts in Europe 2006. Created by Author (2009). DATA Source EEA.

The sheer dimension of the discontinuous urban fabric and their distance to, or the absence of, dense city cores as seen in Figure 1.2 references Secchi (2010), who states, 'It was not something that was born in the city and, from the city, radiated outward into the territory. The novelty was the 'diffuse city', something that had its roots in the territory, its inhabitants, and their history' (translated from French). Figure 1.2 also reveals that, when looking at the regional scale, there are different forms of dispersed urban regions. The most prominent example is the difference between Flanders and the West of the Netherlands. A certain similarity between Paris, London and Berlin can be observed. The alpine valleys and the coastlines show both a linear form of a dispersion. The most widespread pattern is seen in larger parts of Europe that are comprised of a typical network of small cities and towns that seem to cover the whole continent.

TiB do not only occupy a large amount of the area of Europe but they are also home to a large population, dwellings and workplaces. The latest EUROSTAT (Regional statistics team, 2013) urban-rural typology update shows that most NUTS 3 (Nomenclature des Units Territoriales Statistiques) regions in Europe fall in an 'in-between' category, which covers 38.7 per cent of Europe's land surface and hosts 35.3 per cent of the EU population. These numbers are low estimates considering that large parts of the areas classified as predominantly urban are actually low-rise dispersed urban developments with an intermingling of built and green spaces, like the metropolitan areas of the Randstad in the Netherlands, parts of Flanders in Belgium, the Ruhrgebiet in Germany, and the suburban and peri-urban areas of larger European metropolitan areas, like Milan, Paris, Prague, Vienna, Lisbon and Oporto, to name just a few examples. An interesting fact is that there is no area classified as a continuous urban area in the Netherlands.

Recalling, that many authors describe globalisation, decentralisation of economic functions, mass mobility and increasingly affluent population as crucial drivers of dispersion, the question arises whether behind the different spatial patterns there may be actually a similar gestalt, which includes physiological and symbolic elements to the physical ones, when investigating these areas on the regional scale.

The key physiological structures are streets, railway tracks, rivers, canals, power lines, tubes and pipelines, in which most of the people, resources and goods flow. The network of transnational infrastructure is also one of the key instruments and results from the polycentric and territorial cohesion-oriented policy of the European Union. Figure 2, which presents an overlay of the motorways and railway tracks onto the NASA nighttime image shows clearly the differences in the density of the infrastructure network in different parts of Europe, with the highest density. Therefore, connectivity, accessibility and the number of flows is highest in England, the BENELUX, along the Rhine in Germany, France and Switzerland, the north of Italy, around Paris and along the Mediterranean coast. It also reveals a denser network of infrastructure in eastern Europe compared to France and Spain, specifically along the corridor Budapest, Katowitze, and Warsaw.

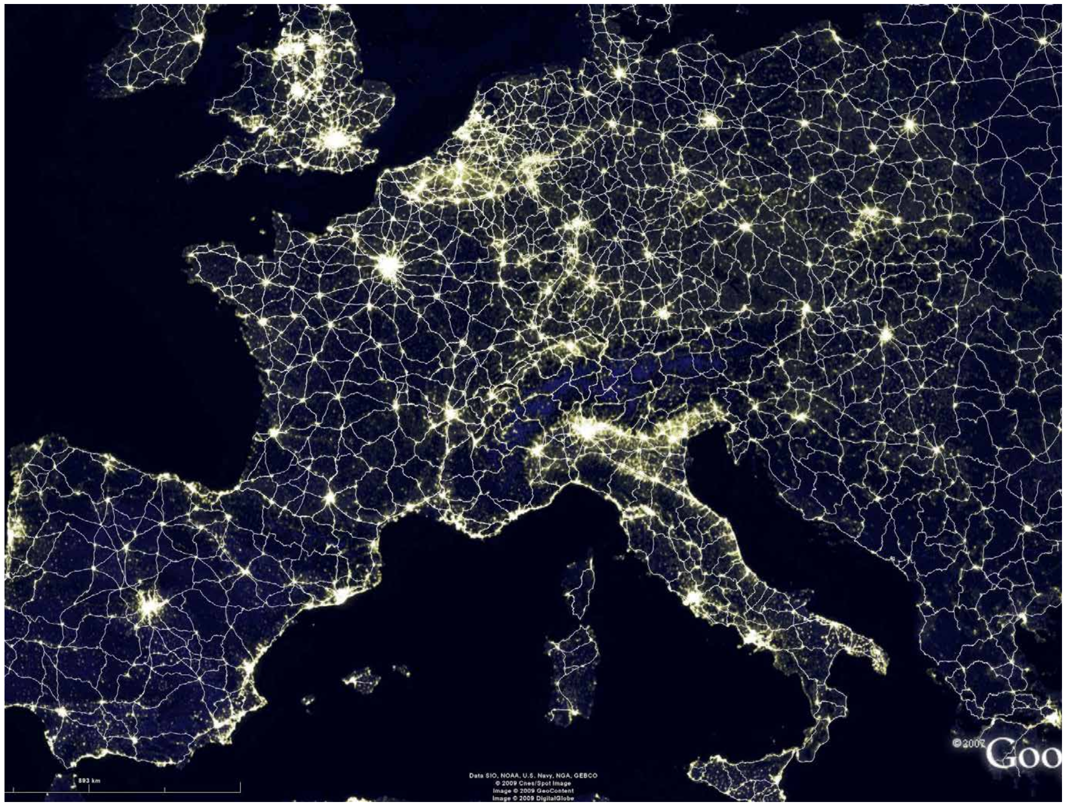


FIG. 1.3 Overlay of NASA nighttime image with motorways and national railway tracks in Europe. Created by Author (2010). Background image: Google, 2007. Data source:openstreetmap.org

Both figures 1.2 and 1.3 clearly show that the morphology and the physiology of the TiB are profoundly interrelated. Therefore, the relationship between infrastructure, settlement patterns and sustainability are present in all four papers. This way, the dissertation adds to the knowledge about the spatial structure and performance of dispersed forms of urbanisation in Europe and focuses on a network centred approach. There is a gap in the existing body of knowledge, as Robinson (2005) pointed out, "there has been little evidence of work that approaches the city as both a place (a site or territory) and as a series of unbounded, relatively disconnected and dispersed, perhaps sprawling activities, made in and through many different kinds of networks stretching far beyond the physical extent of the city" (Ward, 2009: 9). It also adds to the discussions on 'planetary urbanisation' (Brenner and Schmid, 2011, 2015), 'complete urbanisation' (Lefebvre, 1970), 'totale Landschaft (Sieferle, 1997, 2003) and 'Network Urbanism' (Dupuy, 2008; Rocco, 2008; Rooij, 2005). These include theories about realms that are traditionally classified as being outside the urban condition. Brenner (2013: 95) talks about 'small- and medium-sized towns and villages in peripheralized regions and agro-industrial zones, intercontinental transportation corridors, transoceanic shipping lanes, large-scale energy circuits and communications infrastructure, underground landscapes of resource extraction, satellite orbits, and even the biosphere itself'. Therefore, TIB are characterised not only by dispersed settlement patterns but also by networks and functions that feed the present urbanisation process. Chapter 3 deals in more detail with this aspect.

1.4 Don’t call it sprawl: the need for new planning instruments for sustainable development of TiB

TThe concept of sprawl and planning instruments that aim to avoid or retrofit sprawl are dominating the discussion on how to achieve sustainable development. However, the concept is ill-defined and is often used rather superficially in describing any form of low-density urban growth.

‘Don't call it Sprawl’, borrowed from Bogart (2006), stands exemplary for the one-sided discussion about the sustainability of dispersed urban development, which is furthermore dominated by North American studies. Schneider et al. (2008) showed a comparison of urban growth between 25 cities, that ‘researchers, land managers, urban planners and the like have been quick to label any low-density urban expansion or fringe development around the world as sprawl. …. … The amounts and patterns of land development in non-American cities are, in reality, quite different phenomena …, none of the cities in the samples shows any trend towards the dispersion or low population densities common to nearly all US cities.’

The concept of sprawl is too limited, primarily because of its negative connotations, to stimulate the discussion about more sustainable development of territories-in-between. According to Richardson (2004), most of the planning approaches which deal with sprawl or urban dispersion have as primary aim to curb or prohibit sprawl through urban containment.

The policy discussion in Europe is often based on scientific studies which do not consider European cultural circumstances. Not only is Europe different from North America, but many parts of Europe are substantially different from each other. The diversity of history, geography, cultures and socio-economic conditions across European countries and regions is striking. For these reasons, Europe justifies its own research and its own body of theory on this topic (Couch et al., 2007). What Couch et al. (2007) state for the theory on sprawl can also be applied to a broader understanding of dispersed urban development. By conducting a cross-case comparison on territories-in-between, the research adds to the growing body of knowledge of this spatial development process in Europe.

The dissertation is based on the assumption that urbanisation and cities have to be seen as part of the solution to our environmental and social problems. They cannot just be seen as a problem in terms of their negative effects. The discourse on sprawl in relation to sustainable development in Europe has been rather one-sided. More recent and multi-disciplinary research questions the linear link between sprawl and unsustainable development but focuses on the missing policies for sustainable and dispersed urban development. Couch and Leontidou (2007) for example, compared sprawl across Europe and concluded that ‘maybe sprawl is not anything sustainable, but again, it is no more unsustainable than other types of urban development. Environmental policy for sustainability in sprawling areas of our city case studies was weak or non-existent, except perhaps in some instances in the North’.

Nevertheless, as Dehaene (2018) emphasises that ‘more than elsewhere, actors have been able to externalise the social and environmental cost of their individual choices. The distribution patterns of the Horizontal Metropolis have been successful in diffusing the consequences of urbanisation’. He further states that the related challenges, which are related to ‘water, energy, nutrient and soil cycles, localised food production’ are rather new ‘to urbanists, who traditionally focus on housing and mobility’ (ibid).

Torres, Jaeger and Alonso (2016) point out that it is too simplistic to understand 'some metrics of sprawl […] assumed to be valid surrogates of the ecological impacts of transport development like landscape fragmentation'. As this relation is among others, it is highly dependent on both the spatial arrangement of the development and the relief. The first is crucial, as it relates to the environmental impact of multiple spatial design and planning disciplines. The second is relevant when comparing and selecting cases.

The assessment that dispersed territories require a distinctive reading, understanding and planning was confirmed by a survey among 136 experts on spatial planning across Europe that was undertaken by MCRIT (2010). More than 80 per cent agreed that the European territory is mostly 'middle landscapes'. More than 50 per cent expressed the opinion that planning policies have to be reformed to consider the many implications of this distinctive form of spatial organisation.

After reviewing more than 60 papers, Geneletti et al. (2017) identified that 'traditional land–zoning is considered to act as barriers to sustainable development' because it neglects the dynamic reality and ' is often unable to support the need of multi-functionality to cope with social and environmental challenges'. Furthermore, they state that masterplans and other proposals at the neighbourhood scale are seen highly sceptical as they are not able to understand TiB as a whole and in a systemic way. This leads to solutions that are often ineffective and/or cause problem shifting. In contrast, planning approaches at the regional scale have not been criticized. However, they concluded that there is an absence of good indicators and a lack of available data (ibid).

Therefore, this research aims to produce a better understanding of the key issues for sustainable development of the territories-in-between and to develop methods on how to assess those issues, starting from the regional scale but doing this with a rather fine-grained resolution.

1.5 Problem statement

To summarise, the key problems this dissertation aims to tackle are:

- There are several key challenges and potentials for a more sustainable development of TiB which are often ignored or approached in a rather simplistic way due to the application of functionalist and/or compact city planning principles in developing plans for the TiB.

- Mainstream planning is either neglecting or underestimating the extent as well as the specific complexity, identity and dynamics of TiB in Europe. This is partly due to a rather uncritical acceptance of theories from the United States, which ignore the cultural diversity of Europe.

- There is an absence or underdevelopment of planning approaches and related methods that bridge the fields of spatial planning and ecosystems approach to deal with the complexity of the urbanised landscapes of TiB.

2 Research Design and Approach

2.1 Research questions, general thesis approach and thesis structure

The following research questions are going to be answered to reveal the characteristics of TiB and their present state of sustainability and the potential for future sustainability to inform regional planning and design:

- What spatial structures characterise dispersed urban areas in Europe?
- Which morphological and functional structures of dispersed urban areas offer the potential for more sustainable development? If so, how can this potential be mapped and measured to inform regional planning and design?
- Are there similarities and dissimilarities concerning potentials of dispersed urban areas in different locations, planning cultures, topographies and histories?

The core of the thesis at hand are four separate journal papers, see Figure 2.1. Therefore, this section presents the general approach of this research to bind the papers and their results together to provide the reader with a coherent story. Chapters three to six are predominantly composed of already published or accepted double-blind peer-reviewed journal papers. In all those papers, the specific research questions and methods and data used are explained. An atlas, complementing each chapter, presents additional maps, drawings and photos as well as statistical and analytical material and their interpretations. They were not used in the papers as such, but complete the comparative aspect of the research.

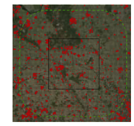
Chapter 3 defines and characterises territories-in-between and thereby, what constitutes a case for the cross-case comparison. Chapters 4, 5 and 6 present methods to assess the potential and possibilities for sustainable development in territories-in-between. Chapter 7 present a meta-analysis of the earlier chapter to identify similarities among cases and outliers to be able to generalise findings. Chapter 8 summarises the key findings of the research and provide, recommendations for planning practice and research.

1. Introduction

1.1. Territories-in-between
1.2. Key concepts - Netzstadt, Horizontal Metropolis and Zwischenstadt
1.3. The vast extent and relational nature of dispersed urban development across Europe
1.4. Don't call it sprawl
1.5 Problem statement

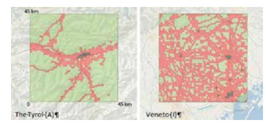
2. Research Design — Atlas - Part A

2.1 Research questions, general thesis approach and thesis structure
2.2 Characteristics of territories-in-between
2.3 A multidimensional typology of open spaces
2.4. Landscape fragmentation and accessibility of green spaces
2.5. Investigating forms of mixed-use in Europe's dispersed urban areas
2.6. crosscutting methodological considerations



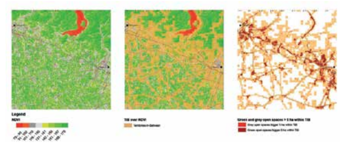
3 Charachteristic of Territories-in-Between — Atlas - Part B

Landscape and Urban Planning 130 (2014) 50–63
Contents lists available at ScienceDirect
Landscape and Urban Planning
journal homepage: www.elsevier.com/locate/landurbplan
Research Paper
Beyond urban–rural classifications: Characterising and mapping territories-in-between across Europe
D.I. Alexander Wandl, Vincent Nadin, Wil Zonneveld, Remon Rooij



4 A Multidimensional Typology of Open Spaces — Atlas - Part C

Planning Practice & Research
Routledge
Towards Sustainable Territories-in-Between: A Multidimensional Typology of Open Spaces in Europe
Alexander Wandl, Remon Rooij & Roberto Rocco



5 Landscape Fragmentation and Accessibility of Green Spaces — Atlas - Part D

COGITATIO
Urban Planning (ISSN: 2183–7635)
2017, Volume 2, Issue 4, Pages 25–44
DOI: 10.17645/up.v2i4.1122
Article
Comparing the Landscape Fragmentation and Accessibility of Green Spaces in Territories-in-Between across Europe
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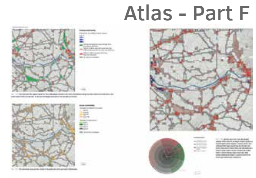
Submitted: 5 August 2017 | Accepted: 20 December 2017 | Published: 29 December 2017

6 Investigating forms of Mixed-use in Europe's Dispersed Urban Areas — Atlas - Part E

Investigating forms of mixed-use in Europe's dispersed urban areas
Alexander Wandl[ab] and Birgit Hausleitner[a]
[a] Delft University of Technology, Faculty of Architecture and the Built Environment, Department of Urbanism.
[b] corresponding author: a.wandl@tudelft.nl

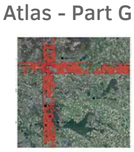
7 Cross-case Comparison — Atlas - Part F

7.1 National pairwise comparison
7.2 Cross-national comparison
7.3 Cross-case comparison of current sustainability and sustainability potential



8 From Dispersed Urban Areas to Territories-in-Between — Atlas - Part G

8.1 Review of research design and process
8.2 The distinctive characteristics of TiB
8.3 Form and function and their relations as indicators for the potential for sustainable development
8.4 Conclusions and Recommendations



9 References

FIG. 2.1 The structure of the dissertation.

A cross-case comparison as over aching approach was chosen in order to avoid what Geneletti et al. (2017) described as a setback of most studies dealing with sustainable development in peripheries, namely that they are often context-specific and solution-oriented and that it stays unclear whether the general ideas can be transferred to other geographical contexts. Therefore, after briefly introducing all chapters of the dissertation, section 2.6.1 provides a more detailed explanation of the advantages and disadvantages of a cross-case comparison. It also presents several cross-cutting methodological considerations, like the selection of the cases, data availability, reliability and limitations as well as general considerations on transferability.

Section 2.7 introduces the atlas of territories-in-between. The aim of the atlas, which is spread out between the article based chapters of the dissertation, is to provide additional information and material, which was not included in the original papers but which either provides maps for those cases the papers did not focus on, or photographic material in order to support the quantitative data with qualitative information.

2.2 Characteristics of territories-in-between

The first step to answer the main research question is to define territories-in-between by the following sub research questions:

- What are the characteristics which distinguish territories-in-between?
- eflHow can those characteristics be used to distinguish TiB from the existing urban-rural classifications?
- Can these characteristics be applied in cases across Europe to map TiB?

Chapter 3 is based on the paper ‘Beyond urban-rural classifications: Characterising and mapping territories-in-between across Europe’ by Wandl, Nadin, Zonneveld and Rooij, published in the journal *Landscape and Urban Planning* in 2015.

The paper proposed an alternative classification of territory, which is precise enough to represent the complex (socio-) spatial configuration of TiB and distinguish them from urban and rural areas. This preciseness that is achieved by a combination of freely available geo-data sets allows a detailed classification and mapping of TiB, which goes beyond existing typologies. Therefore, it is helpful for the comparison of form and performance and the evaluation of spatial policies applied to TiB. The resulting classification was used to define TiB within the cases for the following papers of the cross-case study.

2.3 A multidimensional typology of open spaces

Chapter 4 investigates the potentials of open spaces, green and grey ones, to contribute to sustainable development. It does so by analysing the potential of interaction between different network operators with ecosystem services provided by open spaces. The potentials of sustainable development which are investigated are the following:

- Which potentials of social aspects of sustainability can be associated to open spaces in TiB, like human health, well-being and the possibility to interact, socialise and recreate?
- Which potentials of environmental aspects of sustainability can be associated to open spaces in TiB, like protecting biodiversity by improving ecological functions?
- Which potentials of economic aspects of sustainability can be associated to open spaces in TiB, like increase in property values and contributions to the local economy through increased recreation and/or tourism?

Chapter 4 is based on the paper 'Towards sustainable territories-in-between: a multidimensional typology of open spaces in Europe' by Wandl, Rooij, and Rocco published in the journal *Planning Practice and Research* in 2016.

The paper presents a typology of green and grey spaces for each case as well as a cross-case comparison. Function and ownership as defining criteria are omitted in contrast to other typologies of open spaces, in order to acknowledge the volatile nature of both of them in TiB: function and ownership are often unclear and/or change relatively often in TiB. The typology shows that most common green spaces in TiB, but also a significant part of grey spaces, have the potential for multi-functionality as well as the potential for multiple ecosystem services. These results build on the idea of Gallant et al. (2004) that multi-functionality is the key to the sustainable development of TiB. It also supports Viganò's (2011) claim to start with open spaces when designing within dispersed urban territories. The presented typology is an answer to the call of the European Landscape Convention (ELC) (Council of Europe 2000) to identify landscapes and to explicitly include urban and peri-urban landscapes in addition to the 'natural' and 'rural' ones (ELC Article 2).

2.4 Landscape fragmentation and accessibility of green spaces

Chapter 5 adds a systemic perspective on the potential of green spaces to contribute to the sustainable development of TiB. This chapter focuses on the system of green spaces in contrast to chapter four, which focused on individual open spaces. The chapter adds to the existing knowledge and understanding of the relationship between biodiversity and human well-being in two aspects. First, it adapts the fragmentation index (Jaeger, 2002) in a way that can be applied to the specific spatial characteristics of TiB. Second, it combines the fragmentation index with an indicator for accessibility of green spaces, to integrate aspects of ecology, human well-being and the spatial heterogeneity of the relation between them. With these adapted methods the following questions are answered:

- Do less fragmented green space systems provide better accessibility to green spaces?
- Is it possible to identify both settlement patterns and spatial planning and design approaches, which combine biodiversity and accessibility to green spaces?

Chapter 5 is based on the paper 'Comparing the Landscape Fragmentation and Accessibility of Green Spaces in territories-in-between across Europe' by Wandl published in the journal *Urban Planning* in 2018.

2.5 Investigating forms of mixed-use in Europe's dispersed urban areas

Chapter 6 investigates to what extent TiB across Europe are predominantly mono-functional or not. It positions TiB in the discussion about sprawl, which is usually seen and discussed as monofunctional and segregated. The paper compares how eight European TiB cases perform according to the mix of functions at different scales and spatial resolutions, answering the following research questions:

1. Do mono-functional areas dominate dispersed urban areas in Europe?
2. How is functional mix manifested in TiB?
3. Are there differences in settlement structures between mixed and mono use areas, which can be used to inform planning and design?

Chapter 6 is based on the paper Territories-in-between: Investigating forms of mixed-use in Europe's dispersed urban areas by A. Wandl and B.Hausleitner which is currently under review.

Chapter 6 demonstrates, by developing a multi-scalar typology of settlement characteristics which includs measures of grain, density, permeability and centrality, that local and regional settlement characteristics can explain the location and intensity of mixed-use areas within TiB. Although the building types and local urban tissue vary significantly in mixed-use areas, it can be concluded that across all four countries, the cross-scale settlement characteristics are similar.

2.6 Crosscutting methodological considerations

This section looks at the following four aspects, which were crucial for the overall approach of the research:

1. Which type of case study was chosen for this research project and how was dealt with the most frequent case study research criticism on the transferability of results?
2. How were the type, location and size of the cases selected?
3. What are the right scale and resolution to understand TiB?
4. How was data, theory and methodology triangulation done?

Questions one to three are answered in section 2.6.1. Section 2.6.2 is dedicated to question four.

2.6.1 A cross-case comparison as overarching methodology and selection of cases.

Yin (2003) described a case study as an empirical inquiry with a focus on a contemporary phenomenon in a real-life context, and where the boundaries between the phenomenon and context are not clearly evident. This is the case for the territories-in-between and their related spatial policies, which aim for more sustainable development. A case study may have at least three different aims (Seale et al., 2004; Gerring, 2007; Yin, 2003), which determine the specific methodology selected. It may be understood as the intensive study of a single case, with or without the purpose to shed light on a larger class of cases. Second, case study research may include multiple case studies. From a certain amount on it is no longer possible to investigate those cases intensively: 'where the emphasis of a study shifts from the individual case to a sample of cases' (Gerring, 2007) and generalisation and comparisons become more important, 'we shall say that a study is cross-case' (ibid). The third aim, specifically relevant for a PhD candidate, is that cases are important for the researcher's learning process in developing the skills needed to do good research. 'If researchers wish to develop their own skills to a high level, then concrete context-dependent experience is just as central for them as to professionals learning any other specific skills' (Mils, Harrison, Franklin & Birks, 2017). As Flyvberg et al. (2006) stated 'common to all experts is that they operate on the basis of intimate knowledge of several thousand concrete cases in their areas of expertise. Context-dependent knowledge and experience are at the very heart of expert activity'. As one goal of the dissertation is to better understand TiB across Europe and to test whether the developed methods provide consistent results, the choice was made to make a cross-case comparison.

Many disciplines have further strengthened the case study research approach since Flyvberg (2006) addressed the most common misunderstandings, which were related to its usefulness to the generation of theory, lack of being able to generalise and being biased towards verification. The method as such is not questioned anymore but the problem is rather caused if 'the author does not feel compelled to spell out how he or she intends to do the research, why a specific case or set of cases has been selected, which data are used and which are omitted, how data are processed and analysed, and how inferences were derived' (Maoz, 2002 in Gerring, 2007).

The following paragraphs are dedicated to answering these questions raised by Maoz. In the terminology, we follow Gerring (2007) who defined that a ‘case connotes a spatially delimited phenomenon (a unit) observed at a single point in time or over some period of time. It comprises the type of phenomenon that an inference attempts to explain’. In this sense, territories-in-between and the related potentials for sustainable development in one European region is a single case.

The next decision was to select what Mils et al. (2017) call an information-based selection of cases. This means that cases are selected to maximise the information gained from one, a so-called critical case, or a rather small sample of cases, which vary sufficiently to understand processes and outcomes better. Two aspects were chosen as a variation between the cases: the dominant planning culture and a difference of topographies.

To summarise the selection of the case study approach and the (types of) cases: The dissertation is a cross-case study to explore the spatial structure of several instances of TiB across Europe. The population, so to speak, for the cross-case studies are all territories-in-between in Europe, which vary in ideal types of spatial planning and vary in topographies. This specifications characterises the scope of the research and determines that three aspects which were crucial for the selection of the cases:

1. the cases should be located in countries that are characterised by different planning traditions, and therefore represent different approach towards sustainable development of TiB;
2. the cases should cover a variety of topographies, from Alpine to coastal cases;
3. the key regional planning documents had to be available in a language spoken by the involved researchers. This is the reason why only cases in Western and Central Europe are included.

For the first aspect, the traditions (or ideal types) of spatial planning were used, which were introduced by the European Compendium of Spatial Planning and further developed by Nadin & Stead (2013). These ideal types can be assigned to individual countries within the EU, although it is essential to state that these may vary within countries and are changing over time.

Furthermore, an ideal territorial sample size had to be chosen that would allow to carry out the analysis soundly. Due to the sheer extent of TiB, as described above, it would have been impossible to investigate them for the whole of Europe, definitely as it can be assumed, that they are not the same everywhere. Therefore, squares with a 50 km side length were chosen as samples. Following the tradition of several researchers, we used squares as samples to develop a better understanding of dispersed urban development, which exceeded typically defined metropolitan areas. This way, we captured what Boeri (1997) described as ‘strange, amorphous figures, without any clear division from the countryside, lacking any obvious centre or any sharp distinction among their different parts‘. Neutelings (1990), for example, used a square of 20 km by 20 km when investigating the carpet metropole in the Dutch province of South Holland. Also, Secchi and Vigano (2009) in their studies for le Grand Pari(s), used squares and transects when studying the agglomeration of Paris. Basilico and Boeri (1998) used 18km wide and 50km long transects to describe the contemporary urbanisation patterns in Italy. Plant sociologist and landscape ecologist also use squares as sampling method, often based on Braun-Blanquet (1979), who used a combination of the transect, in his case 50m x 1m, and quadrants of 50 cm x 50 cm to study the density of species. Although the squares are from a completely different size as the urban applications of sampling, the reason to use the approach is the same, namely to understand a population and its composition via individual samples as the number of different species is too large to count and comprehend in a short amount of time.

When located at the edges of large metropolitan areas, such as Île-de-France or the Randstad, squares with a side length of 50 km proved to be large enough to cover areas classified as urban, rural and TiB. Wherever in the spatial analyses methods where used, that would suffer from an edge effect, then an area with an additional 25 km wider buffer was used. See FIG. 2.2. The exact location of the ten squares was the result of an intuitive process of choice-making by the researcher who used the finger, respectively the mouse, over a map of discontinuous urban areas in Europe and Google Earth. In the last step, the location of the square was adjusted to an exact overlay with the 1 km^2 equal-area grid according to the INSPIRE Data Specification for the spatial data theme Geographical Grid Systems also used by the European Environmental Agency to avoid unnecessary data handling. See FIG. 2.3 for the location and name of the ten cases across Europe.

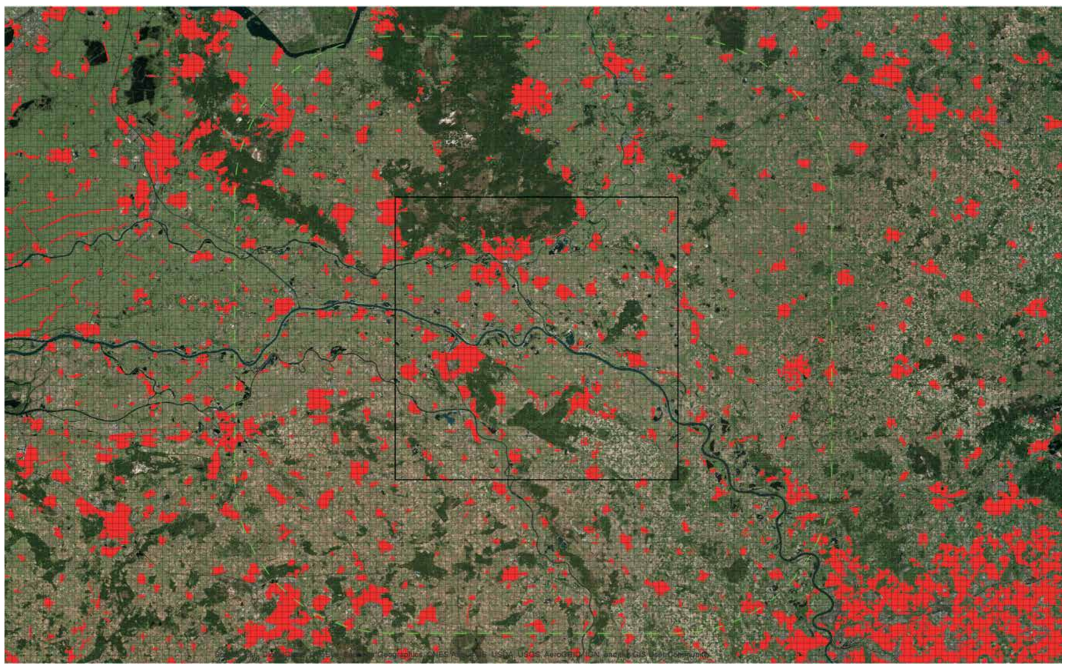


FIG. 2.2 The outline (black) and the 25km buffer area (dotted green) of the case in Gelderland (NL) overlaid on top of a satellite image. The CORINE land cover class discontinuous urban fabric is visualisein red and the EEA reference grid of 1 km in light grey.

FIG. 2.3 The location of the ten selected cases across Europe.

Table 2.1 presents the cases with their ideal type of planning, the area that is classified as TiB and the number and percentage of population living within TiB.

TABLE 2.1 Key features of the ten selected case study squares across Europe

		Population			Area classified as TiB	
		Total	TiB			
Case study name	Ideal type of spatial planning	Absolute	Absolute	%	km²	%
Île-de-France	Regional economic	3.893.228	1.006.492	25.85	1.096	54.16
South-Holland	Integrated comprehensive	2.849.336	1.267.325	44.48	1.089	53.82
The Tyrol	Integrated comprehensive federal[a]	281.199	203.066	72.21	379	18.73
North Somerset	Land use management	736.265	562.595	76.41	790	39.03
Vienna-Bratislava	Integrated comprehensive federal	338.470	266.489	78.73	735	36.34
Gelderland	Integrated comprehensive	1.031.570	832.782	80.73	1.083	53.51
Bergamo–Brescia	Urbanism	1.094.195	913.480	83.48	1.051	51.91
Veneto	Urbanism	1.052.495	888.305	84.40	1.299	64.16
South Wales	land use management	987.624	888.662	89.98	966.	47.72
Pas-de-Calais	Regional economic	970.905	913.379	94.08	1.205	59.53

[a] Note that for the Integrated Comprehensive Model 4 case studies were selected in order to be also able to compare the cases with strong national planning (NL) and the ones with strong subnational planning (AT)

2.6.2 Mixed-method research: Data-, theory- and methods- triangulation

A combination of data from different sources has been investigated to gain an understanding of the complex, social, economic, environmental and spatial relationship within TiB and to untangle the potential for sustainable development. Several sources have been used: survey data, fieldwork, remote sensing data, or literature and planning documents. To understand, combine and interpret the potentials for sustainable development, an inter-disciplinary approach was needed, including the integration of various theoretical frameworks and related methods. Key disciplines are urban-regional planning and design, landscape ecology and geomatics.

Triangulation is commonly used for three reasons: to increase the validity of data and findings of a study, to uncover the deeper meaning in the data and to question dogmas. The validity of a study is supported by evidence from different sources, but as already Patton (2002) warned, it is a common misconception that the only goal of triangulation is to arrive at consistency across data sources or approaches because also inconsistencies have their value when applying triangulation. This aspect is specifically crucial when dealing with a topic that is not covered or even contradicting the dominant theories and related methods. For example, the model of describing cities along an urban-rural gradient is not only dominant in urban planning and design, but as Farinha-Marques et al. (2011) stated, also in ecosystem services research. There the urban-rural gradient is often seen as necessary because it allows comparison across cities and species. At the same time, it is criticised for being an oversimplification of intricate urban patterns and the diverse ecological matrix of cities. Therefore, triangulation was used in this research for both validation of data and results and the critical review of whether or not contradicting results are a sign for the need to adopt theories and related methods.

Guion, Diehl, and Mcdonald (2002) defined five types of triangulation in qualitative research (i) data triangulation, (ii) investigator triangulation, (iii) theory triangulation, (iv) methodological triangulation and (v) environmental triangulation. Three of them are used in this dissertations. Data triangulation involves using different sources of information. Methodological triangulation includes the use of multiple qualitative and/or quantitative methods to study a phenomenon. And theory triangulation – to a certain extent – also includes the use of multiple perspectives to interpret a single set of data.

It is crucial to integrate knowledge and theories to understand the complexity of TiB from different disciplines. Strictly speaking, theory triangulation is done by including scholars from various disciplines. In this case, theory triangulation also stands for the integrated use of methods and concepts from different theories. Figure 2.4 presents the references and their associated research areas, according to the Institute for Scientific Information's web of science, for all four papers from this dissertation. In the case that more than one research area was assigned to an article, the main research area was chosen. The figure shows that the most important areas of research are planning and development, urban studies, ecology, environmental sciences, architecture and environmental studies. All of them have more than ten references. Overall, twenty-two research areas have been included in the body of knowledge of this thesis.

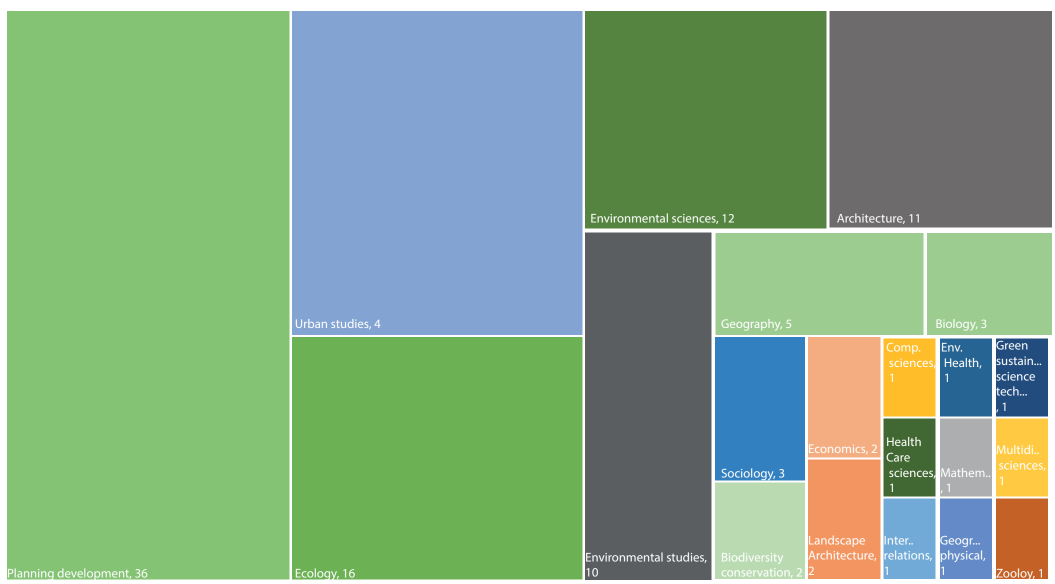


FIG. 2.4 The number of references per research areas of the four articles in this dissertation. Note that only references from the web of science core collection are considered.

Furthermore, it is interesting to see if the dissertation is not only informed by a variety of disciplines but if it is also informing a variety of disciplines. The papers of the dissertation have been cited by authors from fourteen different research areas, see FIG. 2.5. The comparison of the two figures shows that there is large overlap of informing and informed research areas.

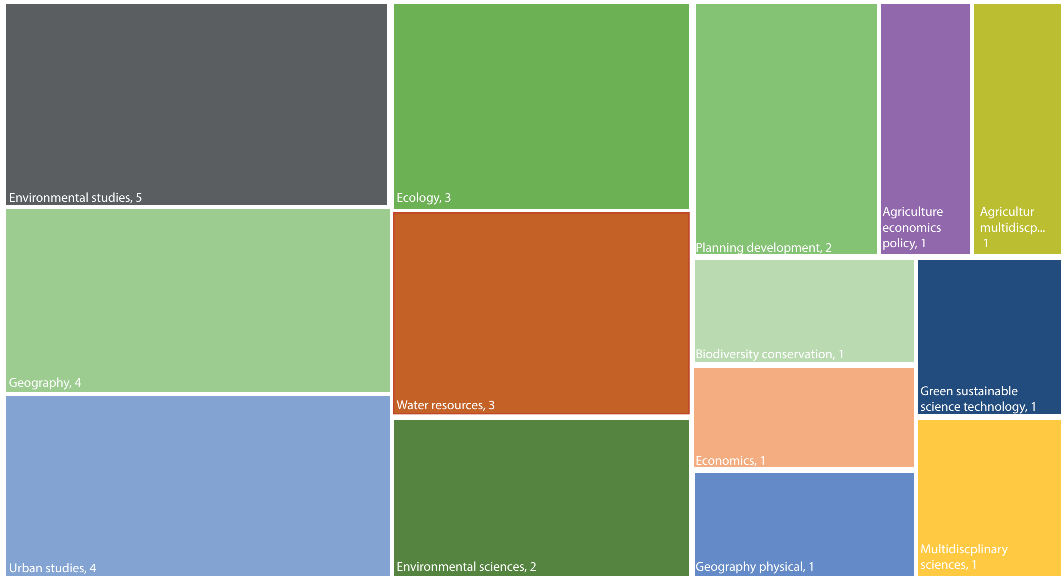


FIG. 2.5 The number of citing papers and related research areas of the four articles in this dissertation. Note that only references from the web of science core collection are considered (until 10-2018).

Data triangulation also played a central role in this dissertation. The following table 2.2 illustrates the different types of data sources. The table is organised from qualitative to quantitative data and it specifies the general type of method in row two. The rows beneath specify in each column the type of data further.

TABLE 2.2 Overview of data sources used in the dissertation.

Qualitative					Quantitative			
Scientific literature	Policiy documents	Planning documents	Observa-tions by site visits	Maps	Aerial images	Satellite images	Counts and measure-ments	Models
Research reports	EU	EU	Photos	Official	Google Earth	Landsat 5/8	Geograph-ic/non geographic	Geographic /non geo-graphic
Journal papers	National	Regional	Personal encounters	Topographic			National	National
Books		Local	Drawings	collaborative			European	European
			Record of feelings perceptions				Collabora-tive	Collabora-tive

The exact methods used during this dissertations are described in the different methodology sections of the papers in chapters three to six. The matrix below provides a brief overview of methods, and it relates them to the research questions of the different articles, and thereby, shows the methodological triangulation of the research.

TABLE 2.3 Overview of methods and their relation to research questions (see next page).

Research question/ Method	a	b	c	d	e	f	g	h	i	j	k
Cross case study			x	x	x	x	x	x	x	x	x
Literature review	x	x	x	x	x	x	x	x	x	x	x
Policy reviews	x	x		x	x	x				x	
GIS supported mapping and analyse of: density, proximity, accesibility, pattern recognition	x			x	x	x	x	x	x	x	x
Geoprocessing	x	x		x	x	x	x	x	x	x	x
Network analyses: different centrality values							x	x			x
Remote sensing: based NDVI calculation				x	x	x	x	x			
Parametric and non-parametric descriptive and clustering statistical methods				x	x	x				x	x
Field visits	x		x				x	x		x	x

A What are the characteristics which distinguish territories-in-between?

B How can those characteristics be used to distinguish TiB from the existing urban-rural classifications?

C Can these characteristics be applied in cases across Europe to map TiB?

D Which potentials of social aspects of sustainability can be associated to open spaces in TiB, like human health, well-being and the possibility to interact, socialize and recreate?

E Which potentials of environmental aspects of sustainability can be associated to open spaces in TiB, like protecting biodiversity by improving ecological functions?

F Which potentials of economic aspects of sustainability can be associated to open spaces in TiB, like increase in property values and contributions to the local economy through increased recreation and/or tourism?

G Do less fragmented green space systems provide better accessibility to green spaces ?

H Is it possible to identify both settlement patterns and spatial planning and design approaches, which combine biodiversity and accessibility to green spaces?

I Do mono-functional areas dominate dispersed urban areas in Europe?

J How is functional mix manifested in TiB?

K Are there differences in settlement structures between mixed and mono use areas, which can be used to inform planning and design?

The last method in the matrix, field visits, is rather underrepresented in the papers, but was crucial to develop an understanding of the different TiB, their qualities and their differences. This step was crucial to interpret the results of the different analytical methods developed. Therefore, we will dedicate the next section to an excursus describing the field visit method in an adequate manner.

TOC

2.7 Excursus on field visits

As Boeri pointed out in 1997 'zenithal morphology – the view from above' was crucial for grasping the dimensions on new forms of urbanisation and metropolitan areas across Europe. But used as single method the risk is high that 'by piling aggregate representations of the territory one on top of the other, as though they were flat specialised layers, we will never attain any grasp of the essence of contemporary inhabited space: the vertical, mobile energies, and the physical and psychological landscapes winding through them. We will have thematic "maps" crammed with useless and highly ordered information, but they will be incapable of conveying the multidimensional, dynamic nature of urban phenomena.' (Boeri, 1997). So, in order to grasp the complexity and dynamics of TiB each case study area was visited for one week and was investigated in a way that was inspired by one of Boeri's lateral thinking inspired gazes, namely the 'sampling gaze'.

The sampling gaze aims at identifying and describing the elements and the relation between elements which are characteristic for TiB. It is an attempt to decipher the complexity of self-organisational powers at the place. To do so the 50km by 50km squares were horizontally and vertically divided into 5km wide strips, because test runs showed, that one strip could be crossed within two days by a car allowing to stop and further investigate around 20 specific locations along the transect. The car as major means of transport for the field visits was chosen as it is the main means of transport used in TiB. It, therefore, is also the main speed people travel in TiB, which is crucial when considering their daily lives.

For each case, the vertical and horizontal strip with the highest amount of as TiB classified as defined in the first paper (chapter 3) was selected. Only strips, which included all three categories (urban-rural-TiB) were considered.

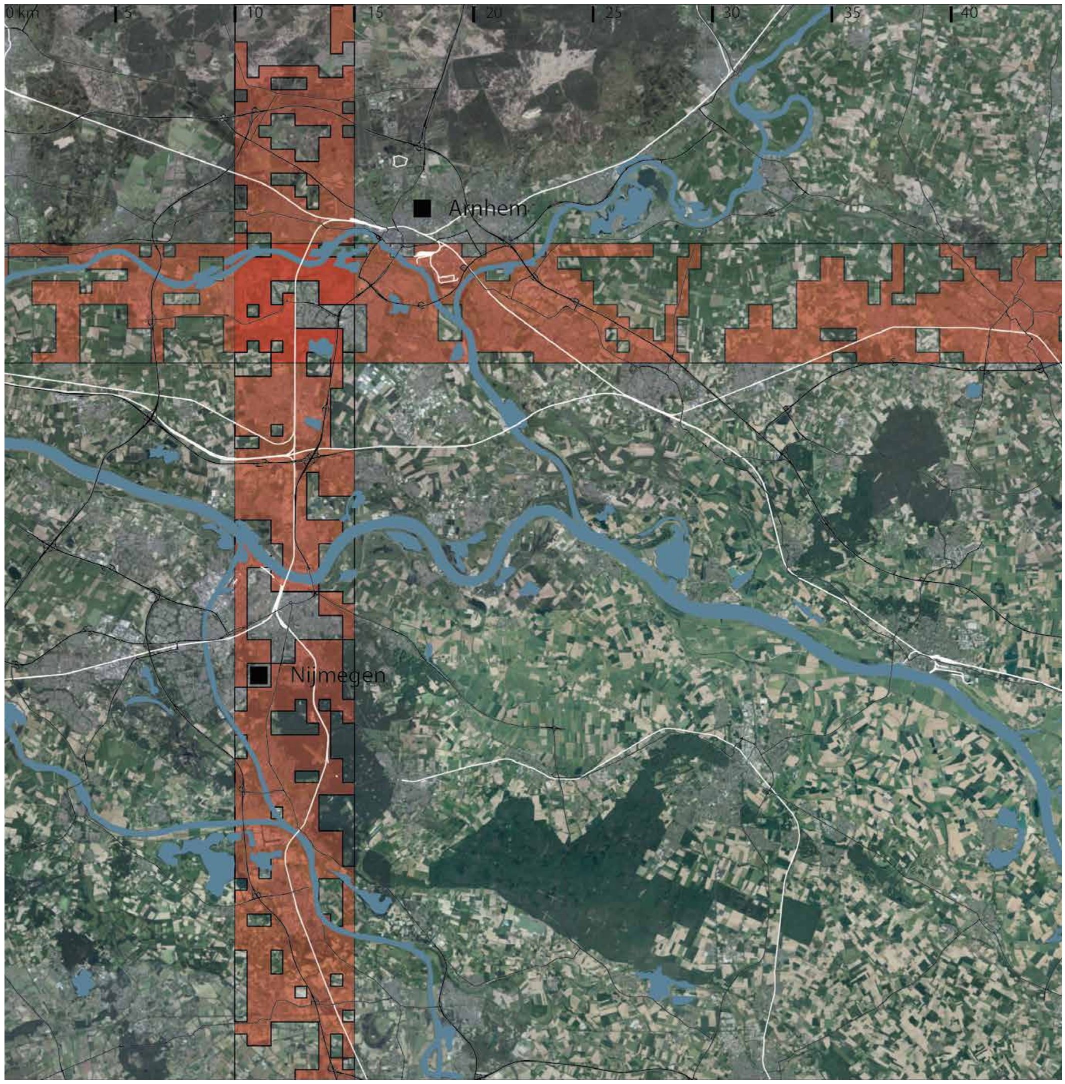


FIG. 2.6 The two field visit strips in the case study area of Gelderland. The red highlighted areas classified as TiB.

In one week time, both strips per case were crossed. The exact path of crossing and the stops along the transects were guided by five types of maps: (i) maps showing different (pedestrian and car-oriented) betweenness centralities of the street network, (ii) maps showing green spaces larger than 10 ha identified by remote sensing analysis, and (iii) density probability maps of consumption and production centralities, such as companies. Additionally, a topographic map and a series of aerial images completed the set of maps.

All these maps were results underpinning the first versions of the papers, which were presented at different conferences. They had basic assumptions concerning the potential for sustainable development. The centrality maps were thought to be important for location choices of economic activities and for indicating the potential for multi-functionality. The green space maps were made following the assumption that many ecosystem services are relying on those green spaces and on the assumption that their permeability and accessibility are therefore crucial. The density probability maps were used as indicators for the suburban centralities, like shopping malls or business parks.

The maps were printed in A3 booklets on a scale of 1:20.000 and as overview maps on a scale of 1: 500.000. Every evening before a field trip day, all 5 maps were inspected. Places were marked as stops when they were interesting, because of the features depicted in the five maps. The following day the points of interest were visited. At each point a short walk was done to see, understand and document the physical manifestation of the depicted feature and properties in the maps. The site visits took place in the years 2014 and 2015.

The observations of the fieldwork can be found in three different ways in this dissertation. They were used to check the plausibility of the results of the gis-based spatial analyses. The knowledge and understanding gained on-site also helped to interpret the results of the spatial analyses. And finally, the photos taken at field trips complete the atlas as they add an additional viewpoint.

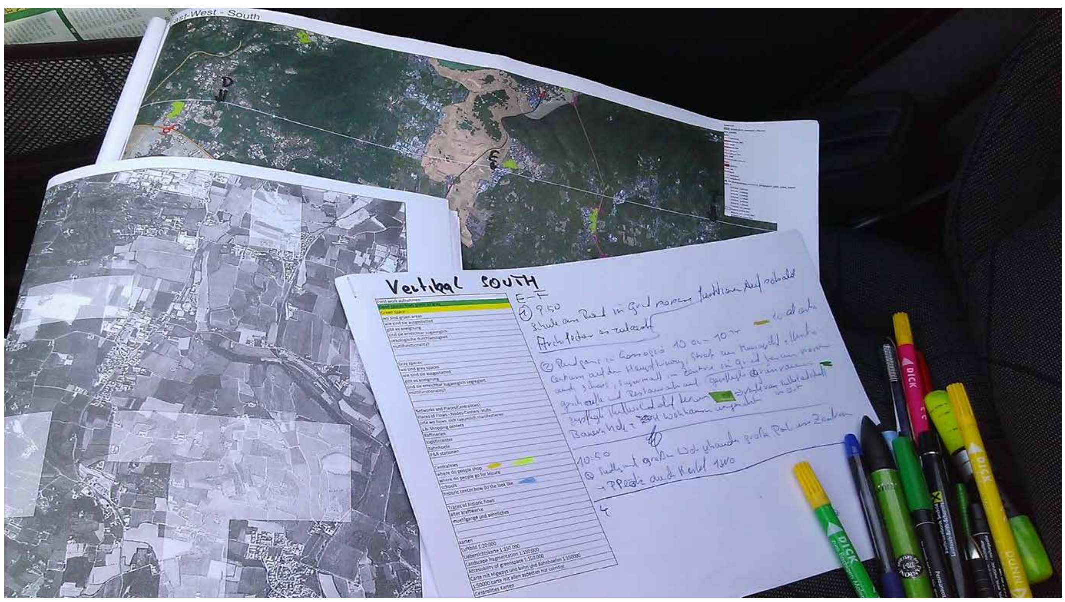


FIG. 2.7 An impression of the maps used during the field visit.

2.8 Atlas of territories-in-between

The atlas is built out of seven parts (A to G). Four different types of double-page spread are used:

1 A double-page spread displayed on the left page shows one thematic map with a 50 km x50 km square scaled approximately at 1: 310.000. Underneath the map has a legend On the right page, up to three selected photographs are chosen.

2 A double-page spread with one thematic map in the format of a 50 km x 50 km square scaled approximately at 1: 310.000. Underneath the map is a legend with an option of an additional diagram on both pages.

3 A double-page spread with ten thumbnail maps of the case studies 50 km x 50 km squares at the scale of 1: 1.000.000. The legend and caption can be found on the left page and an optional additional diagram on the right page.

4 A double-page spread with two thematic maps at a scale of 1: 500.00 with separate legends and captions on the right page. On the left page, one map with the dimensions of 50 km x 50 km at a scale of approximately 1: 310.000. Underneath it, is a legend and one additional diagram,. In addition, a legend and caption for the whole page is found.

Atlas parts C, D and E only use double thumbnail pages to allow for a greater flow of reading, that is not interrupted by a section with too many maps. The maps from these three parts which display original material are repeated at a larger scale in atlas section G. The following list presents the content of the different parts of the atlas:

Part A: Introduction to the ten cases

This section of the atlas of territories-in-between contains:

- An aerial view to provide the reader with a general overview and impression of the case study area. The aerial view includes an overlay of the field visit strips as defined in section 2.7.
- Three photographs illustrate a specific feature of the case study area.
- A thumbnail page with hill shade maps, which is a grayscale 3D representation of the surface with the sun's relative position is taken into account for shading the image to get a first impression of the key features of the topography for the ten cases. The hill shade map also includes the administrative borders of the area as an indication of the governmental complexity of each case.

Part B: Characteristics of TiB

This section of the atlas of territories-in-between contains five thumbnail double-pages:

- A land cover map to understand the landscape and urbanisation pattern in the case study areas.
- The population density to provide a basic understanding of the distribution of the residential population.
- The location and size of companies to provide an understanding of the type of economy and the spatial distribution of the working population.
- Mobility infrastructure to present the different types, mesh sizes and spatial distribution of different kinds of transportation infrastructure.
- The areas classified as territories-in-between, with an overlay of buildings and transport infrastructure.

Part C: A typology of open spaces

This section of the atlas of territories-in-between contains one thumbnail double-page:

- Typology of open spaces overlaid on territories-in-between and overlaid by major transport infrastructure.

Part D: Landscape fragmentation and accessibility of green spaces

This section of the Atlas of territories-in-between contains three thumbnail double-pages spreads with:

- Ten maps which present the size of the different green spaces overlaid on to the territories-in-between. The maps were used to calculate the effective mesh size of the ten cases.
- Ten maps illustrating the number of residents in TiB with access to green spaces.
- Ten maps showing the intensity of access to green spaces which demonstrate how much of the territory is within the service area of green spaces.

Part E: Mixed-use and Settlement Structure

This section of the Atlas of territories-in-between contains three thumbnail double-pages spreads with:

- Eight maps presenting the number of different functions per 500 m x 500 m grid cell as one indicator for the presence of mixed-use. These maps cover the whole case study area, which includes urban and rural areas.
- Eight maps presenting the number of different functions per 500 m x 500 m grid cell as one indicator for the presence of mixed-use. These maps cover only the territories-in-between.
- Eight maps Maps illustrating the typology of settlement structure as described in chapter 6.

Part F: Present and potential for future sustainability

This section of the atlas of territories-in-between contains a total of ten double-pages spreads:

- The above map on the left page shows the indicators that were used to assess the present situation.
- The bottom map on the left page shows potential for future sustainability.
- The map and diagram on the right page provide an overlay and summary of both.

Part G: Atlas of territories-in-between

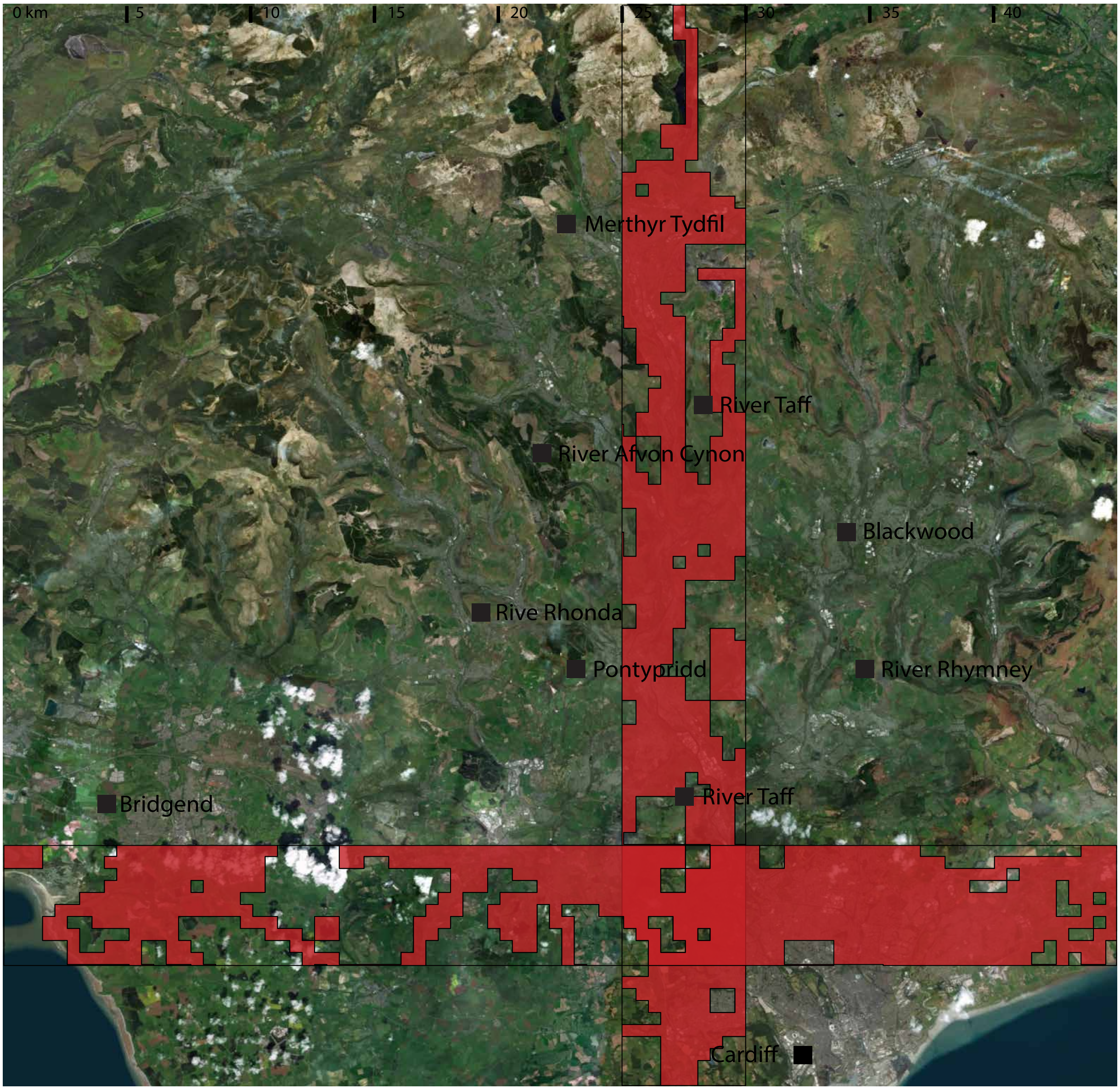
This sub-chapter presents primarily maps from parts B to E, which were generated originally from this research. An additional aerial view, as well as photos of example green and grey spaces are provided.

2.9 Atlas of territories-in-between – Part A: Introduction to the ten cases

This section of the Atlas of territories-in-between contains:

1. An aerial view to provide the reader with a general overview and impression of the case study area. The aerial view includes an overlay of the field visit strips as defined in section 2.7.
2. Three photographs illustrate a specific feature of the case study area.
3. A thumbnail page with hill shade maps, which is a grayscale 3D representation of the surface with the sun's relative position is taken into account for shading the image to get a first impression of the key features of the topography for the ten cases. The hill shade map also includes the administrative borders of the area as an indication of the governmental complexity of each case.

SOUTH WALES



Legend

Fieldwork strip with the areas classified as TiB according to the method described in chapter 3

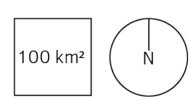


FIG. 2.8 The case study area of South Wales, with the capital city Cardiff in the south-east, Bridgend in the south-west and the rest is covered by the 'South Wales Valleys'.

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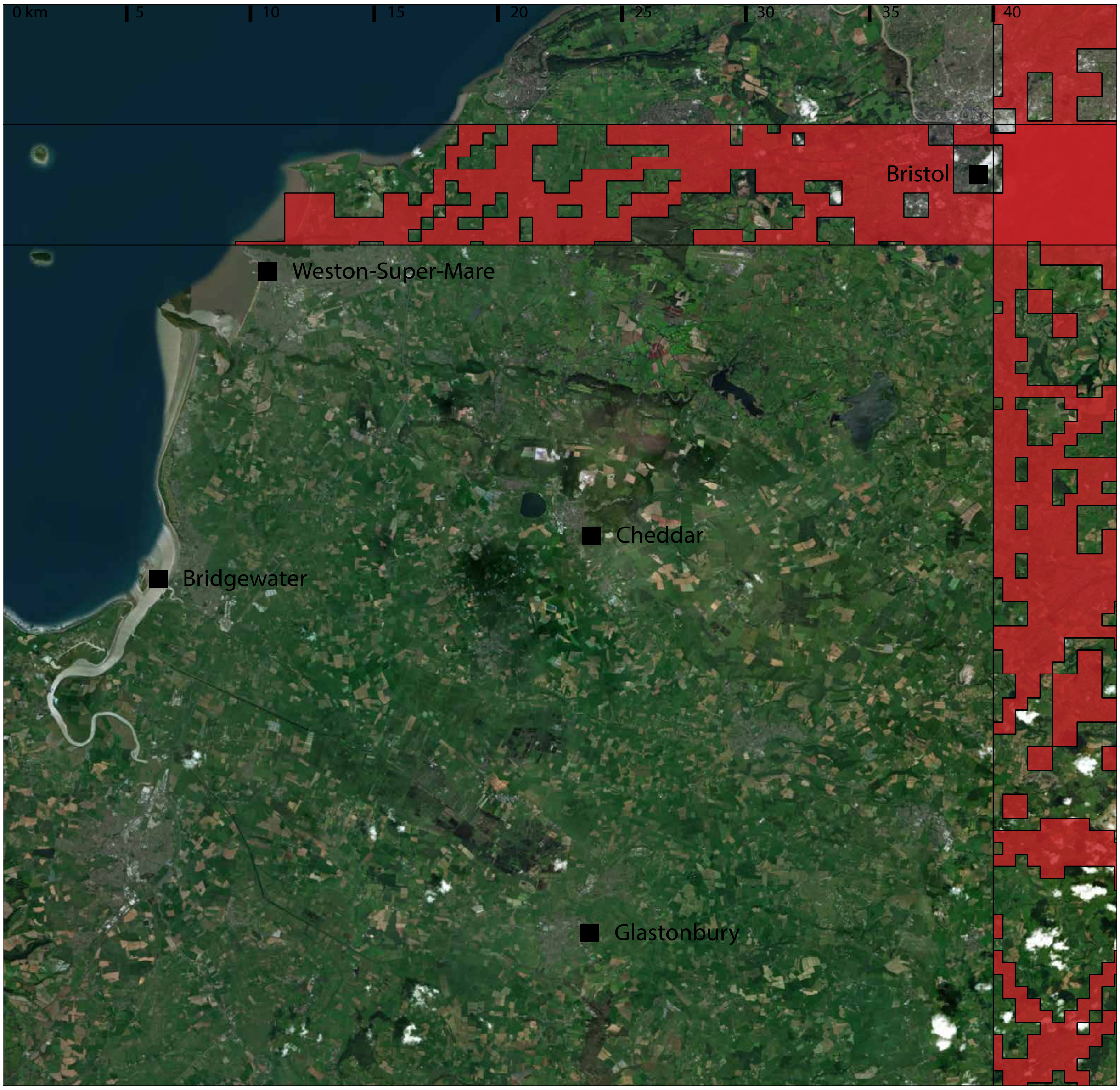
FIG. 2.9 (1) View over the welsh countryside. (2) A cul de sac street as a typical suburban element. (3) Images of the historic - mining and iron industry - and present manufacturing industries.

NORTH SOMERSET



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Fieldwork strip with the areas classified as TiB according to the method described in chapter 3

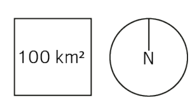

FIG. 2.10 The case study area of North Somerset, which stretches from Bridgewater and the mouth of the River Parrett in the south-east of the square via the Somerset Levels to Bristol in the north-east of the square. The largest town along the coast is Weston-Super-Mare. At the edge of the Somerst Levels and the surrounding hills are cities, with a rich history like Glastonbury and Cheddar.

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FIG. 2.11 (1) The view from Dundry in the direction of Bristol across the urbanised landscape. (2) A high-street is one of the key features of many small towns. (3) Three ubiquitous features: the Pub, the mono-functional residential neighbourhood and the forest hills (greenbelt) in the back.

ÎLE-DE-FRANCE

Legend

Fieldwork strip with the areas classified as TiB according to the method described in chapter 3

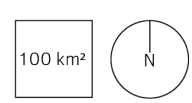

FIG. 2.12 The case study area Ile-de-France, stretching from the North of Paris to Creil in the North. With the Oise Valles crossing from south-west to northeast. The airport, Paris-Charles de Gaulle is a clearly visible in the South-eastern quadrant.

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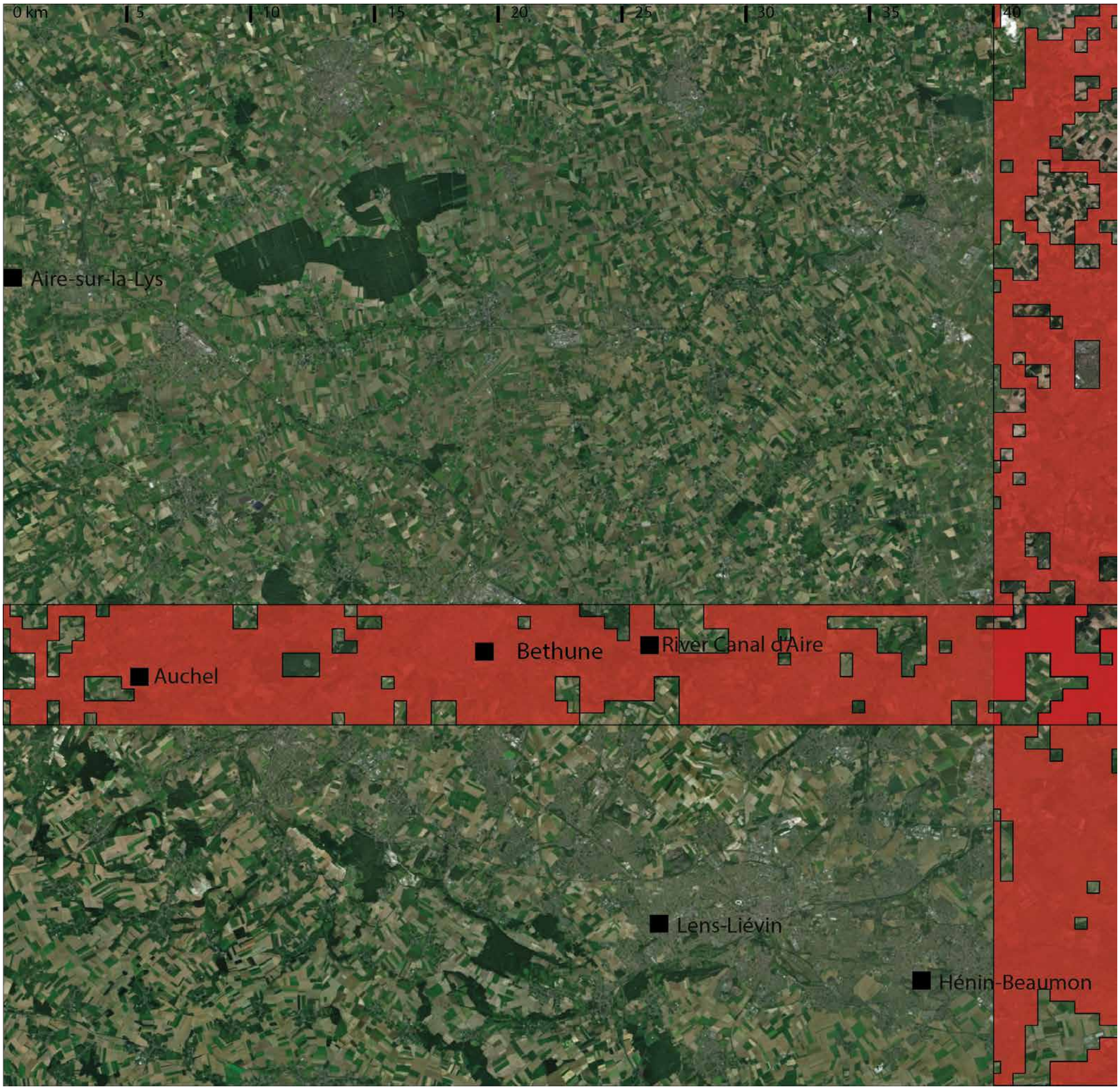
FIG. 2.13 (1) A typical sharp edge between pavilionaire and agricultural areas in the outskirts of Paris. (2) An intricate pattern in the urbanised valleys. (3) The Great Stables of the Château de Chantilly as the epicentre of an extended equestrian leisure landscape.

PAS-DE-CALAIS



Legend

Fieldwork strip with the areas classified as TiB according to the method described in chapter 3

100 km²

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FIG. 2.14 The case study area of Pas-de Calais is situated just east of Lille, with the city of Bethune in the middle of the case study area. The Canal d'Aire crosses the case study area from Northeast to Southwest. West of Bethune, around Auchel is a former mining area. The former military Airport of Merville-Calonne is located in the center of the case study area.

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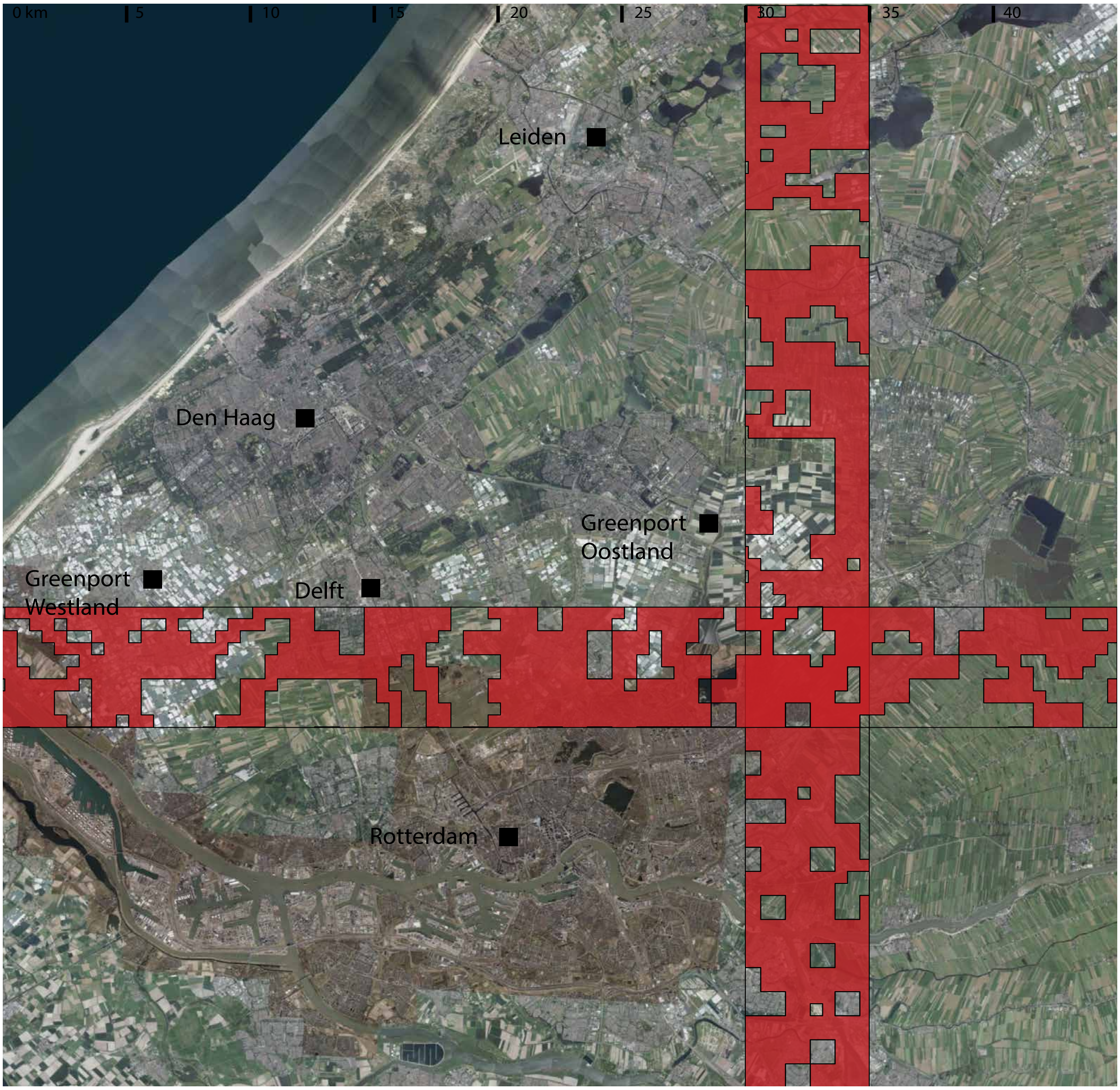
FIG. 2.15 (1) A former mining site transformed into a leisure and sports facility. (2) A 'polish' mining village. (3) View along the Canal d'Aire

SOUTH-HOLLAND



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Fieldwork strip with the areas classified as TiB according to the method described in chapter 3

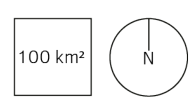

FIG. 2.16 The case study area in South-Holland, with the Maas delta in the south. The Den-Haag- Rotterdam metropolitan area as the south-wing of the Randstad and the edges of the green heart are the main features of the area. Extended greenhouse areas of the so-called Greenport Westland and Oostland are also clearly visible. Another prominent feature is the dunes along the coastline.

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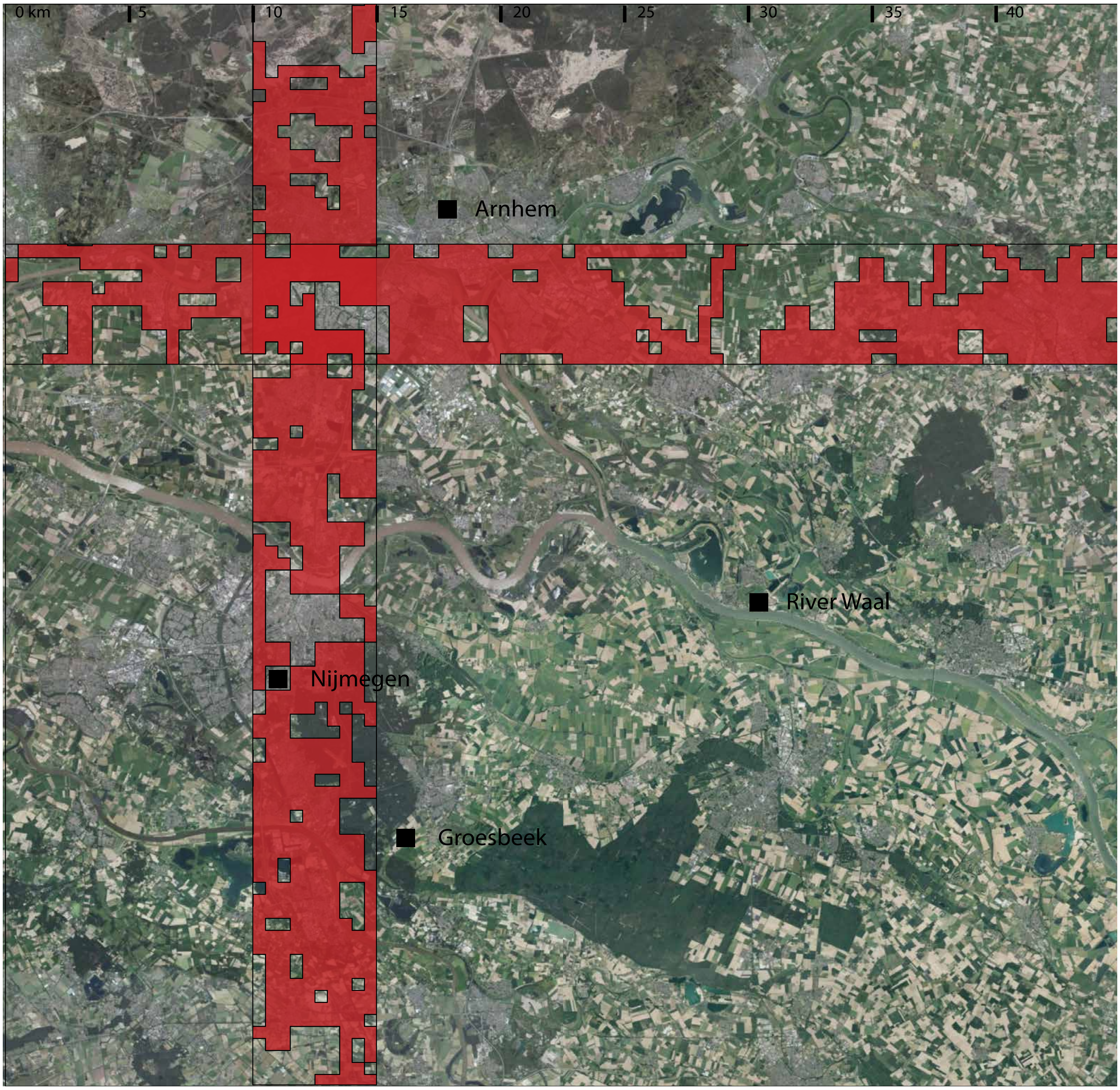
FIG. 2.17 (1) View from the Greenheart towards Rotterdam. (2) Greenhouse meets a terraced house in the Westland. (3) The intermingling of the city and countryside at the edges of Delft. Note the ubiquitous bicycle infrastructure.



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Fieldwork strip with the areas classified as TiB according to the method described in chapter 3

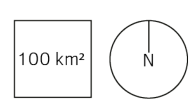

FIG. 2.18 The case study area in Gelderland includes two cities, Arnhem and Nijmegen as well as the river planes of the river Waal, Rhine and Ijssel and a ribbon of towns and villages in the otherwise agriculturally used plain. The north of the area is dominated by the De Hoge Veluwe National park, a landscape consisting of heathlands, dunes, and woodlands. In the south, between Nijmegen and Groesbeek, are forests.

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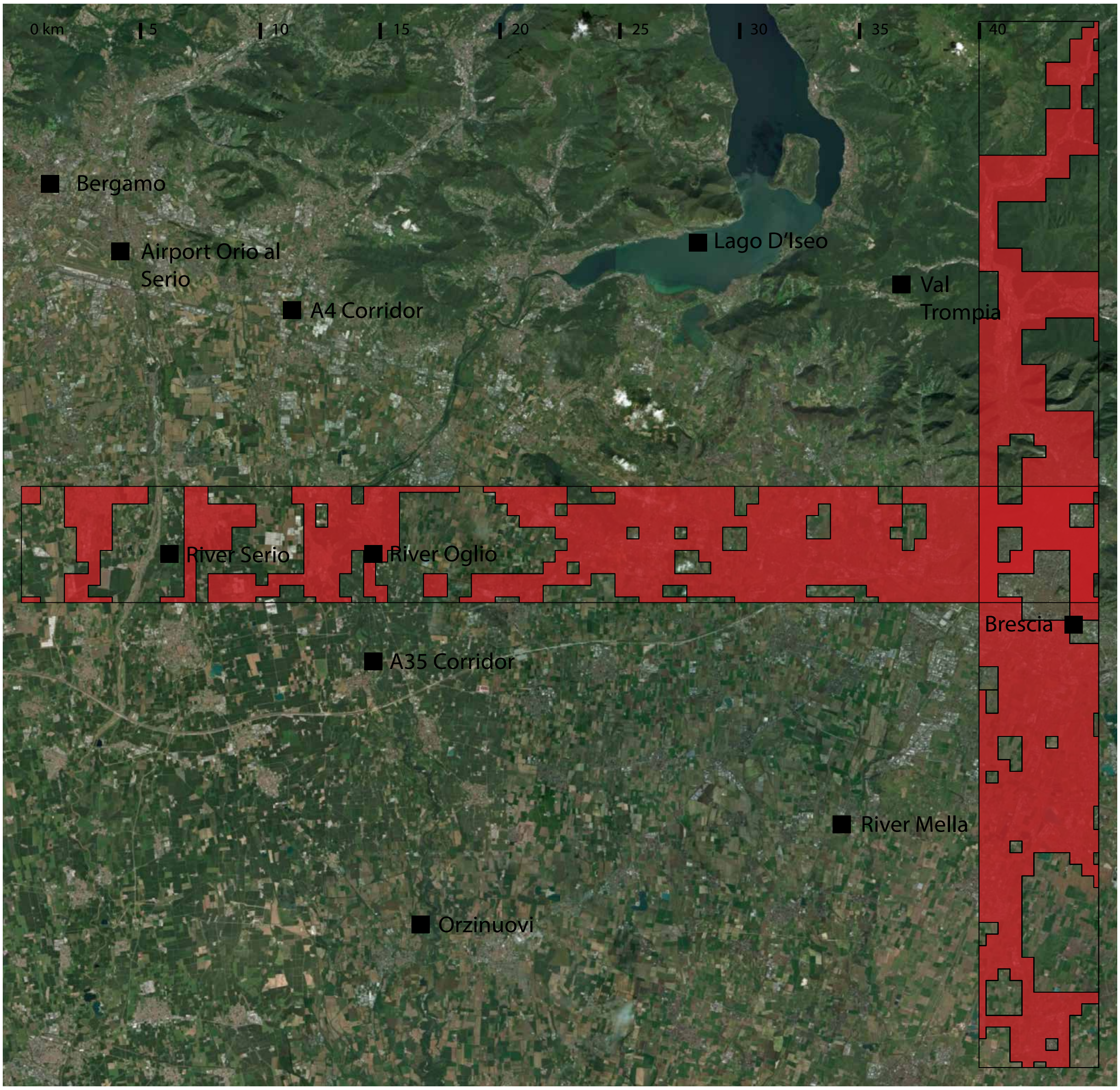
FIG. 2.19 (1) The Next to each other, ‘sub-urban’ development and stables and meadows. (2) A typical shopping street in one of the towns. (3) A bundle of transport infrastructure that crosses the area which connects the west of the Netherlands with Germany.



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Fieldwork strip with the areas classified as TiB according to the method described in chapter 3

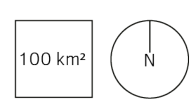

FIG. 2.20 The case study area in Bergamo-Brescia can be divided into three parts These are: the alps in the north and the riverplain in the south and an intensive zone full of infrastructures, like motorways, rail lines and an airport with accompanied urbanisation at the foots of the Alps between Bergamo and Brescia.


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FIG. 2.21 (1) View over the intermingling of the built and unbuilt environment from the alps towards the river plain. (2) The Porte Franche shopping and entertainment centre. (3) View from the riverplain towards the Alps.

Legend

Fieldwork strip with the areas classified as TiB according to the method described in chapter 3

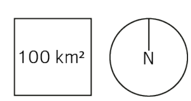

FIG. 2.22 The case study area in Veneto spans from the pre-Alpine hills via the lower plain towards the coastal zone. The city of Mestre is situated in the most south-eastern corner. The river Piave is a visible landscape feature in the north-east in the case study area. The biggest cites in the central area of the cases study area is Treviso. A large part of the case study is occupied by a settlement pattern identified as città diffusa by Indovina.

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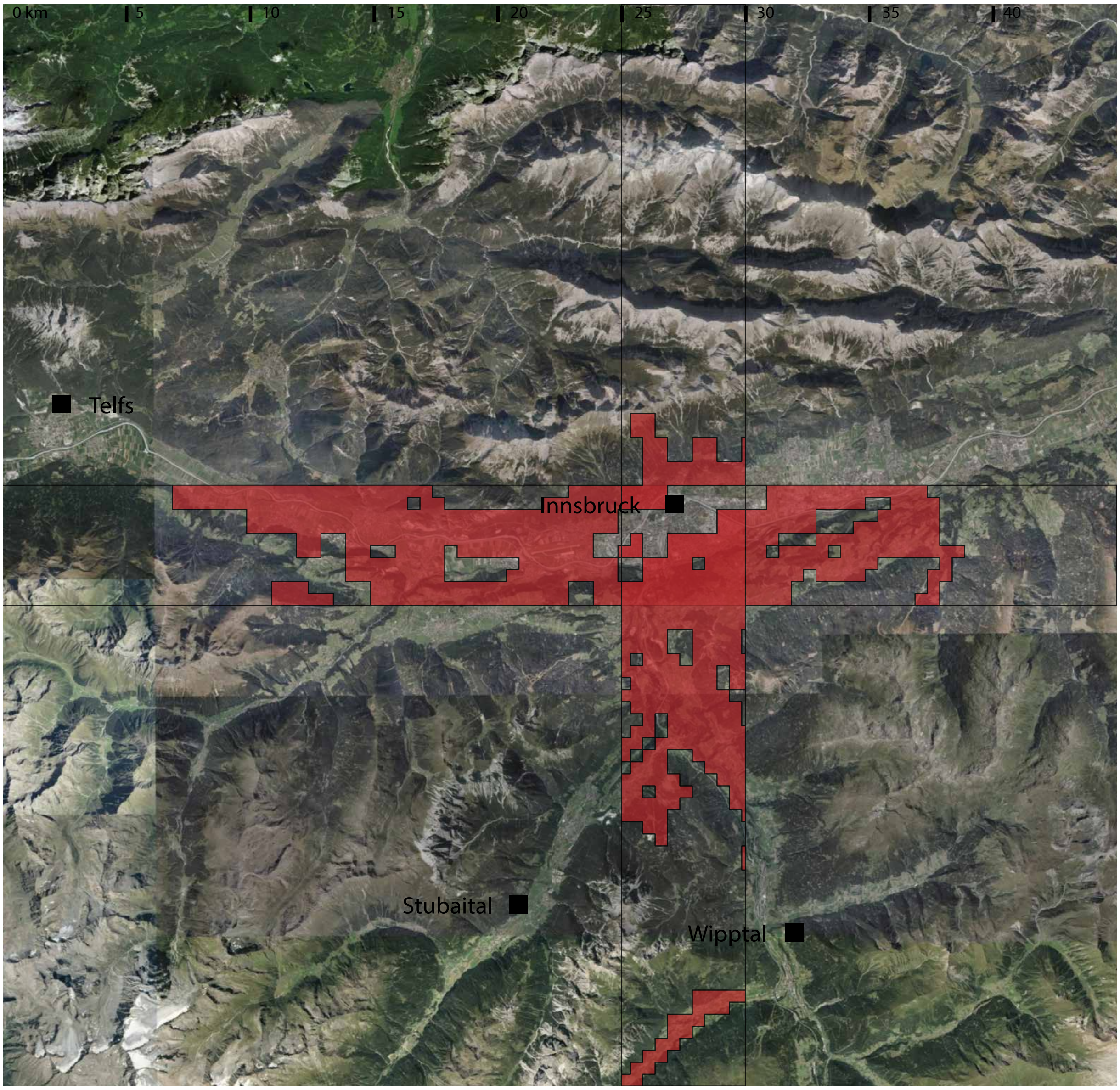
FIG. 2.23 (1) View across the intermingling of the built and unbuilt infrastructure from the hill-zone towards the lower plain. (2) A typical centre of one of the many historic towns. (3) Long straight roads alongside a diversity of uses.



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Fieldwork strip with the areas classified as TiB according to the method described in chapter 3

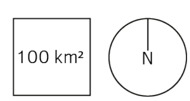

FIG. 2.24 The case study area in The Tyrol with the Inn valley in the centre and the Alps as the most dominant feature. The two valleys leading to the south are the Stubaital wich is one of the the most prominent winter tourism areas in the area.The Wipptaal to the east, which leads to the Brenner pass, is one of most important passes of the Eastern Alpine range with the lowest altitude among all passes in the eastern Alps.

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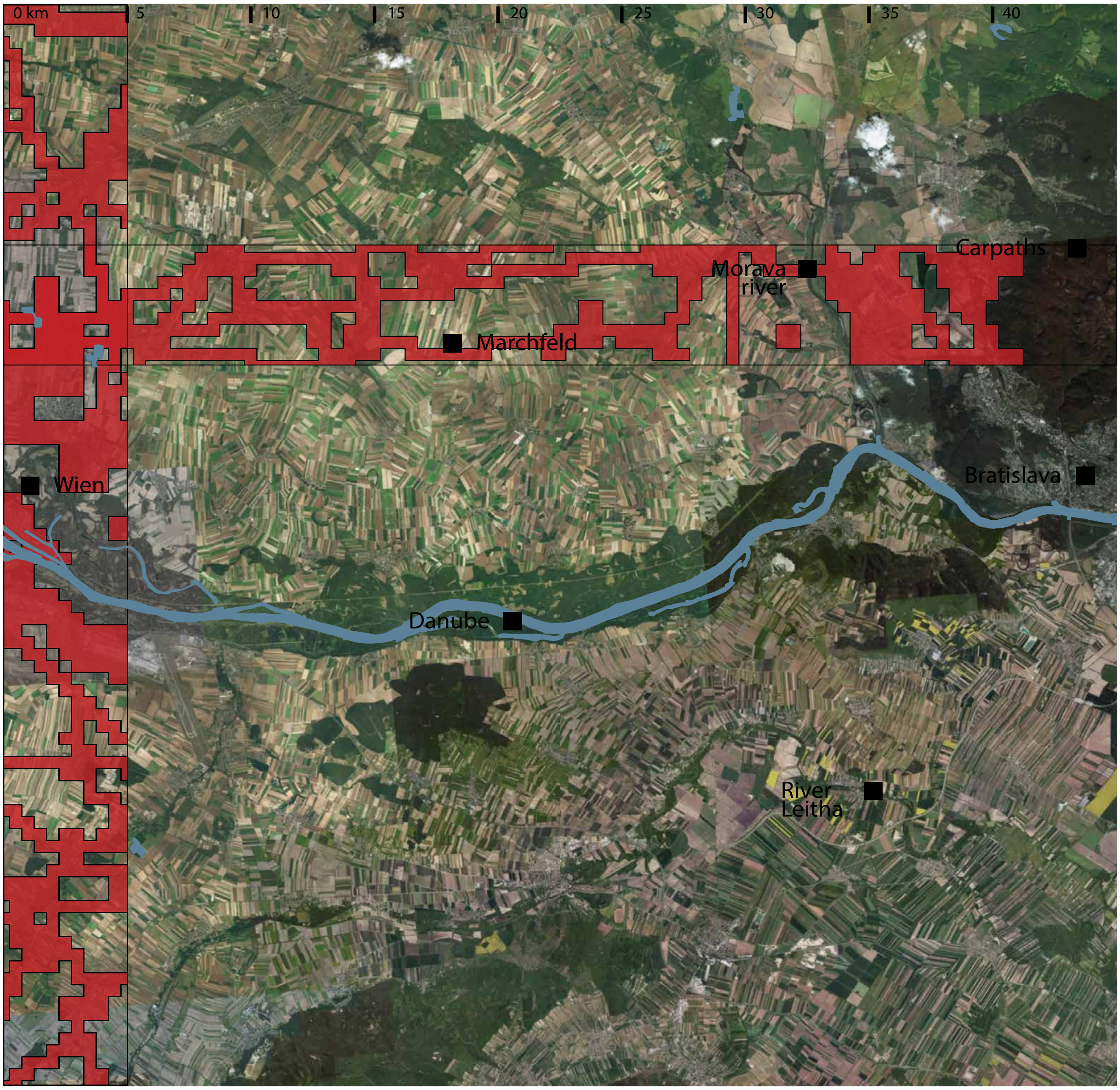
FIG. 2.25 (1) View along the Inn valley showing the intermingling of agriculture and urbanised areas. (2) Global meets local in the town centre of Telfs. (Photo by B. Hausleitner) (3) The typical transition from an agricultural area into a village in the Inn valley.



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Fieldwork strip with the areas classified as TiB according to the method described in chapter 3

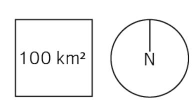

FIG. 2.26 The case study area in Vienna-Bratislava, with the outskirts of Vienna to the west and Bratislava to the east and the river Danube wetlands, a national park – in between. The majority of the case study area is part of the Vienna Basin. North of the Danube is the Marchfeld, one of the most fertile regions of central Europe. The mountain ridges that cross the area from south-west to northeast are the Leitha Gebirge and the Carpaths, which separates the Vienna Basin from the Pannonia Basin. There is a notable difference in the plot size of the agricultural areas in the Austrian part of the case study compared to the Slovak areas. This is the result of different agricultural systems during the cold war, as the Morava river has been part of the iron curtain.

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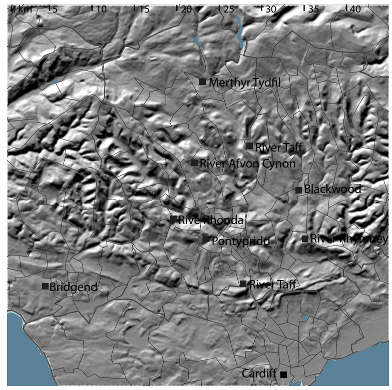
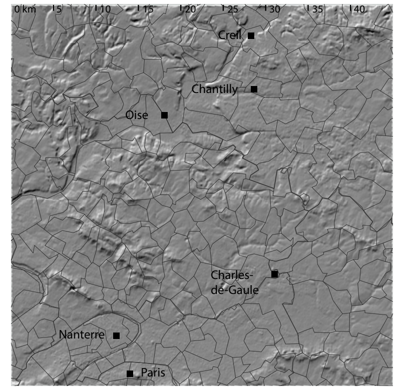
FIG. 2.27 (1) The intermingling of infrastructure agriculture and 'sub-urban' development. (2) A typical shopping mall, which can by found nearly at the edge of evry town or city. (3) An example of the many historic town and city centers.

Hillshade with Administrative Boundaries

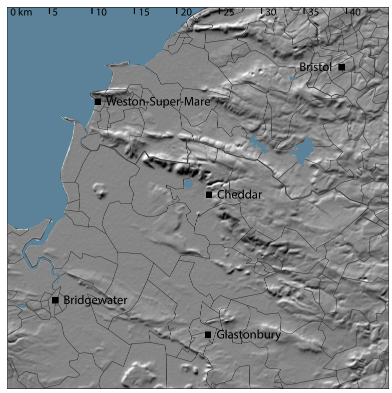
- Municipal Boundaries
- Boundaries NUTS 3
- Boundaries NUTS 2
- Boundaries NUTS 1
- Boundaries NUTS 0



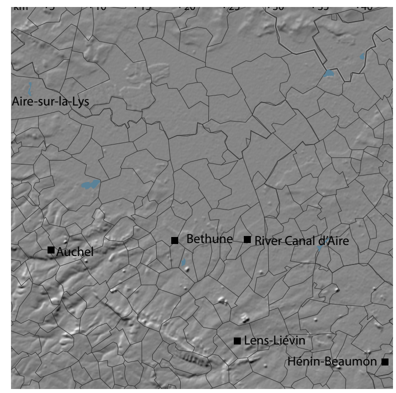
1 South Wales



2 Île-de-France



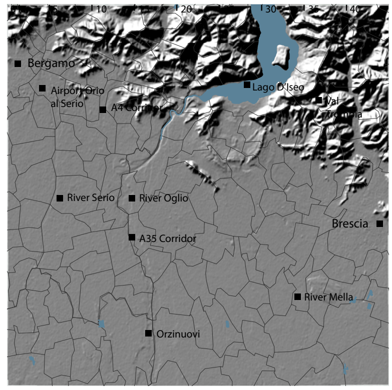
6 North Somerset



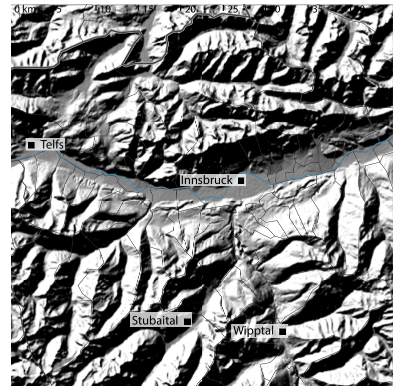
7 Pas-de-Calais

FIG. 2.28 Thumbnails of the ten cases hillshade maps. This is shown through a grayscale 3D representation of the surface, with the sun's relative position taken into account for shading the image to get a first impression of the critical features of the topography of the ten cases. The hill shade map also includes the administrative borders of the area as an indication of the governmental complexity of each case.

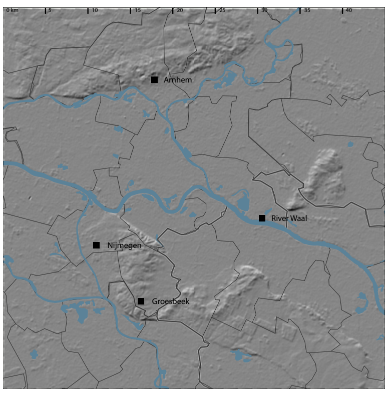
3 South-Holland



4 Bergamo-Brescia

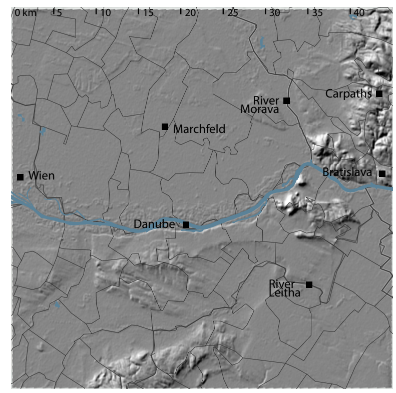


5 The Tyrol



8 Gelderland

9 Veneto



10 Vienna-Bratislava

3 Characteristics of Territories-in-between

Beyond Urban–Rural Classifications: Characterising and Mapping Territories-in-between Across Europe

Wandl, A., Nadin, V., Zonneveld, W., & Rooij, R.

Published in Landscape and Urban Planning (2014), 130, 50–63. doi:10.1016/j.landurbplan.2014.06.010

KEYWORDS dispersed urban development; the Tyrol, South-Holland; urban rural classification; GIS-mapping

ABSTRACT Much of physical territory of the Europe does not fit classic ‘urban–rural’ typologies but can best be described as ‘territories-in-between’ (TiB). There is considerable agreement that TiB is pervasive and very significant. However, typologies of territory or spatial development continue to employ only degrees of either urban or rural. Similarly, spatial planning and territorial development policies rarely make use of the notion of in-between areas but tend instead to divide the territory into urban and rural zones. Questions have been raised therefore about the lack of understanding of territories-in-between and their negligence in planning policy. This paper contributes to a better understanding of TiB, by proposing a method for their characterisation and mapping. It asks if there can be a common definition of TiB that reflects consistent and distinctive characteristics across the great variety of spatial development contexts in Europe. It proposes spatial and demographic criteria for their definition, mapping and comparison. The comparison with widely used urban–rural classifications shows that the presented classification of TiB has three advantages: (i) it maps the complexity of the spatial structure of urbanised areas on a regional scale, and thereby helps to overcome the prevalent idea that urbanised regions are characterised by a spatial gradient from urban centre(s) to rural periphery; (ii) it emphasises the network structure of territories-in-between and the underlying connectivity of places with different functions and (iii) it raises awareness that in some parts of Europe a settlement pattern has developed that cannot be understood as either urban or rural.

3.1 Introduction

Europe is largely made of 'middle landscapes' or 'hybrid geographies'. 'Urban' areas can be found in rather rural areas. . . while 'rural' areas can be found within urban environments. (MCRIT, 2010: 41).

Much of the territory of Europe is neither distinctly urban nor rural but something 'in the middle' or 'in-between'. These areas cannot be understood as simply places of intensification of urban functions in the rural environment or places of interaction of urban and rural territories. Rather they have specific spatial and programmatic features that do not fit the classic urban–rural dichotomy (Garreau, 1991; Sieverts & Bölling, 2004; Viganò, 2001). This paper aims to unravel the complex relation between urban and rural in the territories-in-between (TiB) of the European Union (EU) and thereby introduce a new territorial classification method. territories-in-between are not a specific European phenomenon, but as Castells (2010), building on Hall and Pain's (2006) work on European polycentric metropolis, puts it, they are a defining characteristic of metropolitan regions across the planet. A metropolitan region is a new form because it includes in the same spatial unit urbanised areas and agricultural land, open space and highly dense residential areas' (Castells, 2010: 2739). What makes territories-in-between in Europe of specific interest is that they also emerged outside of the metropolitan regions.

In this introductory section we first introduce our understanding of territories-in-between. Second, we describe the challenges related to the overlooking of territories-in-between in existing territorial classification models.

3.1.1 Territories-in-between

The many names given to the form of spatial development in territories-in-between reflect its pervasiveness across Europe as well as the particular context in which it is discussed. They include: *Zwischenstadt* (Sieverts, 2001), *Tussenland* (Frijters et al., 2004), *city fringe* (Louis, 1936), Città diffusa (Secchi, 1991), territories of a new modernity (Viganò, 2001), *Stadtlandschaft* (Passarge, 1968), shadowland (Hamers in Andexlinger et al., 2005), spread city (Webber, 1998), and *Annähernd* Perfekte Peripherie (Campi, Bucher, & Zardini, 2000). A translation of the non-English terms is not given so as to preserve the meaning embedded in the original language. (We will come back to this in Section 2 where we discuss a variety of concepts). However, while the precise form and meaning of these terms vary, we argue that they share a common conceptual base. They represent a discrete class of territorial development: 'territories-in- between' urban and rural which are more than a simple mixing of the two. The variety in naming is an indication that within this class of territory there is some diversity. At the same time, these terms are an indication of two general issues: (i) the growing attention given in the literature to changing relationships between the urban and the rural and the implications of their interconnections; and (ii) the uncertain relationship between policy and spatial development in territories-in-between in terms of policy influences on the location of housing and economic activities, mobility, social relations and the overall sustainability.

Although this spatial phenomenon has been identified in Europe for at least three-quarters of a century, territories-in-between (in whatever guise) have not generally found their way into mainstream spatial planning discourse and policy until the 2000s, and then only in very limited ways. The geographer Friedrich Leyden (Sieverts & Bölling, 2004) noted as early as 1933 that the areas outside the *Berliner Ringbahn* developed in ways that go beyond how spatial organisation is generally understood. It created a non- traditional urban form requiring fresh analysis. He describes these areas as an intermingling of urban and rural land uses and lifestyles, of city and landscape. Decades later Hamers (in Andexlinger et al., 2005) identified a similar phenomenon in the Netherlands, and called it 'Shadowland'. He understands this as comprising areas forgotten and neglected by planners and policy makers. 'Planners, designers and administrators often lack a sufficient insight into what goes on in areas that cannot be pinned down in conventional categories. They deny the conditions in which such areas emerged, . . . who is active in them' (p. 50). Hamers' conclusion for the Dutch case was confirmed by a survey among 136 experts on spatial planning across Europe undertaken by MCRIT (2010). More than 80 per cent agreed that the European territory is mostly 'middle landscapes'. More than 50 per cent expressed the opinion that planning policies have to be reformed to consider the many implications of this distinctive form of spatial organisation.

3.1.2 The problem of territorial classifications

An important factor affecting the way that government policies may address territories-in-between is the classification of types of territory, which underpins analysis and policy-making. Territories- in-between have been overlooked in the dominant schemes of classification of territory which generally only define land as either urban or rural, or in degrees of urban. Furthermore, the methods used to separate urban from rural tend to be dominated bythe use of one criterion – resident population density (OECD, 2010; Scholz, 2009).

Spatial planning policy-making processes based on this kind of classification have produced, not surprisingly, policies for 'urban' and 'rural', indeed often seeking to divide urban from rural and ignoring the real nature of territories-in-between. One consequence of the oversimplification of categorisations of territory has been vagueness in the many terms that are used to explain this form of spatial development. Geographers and planners use notions such as suburbanisation, sprawl, urban–rural relations, fringe and peri-urban to try to capture the real diversity and complexity of such territories. But these terms tend to be ambiguous overgeneralisations with little common definition, while some of them – especially sprawl – have become rather pejorative. For example, Forsyth (2012) gives an overview of the very diverse meanings of 'suburb' and related concepts. Bruegmann (2005) and Galster et al. (2001) set out the plethora of meanings and connotations that are attached to the term sprawl. This ambiguity undermines both spatial planning policy and the empirical research that underpins it. A clearer specification of territories-in-between should provide much needed clarity in meaning and also a means of measurement and comparison.

This paper proposes an alternative classification of territory,which is precise enough to represent the complex (socio-) spatial configuration of territories-in-between and distinguish them from urban and rural areas. This preciseness is achieved by a combination of freely available geo-datasets which allow for a detailed classification and mapping of territories-in-between, going beyond existing typologies. The proposed classification can make a significant contribution comparison of the form of territories-in-between, their performance in terms of sustainability, and the evaluation of spatial policies applied within them territories-in-between.

3.2 Methodology and structure of the paper

3.2.1 Research approach

This new classification method is based on analyses of a variety of concepts that are used across Europe to describe dispersed urban development within different cultural and topographic settings. These concepts understand urbanised areas not as gradients from urban and rural but as distinct and highly interconnected regions. Therefore, the presented classification forms a solid base for cross- European comparisons which go beyond the problematic use of administrative boundaries as the classification unit and simple population density studies. The method is especially appropriate for spatial analyses of the networked territory in Europe.

The overarching general concept of territories-in-between is used here as a starting point. The term incorporates all forms of mixed urban and rural that have so far been mentioned. The measurement and analysis of comparative cases using specified parameters provide more specific descriptions of particular types of territories-in-between.

We first review the existing concepts used to describe dispersed urban development across Europe in order to define common spatial characteristics (Section 3). In the next step explained in Section 4, we review existing territorial classification models, in order to understand which criteria and spatial classification units are commonly used, and what are their advantages and limitations. In Section 5 we use two cases, the Tyrol in Austria and South-Holland in the Netherlands, to test which commonly available geographic datasets and thresholds for them can be used to produce a geographical information system (GIS) supported mapping of territories-in-between. The results are verified by fieldwork and the analyses of aerial pictures. Finally, in Section 6 we discuss the outcomes in comparison to other existing classification methods.

3.2.2 Two test cases

The test areas are The Tyrol in Austria and South-Holland in the Netherlands. They represent two extreme cases for European territories, being very different in topography and population density. The Tyrol is a mountainous area in the eastern Alps, with around 750,000 people living in area of 12.5 thousand square kilometres, of which actually only 20% (the valleys) is inhabitable. South-Holland, is the southern wing of the Randstad a metropolitan area in the Dutch delta. Around 3.5 million of people live on an area of 3.5 thousand square kilometres. The assumption is that if the same method to map territories-in-between is successful in these two cases, it should be applicable to a European-wide selection. Ssee FIG. 3.1 for the location, as well as impressions and major characteristics of the two test case study areas).

Our criteria for being successful are: (1) avoidance of illogicaloutcomes meaning the selection of areas, which are obviously no territories-in-between; (2) showing the relational nature of many territories-in-between, i.e. the strong linkages with infrastructure; (3) use of existing and comparable databases with a minimum need of additional local knowledge to filter out illogical outcomes.

3.3 The characteristics of territories-in-between

Caplan and Nelson pointed out in the context of social problems, ‘what is done about a problem depends on how it is defined’ (1973: 200, quoted in Forsyth, 2012: 271). This is very appropriate for definitions of ‘territory’, if territories are defined as either urban or rural then policy and action will follow in the same pattern. So the reality of spatial development including territories-in-between needs to be defined and mapped, that means they should be geographically located and distinguished from other related spatial conditions that are primarily urban or rural. The definition of territories- in-between requires careful selection of demographic and spatial features that are on the hand, common characteristics for all such areas, but which on the other, can also accommodate variations resulting from historical and cultural differences. Although the discussion that follows reveals varying views about the nature of territories-in-between (and thus the use of different terms) there is sufficient agreement in a wide field of literature, projects and plans dealing with disperse urban development, about key spatial and demographic properties that define them.

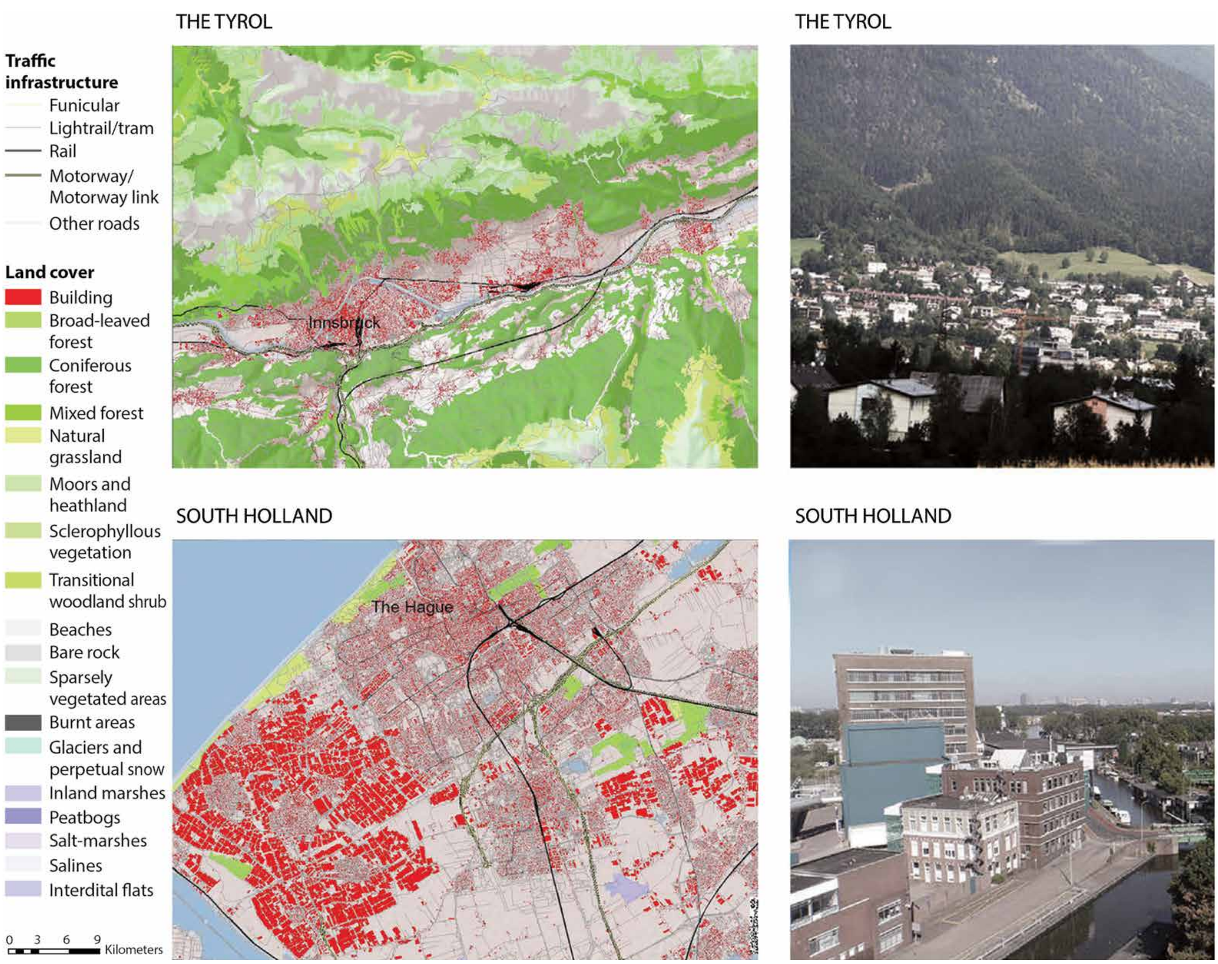


FIG. 3.1 Case study locations, spatial characteristics and visual impressions. Source: Authors’ own. Data sources: ESRI 2013; DeLorme; USGS, NPS and EEA Copenhagen 2010.

Table 3.1 presents a summary of the most used terms for territories-in-between in the literature together with an explanation of their meaning and the approach followed by the authors and researchers.

TABLE 3.1 Recent characterisations of territories-in-between across Europe in comparison to sprawl and peri-urban.

Concept	Country authors	Summary of approach and explanation
Annähernd Perfekte Peripherie	Suisse Campi et al. (2000)	Campi et al., describe the territory between Zurich and its airport as one example of an area with a new form of urbanity, characterised by a heterogeneity of fragments of urban and rural land uses. They come to the conclusion that such areas cannot be described as periphery but form an autonomous city, the 'Glattalstadt',
Tussenland	Netherlands Frijters et al. (2004)	The term Tussenland (Dutch for in-between land) arose from research done by the Dutch National Environmental Agency that aimed to identify and raise awareness of territories-in-between for Dutch planning practice. It focuses on the manifoldness of actors interacting in the production of the Tussenland, developed in the shadow of Dutch spatial planning which has given priority to the containment of cities and protection of green spaces over recent decades.
Città diffusa	Italy Indovina (1990) Secchi (1991)	Città diffusa describes the dispersed urban development of parts of the Veneto Region in northern Italy and its distinct urban form and socio-economic condition. The fine-grained character of its urban structure is the basis for its spatial diversity and decentralised but heavily interconnected economy, supporting a variety of lifestyles.
Territori della nuova modernità	Italy Viganò (2001)	In Territories of a New Modernity, a spatial development strategy for the Salento region in the province of Lecce in southern Italy, Paola Viganò and colleagues explain the porosity of the landscape as a driving spatial property for future development. They stress that in the Città diffusa an approach that focuses more on relations than on functions and that understands the landscape as the major infrastructure, offers more possibilities for local and regional development than traditional plans that primarily concentrate on the cites.
Urban fringe	England Gallent, Bianconi, & Andersson (2006)	In a series of articles from 2000 to 2006 Gallent et al. describe the English urban–rural fringes and their planning challenges. They investigate the role (or not) that planning played in 'urban fringe' development in England. They explain the struggles of an urban containment orientated spatial planning with areas where urban and rural uses intermingle. They conclude that, while spatial planning in the UK focused on the containment of cities and the separation of urban and rural land uses, the edges of cities evolved into a mixture of less favoured urban uses, agriculture and other rural land uses.
Zwischenstadt	Germany Sieverts (2001) Sieverts and Bölling (2004)	The term Zwischenstadt (German for in-between city) was introduced by Thomas Sieverts in the late 1990s to describe a new emerging type of city that is in-between on three dimensions: between built and open landscape; between the local rooted and global economy; and between recent young urban development and a yet unknown urban future. He argues that a better understanding of the Zwischenstatd is the base for planners and designers to contribute to its 'qualification'.
TyrolCity	Austria Andexlinger et al. (2005)	TirolCity is a provocative study of the State of The Tyrol in Austria taking the scenario of the whole federal state being seen as one city (TirolCity). The study investigates what this paradigm change would mean for planning for an area that has a traditional self-understanding as an 'Alpine rural landscape idyll'. The authors conclude that large parts of the Tyrol are a territories-in-between.
Sprawl	For an overview of definitions see (Bruegmann, 2005)	There are manifold definitions of sprawl, in this article the following is used: sprawl is a land development pattern that spreads residential units over a large area . . . sprawl also encompasses the separation of residential from commercial land uses, the absence of clustered development of town centres, and reliance on the automobile (Dreier, Mollenkopf, & Swanstromm, 2004, p. 59).
Peri-Urban	France Le Jeannic and Vidalenc (1997) EU Piorr et al. (2011)	The term Peri-urban is from French origin, and is used in to identify the wide territory of urban diffusion around urban centres. Only recently, it entered the planning discussion within the EU, primarily through the PLUREL project, which defines peri-urban areas as discontinuous built development, containing settlements of less than 20,000, with an average density of at least 40 persons per km^2. Together with the urban and the rural hinterland they form the rural–urban region

Some approaches remain firmly rooted in the idea of an urban–rural dichotomy, explaining territories-in-between in terms of a gradient of urban to rural or vice versa. They concentrate heavily on characterising territory based on resident population density. Prominent in this category is the notion of urban sprawl. Sprawl is characterised as low-density urban dispersion with segregation of employment and residential development. It is associated with very negative views of urban development including in particular, high car dependency and major traffic infrastructure such as highways and extensive car parking. Galster et al. (2001: 681–682) set out the limitations of this approach. From a European perspective Couch et al. understand 'sprawl, not as a pattern of urbanisation, as it is more common in the literature, but rather as a process of urban change' (2007: 4). This is a first step towards understanding territories-in-between as more than just the intensification of urban uses in the rural.

Similarly, the approach coined in terms of urban–rural relations reinforces the urban–rural dichotomy. The notion has been particularly popular in European policy studies to draw attention to urban–rural interrelationships in a context of dominance of urban policy (Dühr, Colomb, & Nadin, 2010; Zonneveld & Stead, 2007). Although the concept is based on a dynamic understanding of urban–rural relations, research is mainly focused on redefining what the two 'opposites' 'urban' and 'rural' mean and thus is not helpful in understanding 'the in-between', although it has helped to undermine the separation of urban and rural policy. Concerning spatial characteristics, the focus is very much on flows, the exchange of people and goods, and therefore, the importance of transport and other infrastructure. This is taken forward into the analysis below.

The idea of territories-in-between being a distinctive form of territory was introduced by Jean Gottmann in his1957 study of the Boston-Washington metropolitan region. He described this as the "BosWash" – Megalopolis – the outcome of poly-nuclear urban growth in urban and suburban areas along a 600-mile axis between the cities. Subsequently, the significance of Gottman's megalopolis concept to be 'a blurring of the distinction between urban and rural areas, it gave an impetus to a vast array of studies on both sides of the Atlantic which focused on how to delineate urban and metropolitan areas' (Zonneveld in Caves, 2005). Gottman was arguing that the BosWash represented a fundamentally different form of socio-spatial organisation. Later, Castells (2010: 2739) was to reinforce this argument in relation to metropolitan regions across the world:

the metropolitan region is not just a spatial form of unprecedented size in terms of concentration of population and activities. It is a new form because it includes in the same spatial unit urbanised areas and agricultural land, open space and highly dense residential areas: there are multiple cities in a discontinuous countryside. It is a multi-centred metropolis that does not correspond to the traditional separation between central cities and their suburbs.

The 'new form' of spatial organisation that Castells refers to has been shown to exist beyond the major metropolitan regions of Europe into the Alpine valleys (Andexlinger et al., 2005; Dessemontet, Kaufmann, & Jemelin, 2010) and along the Mediterranean coast line (Viganò, 2001).

Numerous studies have undertaken analysis of this new form of territory from various disciplinary perspectives including geography, environmental and spatial planning, and urbanism (Andexlinger et al., 2005; Barman-Krämer, Brandl, Unruh, Magnago Lampugnani, & Noell, 2007; Campi et al., 2000; Couch, Leontidou, & Gerhard, 2007; Frijters et al., 2004; Gallent et al., 2004; Oswald, Baccini, & Michaeli, 2003; Secchi, 1991; Sieverts & Bölling, 2004; Sieverts, 2001; Viganò, 2001; Woods, 2009). They have broadened their characterisation beyond population density to examine three main spatial qualities:

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- the morphology of mixed built and open spaces;
- the connecting and separating role of infrastructure at different scales; and
- the specific mix of functions at the regional scale.

The findings for each variable are presented in the following sections.

3.3.1 The morphology of built and open spaces

In relation to morphology, inherent in all of the studies is an understanding of the 'urban landscape as a large interlocking system rather than as set of discrete cities surrounded by countryside' (Bruegmann, 2005: 277). This interlocking system is characterised by an *intermingling of built and unbuilt* where 'the sharp distinction between city and countryside has dissolved into an ecological and cultural continuum of a built structure between city and landscape' (Huhlmann & Promski, 2007). Unbuilt or open land becomes according to Viganò (2001) a critical feature for planning and designing in metropolitan regions. Planning approaches such as, landscape urbanism, green infrastructure and eco system services have all in common that the approach the relation between built and unbuilt from the perspective of the open space.

For some authors this distinctive morphology also has a cultural component. In explaining his concept of the *Zwischenstadt*, Sieverts uses examples such as the *Regionalpark Rhein-Main* and the *IBA Emscherpark* (International Bauausstellung Emscherpark). The latter was a ten year long regeneration and redevelopment project in the German Ruhr area which aimed to demonstrate the potential to (re)develop a landscape based on its topography and history in mining and heavy industry leading to a kind of continuum of '*Stadt- Kultur-Landschaft'*, city-cultural-landscape. Another example is the Glatttal, a term coined by Barman-Krämer et al. (2007). It emphasises the importance of a landscape feature, namely the river valley of the Glatt as a structural element to create a unifying 'identity' for the 'peripheral' region in the north Zurich.

Both examples, the Glatttal as well as *IBA Emscherpark*, show how the specific morphology of a territory-in-between influenced the planning approaches and instruments in a specific area.

3.3.2 The connecting and separating role of infrastructure

The second common character of the literature on territories-in- between is *infrastructure*, and its role in creating a distinctive spatial organisation. Infrastructure includes primarily transport and traffic infrastructure, but also services such as power plants and water treatment facilities. For Viganò infrastructure plays a crucial role for the concept of a porous territory, but infrastructure in her view is not just big traffic infrastructure like highways and railways, which she calls tubes, but also the dense network of secondary roads (and other connections) which she calls the sponge. The structure of a diffuse territory needs to be understood through its infrastructure: 'where dispersion of settlement has reached serious proportions and caused the formation of an enormous extended city, the extension of the road network and, generally speaking, the network of infrastructure also plays a primary role' (Viganò, 2001: 27).

There is a common understanding that infrastructure plays different roles at the local and regional scales. At the local scale infrastructure divides the territory, physically separating adjacent land uses. At the regional scale infrastructure has a connecting role – linking places and functions.

The outcome for territories- in-between is that they are a network of distant but functionally connected areas at the regional scale, and a patchwork of proximate but functionally disconnected areas at the local scale. In other words, adjacent land uses may not have any spatial or functional interconnection, whereas there are closer socio-economic functional relations between areas that are not in the same local area. The result is often a seemingly monofunctional landscape at the local level but a surprising mix of functions at the regional scale.

3.3.3 The specific mix of functions at the regional scale

Gallent et al. (2004: 227) argue that multi-functionality is a key issue in spatial structure: 'working out how the built environment can be sustainable often leads to the conclusion that the way forward is to lessen the impact of the existing built form by enabling it to perform other desirable objectives'. But already a closer look at territories-in-between shows that, despite the dominant view, these areas are not monofunctional sleeping suburbs or simply areas only occupied by transport and logistics uses but exhibit a complex mix of functions. Particularly from a regional perspective the mix of uses often results in a surprisingly high level of functional diversity. For example, as the analysis of two test cases in the following sections will show, territories-in-between are often characterised by a ratio of 0.5 jobs per residents. This is a slightly higher ratio than in the urban areas of South-Holland (0.4) and also higher than the ratio in rural areas in the Tyrol (0.25). This shows also that calling TiB sprawl would be extremely misleading as the latter is characterised as nearly mono-functional residential.

In addition to the three main spatial qualities, the literature also indicates a fourth common concern, the relationship between spatial characteristics of territories-in-between and public policy, particularly spatial planning. In general, there is a view that existing design and planning tools and policies are inadequate to address the conditions and drivers of spatial development in territories-in-between (Andexlinger et al., 2005; Frijters et al., 2004; MCRIT, 2010). For example, authors agree that networks of infrastructure result from both top-down planning and bottom-up pressures, which interact and often conict in the same area. This interaction may lead to informal responses with a high level of self- organisation, often in loopholes of regulations, which do not reflect the demands of people living and working there. The examination of planning policy for territories-in-between is beyond the scope of this paper, though the argument for the analysis set out here and the intention to provide a more accurate characterisation of territories-in-between is motivated by the need for a better relationship between policy and the reality of spatial development in territories-in-between.

To summarise, numerous studies have demonstrated specific characteristics of territories-in-between, and argued that they constitute a specific variable form of spatial structure that is distinctive from urban and rural classes of territory. The studies draw attention to three interrelated variables or spatial characteristics that distinguish them from urban and rural areas: the intermingling of built and unbuilt or open land; the importance of infrastructure in defining spatial organisation, and the varying mix of functions at local and regional scales. Planning policy has not generally recognised the distinctive character of territories-in-between. The next section explains how much policy has been based on classifications of the territory that characterise territories-in-between only in degrees of urban or rural.

3.4 A critical review of urban and rural classifications

There are four principal forms of characterising and classifying the spatial structure of the territory. Here we critically review these four approaches with references to typologies of territory used in Europe and elsewhere.

3.4.1 Population density-based classifications

The most well-known and globally used typology is the Organisation for Economic Cooperation and Development's (OECD) regional typology.

Regions of OECD member countries have been classified into Predominantly Urban, Intermediate and Predominantly Rural to take into account geographical differences among them. Comparing the socio-economic performance of regions of the same type (whether urban or rural) across countries is useful in detecting similar characteristics and development paths.

(OECD Directorate for Public Governance and Territorial Development 2010: 2)

Like other urban–rural typologies the OECD approach is based on thresholds of population density within a specific spatial entity as the organising factor. The OECD method first classifies local administrative units (LUAs) (mostly municipalities) with a population density below 150 inhabitants per square kilometre as rural. In a second step, these lower level units are aggregated to higher administrative levels (TL3). Classifying the latter as:

- predominantly urban (PU), if the share of the population living in rural local units is below 15%;
- intermediate (IN), if the share of population living in rural local units is between 15% and 50%;
- predominantly rural (PR), if the share of population living in rural
- local units is higher than 50%.

In a final step the predominantly rural units according to steps 1 and 2 are reclassified to intermediate where they contain an urban centre of more than 200,000 inhabitants. Similarly predominantly intermediate areas are reclassified to predominantly urban areas if they contain an urban centre of more than 500,000 inhabitants. In both cases this only applies if the population of the urban centre is representing at least 25 per cent of the regional population. It is important to mention that the OECD defines urban centres 'by population density and size, not by functional criteria such as commuting' (OECD, 2010: 3).

Newer typologies like the new European Union (EU) typology of 'predominantly rural', 'intermediate' or 'predominantly urban' regions use population data based on a spatial grid (1 km 1 km). This approach was intended to overcome difficulties with using administrative boundaries that led to distorted results.

The first distortion is due to the large variation in the area of local administrative units level. The second distortion is due to the large variation in the surface area of NUTS 3 regions and the practice in some countries to separate a (small) city centre from the surrounding region. (EUROSTAT, 2012)

Eurostat also provides examples for such distortions. 'For example, Aldea de Trujillo in Spain is classified as urban despite having a population of only 439 inhabitants' or 'Badajoz and Cáceres in Spain and Uppsala in Sweden are classified as rural despite all three having a population of 150,000 or more' (EUROSTAT, 2012).

To avoid this distortion Eurostat adjusted the OECD methodology starting from the urban rather than rural, namely every 1 km^2 grid cell that has more than 300 inhabitants within its boundaries as well as more than 5000 in the boundaries of the eight grid cells from its centre. All other grid cells are considered rural.

To achieve a classification at the regional scale the values of the grid cells are aggregated to the NUTS 3 level, using the same threshold of the share of rural population (50%) for the division between predominantly rural and predominantly intermediate as used by the OECD. The border between predominantly intermediate and predominantly urban was changed to a share of 20% of the population living in rural grid cells. This change is argued by EUROSTAT (2012) 'to ensure that the population share in predominantly urban regions does not differ too much from the original OECD classification applied to NUTS 3 regions'. It is worth noting here that without this adaptation most of Europe would be classified as intermediate.

3.4.2 Land cover based classifications

The *Coordination of Information on the Environment Project* or CORINE uses remote sensing methods to monitor and assess land cover changes in Europe to support policy making. The CORINE land cover classification – maintained by de European Environment Agency – is not an urban–rural classification per se, but was used to define and map urban morphological zones (UMZs) (EEA, 2011). UMZs are defined as built-up areas lying less than 200 m apart. They are primarily made up of four CORINE land cover classes.

- 'Continuous urban fabric' comprises buildings, roads and artificially surfaced area covering almost all ground; non-linear areas of vegetation and bare soil are exceptional.
- 'Discontinuous urban fabric' comprises buildings, roads and artificially surfaced areas with vegetation and bare soil occupying discontinuous but significant surfaces.
- 'Industrial or commercial units' primarily comprise artificial surfaces (concrete, asphalt) devoid of vegetation but also contain buildings and/or vegetated areas.
- 'Green urban areas' are patches of vegetation within the urban fabric including parks and cemeteries with vegetation.

In addition, port areas, airports, and sport and leisure facilities are included within UMZs if they are adjacent to these four land cover classes. Road and rail networks and water courses are considered part of a UMZ if they are located within 300 m. Forest and scrub areas belong to the UMZ if they are completely encircled by one or more of the four core classes.

The CORINE methodology has on the one hand the advantage that it allows for a division between urban and rural at a very precise resolution of 100 m, taking into account geographic and topographic features. On the other hand, it has the disadvantage that the same urban land cover may host very different intensities of urban use. For example a big villa style single family house which hosts four persons could have the same land cover as a housing tower block being home to many more people.

A combination of land cover and population density-based classifications

The EU project on *Peri-urban Land Use Relationships – Strategies and Sustainability Assessment Tools for Urban–Rural Linkages* (PLUREL) defines peri-urban areas as 'discontinuous built development, containing settlements of less than 20,000, with an average density of at least 40 persons per km^2 (averaged over 1 km^2 cells)' (Piorr, Ravetz, & Tosics, 2011: 10). Together with the urban area (continuous urban areas and cities with over 20,000 population) and the rural hinterland (less than 40 inhabitants per square metre) they form the rural–urban region (Piorr et al., 2011: 25). The PLUREL synthesis report presents this graphically as a gradient from urban core to rural. Nevertheless the report also points out that, 'in the polycentric version, the peri-urban areas do not only surround the urban, they are also a geographical type and territory unto their own', and that 'the reality on the ground is often complex and fast changing' (Piorr et al., 2011: 25). This is an important starting point for the following discussion on territories-in-between, as it raises other questions about whether territories-in-between emerge outside or around urban centres, or if they emerge without them, or even within them.

This discussion of urban–rural territorial classification methods leads to a number of conclusions for the task of putting territories- in-between on the map so as to inform regional planning. First, an accuracy similar to that used in the UMZs should be achieved. Second, a combination of land use and population density seems more promising than using only one of these variables, as one and the same land use unit may be inhabited by widely varying numbers of people. Third, a classification of territories-in-between should include aspects that recognise functional relations between different areas.

3.4.4 Comparing US and EU classifications

The United States Census Bureau used for its 2010 Urban and Rural Classification a combination of resident density and adjacent non-residential urban land uses. Of specific interest is the territorial classification unit that is used: the census block, which is neither a regular grid nor an administrative jurisdiction, but bounded by streets, roads or creeks. The result is that in cities, infrastructure networks define a census block, but in rural areas with fewer roads, other features, like rivers, may limit blocks. The area and population of census blocks varies greatly. The US Census Bureau (2013) differentiates between urbanised areas (UAs) of 50,000 or more people, and urban clusters (UCs) of at least 2500 and less than 50,000 people while all other areas are considered rural.

It is particular interest to note that only nine and a half percent of the US population lives in UCs (CENSUS, 2010), whereas in Europe, depending on the definition, up to 50% of the population lives in territories-in-between (Piorr et al., 2011). This highlights a major difference between cities in Europe and the US, namely the relatively large proportion of the European population living in small and medium-sized cities and the stability of this pattern over time. Le Galès and Zagrodzki (2010: 11) summarise the factors that distinguish European spatial structure from that in the United States.

Europe is characterized firstly by its very large number of cities and their marked proximity to one another: secondly, by the fact that the major cities of Europe are not huge: large metropolises with a population of over two or three million are rare, and 'if one compares the total number of urban areas of over 200,000, the average size is of the order of 800,000 in Europe, as against 1.3 million in the United States and Japan . . . and thirdly, by the relative importance of small and medium-sized cities: Europe distinguishes itself by its relatively large number of urban areas of between 200,000 and one or two million.

They also hint that, at least until recently, suburbs grew in the US, while city centres lost inhabitants, whereas in Europe small and medium sized cities both the centre as well as in the periphery have grown. In the US the urban pattern is related with sprawl, in the sense of low density, car dependent, monofunctional residential development. In Europe, the urban pattern has followed the form of territories-in-between, mixed open and urban land of varying density, intersected by infrastructure including public transport. In Europe urban development has tended to be less monofunctional with mixed uses, especially at the regional scale. The distinction is valid for typical development, although we should beware over- generalisation because some older suburbs in the States also have a more complex configuration as in Europe (Bruegmann, 2005; Fishman, 1990; Mikelbank, 2004).

3.5 Putting different forms of territories-in-between on the map

This section explains how we translated the characteristics of territories-in-between described above, into operational properties (or proxies) used to measure and map, using commonly available data sets in a geographical information system (GIS). The data sets were chosen because their availability allows for relatively uniform application across different countries, and the approach can be repeated and replicability tested rather easily by other researchers. Formerly comparison of territories-in-between has relied on more qualitative verbal description than quantitative analysis. The approach adopted here continues to incorporate a qualitative analysis of the character of the areas but the underlying spatial analysis provides a much more solid base to examine their actual characteristics and make international comparisons.

3.5.1 Mapping territories-in-between in the Tyrol and South-Holland

For the task of mapping characteristics of territory the size of the spatial unit or entity is very important. In previous research (Wandl, 2010, masked for blind review) has shown that a 500 m 500 m grid delivers the most useful results. Thereafter, different analyses and geoprocessing tools of the commercial GIS software ArcGis were used to combine the selected spatial characteristics to map the location of territories-in-between in the two test areas. The result of the GIS mapping was then confronted with observations made in the field and with aerial images obtained from Google Earth in order to evaluate whether the areas selected do have the spatial properties described in the literature.

One important lesson from the review above is that for territories-in-between functions like shopping malls or distribution centres often located in these areas, would be considered ‘rural’ in the traditional territorial typologies, as the resident population is usually around zero or at least very low. This is also true for other parts of territories-in-between that may exhibit important urban functions but where people work or spend their leisure time, and where there is very small resident population. In other words, if the living population is considered as the only demographic factor, certain areas with function that are typically located in territories- in-between, would be ignored. Therefore, the method explained here includes the working population as an additional demographic factor (as explained below) and together with the resident population adds up to what we call the 'maximum population'. We are aware that this may entail counting the working population twice, once as residents and once as employees in those cases where people live and work in the same unit. Nevertheless, until we have reliable and large-scale dynamic census, this is the easiest and most reliable way to cover the spatial dynamics in Territories-in- between.

In summary, the spatial selection method can be described in the following four steps, which are also illustrated in FIG. 3.2:

1 dividing the area of interest into 500 m 500 m grid cells;
2 selecting those grid cells with a maximum population density that is characteristic for territories-in-between;
3 adding those grid cells with a maximum rural population that spatially overlap with typical infrastructures and services;
4 subtracting those grid cells with a territories-in-between corresponding maximum population that are not characterised by the intermingling of built and open landscape pattern.
5 The thresholds for the single steps are explained in the following section.

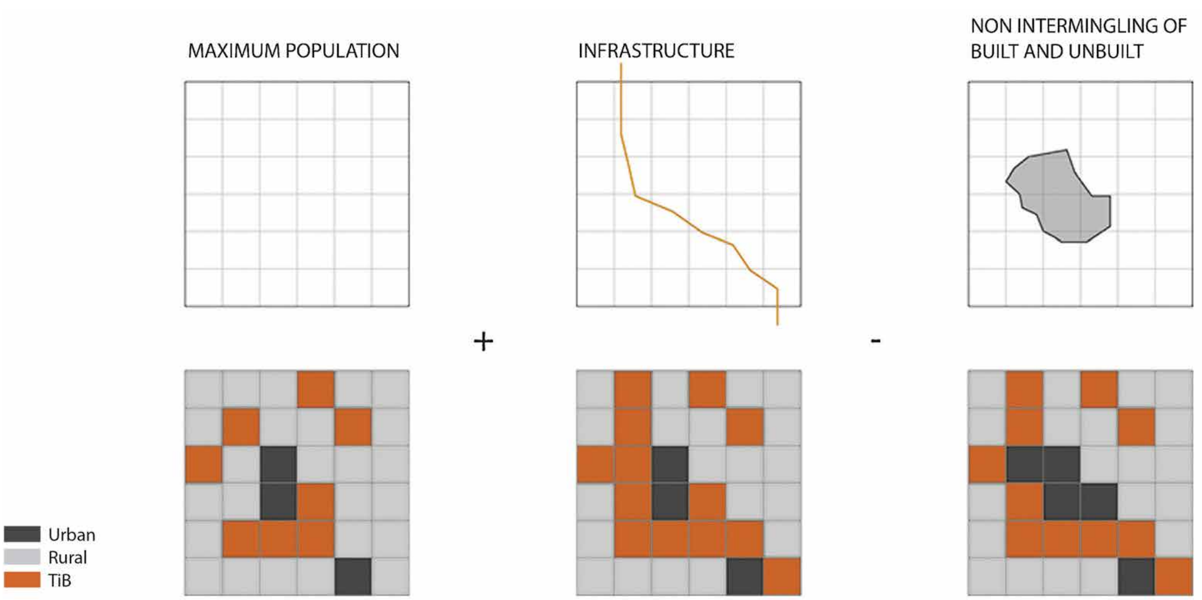

FIG. 3.2 The four steps in mapping territories-in-between. First, the area of interest is divided into a 500 m × 500 m grid. Second, the maximum population density is calculated for every grid cell. Third, rural grid cells that contain infrastructure are added to the territories-in-between grid cells. Fourth, grid cells that have no intermingling of the built and unbuilt environment are subtracted from the territories-in-between.

3.5.2 Defining the thresholds of territories-in-between

Maximum population density

As described above, using only the residential aspect of the population would exclude areas that are considered as territories- in-between. In an ideal case the working population as well as the number of tourists and secondary home ‘residents’ would be added as spatial selection criteria, but data on these aspects is either not available at all, or not available in sufficient detail. Therefore, the sum of the number of inhabitants and the number of jobs per km^2 was used as the first selection criteria, and referred to as maximum population density.

For the Tyrol both numbers were available on a 250 m 250 m grid basis and were aggregated into a 500 m 500 m grid. In South- Holland both numbers where available per six digit postal code, which is as small as a block in bigger cities and parts of a street in towns and villages. They were also aggregated to the 500 m 500 m grid. As there was no existing classification method available a deductive and iterative approach using spatial queries, fieldwork and the interpretation of aerial pictures led to the definition of the thresholds. For the delimitation of the territories-in-between to the rural (the lower threshold of maximum population) the Tyrol was used as the primary case as it can beconsidered as the more rural one; whereas to distinguish the territories-in-between from the dense urban areas (the higher threshold) the case of South-Holland was used as it is the more urbanised one. Both values were then applied to the other case and their validity tested.

Separating territories-in-between from the rural

FIG. 3.3 shows how different maximum population densities relate to urbanisation patterns in the Tyrol. The image shows three typical steps of the urbanisation process in the Tyrol. Starting from a single farm (1) to a farm with additional single family houses originally used by the families who did not inherit the farm in the main (2) and finally a settlement pattern with farm, single family houses and other additional uses (3). In the latter case, multi-story housing or other building forms of a rather urban kind can be found. The in-between may include types 2 and 3 but not type 1. Therefore, the lower limit of territories-in-between to rural was defined with a maximum population density of 150 persons/km^2, which is equal to a maximum population density of 37.5 persons in a 500 m × 500 m.

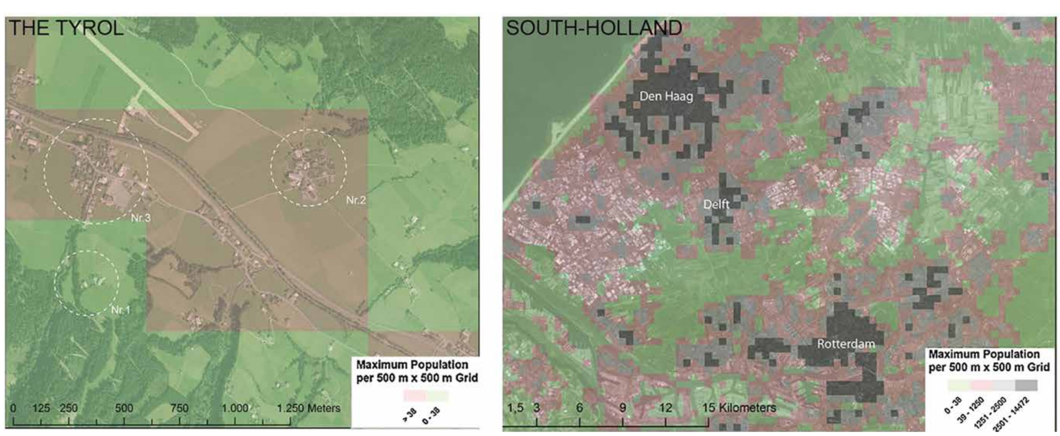

FIG. 3.3 Overlay of different urbanisation patterns and the maximum population density in the Tyrol on the left and South-Holland on the right. Background image: Bing Maps aerial imagery, data Sources: TIRIS; Province Zuid-Holland.

Separating territories-in-between from the urban

The case of South-Holland is used to define the upper limit of the maximum population density threshold. South-Holland is for this exercise a specifically interesting case because, there is no land in Holland which is classified as contiguous urban fabric in the sense of the CORINE land cover classification, although it is very densely inhabited. This means that a land cover based distinction between urban and the in-between is not possible. This also means that a certain intermingling of built and open land uses is present over the entire area.

FIG. 3.3 presents different ranges of maximum population density in a part of South-Holland and shows that a maximum of 5000 people/km^2 or 1250 persons per 500 m 500 m, describes very well the low rise urban edges around the cities, as well as areas with 'big box development' and vast greenhouse areas, which are a specific form of territory in this region.

The resulting spatial selection shows that at this stage most of the areas with the spatial properties of territories-in-between are covered, but that areas with just infrastructure are omitted and parts of the cities are selected that are not characterised by an intermingling of built and unbuilt. Therefore, further adjustments using information about the location of infrastructure as well as land cover have to be added.

Infrastructure and intermingling of built and unbuilt

Regional and global transport infrastructure like motorways, train lines and airports are a characteristic feature of territories- in-between. They produce the typical duality of spatial segregation and what Graham and Marvin (2001) call premium networked spaces, i.e. areas of high global accessibility. Additionally the literature review showed that specific uses like waste and sewage treatment plants or power plants are typically situated in territories-in-between. In the two test areas, two kinds of infrastructure are particularly important. For South-Holland these are the logistics centres, like the Rotterdam seaport, and the glasshouse areas with an underlying infrastructure of gas and CO2 pipes. In the Tyrol the tourist resorts play a similar role.

The glasshouse areas are captured in the analysis already. This is because the working population was considered in the spatial selection. For the tourist areas in the Tyrol this is true for the villages, but the large areas covered and crisscrossed by winter sport infrastructure like cable cars and snowmaking facilities are left out, though they should be considered when choosing the spatial proxies for the aspect of infrastructure.

TABLE 3.2 Overview of infrastructure and land use data sets used for analysis.

Data Set	Description	Source	Date
CORINE land cover data 2006 for both cases			
1.2.1	Industrial or commercial units	The European Topic Centre on Land Use and Spatial Information.	August 2011
1.2.2	Road and rail networks and associated land	The European Topic Centre on Land Use and Spatial Information.	August 2011
1.2.3	Port areas	The European Topic Centre on Land Use and Spatial Information.	August 2011
1.2.4	Airports	The European Topic Centre on Land Use and Spatial Information.	August 2011
1.3.2	Dump sites	The European Topic Centre on Land Use and Spatial Information.	August 2011

TABLE 3.2 Overview of infrastructure and land use data sets used for analysis.

Data Set	Description	Source	Date
1.4.2	Sport and leisure facilities	The European Topic Centre on Land Use and Spatial Information.	August 2011
South Holland			
National and regional roads	All roads that are categorised 'autosnelweg' of 'regionale weg' and are wider than 4 m	TOP 10 – Kadaster	January 2010
Railways		TOP 10 – Kadaster	January 2010
The Tyrol			
Railways		TIRIS	December 2009
National and main regional roads	All roads that are categorised: A, AS and LST B	TIRIS	December 2009
Skiing Areas		TIRIS	December 2009
1.1.1	Continuous urban fabric	The European Topic Centre on Land Use and Spatial Information.	August 2011

A combination of CORINE land cover data (Seamless Vector 2006) and vector data for motorways, regional roads, railways and (in the case of Tyrol) skiing resorts, provided by the planning agencies of the Tyrol and South-Holland is used to add grid cells to those already selected as territories-in-between. An overview of the datasets used is given in Table 3.2. FIG. 3.4 shows the result of the combination of maximum population and infrastructure on the selection of territories-in-between.

FIG. 3.4shows how the inclusion of infrastructure extends the parts of the territory identified as in-between, incorporating areas like the harbour in Rotterdam and big infrastructure nodes. This factor also leads to the inclusion of the densest parts of the cites, particularly in the Tyrol. This contradicts the spatial characteristic of intermingling of built and unbuilt. Therefore, grid cells that are primarily covered with continuous urban fabric (>80% impervious land cover) following the CORINE land cover classification, need to be excluded from the selection to give a final result. FIG. 3.5 and FIG. 3.6 show the final result of the spatial selection method explained in this paper.

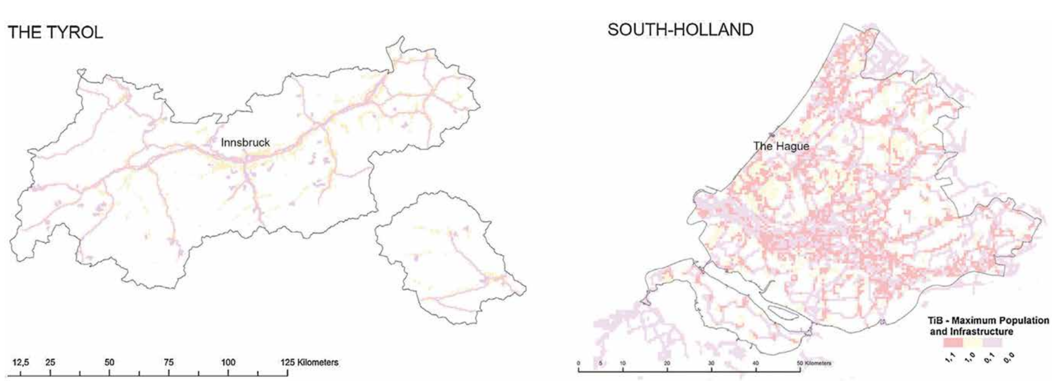

FIG. 3.4 Grid cells considered as territories-in-between in both case study areas because of either the maximum population density and/or the location of infrastructure: red cells (1,1) fulfil both aspects; yellow cells (1,0) are selected only by the aspects of infrastructure; violet cells (0,1) by the maximum population aspect.

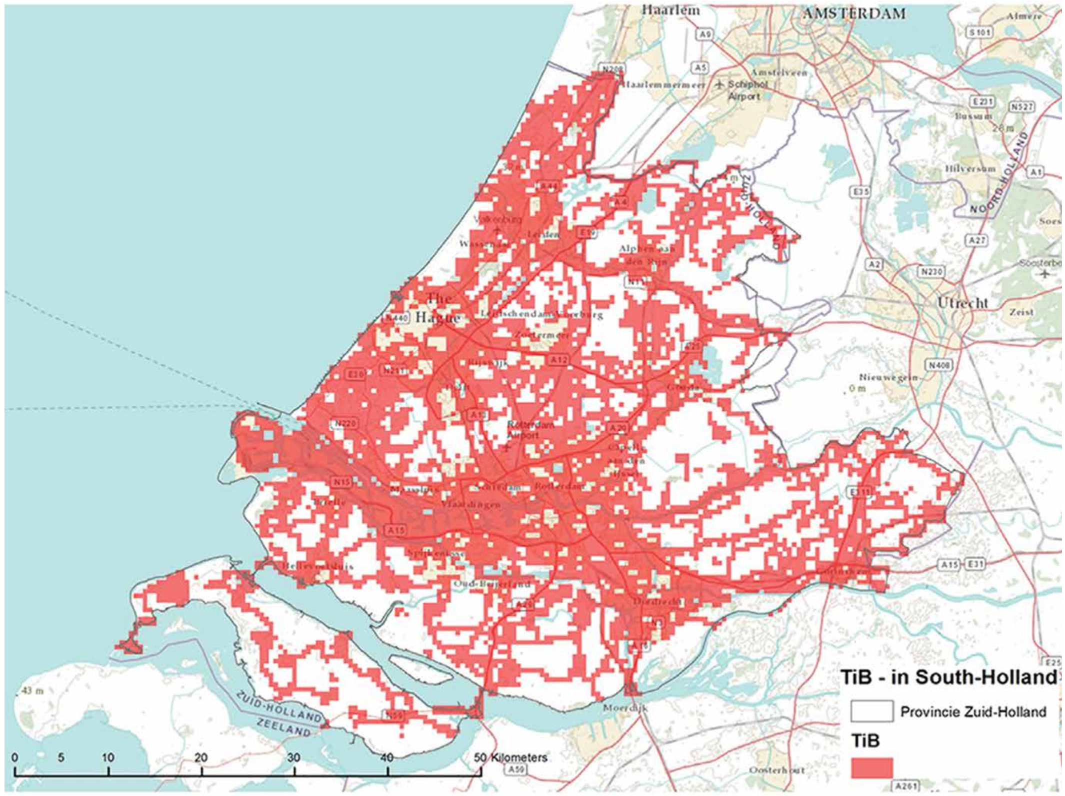

FIG. 3.5 Territories-in-between (red) in South-Holland. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of the article.) Background image: USGS, NPS, ESRI, TANA, AND.

To summarise, the method and the developed thresholds to map the extent of territories-in-between in South-Holland and The Tyrol has followed four steps:

1 dividing the area into 500 m 500 m grid cells;
2 selecting those grid cells with a population between 38 and 1250 inhabitants per 500 m 500 m;
3 adding grid cells, with a rural density of maximum population density that overlap with areas of the CORINE land cover classes industrial or commercial units, port areas, airports, mineral extraction sites, waste sites, port and leisure facilities, and all major roads and railway tracks and associated land;
4 subtracting all cells that are classified continuous urban fabric according to the CORINE land cover classification.

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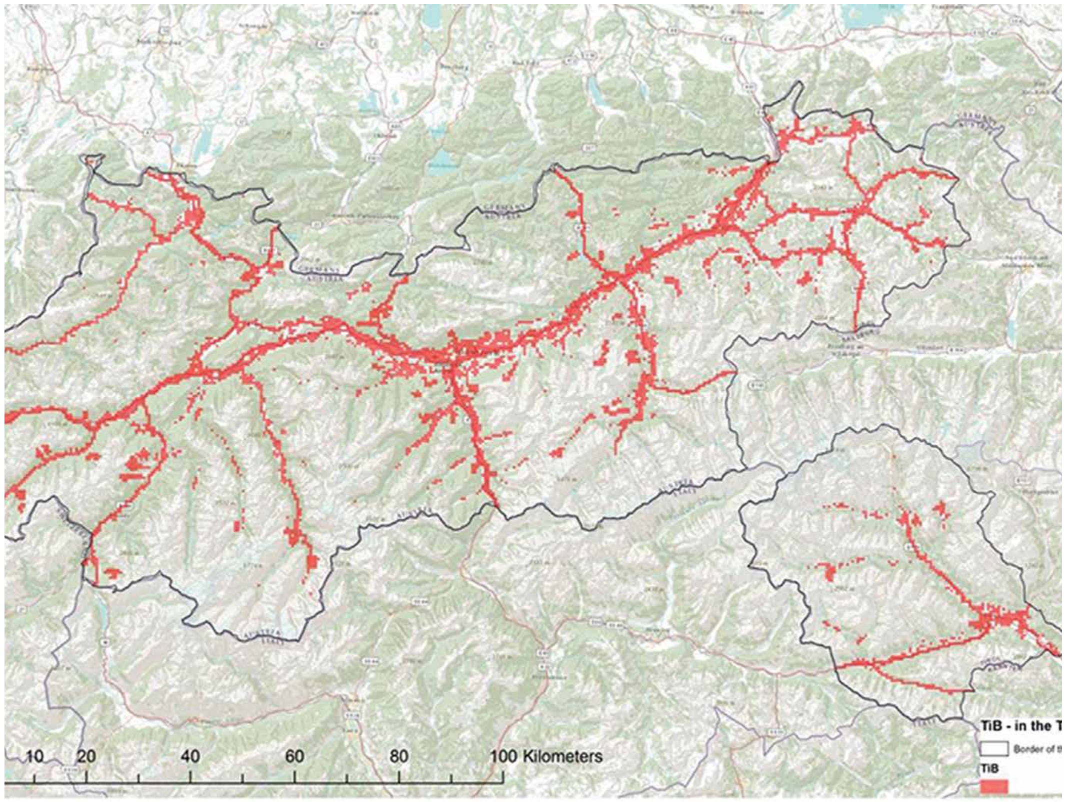


FIG. 3.6 Territories-in-between (red) in the Tyrol. Background image: USGS, NPS, ESRI, TANA, AND. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of the article.)

To illustrate the applicability of this method and the general and networked characteristics of territories-in-between more fully, it was applied to two other regions in Europe: west of Lille in France and parts of the Veneto in Italy. A map of the results is shown alongside the findings for the two test cases reported in this paper in Figure 7. To be able to apply the method to other cases across Europe two adaptations had to be made. First, instead of locally acquired data sets for the road infrastructure, open street map data was used. Cross-checking results in the field showed that the open street map data were reliable and makes no difference in the results, at least concerning the national and regional roads that were used. Second, data on the location of workplaces had to be acquired on a case- by-case basis as there are no consistent data sets on the location of workplaces. The results confirm that the method, which was developed in two extreme cases, can be applied to other locations and deliver reliable results.

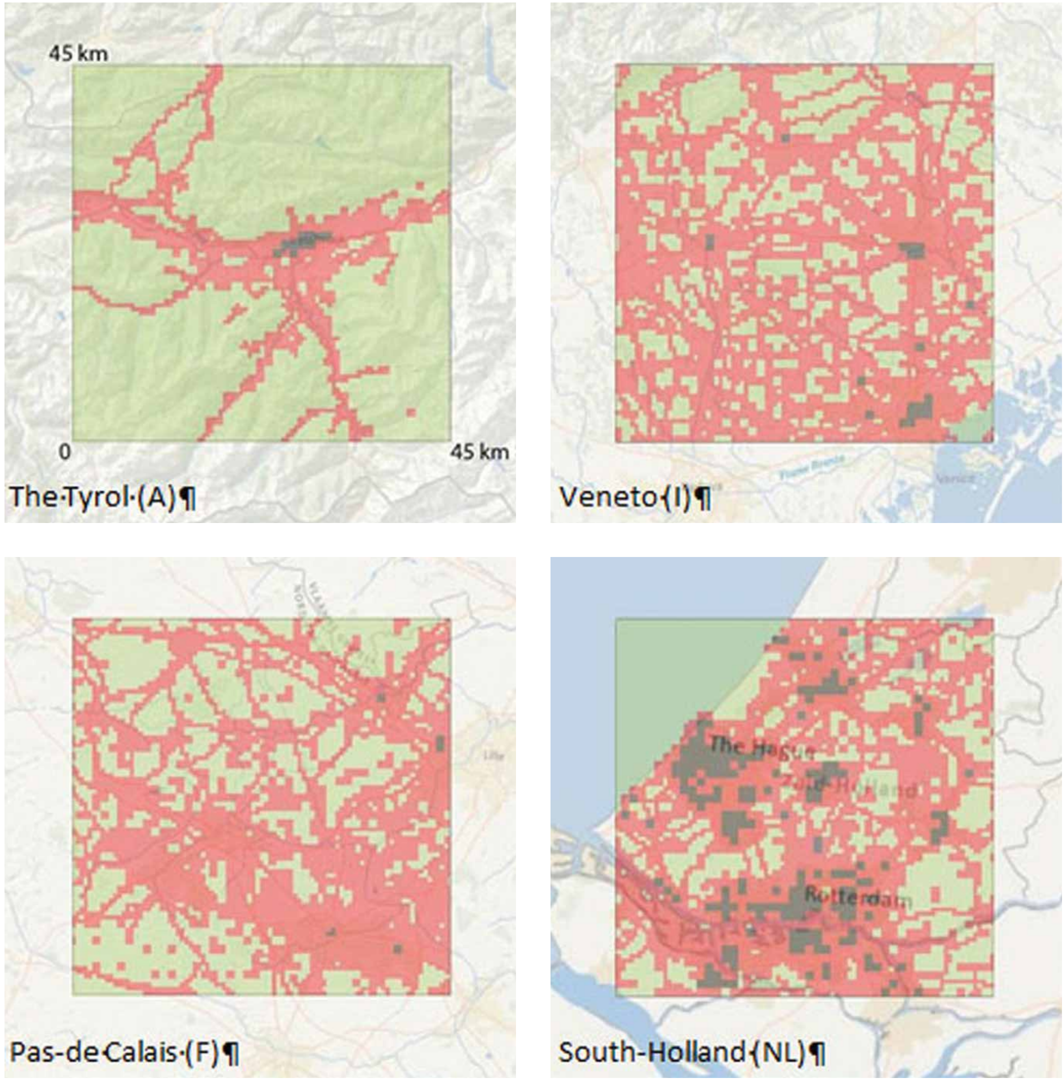


FIG. 3.7 Territories-in between (in red): four examples in Europe: top left, parts of the Tyrol (Austria); on the bottom left-hand side, the area west of Lille (France), on the top right-hand side, parts of the Veneto (Italy) and finally on the bottom right-hand side, parts of South-Holland (The Netherlands). The green areas are rural areas, and the black areas are urban.

TABLE 3.3 Comparison of characteristics of territories-in-between and their wider regions.

Test areas	Inhabitants total	Inhabitants TiB	Jobs total	Jobs TiB	Area total in km²	Area TiB in km²
South-Holland	3,450,488	2,267,898 (65%)	1,433,094	1,102,561 (78%)	32,295	17,567 (54%)
The Tryol	693,703	591,574 (85%)	292,264	241,404 (82%)	126,185	1366 (1%)

3.6 Discussion

3.6.1 The importance of territories-in-between

Having completed the analysis to define territories-in-between in the two test cases, it is possible to examine and compare the extent of these areas and their significance in their respective regions. The findings in Table 3.3 show that more than two thirds of the population live and/or work in these areas and the ratio of jobs and population is higher than outside of territories-in-between in both cases, mirroring the continuing spatial decentralisation of economic activity over recent decades.

The results broadly support that our understanding of territories-in-between. In South Holland the number of people living outside territories-in-between, both urban and rural, is very significant and equals the number of inhabitants of Rotterdam and The Hague together. Considering the low rise nature of Dutch cities and comparably large areas of open space (like parks and canals) within them, the results confirm that the decision to start the selection with a demographic aspect was appropriate. It ensures that the city centres of The Hague and Delft for example are excluded. This would not have been the case if the land cover category ‘discontinuous urban’ was chosen as a starting point.

The spatial selection also shows areas that are characterised by an intermingling of built and unbuilt which on the one hand excludes the larger parts of primarily agricultural areas within the Den Haag–Rotterdam metropolitan area in South-Holland; while on the other, includes the rather small green ‘left-over spaces’ within the alpine valleys in the Tyrol.

However, the most striking part of the mapping exercise is that in both cases the resulting image is one of a network or web of territories-in-between. This reflects their relational nature where, as explained in the literature (inter)connections are more relevant than spatial proximities.

3.6.2 Evaluation of the proposed classification

In this section we compare our approach with the urban–rural classification methods presented in Section 4 and discuss advantages as well as disadvantages. In the OECD classification the central part of the Tyrol, which includes the state capital Innsbruck, is classified as intermediate, while the rest of the state is classified as rural. South-Holland is completely classified as predominantly urban. The only difference in the new EEA urban–rural typology is that the central part of the Tyrol is classified as predominantly urban.

The method proposed in this paper gives a more detailed analysis and mapping, as the results are not aggregated to NUTS 3 level. It therefore describes the complex pattern of urban, rural and in- between areas much more clearly. We argue that this reflects the reality of urbanisation patterns in the test areas far more accurately than other methods. For example, the Inn-valley in the Tyrol can be described as a ribbon city, including parts of densely built- up and populated Innsbruck and other towns, but intermingling with agricultural land and other open spaces. The same is true for the urbanisation pattern of South Holland that exhibits a complex intermingling of built and open land. Both the OECD and the EU classifications do not represent these patterns well, instead they show either sharp transitions from urban to rural, as in the Tyrol, or define the whole area as urban, as in South Holland.

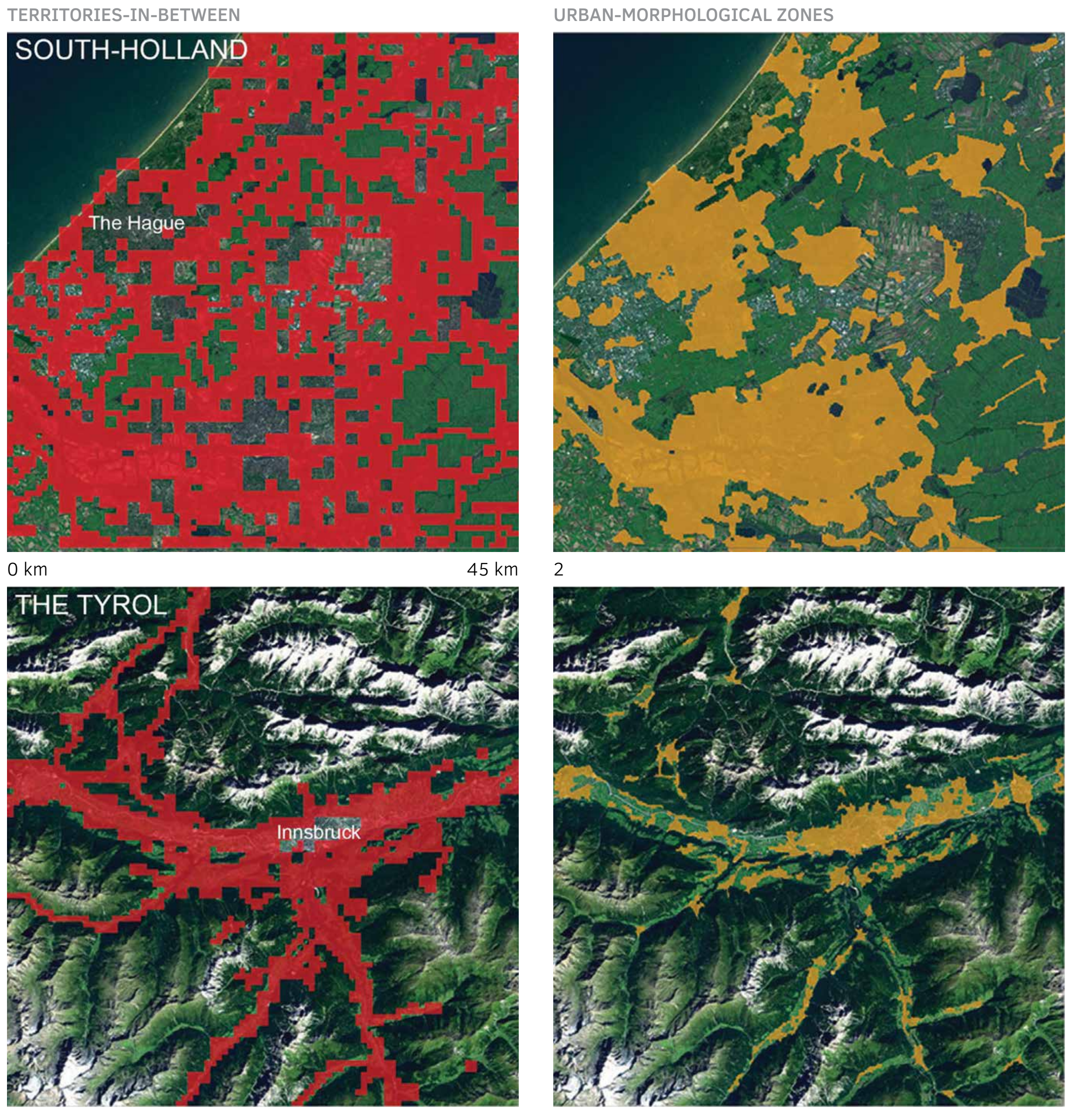


FIG. 3.8 A comparison of the territories-in-between classification (left) and the UMZ classification (right) in a 45 km per 45 km square showing the most densely inhabited areas in both cases.

South-Holland was also used as a case study in the PLUREL project which developed a more sophisticated and detailed method than the OECD one. The comparison of the map in the synthesis report (Piorr et al., 2011: 28) with our classification shows two major differences. First our classification shows a softer edge between urban areas and territories-in-between, while also acknowledging that territories-in-between can be found within cities. The second major difference is that large parts of the harbour of Rotterdam are classified by the PLUREL approach as rural, whereas we classify these areas as territories-in-between.

The first difference may be explained by a diverging understanding of the structure of urbanised areas. Apparently, the understanding of peri-urban as a result of an urban centre to edge gradient was dominant within PLUREL. The second difference could be either a result of using old or limited sets of land use data, or resulting from the fact that the working population is not included in the PLUREL method. Both points indicate that the proposed classification method here has advantages.

The urban morphological zones (UMZs) derived from the CORINE land cover mapping do not share the disadvantage of aggregation to large administrative areas. Therefore, a closer look at difference, between the UMZ and the proposed method presented here is shown in FIG. 3.8. The figure demonstrates that the inclusion of infrastructure offers significant benefits. The presence of infrastructure is clearly a driving force of both urban development patterns and the daily routines of life within territories-in-between. This relational aspect provides a glue-like function for spatial development of metropolitan regions and therefore is crucial to the analysis.

3.7 Conclusions

We started with the aim to develop a new territorial classification method, and in particular to unravel the complex relation between urban and rural in territories-in-between. We have shown that by using a combination of publicly available data on resident and working population, CORINE land cover and infrastructure, we can separate territories-in-between from urban and rural areas with logical outcomes. The maps resulting from the classification method show the relational nature of many territories-in-between, i.e. the strong linkages of urbanisation with infrastructure.

In conclusion we argue that the methods of the dominant territorial classifications have significant disadvantages, particularly in defining areas of great importance for Europe's contemporary spatial development, the territories-in-between. The aggregation to NUTS 3 level may be convenient for administrations but it results in gross overgeneralisation, and does not consider detailed topographic aspects. The higher grade of detail makes the new selection method better suited to map, understand and therefore, to undertake planning and design tasks in territories-in-between. Urban development patterns are increasingly characterised by places that are neither urban nor rural but 'in-between'. Current territorial typologies tend to be limited to shades of urban and rural that do not reflect the reality of urban development and are thus less useful in explaining the nature of spatial development and supporting spatial planning policy and action. A method of defining types of territory is needed that reflects the actual complex morphology of built and unbuilt land, mix of functions, and the connecting and separating effects of infrastructure. The method reported here is a first attempt to meet that objective. The testing of the method suggests that this general approach can be more widely applied and has three advantages in making a typology of the territory: (i) it maps the complexity of the spatial structure of urbanised areas on a regional scale, and thereby helps to overcome the prevalent idea that urbanised regions are characterised by a spatial gradient from urban centre(s) to rural periphery; (ii) it emphasises the network structure of territories-in-between and the underlying connectivity of places with different functions and intensities; and (iii) it raises awareness that in some parts of Europe a settlement pattern has developed that cannot be understood as either urban or rural.

3.8 Atlas of territories-in-between – Part B: Characteristics of TiB

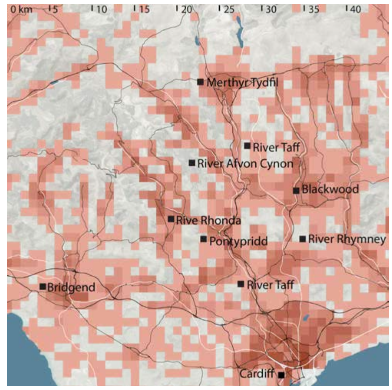
This part of the atlas of territories-in-between contains five thumbnail double-pages:

1. A land cover map to understand the landscape and urbanisation pattern in the case study areas.
2. The population density to provide a basic understanding of the distribution of the residential population.
3. The location and size of companies to provide an understanding of the type of economy and the spatial distribution of the working population.
4. Mobility infrastructure to present the different types, mesh sizes and spatial distribution of different kinds of transportation infrastructure.
5. The areas classified as territories-in-between, with an overlay of buildings and transport infrastructure.

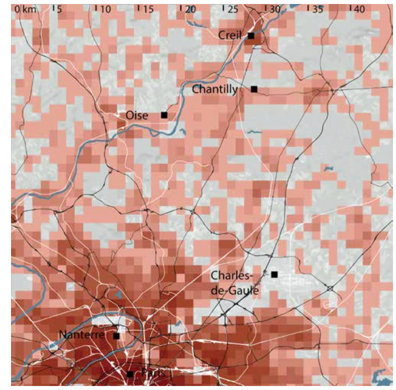
RESIDENTIAL POPULATION DENSITY

Number of Inhabitants (2006)

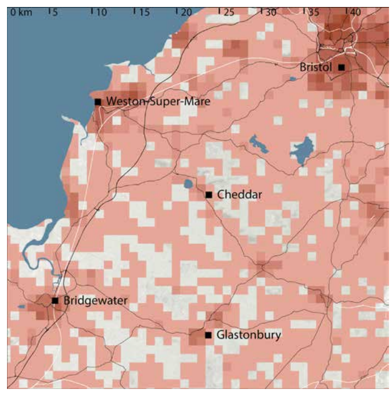
- 1 - 400
- 401 - 1150
- 1150 - 2200
- 2201 - 3500
- 3501 - 5000
- 5001 - 7500
- 7501 - 11000
- 11001 - 17500
- 17501 - 28000
- > 28001



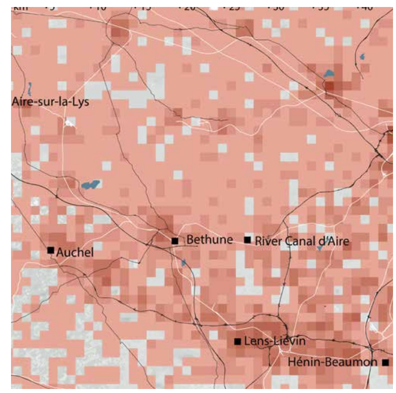
1 South Wales



2 Île-de-France



6 North Somerset



7 Pas-de-Calais

FIG. 3.9 The thumbnails show the population density per square kilometre, which together with the density of the working population was used to map TiB. Data Source: Eurostat GEOSTAT_ Grid_POP_2006.

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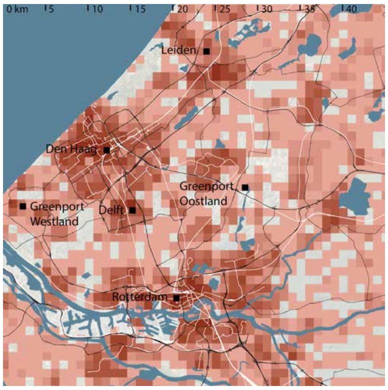
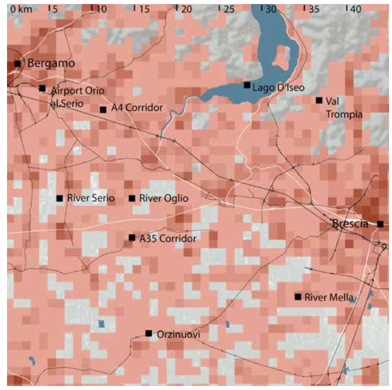
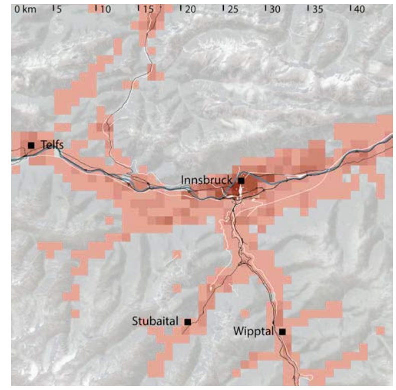


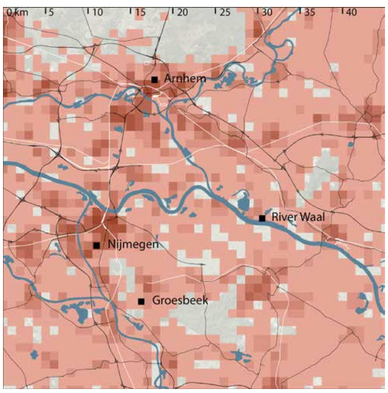
3 South-Holland



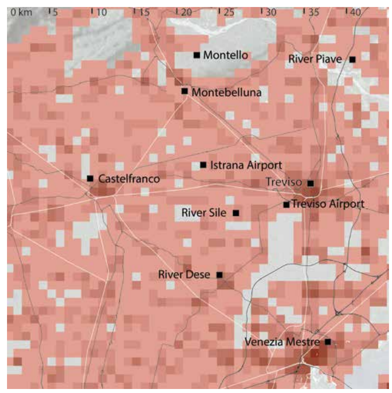
4 Bergamo-Brescia



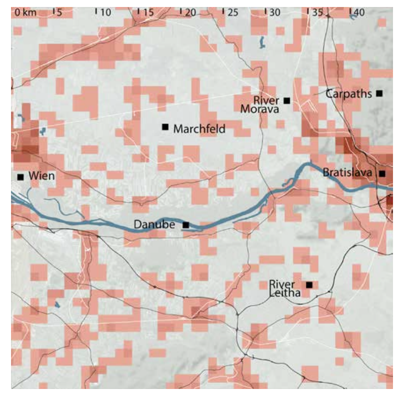
5 The Tyrol



8 Gelderland



9 Veneto

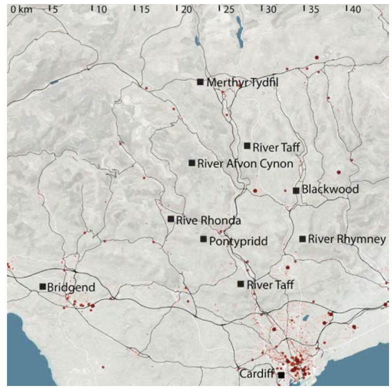


10 Vienna-Bratislava

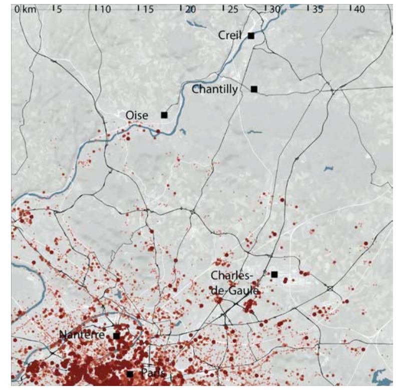
COMPANIES

Location and Size of Companies

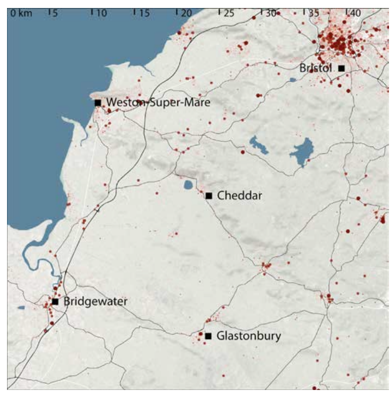
- Small
- Medium
- Large
- Very Large



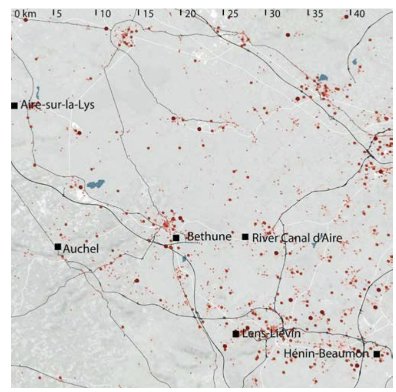
1 South Wales



2 Île-de-France

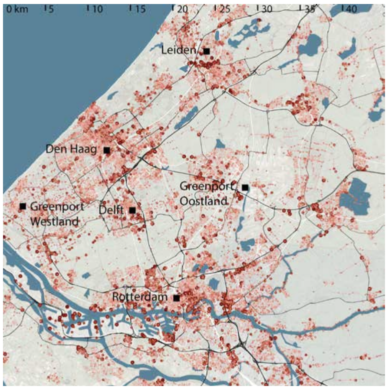


6 North Somerset

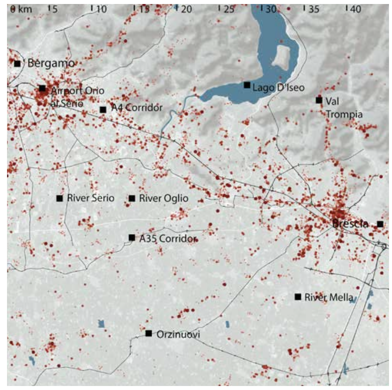


7 Pas-de-Calais

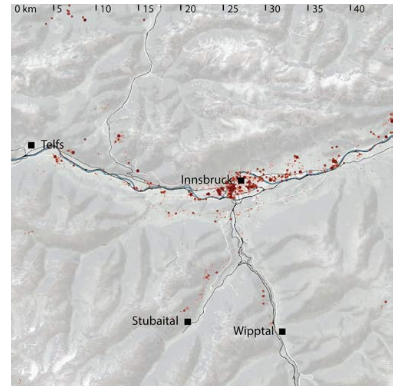
FIG. 3.10 The thumbnails show the distribution and the size of the companies, which were used to estimate the working population together with the density of the residential population to map the TiB. Data source: Bureau van Djik, Amadeus Database 2014.



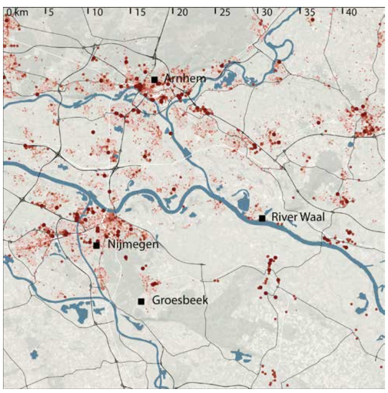
3 South-Holland



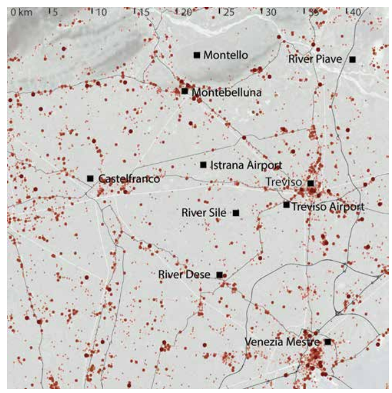
4 Bergamo-Brescia



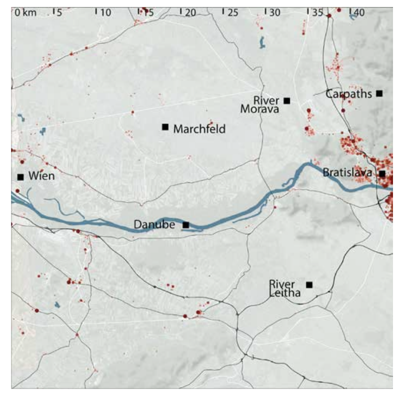
5 The Tyrol



8 Gelderland



9 Veneto



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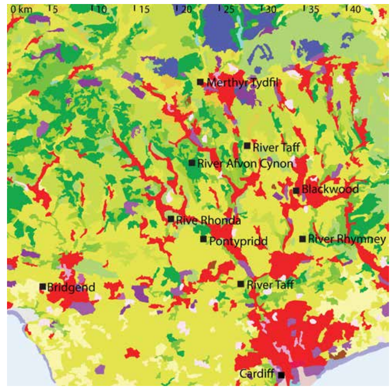
TOC

Corine Land Cover

- 111: Continuous urban fabric
- 112: Discontinuous urban fabric
- 121: Industrial or commercial units
- 122: Road and rail networks and associated land
- 123: Port areas
- 124: Airports
- 131: Mineral extraction sites
- 132: Dump sites
- 133: Construction sites
- 141: Green urban areas
- 142: Sport and leisure facilities
- 211: Non-irrigated arable land
- 212: Permanently irrigated land
- 213: Rice fields
- 221: Vineyards
- 222: Fruit trees and berry plantations
- 223: Olive groves
- 231: Pastures
- 241: Annual crops associated with permanent crops
- 242: Complex cultivation patterns
- 243: Land principally occupied by agriculture, with significant areas of natural vegetation
- 244: Agro-forestry areas
- 311: Broad-leaved forest
- 312: Coniferous forest
- 313: Mixed forest
- 321: Natural grasslands
- 322: Moors and heathland
- 323: Sclerophyllous vegetation
- 324: Transitional woodland-shrub
- 331: Beaches, dunes, sands
- 332: Bare rocks
- 333: Sparsely vegetated areas
- 334: Burnt areas
- 335: Glaciers and perpetual snow
- 411: Inland marshes
- 412: Peat bogs
- 421: Salt marshes
- 422: Salines
- 423: Intertidal flats
- 511: Water courses
- 512: Water bodies
- 521: Coastal lagoons
- 522: Estuaries
- 523: Sea and ocean



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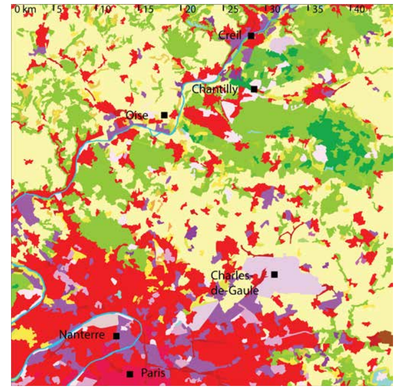
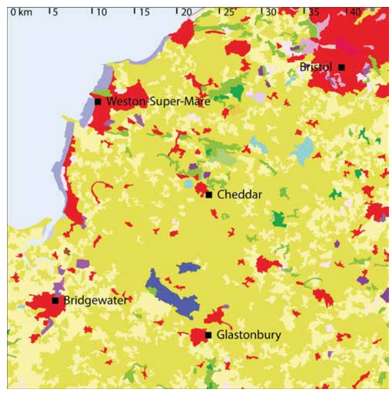


2 Île-de-France



6 North Somerset

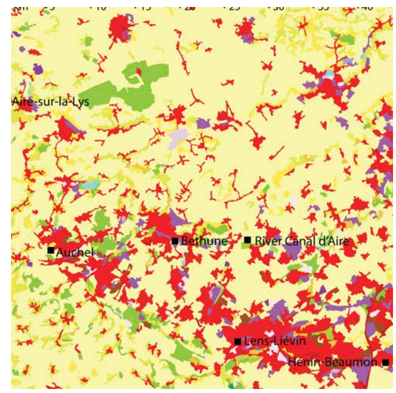


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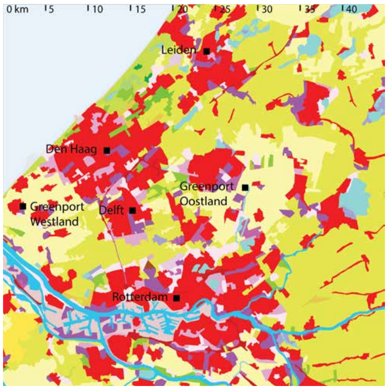
FIG. 3.11 The thumbnails show the spatial distribution of the Coordination of Information on the Environment (CORINE) Land Cover Classes; Classes 1.1.1-Continuous urban fabric, 1.2.1-Industrial or commercial units, 1.2.2-Road and rail networks and associated land, 1.2.3-Port areas, 1.2.4-Airports, 1.3.2-Dumpsites and1.4.2-Sport and leisure facilities were used as spatial proxies for the infrastructures and other facilities, which characterise TiB. Source: CORINE land cover 2012; EEA: https://www.eea.europa.eu/legal/copyright



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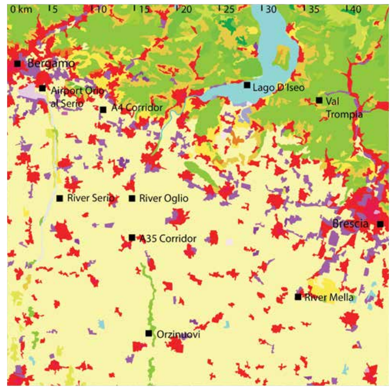
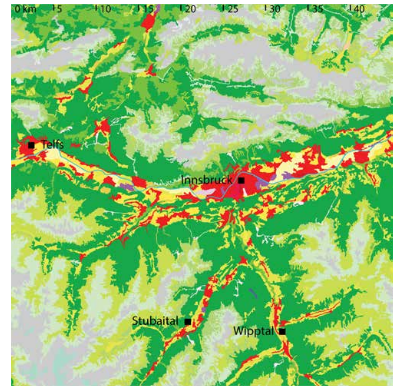
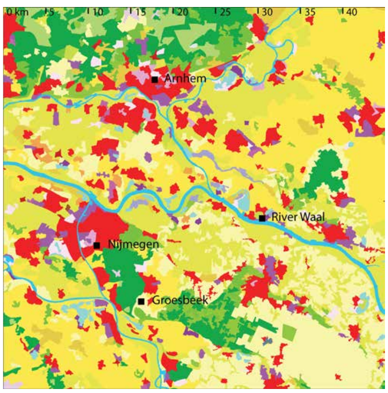


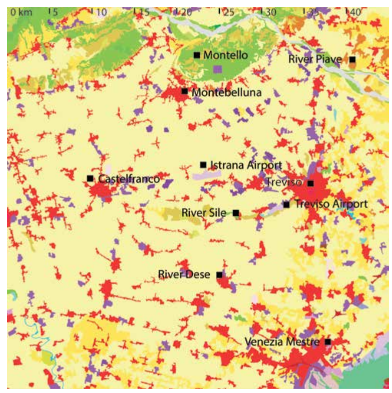
4 Bergamo-Brescia



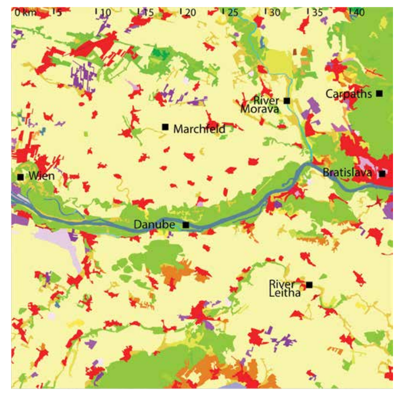
5 The Tyrol



8 Gelderland



9 Veneto



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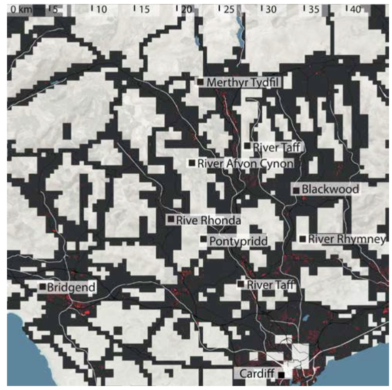
TOC

TERRITORIES-IN-BETWEEN

- Territories-in-between
- Buildings
- Roads infrastructure
- Rail infrastructure



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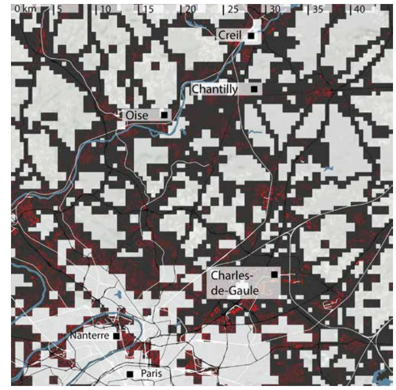
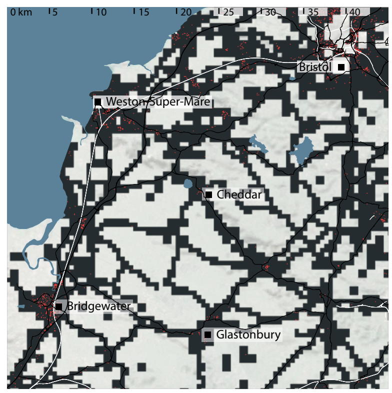


2 Île-de-France



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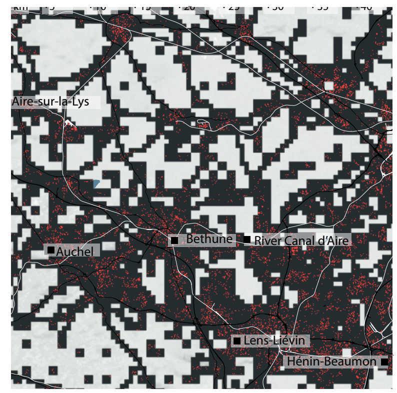

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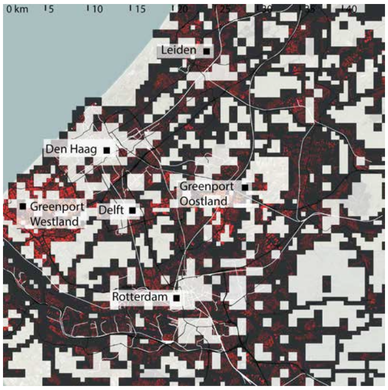
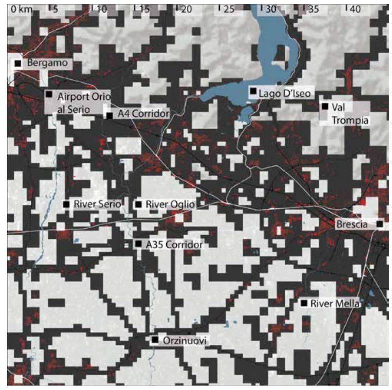
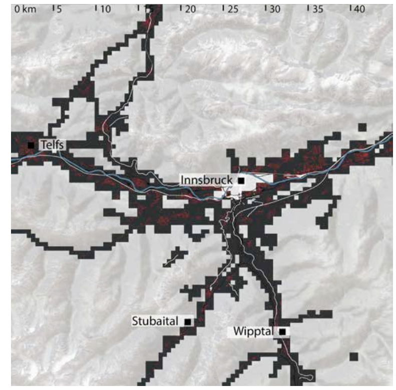
FIG. 3.12 The resulting thumbnail maps of territories-in-between for all ten cases. Overlayed with buildings and transport infrastructure. For large maps and more detailed description see Atlas part G. Data source overlay: copyrighted OpenStreetMap contributors https://www.openstreetmap.org.



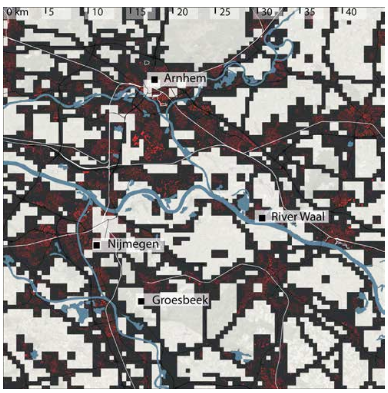
3 South-Holland



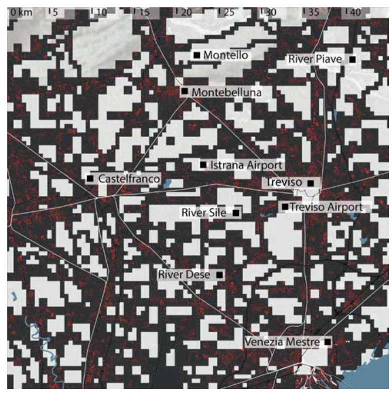
4 Bergamo-Brescia



5 The Tyrol



8 Gelderland



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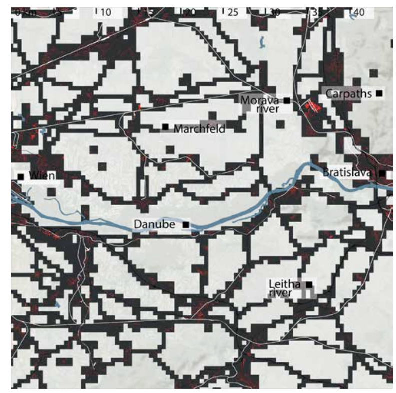

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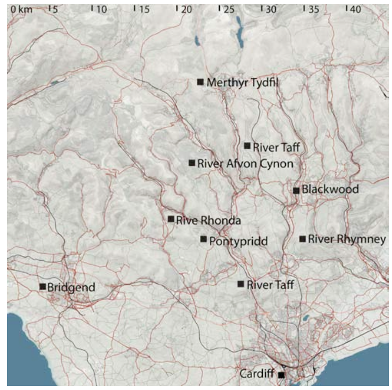
Transport Infrastructure

Rail Infrastructure

- Rail
- Tram
- Light rail
- Subway
- Funicular

Road Infrastructure

- Main roads
- Regional roads
- Local roads



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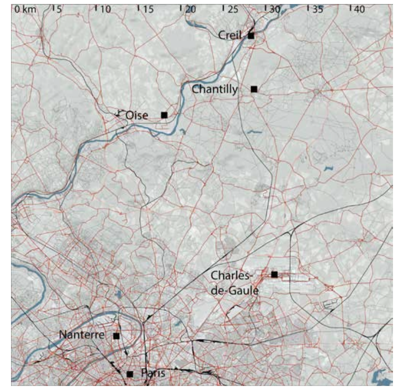

2 Île-de-France

6 North Somerset

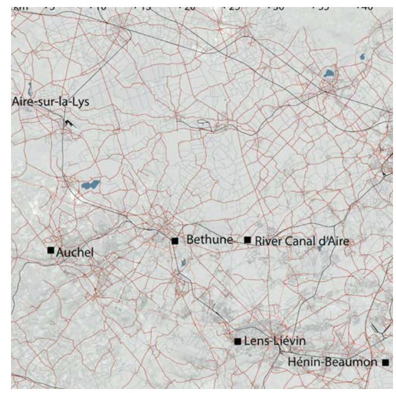

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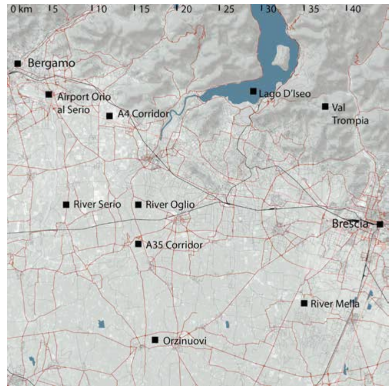
FIG. 3.13 The thumbnails show transport infrastructure networks. Rail, tram and light-rail, and main roads were used to map the territories-in-between. Data source: copyrighted OpenStreetMap contributors https://www.openstreetmap.org.

3 South-Holland



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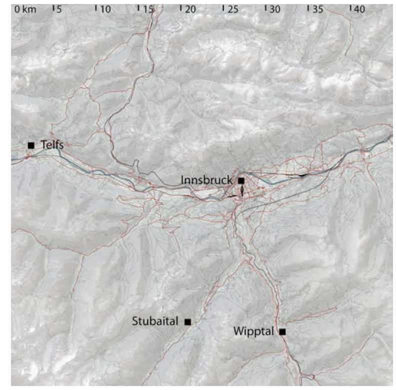

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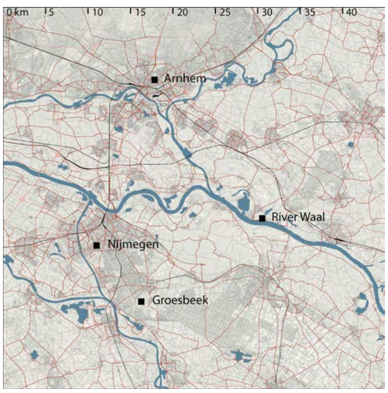
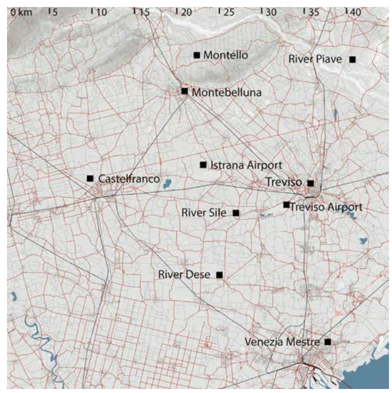


8 Gelderland



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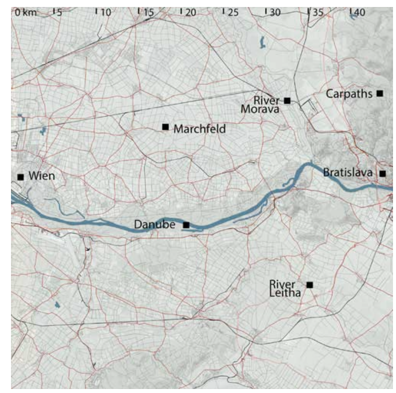

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4 A Multidimensional Typology of Open Spaces in Europe

Article: Towards Sustainable Territories-in-between: A Multidimensional Typology Of Open Spaces in Europe

Wandl, A., Rooij, R., & Rocco, R.

Published in the journal Planning Practice & Research (2014).doi:10.1080/02697459.2016.1187978

KEYWORDS open spaces; sustainable development; ecosystem services; peri-urban, network urbanism

ABSTRACT To improve the ecosystem service provided by open spaces in dispersed urban areas is a key challenge for sustainable spatial development in Europe. The typology presented in this article illustrates the different potentials that open spaces in territories-in-between have across 10 cases in Europe. Unlike other typologies, neither function nor form is used for the classification, but the potential interaction of open spaces with social, technical and ecological networks. Therefore, the typology informs regional spatial planning and design about the potential ecosystem services in networked urban regions. Thereby the importance of territories-in-between, which are often neglected by mainstream spatial planning and design, for sustainable development is highlighted.

4.1 Introduction

Much of the territory of Europe is neither distinctly urban nor rural but something 'in-between' (Ulied et al., 2010) The latest EUROSTAT (Regional Statistics Team, 2013) urban–rural typology update shows that most Nomenclature des Units Territoriales Statistiques (NUTS 3) regions fall in this 'in-between' category, which covers 38.7% of Europe's land surface, whereas urbanized areas cover 9.9%. 35.3% of the EU population live in these intermediate areas in relation to 42.4% in predominantly urban areas. Big parts of the areas classified as predominantly urban are actually low-rise dispersed urban development, like the metropolitan areas of the Randstad in the Netherlands, Flanders in Belgium, the Ruhrgebiet in Germany, as well as the suburban and peri-urban areas of larger European cities, like Milan, Paris, Prague, Vienna, Lisbon and Oporto, to name just a few examples. Hence, we can assume that the majority of Europeans are actually living in some sort of territory-in-between (TiB), which cannot be understood simply as an intensification of urban functions in the rural environment or places of interaction of urban and rural territories.

TiB play a crucial role for sustainable development, because of their extended geography and the large share of population living in them. The challenges to achieve a more sustainable urban development are related with their specific spatial, programmatic and cultural features (Garreau, 1992; Viganò, 2001; Sieverts & Bölling, 2004). Recent and multidisciplinary research questioned the linear relationship between urban dispersion and unsustainable development, and focuses on the missing policies for a sustainable dispersed urban development. Couch et al. (2007, p. 264), for example, conclude from a comparison of sprawling areas across Europe:

Maybe sprawl is not anything sustainable, but again, it is no more unsustainable than other types of urban development. environmental policy for sustainability in sprawling areas of our city case studies was weak or non-existent, except perhaps in some instances in the North.

In this article, we present an initial framework based on solid empirical analysis of TiB to inform policies for a more sustainable spatial development. We do so by investigating the potential contribution of open spaces in TiB to sustainable development. To achieve this, we developed a typology that does not predominantly consider function, land cover and form of open spaces but rather their spatial relation to the physical manifestation of different network operators as formulated by French engineer and urban geographer Gabriel Dupuy (1991). This typology thereby describes the potential of open spaces to contribute to:

- social aspects of sustainability, like human health, well-being and the possibility to interact, socialize and recreate (Maas et al., 2006; Volker et al., 2006; Harnik, 2012);
- environmental aspects of sustainability, like protecting biodiversity by improving ecological functions, as well as providing and developing ecosystem services (Cranz & Boland, 2004; Harnik, 2012);
- economic aspects of sustainability, like increase in property values as well as contributions to local economy through increased tourism (Crompton, 2001).

To be able to do so we typified the open spaces in TiB according to their potential of interaction with different network operators and related this types to potential (eco) system services.

In the next chapter, we introduce the concept of territories-in-between in detail and analyse how the spatial characteristics of TiB ask for an innovative typology. We also describe the role of open spaces for sustainable development, overcoming the limitations of existing typologies.

Subsequently, we introduce and extend Dupuy's (1991) concept of network operators in order to develop a typology that links physical space and social space in an analytical model. In the following part of the paper, we then present a multidimensional method to classify open spaces in relation to the proposed four layers of network operators. Later, we apply this method to 10 TiB across Europe and apply a stepwise cluster analysis in order to develop a cross-national typology. This typology allows us to relate different open spaces with specific aspects of sustainable development and thereby inform regional planners.

4.2 Towards a network approach to open spaces in territories-in-between

4.2.1 Spatial characteristics of territories-in-between

Zwischenstadt (D)(Sieverts, 2003), *citta difusa* (I) (Indovina, 1990), *annaehernd perfekte peripherie* (CH) (Campi et al., 2000), (F) are among the numerous concept and terms that have been used to describe and explain the large areas that are neither urban nor rural in Europe. This 'new form' of spatial organization has been shown to exist beyond the metropolitan regions of Europe, reaching very often areas classified as rural, like the Alpine valleys (Andexlinger et al., 2005; Dessemontet et al., 2010) and along the Mediterranean coastline (Viganò, 2001).

In order to be able to compare these TiB areas across European countries, we have developed a multidimensional characterization and a GIS-based mapping method, which we describe elsewhere (Wandl et al., 2014). We coined the term 'territories-in-between' to designate these areas in order to emphasize the common aspects of the previous mentioned concepts, which are:

- a morphology that can described as an 'urban landscape as a large interlocking system rather than as set of discrete cities surrounded by countryside' (Bruegmann, 2005, p. 277) This interlocking system is characterized by an intermingling of built and unbuilt environments where the dichotomy of city and countryside has dissolved into an ecological and cultural continuum of built landscape.
- extended networks of infrastructure, which result in a spatial configuration that is characterized by the coexistence of a network of distant but functionally connected areas at the regional scale, and a patchwork of proximate but functionally disconnected areas at the local scale.
- a surprisingly high level of functional diversity, specifically from a regional perspective, with job to resident ratios that are higher than usually found in urban areas.

We are going to use the term territories-in-between (TiB) in the following section as an umbrella term for territories with the characteristics listed above to avoid overemphasizing specific local connotations, which are attached to every single one of the concepts listed at the beginning of this section.

4.2.2 The role of open spaces for a sustainable development of TiB

The importance of planning open spaces is effectively summarized by Sandercock (2004, p. 134), who states that planning is 'an always unfinished social project whose task is managing our coexistence in the shared spaces of cities and neighbourhoods in such a way as to enrich human life and to work for social, cultural, and environmental justice'. This means that planning open spaces is crucial for a sustainable spatial development.

It is important to define our understanding of open spaces, as open spaces and green spaces are often used interchangeably in literature (Swanwick et al., 2003) leading to confusion and misunderstandings. Moreover, here we are concerned with open spaces only in TiB. Simply put, we understand open spaces in TiB as spaces not covered by buildings. Following Swanwick et al. (2003) we divide them into 'green open spaces' and 'grey open spaces'. 'Grey open spaces is land that consists of predominantly sealed, impermeable "hard" surfaces' (Swanwick et al., 2003, p. 96), like parking lots or streets. Green open spaces consist of 'predominantly unsealed, permeable "soft" surfaces' (Swanwick et al., 2003, p. 96), like lawn or fields. The distinction between open spaces and green spaces is important because the ecosystems services potentially provided by them differ significantly with an implication for their contributions to sustainable development.

The positive effects of green spaces on urban quality have been widely studied during the last decades. Matsuoka and Kaplan (2008) provided a review that focused on the health benefits of urban green spaces, while Ibes (2015) recently presented a review of the positive effects of an urban park system on biodiversity, social cohesion as well as economic factors like property values and cities attractiveness for tourists.

Low et al. (2005) as well as Whyte (1980) state that these effects can, to a certain extent, also be attributed to grey open spaces, although variations occur depending on the social and cultural composition of an area.

Urban park (system) studies in recent years have focused on equal access to green spaces and whether or how parks can contribute to a more just city (Talen, 2010). These studies have focused on urban areas as well as on publicly owned open green spaces. This limitation is to a certain extent surprising, as green belts and regional parks are widely used planning concepts (Kühn, 2003; Amati & Taylor, 2010) and have traditionally been composed by both public and private areas. Ibes (2015, p. 123), criticizes the fact that 'static, generic park models and standardized people-parkland ratios do not always result in socially and ecologically functional urban parks'. There is clearly a need to better understand, plan and implement multifunctional green spaces.

The contribution of grey spaces to sustainable development is not as well documented as the contribution of green open spaces, specifically when focusing on TiB. For the 'traditional city', well-managed and well-designed grey spaces, like streets and squares are often praised for their importance for social, political and physical health of urban populations. Grey spaces are seen as important for interpersonal connections, that go beyond personal networks (Jacobs, 1961; Stanley et al., 2012). This facilitation of interactions between different subcultures which is potentially provided by grey spaces is also often seen as fundamental for the functioning of democracy (Carr, 1992). Badly designed and badly managed public spaces are often blamed for uncivil behaviour and increased (fear of) crime. In TiB, ambiguous forms of publicness can be found, independent of public and private ownerships. This ambiguity is often named as reason for the retreat of the public from open spaces. Carmona (2010a) states that there are arguments for both claims, and asserts that this retreat is a result from either under-management or over-management of open spaces. It is clear that the ambiguity of public and private spaces in TiB makes it difficult to include aspects of ownership into a typology of open spaces of TiB.

Spatial development plans and related research (Sieverts, 2007; Sieverts & Bölling, 2004; Viganò, 2011), which focused on TiB state very clearly that focusing on open spaces, and specifically increasing their multifunctionality is key for a more economically, socially and environmentally sustainable development (Gallent et al., 2004, 2006; Braat & de Groot 2012). The rise of concepts like green infrastructures (Sandstroem, 2002; Tzoulas et al., 2007; Mell, 2009; Davies et al., 2015) and ecosystem services (ES) in regional planning (Niemelä et al., 2010; Aalbers & Eckerberg, 2011; Braat & de Groot, 2012; Farley, 2012; Pincetl et al., 2012), can also be understood in this way. The UN Millennium Ecosystem Assessment groups ES in four categories: provisioning, like food, fresh water, wood, fibre and fuels; regulating, such as the control of climate, flood regulation, water and air purification; supporting, such as nutrient cycles and primary production; and cultural, such as aesthetic, educational, spiritual and recreational benefits (Millennium Ecosystem Assessment,2005).

Typologies of open, green or public urban spaces as well as hybrids of all three of them are of course not new. Most typologies are organized either by form, function, size and land cover or combinations of these categories. There are also typologies with sociocultural or political-economic dimensions. In the following section, we present a brief overview of typologies of open spaces in order to, (i) better understand the importance of open spaces for the planning and design of sustainable of urban environments and to, (ii) identify those aspect that either should or should not be included into a typology of open spaces in TiB. Stanley et al. (2012) state that open space typologies from both modern urban studies and archaeology had a clear morphological focus. Carmona (2010b), like others, starts with Sitte's (1889/2002) classifications and related design of urban squares as one of the first morphologic investigation of open spaces. He draws a line from these simple morphologic studies to typo-morphologic studies, which combine the 'volumetric characteristics of built structures with their related open space to describe the urban landscape' (Moudon, 1994,p. 291). Carmona, reviewing G. Canigga, M. R. G. Conzen and J. W. R. Whitehand, draws the conclusion that design function-based typologies should be favoured over those based on typo-morphology, because the later are often too complicated and did not find their way into planning practice. A closer look at the Italian and French schools of morphology suggests an overhaul of this conclusion for TiB. Both schools, understand the 'city not as object but as a process' (Moudon, 1994, p. 292). This understanding implies that design and planning should not focus on programmatic needs only, but concentrate on spatial compositions that are able to facilitate a variety of different uses and related spatial needs. Therefore, it is important to understand green and grey open spaces in a multidimensional way. This is especially relevant in the light of Gallent et al. (2004), for whom multifunctionality is one way to make the urban fringes more sustainable. Considering the fast-changing function of some of the open spaces in TiB, we can conclude that a typology of open spaces in TIB should not include functions only, but rather spatial structures and processes.

Other open space typologies that have a sociocultural perspective emphasize the potentials of interaction for different parts of society. Spatial typologies that include a more political-economic perspective deal predominantly with aspects of ownership and management of specific open spaces. Carmona (2010a) integrates perceptions of function and perception of ownership in his typology of public spaces and comes to the conclusion that the majority of the types studied fall under the category of ambiguous open spaces, 'in that their ownership and the extent to which they are "public", or not, is unclear' (Carmona, 2010a, p. 171). This ambiguity is even stronger in TiB, if we follow Hajer and Reijndorp (2001, p. 28) who understand the contemporary city 'as an urban field, which is no longer the domain of civic openness, as the traditional city used to be, but the territory of a middle-class culture, characterized by increasing mobility, mass consumption and mass recreation'. Therefore, it seems rather more appropriate to include aspects of accessibility and connectivity into a spatial typology than aspects of ownership.

4.2.3 Adopting and adapting Dupuy's urbanism of network approach

In order to move away from a purely functional way of understanding and planning urbanized areas, namely the dominant zoning approach in urban planning during the twentieth century, mathematician and civil engineer Gabriel Dupuy developed an alternative approach based on the meaning of technological networks in urbanism. This approach is known as network urbanism (Dupuy, 1991), which we see as well suited to deal with the complex and relational nature of TiB.

Based on Fishman (1990), Dupuy (2008) developed a theoretical model to describe the interrelations between different levels of network operators, who in their totality constitute a territory. He distinguished three levels of network operators, who each are constituted by a number of networks:

- The level one operators are the operators of the manifold technical networks, such as the infrastructure managers and providers of cables, roads, pipes, streets, wires, sewers
- The level-two operators are constituted by the production, consumption and domestic networks, which are heavily interconnected

The level-three operator is the territory of the urban household, who using the different means of communication provided by the level-one operator and thereby 'making the necessary connections among the three level-two networks … constitute each person's city' (Dupuy 2008, p. 49).

As a result of his studies in spatial planning theory using Dupuy's framework, Rocco (2008) introduced two additional levels that complement the previous layers of Dupuy's network approach: the 'first nature' and 'governance'. These elements are specifically meant to analyse and evaluate spatial planning performance and spatial policy-making in light of sustainability theory and governance theory. Governance responds to the need to understand the specific actors interacting on a certain territory in order to be able to assign roles and responsibilities in policy-making and policy assessment.

Dupuy's three original network levels do not operate dissociated from their geographical setting or the 'first nature'. The first nature is the geographical concept that expresses the original or adapted geography of a place. This layer expresses that there are geographical places with specific properties that set them apart from others: river basins, climate zones or specific relational positions. The adapted model allows describing and understanding socio-technical complex systems that operate within an immutable first nature as a kind of containing space. It does not allow describing the socio-ecological systems of an area. Big parts of TiB, like forests, fallow land, brown fields and other green and grey spaces can hardly be captured as technical networks, but are mostly the result of human activities and are subject to often fast changes and therefore, don't fall into the realm of the first nature. To support sustainable planning it TiB, they should be described as both social–environmental and socio-technical system. In order to also integrate ecological and environmental aspects into Dupuy's model, we choose to replace the first nature layer by green infrastructure (GI), following a definition of Kambites and Owen (2006, p. 483): 'Green infrastructure … encompasses connected networks of multifunctional, predominantly unbuilt spaces that support both ecological and social activities and processes'. Through this redefined layer we are able to develop a framework to describe open space in relation to both socio-technical networks and social–ecological networks. A further advantage of this extra layer is, that it allows us to overcome the problem stated by Read (2013, p. 3) 'that relational space escapes our cartographic intuitions and present us with the problem of how to define them analytically', because socio-ecological systems are, in contrast to socio-technical, place based (Smith & Stirling, 2010, Figure 1).

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The arrows between the different levels of network operators in Dupuy's model stand for the relationships between them. To better define this relationship in the sense of potential interaction between the four layers, we refer to the concept of ecosystem services, which is an attempt to bridge the gap between ecological and economic sciences. Bridging this gap will help us to understand TiB as social–environmental system. The term ecosystem service was coined for the first time by Ehrlich and Ehrlich (1982) but has evidently older roots in both ecological and economic sciences. For a history of the development of the concept see Braat and de Groot (2012). Müller and Burkhard (2012, p. 26) define ecosystem services 'as the direct and indirect contributions of ecosystem structures and functions – in combination with other inputs – to human well-being'. Ecosystem services describe clearly a relationship between the GI and the other three levels. Omitting the 'eco' in the above definition allows us to extend the concept to also describe relations between the other layers. These relations cannot be seen as distinct from material arrangements that facilitate their interactions, like infrastructures and concrete physical places of interaction. Based on Dupuy (2008), Caso (1999), Rooij (2005), proposed describing the modern notion of networks using three criteria:

- the topological criterion: here topology refers to the geometrical or physical configuration of a network; to the way in which the nodes of a network are physically connected. The amount of links of a node—i.e. the degree of how networked a node actually is—is a measure of the quality of that specific node. Moreover, the connectedness of all network nodes is a qualitative characteristic of the network as a whole.
- the kinetic criterion: kinetic qualities refer to movement and communication between nodes; that is essentially a relationship between space and time, which is translated in speed. The rapidity of the connections within a network is a measure of the quality of the network itself.
- the adaptive criterion: adaptability concerns the capacity of a network to evolve over time and space. On the one hand, a network should be able to modify its own structure of nodes and links. On the other hand, it should be able to 'guarantee' or adapt itself to the various and changing needs and desires of its users by offering them a range of choices to help them reach their goals. Both robustness and flexibility are measures of the quality of a network.

FIG. 4.1 The adaptation of Dupuy's network operators (1991), by Rocco (2008) and the Wandl et al. (2012).

In order to describe the spatial relation of every single open space in TiB with the different levels of network operators and the qualities of the connecting infrastructure networks, seven maps were produced for all 10 case studies:

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- One proximity map for the green infrastructure, showing the potential of interaction for open spaces with the regional–ecological network.
- Four kernel density maps of the following network operators visualizing the concentration of :
  - the operators of the network of households,
  - the operators of network of consumption,
  - the operators of network of production,
  - the operators of technical infrastructure;

  and thereby the potential of interaction of every single open space with the specific operators.

- two network analytical maps as spatial proxy for the network criteria described above, expressing the access to the high-speed street network as well as the centrality distribution over the street network.

The detailed methodology for each map is explained in the following section. This includes an explanation on how the maps were combined to build the typology of open spaces based on the potential of interaction of every single open space, in combination with the different layers of the model of network urbanism.

4.3 Cases, methodology and data

In this chapter, we first introduce the 10 territories-in-between, which were used to develop the typology of open spaces. Second, we describe the remote sensing-based method that was used to identify the relevant open spaces. Third, we introduce the method through which the above layers of network operators have been translated into maps that allow classifying the open spaces according to their potential of interaction to the different layers. Finally, a two-step cluster analysis is conducted to distinguish the different types of open spaces and thereby build up the typology.

4.3.1 Selecting 10 TiB across Europe

This article is part of a larger research project, which compares territories-in-between across Europe in order to understand how planning approaches and spatial performance are interrelated. This has characterized the scope of the research and determined that three aspects were crucial for the selection of the cases:

1. the cases should be located in countries that are characterized by different planning traditions, and therefore represent different approach towards sustainable development of TiB;
2. the areas should be big enough to contain urban areas, TiB as well as rural areas as defined by Wandl et al. (2014); and
3. the key regional planning documents had to be available in a language spoken by the involved researchers. This is the reason why only cases in Western and Central Europe are included. For the first aspect, we have used the traditions (or ideal types) of spatial planning introduced by the European Compendium of Spatial Planning and further developed by Nadin and Stead (2013). These ideal types can be assigned to individual countries within the EU.

For the second aspect, we needed to decide on an ideal territorial sample size that would allow us to carry the analysis soundly. When located at the edges of large metropolitan areas, such as Île-de-France or the Randstad, squares with a side length of 50 km proved to be big enough to cover areas classified as urban, rural and TiB. For all spatial analyses an area with a 25 km larger perimeter was used, in order to avoid edge effects.

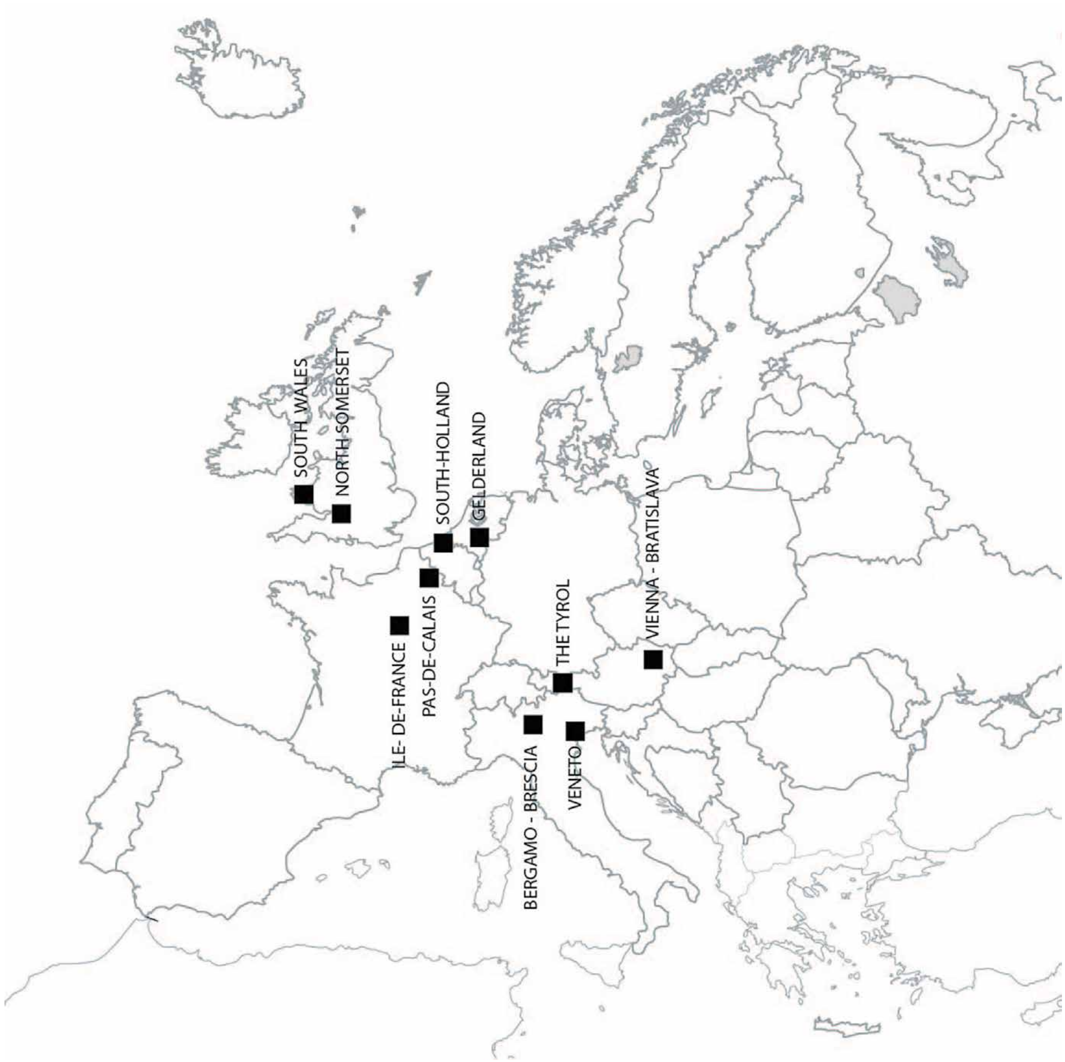

FIG. 4.2 The location of the 10 selected cases across Europe.

See FIG. 4.2 for the location and name of the 10 cases across Europe.

Table 4.1 present the cases with their ideal type of planning as well as the area that is classified as TiB and the number and percentage of population living within TiB.

In the following sections, we will use the case of Bergamo–Brescia to illustrate the methodology used to develop the typology of open spaces. FIG. 4.3 presents a topographic map of the 50 km on 50 km^2 in the area between Bergamo and Brescia, with the location of the historic city centres of Bergamo and Brescia (black squares), key infrastructures (roads in white, railways in black) and

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TiB, delineated according to the methodology explained in Wandl et al. (2014), in transparent red. The area can be roughly subdivided in three zones for further description of the different analytical steps: The alps in the north, the corridor of dispersed urbanization along the highway between Bergamo and Brescia and the river plain in the south. The case of Bergamo–Brescia was selected as example, as it combines a variety of topographies, from alpine in the north to a flat river basin in the south and therefore includes a variety of open spaces types that can be found in the other cases as well.

TABLE 4.1 Key features of the 10 selected TiB across Europe.

		Population			Area classified as TiB	
		Total	TiB			
Case study name	Ideal type of spatial planning	Absolute	Absolute	%	km²	%
Île-de-France	Regional economic	3.893.228	1.006.492	25.85	1.096	54.16
South holland	Integrated comprehensive	2.849.336	1.267.325	44.48	1.089	53.82
The Tyrol	Integrated comprehensive federala	281.199	203.066	72.21	379	18.73
North Somerset	Land use management	736.265	562.595	76.41	790	39.03
Vienna-Bratislava	ntegrated comprehensive federal	338.470	266.489	78.73	735	36.34
Gelderland	Integrated comprehensive	1.031.570	832.782	80.73	1.083	53.51
Bergamo–Brescia	Urbanism	1.094.195	913.480	83.48	1.051	51.91
Veneto	Urbanism	1.052.495	888.305	84.40	1.299	64.16
South Wales	land use management	987.624	888.662	89.98	966.	47.72
Pas-de-Calais	Regional economic	970.905	913.379	94.08	1.205	59.53

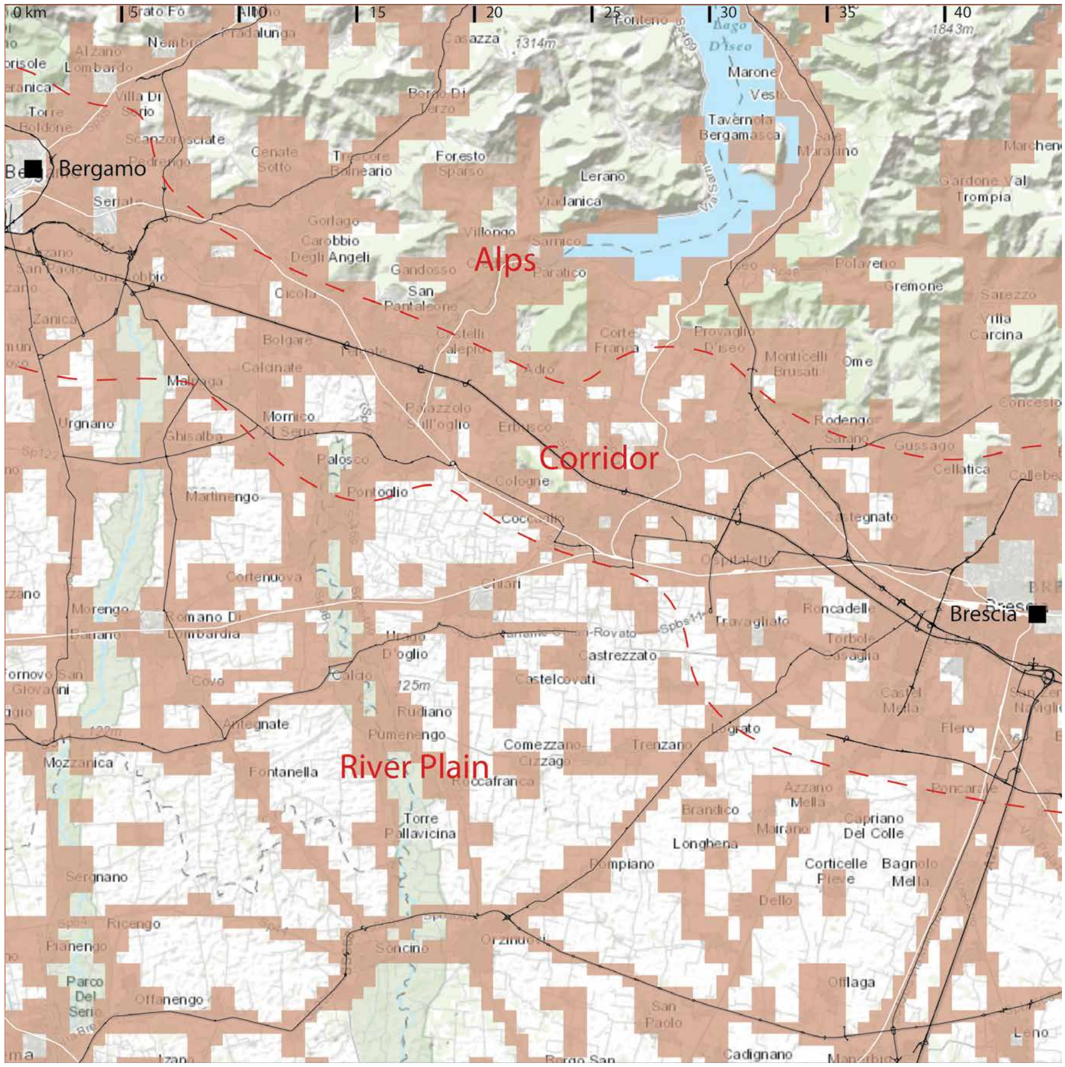

FIG. 4.3 Topographic map of the ilustration case Bergamo–Brescia. source: authors own; data sources background map for all figures: World_Topo_Map: Esri, HERE, DeLorme, Intermap, Increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, Meti, Esri China (Hong Kong), swisstopo, Mapmyindia, © OpenstreetMap contributors, and the GIS User community.

4.3.2 Selecting the relevant open spaces

This section showcases the methodology used to select specific green and grey open spaces. GIS-based analysis of data collected using remote sensing was used. The reason to use a remote sensing-based methodology was to have a fast and easily replicable method at hand that is independent from the provision of locally available data and expertise and therefore, would allow for easier cross-national comparisons. Freely available European wide spatial data-sets, like the CORINE land cover classification (EEA) could not be used as starting point, because green spaces in dispersed urban environments are always included in areas classified as discontinuous urban fabric, which do not show a distinction of open and built up spaces. A manual, expert-based classification based on a real image could have been an alternative approach, but it is excessively time intensive and difficult to reproduce.

Therefore, we decide to use the Normalized Difference Vegetation Index (NDVI) to locate open spaces. The NDVI is an index for the level of photosynthetic activity and is based on the fact that photosynthetically active vegetation absorbs most of the red light that hits it while reflecting much of the near infrared light. NDVI values capturing the case study areas were derived using Landsat 5 TM + images, which were acquired via U.S. Geological Survey and the following equation.

$$NDVI = ((IR- R)/(IR + R)) \times 100 + 100$$

where R and IR are the spectral reflectance red and near-infrared bands, respectively. The NDVI equation produces values in the range from 0 to 200 with a raster resolution of 30 m. Values larger than 100 indicate vegetated areas and values smaller than 100 signify non-vegetated surface features. Values above 130 coincide in all 10 cases with green spaces as defined above. Values between 100 and 130, coincided with three types of grey spaces, ackers, big parking spaces around shopping malls or within industrial and commercial zones and low-rise residential areas with an high amount of paved surface and very little green. The last type would not qualify as open space as defined above. Therefore, we eliminated those areas with a NDVI value between 100 and 130, which are categorized as continuous or discontinuous urban areas according to the CORINE land cover classification.

The review of typologies presented in Chapter 2 suggested that neither present function, because of its instability, nor ownership, because of the hybrid nature of ownership of open spaces in TiB, could be used to classify open spaces effectively. That leaves size and configuration as basic features for the selection of open spaces. The latter will be expressed by the relation to the layers of network operators.

Van Herzele and Wiedemann (2003) provide a classification of urban green spaces in relation with their size and accessibility. They consider only green spaces larger than 5 ha relevant for serving larger areas than a neighbourhood. This size seems also reasonable for TiB, for example, a single garden of a detached house may not be considered relevant for regional planning but a whole neighbourhood with big gardens is relevant for several aspects of sustainable development with a regional dimension, like urban climate, air quality and ecological connectivity. The same is true for streets with rows of trees. The positive effect of a single short street with trees may be very small but a system of streets with trees that crosses through several neighbourhoods can be of regional importance. Therefore, we decided to include all open spaces that are larger than 5 ha. FIG. 4.4 shows in a sequence of maps from left to right, the NDVI values for the complete case study area with a resolution of 30 m, the areas classified as TiB in the case study area in the middle and the opens space which are larger than 5 ha and are completely within TiB on the right.

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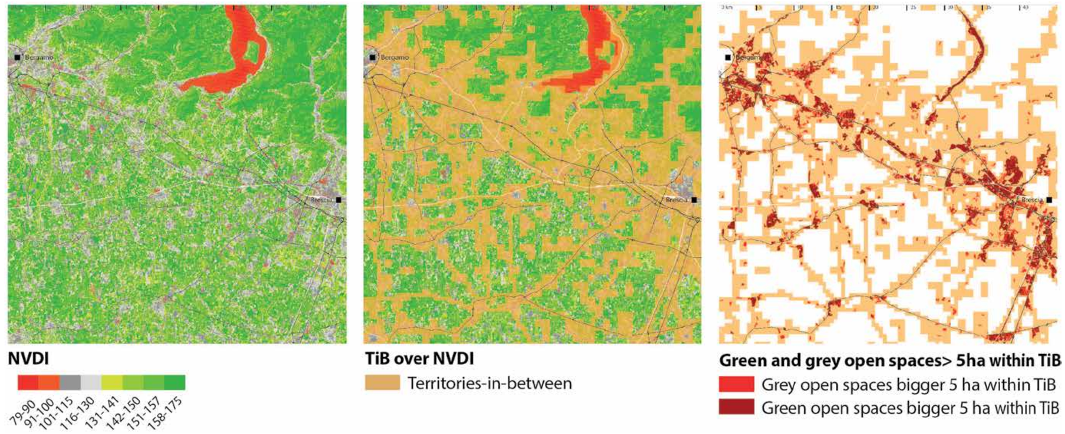

FIG. 4.4 From NDVI to green and grey open spaces that are larger 5 ha within the TiB.

4.3.3 Defining proxies for the layers of the adapted Dupuy model

In the following section, we describe the methods that allow us to describe the potential interaction of every single open space in all case study areas with the four layers from the model of network urbanism we have adopted. Every map produced in this step is subdivided in five zones, where zone 5 shows the highest potential for interaction and zone 1 show the lowest potential for interaction in the specific case.

Mapping the proximity to green infrastructure in TiB

For the classification of the potential interaction with the existing green infrastructure a proximity analyses with the following two steps was conducted: (i) the key landscape elements, which form the backbone of the regional green infrastructure were identified and (ii) the rest of the area was subdivided into four zones according to their Euclidian distance to the key landscape. The rather simple assumption is the longer the distance, the lower the potential for interaction.

As spatial proxy for the layer of green infrastructure we used those landscape elements that are considered to be the most important for a functional regional ecological system and provide the highest ecosystem services. These areas are legally protected areas like designated Natura 2000 areas, large unfragmented areas, which are crucial for ecological migration process and biodiversity, rivers and creeks, which are important ecocorridors. Furthermore, areas with complex cultivated land use pattern as well as agricultural areas with significant natural vegetation are included. All of these areas provide the ecosystem services, which were described in Section 2 as crucial for a sustainable spatial development. Table 4.2 presents the geographic datasets that were used for this step, as well as the rationale that is behind using them, and the source of the data-sets.

The subdivision in five zones of potential for interaction is presented in Table 4.3.

FIG. 4.5 presents the resulting map for the demonstration case of Bergamo–Brescia. It shows the typical landscape mosaic for an area located in the transition from the Alps towards the river plains. Therefore, zone 5 is formed by the forested ridges of the Alps in the north, while further south we can identify batches of complex cultivation patterns on the peri-alpine hills. Three rivers, which drain the area and flow into the River Po form the most important regional ecological corridor in the area. Large batches of unfragmented agriculturally used areas in the south complete zone 5 of our classification. The rest of the map is a result of the classification according to the distances described in Table 4.3.

TABLE 4.2 The geographic data features, which combined form the backbone of the green infrastructure within the case study areas.

Type of area	Rationale to use	Data source	Comment
Natura 2000	European wide nature protection network that includes most important habitats of endangered species.	http://www.eea.europa.eu/data-and-maps/data/natura-1 both special areas of conservation (sac) habitats Directive, and special Protection areas (sPas) Birds Directive.	Not only within the 50 km × 50km box but also in the vicinity of 25 km
Large non-fragmented (by infrastructure or urbanization) areas larger 29 km^2	According to (girvetz et al., 2008), these areas are crucial for migration processes and biodiversity	NDVI and infrastructure based on open street map data. www. osm.org	In general, 100 km^2 are considered large non-fragmented areas, but 29 km^2 was the smallest of the biggest areas in the 10 cases.
Rivers	Rivers are (potentially) ecocorridors	EEA hydrographic data-set http:// www.sharegeo.ac.uk/handle/10672/310 and http://projects.eionet.europa.eu/ecrins/	Buffers according to river types were applied
Land principally occupied by agriculture, with significant areas of natural vegetation	High biodiversity and important as stepping stones for animal migration processes	CORINE land cover class 243—land principally occupied by agriculture, with significant areas of natural vegetation http://www.eea.europa.eu/data-and-maps/data/ clc-2006-vector-data-version-3	
Complex cultivation patterns	High biodiversity and important as stepping stones	CORINE land cover class 242—complex cultivation patterns http:// www.eea.europa.eu/data-and- maps/data/clc-2006-vector-data-version-3	

Subdivision of five zones of potential interaction with the basic network of the green infrastructure

TABLE 4.3 The subdivision of five zones with potential interactions with the basic network of green infrastructure.

Zone and level of potential interaction	Description of Area	Rationale
5—very high	Backbone of green infrastructure	If open space are part of the backbone of the GI than their potential of interaction is highest.
4—high	A 500 m wide zone around zone 5	Transition zones between areas with high natural
3—medium	Area with distance from zone 5 of 500 to 2,000 m	Important function as stepping stones
2—low	Area with distance from zone 5 of 2,001 to 4,000 m	Provide predominantly local ecosystem services reduced function as stepping stones
1—very low	Area with distance from zone 5 of larger than 4001 m	Provide mainly local ecosystem services isolated open spaces with very local ecosystem services

Mapping the density of network operators

As a spatial proxy for the potential for interaction of open spaces with the three network operators described in Section 2.3, as well as the network of households, density probability maps were produced. In these maps, we have used the number of companies and employees respective to the number of inhabitants in the area. The mapped areas were thereafter subdivided in five classes, where high density stands for a high potential and low density for low potential of interaction. The following five steps are common to all four maps.

- The address information that is provided by the Amadeus database (Bureau van Dijk, 2014), which contains comprehensive information on around 21 million companies across Europe, was used to generate a point file via the ESRI geocoding service.
- The Amadeus database provides a NANCE (Nomenclature of Economic Activities) code for every company. This code was used to assign the companies to the networks of production, consumption or infrastructure provision respectively. See Table 4.4 for the assigned codes per category of network operators.
- These point files were then used to generate density probability map, using a kernel operation provide by a GIS software. For detail explanation of the kernel function (see Seaman & Powell, 2013). The density values were weighted by the number of employees per company.
- The kernel density values were reclassified into quintiles (five equal parts), where the grid cells with the 20% highest density value were assigned to class 5 and the 20% grid cells with the lowest density values to class 1.

TABLE 4.4 NANCE codes and their categorization into operators of production, consumption and technical infrastructure.

NACE Rev 2 code	Production	Consumption	Technical infrastructure
A. Agriculture, Forestry and Fishing			
01.00-03.99 l	x		
B. Mining and Quarrying			
05.00–09.99	x		
C. Manufacturing			
10.00–33.99	x		
D. Electricity, Gas, Steam and Air Conditioning Supply			
35.00–35.11	x		
5.12-32.50			x
35.21	x		
35.22-35.30			x
E. Water supply; Sewerage, Waste Management and Remediation Activities			
36.00–39.99			X
F. Construction			
41.00-43.99	x		
G. Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles			
45.00–47.99		x	
H. Transportation and Storage			
49.00–53.99			X
I. Accommodation and Food Service Activities			
55.00–56.99		x	
J. Information and Communication			
58.00–63.99	X		
K. Financial and Insurance Activities			
64.00-66.99	x		
L. Real Estate Activities			
68.00-68.99	x		
M. Professional, Scientific and Technical Activities			
69.00–75.00	X		
N. Administrative and Support Service Activities			
77.00–82.99	x		
O. Public Administration and Defence; Compulsory Social Security			
84.00–84.99	x		
P. Education			
85.00–85.99	x		
Q. Human Health and Social Work Activities			
86.00–88.99	x		
R. Arts, Entertainment and Recreation			
90.00–93.99		X	
S. Other Service Activities			
94.00–96.99	X		
U. Activities of Extraterritorial Organizations and Bodies			
No NANCE	x		

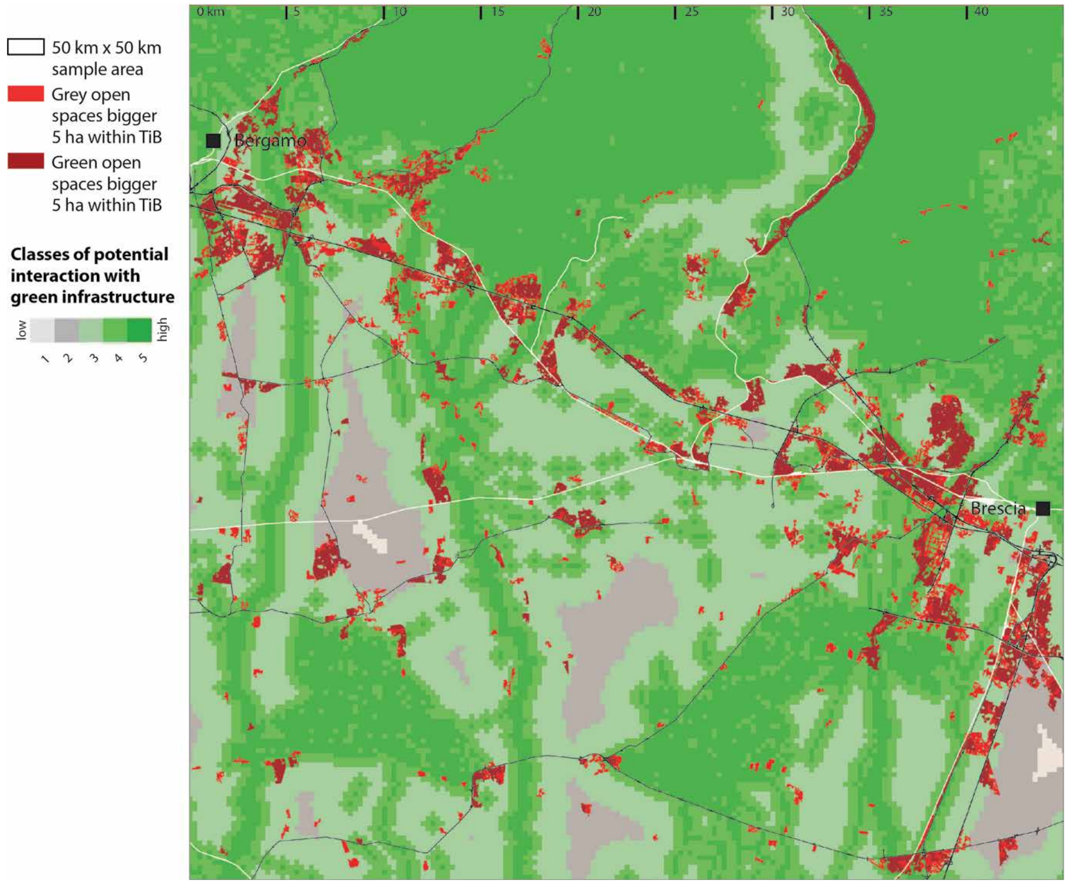

FIG. 4.5 The five zones of potential interaction of open spaces and the green infrastructure in the case of Bergamo–Brescia.

FIG. 4.6,FIG. 4.7 ,FIG. 4.8 , and FIG. 4.9 present the resulting maps of above-described operation for the demonstration case of Bergamo–Brescia. The four maps clearly show different spatial distributions for all four network operators. The households map FIG. 4.6 shows the most dispersed pattern of densities, with peaks in Bergamo and Brescia and along the corridor between this two cities, but also in the plain in the south. The consumption map FIG. 4.7 shows clear concentrations in the two big cities and along the highway, but here more concentrated around the highway exits. In the southern plain, a concentration on the lager towns, specifically those in vicinity to bridges over the rivers is visible. The production map FIG. 4.8 shows concentrations along the complete highway corridor between Bergamo and Brescia and only a few peaks in the plain in south. The infrastructure map FIG. 4.9 shows a different pattern, which is one of dispersed concentrations, both along the corridor between Bergamo and Brescia, but also in the southern plain.

The observation of these differences is important, as it confirms the possibility, previously formulated theoretically, of using the potential of interaction with network operators as a distinctive characteristic of open spaces.

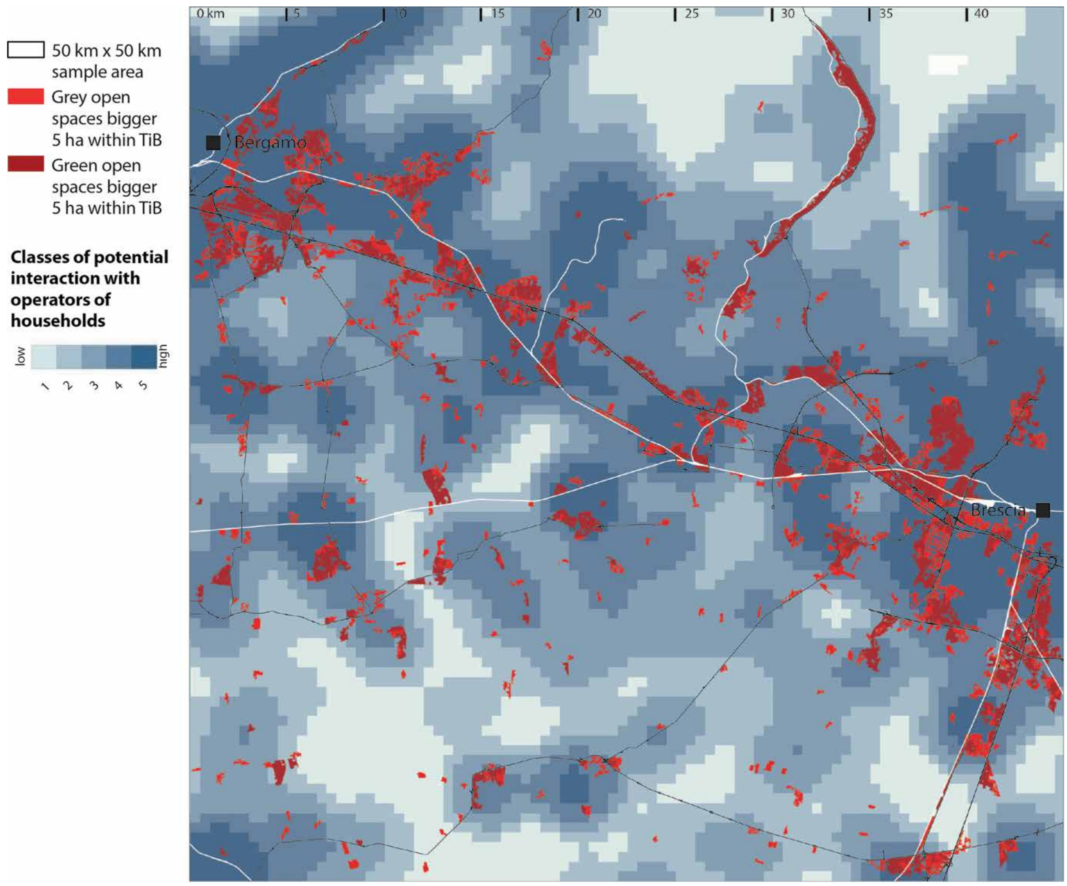

FIG. 4.6 The relation of open spaces to the kernel density of households as a spatial proxy for the potential of interaction.

Mapping the quality of the service of technical infrastructure

The following sections describe how different types of network analyses measures were used to produce a map that presents, again in five classes, the quality of the street network in relation to open spaces in TiB for the three criteria of networks presented above. For all two maps, the street network provided by open street maps (OSM) was used as input data-set for the spatial analyses.

Topological criterion and adaptive criterion. We used the betweenness measure (Freeman, 1977), which identifies places that are structurally made to be traversed more often and therefore are considered central to the network. The urban network analyses toolkit (Sevtsuk & Mekonnen, 2012) and extension to ArcGis, was used to calculate the betweenness value for every street junction in the case study areas using the following formula:

Equation 1: The betweenness of a junction is defined as the fraction of shortest paths between pairs of other junctions in the network that pass by junction *i*. Betweenness measure is defined as follows:

$$Betweenness\,[i]^r = \sum_{j,\,k \in G - \{i\},\, d[j,k] \leq r} \frac{n_{jk}[i]}{n_{jk}} \cdot W[j]$$

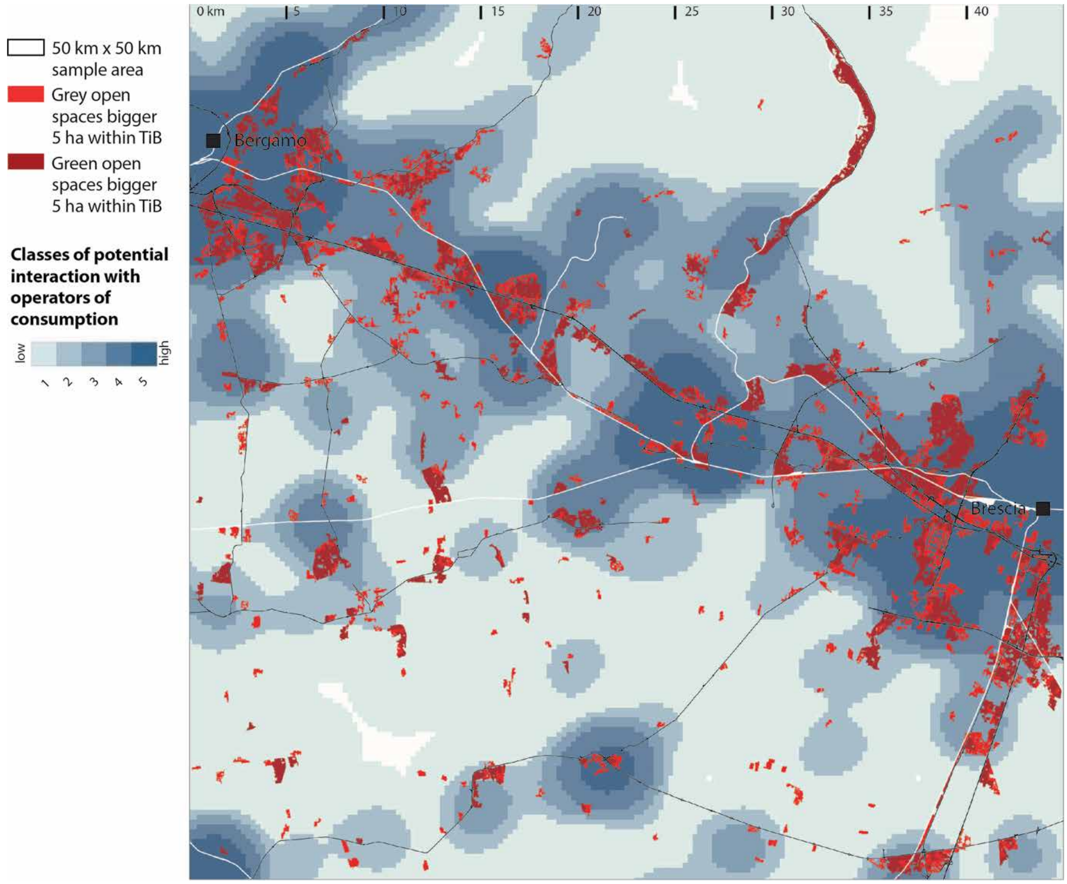

FIG. 4.7 The relation of open spaces to the kernel density of operators of consumption as a spatial proxy for the potential of interaction.

where Betweenness *ir* is the betweenness of junction *i* within the search radius *r; n* $_{jk}$*i* is the number of the shortest paths from junction *j* to junction *k* that pass by junction *i*; and n_{jk} is the total number of the shortest paths from j to k for more detail, see Sevtsuk and Mekonnen (2012).

The resulting point map and the betweenness values of the junctions was than transformed to a raster representation using a kernel probability of density function. The resulting raster values were then reclassified into quintiles (five equal parts), where the grid cells with the 20% highest centrality value were assigned to class 5 and the 20% grid cells with the lowest density values to class 1. See FIG. 4.10 for the resulting density classification in relation to the green and grey open spaces for the demonstration case Bergamo–Brescia.

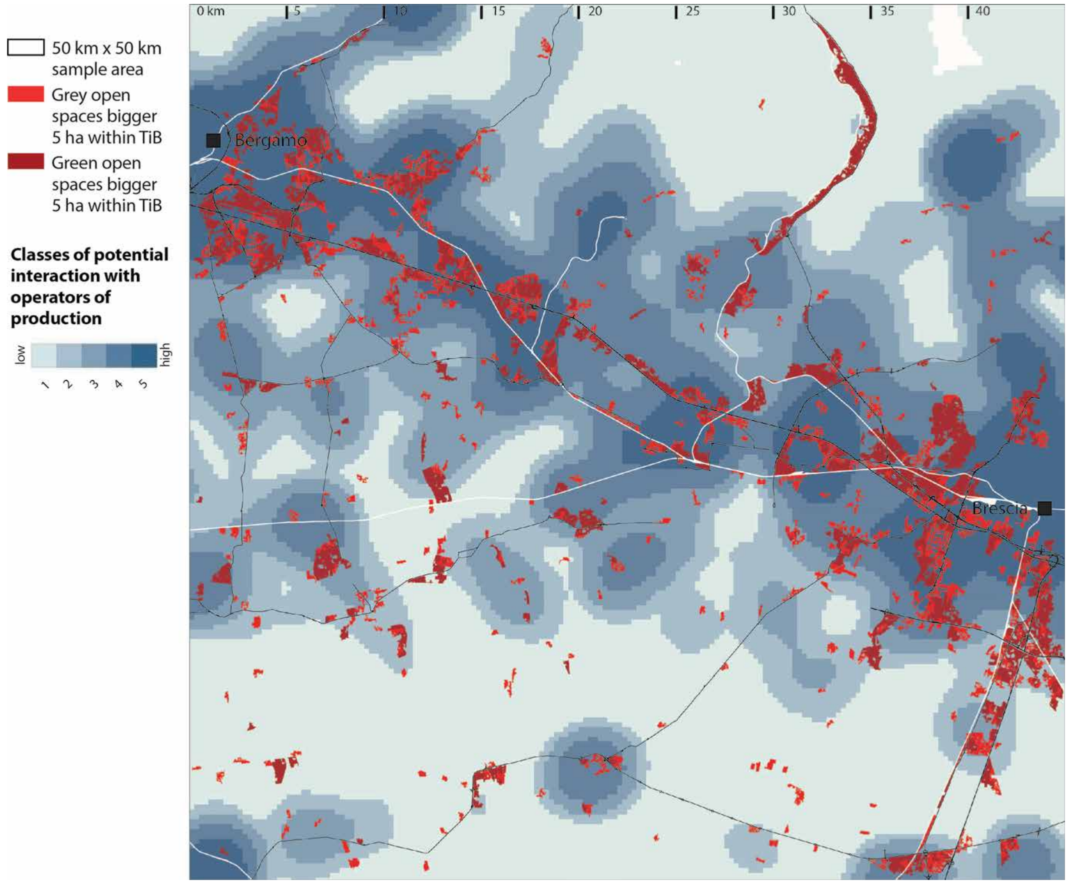

FIG. 4.8 The relation of open spaces to the kernel density of operators of production as a spatial proxy for the potential of interaction.

FIG. 4.10 shows clearly a broad corridor between Bergamo and Brescia with the highest betweenness centrality values. The zone of high centrality extends into the valleys of the alps to the north.

The kinetic criterion. As a proxy for the quality of a location in relation to the kinetic criterion of the street network we choose the network distance to entry points to the high-speed road networks as a measure for access to high-speed connections. The final map presented in FIG. 4.11, was developed using the following steps:

- building the network data-set of the road network using OSM data;
- selecting those links (streets) which form the fast network (motorways and national roads);
- selecting the entry and exit points to the fast network;
- calculating the service areas—the areas that can be reached within a certain network distance—of this entry point using the complete road network;
- classifying the service areas into five categories (1500 m; 3000 m; 6000 m; 12,000 m; and >12,000 m);
- transforming the vector data-set into a raster data-set with a resolution of 250 m.

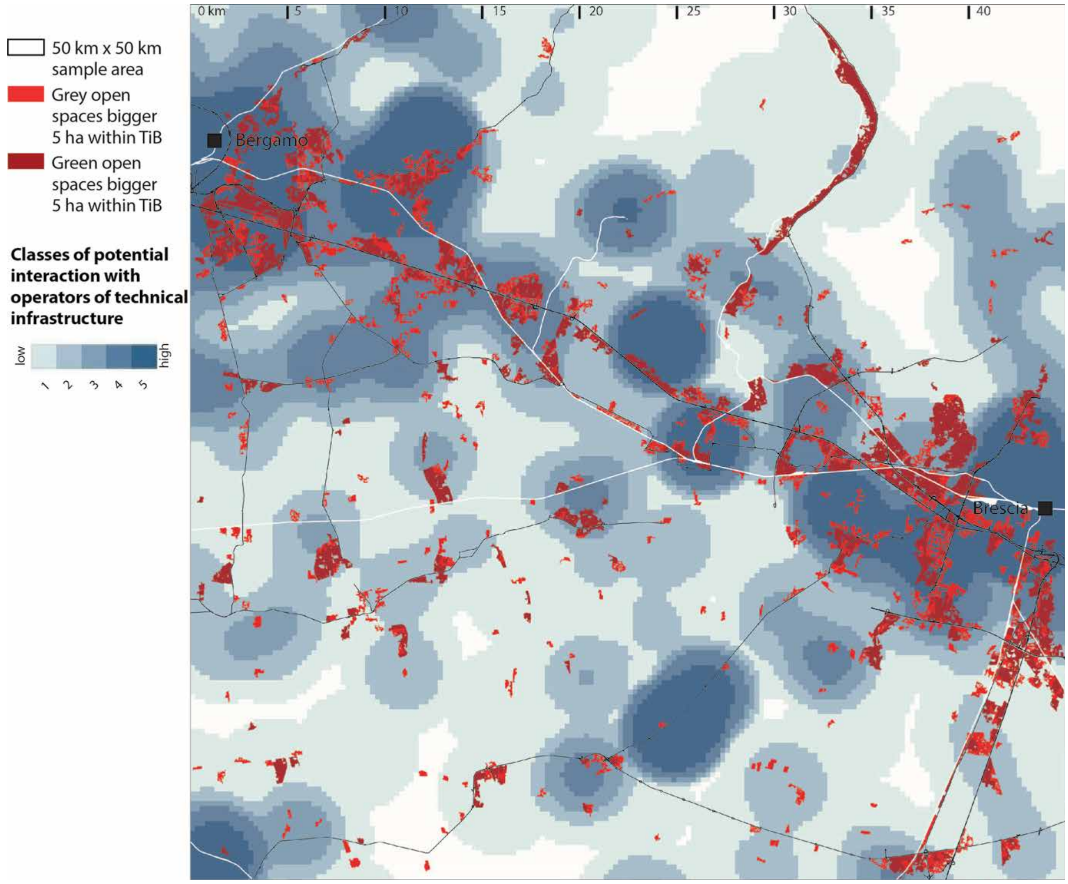

FIG. 4.9 The relation of open spaces to the kernel density of operators of technical infrastructure as a spatial proxy for the potential of interaction.

FIG. 4.11 resulting from the above methodology presents a clear concentration of the value 5 zone around the two big cities. The corridor between the cities is not accentuated very strongly.

The last paragraphs presented one way of translating Dupuy's adapted concept of network urbanism into a series of analytical maps. These maps and the related spatial data allow us to compile a spatial database, which assigns a value between 1 and 5 for every layer to each open space within a TiB. These values express the level of potential interaction of the specific open spaces to the single layers of network operators and therefore to the network city understood as social–environmental system. Using SPSS, a two-step cluster analyseswas performed to identify different types of open spaces. This explorative statistical method was used as it allows to run cluster analyses on large data that is not normal distributed and includes categorical variables, other commonly used clustering methods cannot be applied under this circumstances. The resulting typology consists of five green and five grey types, which are presented in the following section.

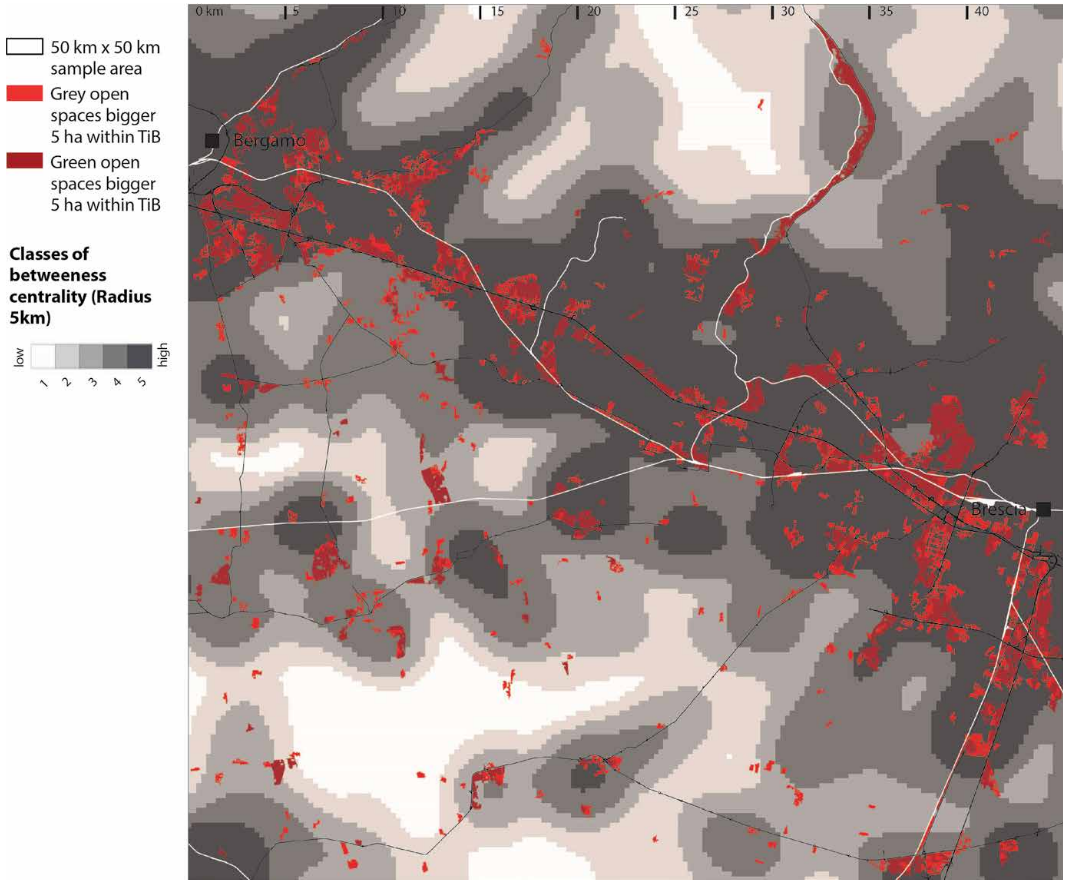

FIG. 4.10 The open spaces in relation to the five classes of the betweenness centrality of the street network in the case of Bergamo–Brescia.

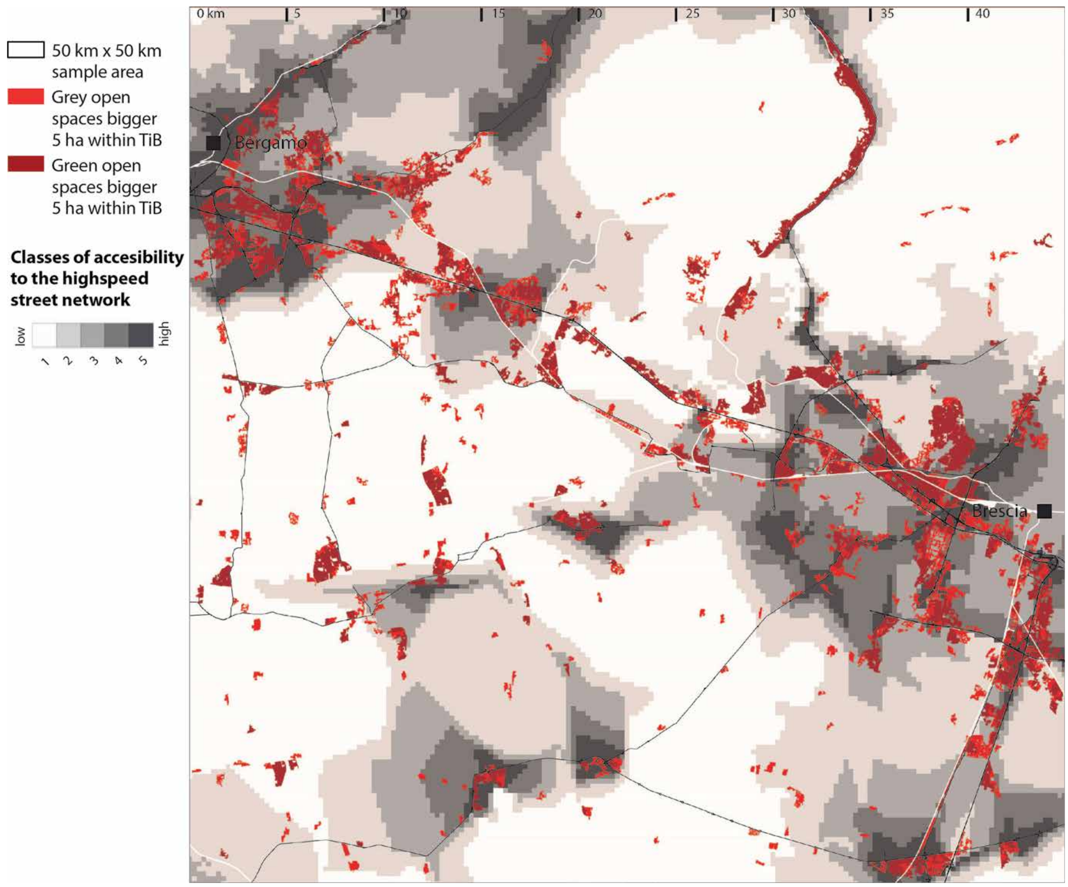

FIG. 4.11 The relation of open space to the kinetic criterion of the street network in the case of Bergamo– Brescia.

4.4 Results—a cross-national multidimensional typology of open spaces in TiB

The results section is organized in three parts, first we present the different types of open spaces, thereafter we describe the relation between the types of open space and the aspects of sustainable development introduced earlier and, finally, we present their distribution pattern within the 10 cases.

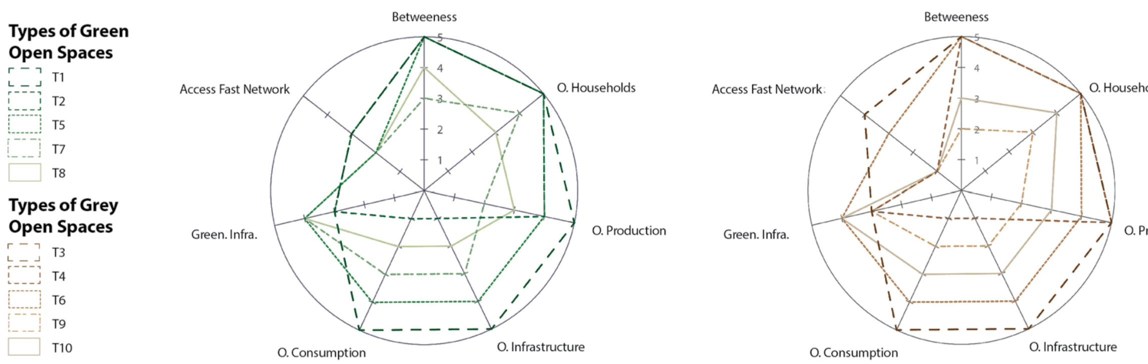

FIG. 4.12 Radar diagrams displaying the types of open space in relation to their potential of interaction with the seven aspects of the networked city. The left diagram shows the green open spaces and the right diagram shows grey open spaces.

The cluster analyses resulted in 10 types of open spaces, 5 green types as well a5 grey types. The radar diagrams presented in FIG. 4.12 show, that the grey types, with the exception of type 4, have a clear gradient from high potential to low potential of interaction in regards to all aspects. The green types show a more differentiated image, which means that they vary more in the potential of interaction with the network operators. Also, apparent from FIG. 4.12 shows that there are green and grey types, which are very similar, like types 1 and 3, types 5 and 6. The key difference, beside the intensity of coverage by plants, is the accessibility of the fast network, which is higher for the grey open spaces.

Table 4.5 presents a description of the key features of the different types of open spaces as well as an assessment, that enable us to relate the different types of open spaces to a more sustainable development of TiB in reference to the earlier described ecosystem services. This assessment is of course limited as it a generalization across Europe and focuses on the regional scale.

FIG. 4.13 shows that type 5 covers the largest area across cases of the green types, followed by type 1 and 2. Types 9, 10 and 6 are the types of grey spaces that cover the largest area across all cases. The most frequent type of green space is type 1. Type 10 is the most frequent grey open space. Type 4 is the only type, which is only playing an important role in one single case. In the UK, Italy and to a certain extend also in the Netherlands, both case show a similar distribution patterns of types.

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TABLE 4.5 The relation between the different types of opens spaces in TiB and examples of their potential contribution to sustainable development and related ecosystem services. In order to avoid repetition, types of green and grey open spaces with similar characteristics were grouped.

Type	Green or grey	Short description	Key contributions to sustainable development
T1	Green	Open spaces within the fringe zone of large and medium sized cities; high potential of interaction with all operators, with a central location within the street network and best access to the fast transportation network. Bigger distance to existing backbone of GI.	High potential for multifunctional uses, specifically in relation to regulating and cultural ES; These open spaces are under the highest urbanization pressure; Key areas to facilitate social interaction.
T3	Grey		
T5	Green	Similar to type 1/2 but slightly less potential of interaction with all operators. lower accessibility to the fast network, but closer to the backbone of existing green infrastructure. Very often not urbanized, because the quality of the soil underground or other effects still allow 'profitable' agriculture or the winning of material.	High potential for multifunctionality, but under less development pressure than type 1 and 2. Specifically important for ES in relation provisioning and regulating. Crucial areas for the establishment of an ecological network that connects rural and suburban ecosystems.
T6	Grey		
T10	Grey	The grey type with a medium potential of interaction with all kinds of operators, but also very close to the backbone of the GI. Very often located at the edges and within smaller settlements or in industrial areas as well as along big technical infrastructures, like highways and airports.	Crucial areas in relation to regulating, ES specifically heat and water, as well as cultural (aesthetic and recreational) ES.
T9	Grey	The grey type with the lowest potential of interaction with all kinds of operators, but also rather distant from the backbone of the GI. Very often locate in smaller settlements or in industrial areas with automated functions like ports.	Crucial areas in relation to regulating, es specifically heat and water, as well as cultural (aesthetic and recreational) es, because these areas are very often underused back yards also important for supporting primary production.
T2	Green	Open spaces, in very central locations of the street network, with high potential of interaction with operators of households as well as operators of production. But low potential of interaction with operators of consumption and infrastructure. Very often located in valleys or areas, where the dispersion is constrained by topography or infrastructure.	Areas are often under high development pressure because of limited reserve of buildable spaces. Key ES are regulating climate as well as provisioning specifically in relation with the different forms of production. But also cultural aspects are of important, therefore, for this type multifunctionality is key. Very often this spaces are important as ecological corridors.
T4	Grey		
T7	Green	This type of open space can be best described as the backyards of smaller settlements, with rather high potential of interaction with the operators of households and the backbone of GI, and significantly less to the other operators as well as low accessibility to the fast network.	Key role as buffer areas between housing areas and intensive agricultural areas, but also as ecological corridors connecting the backbone of GI with the urban green network. Regulating and cultural ES are important here.
T8	Green	Similar to seven, but with higher potential of interaction with operators of production and lower with operators of households.	Key role as buffer areas between industrial areas and intensive agricultural areas, but also as ecological corridors connecting the backbone of GI with the urban green network. regulating and provisional ES in relation with production are important here.

There are four different limitations we think are important to consider when using the typology presented in this paper:

- The assignment of the NANCE codes to the different operators in Table 4.4. The border between operators of production and infrastructure is sometime not very apparent or certain codes are a combination of both. A slightly different classification would be plausible and may influence the typology.
- The selected value for the NDVI that separated the grey from the green open space led to the situation, that acres without vegetation are considered as grey spaces, which is not true for the period of the year they carry crop.
- The assessment of possible contributions of the single types toward a more sustainable development is limited as it a generalization across Europe and focuses on the regional scale, specific local solutions may vary significantly. Despite the above limitations, the typology presented can be seen as a valuable contribution to the characterization of open spaces as well as to identifying their potentials to support sustainable development.

4.5 Discussion and conclusion

In this article, we presented an initial framework based on solid empirical spatial analysis of TiB to inform policies for a more sustainable spatial development of TiB. We did so by investigating the potential contribution of different types of open spaces to sustainable development.

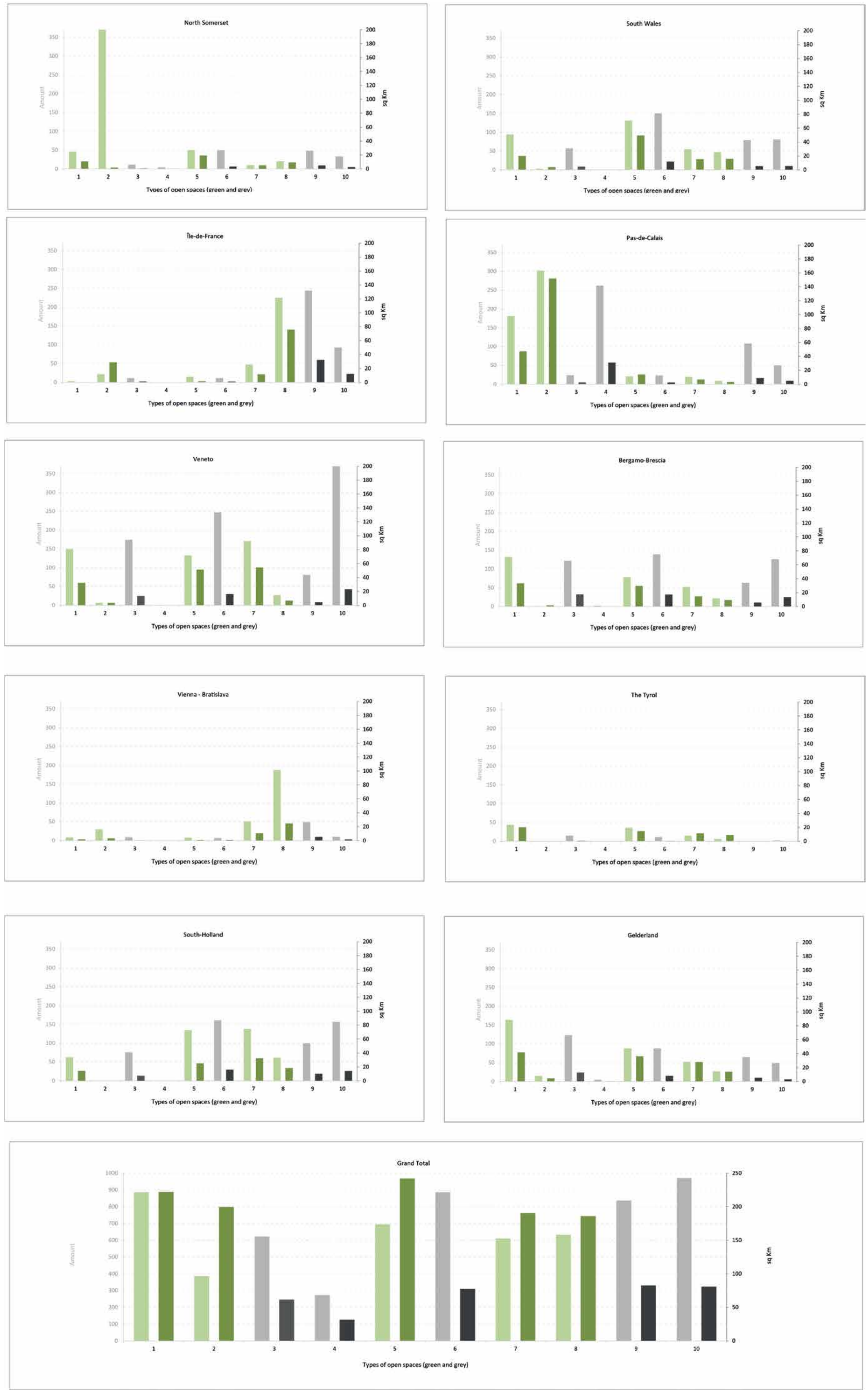

FIG. 4.13 Comparison of the amount and area of each type of open spaces across the 10 case studies across Europe.

According to Lovell and Taylor (2013), urban ecosystems, and therefore open spaces in TiB, are becoming increasingly important as contributors to both the problems and potential solutions to the environmental issues in the near future. The globally ongoing expansion of urban areas and the loss of more rural or ‘natural’ landscapes require that crucial ecosystem services have to be supplied by urban grey and green spaces.

At the same time, these spaces must continue to meet the traditional cultural needs of nearby residents by encouraging recreational activities, embodying the aesthetic preferences of the community, educating people about nature, and preserving historic landscape features. These various functions, which provide the ‘ecosystem services’ that benefit humans directly or indirectly, will need to be considered simultaneously and to be balanced to meet the needs and preferences of local residents as well as society as a whole (Lovell & Taylor, 2013, p. 1).

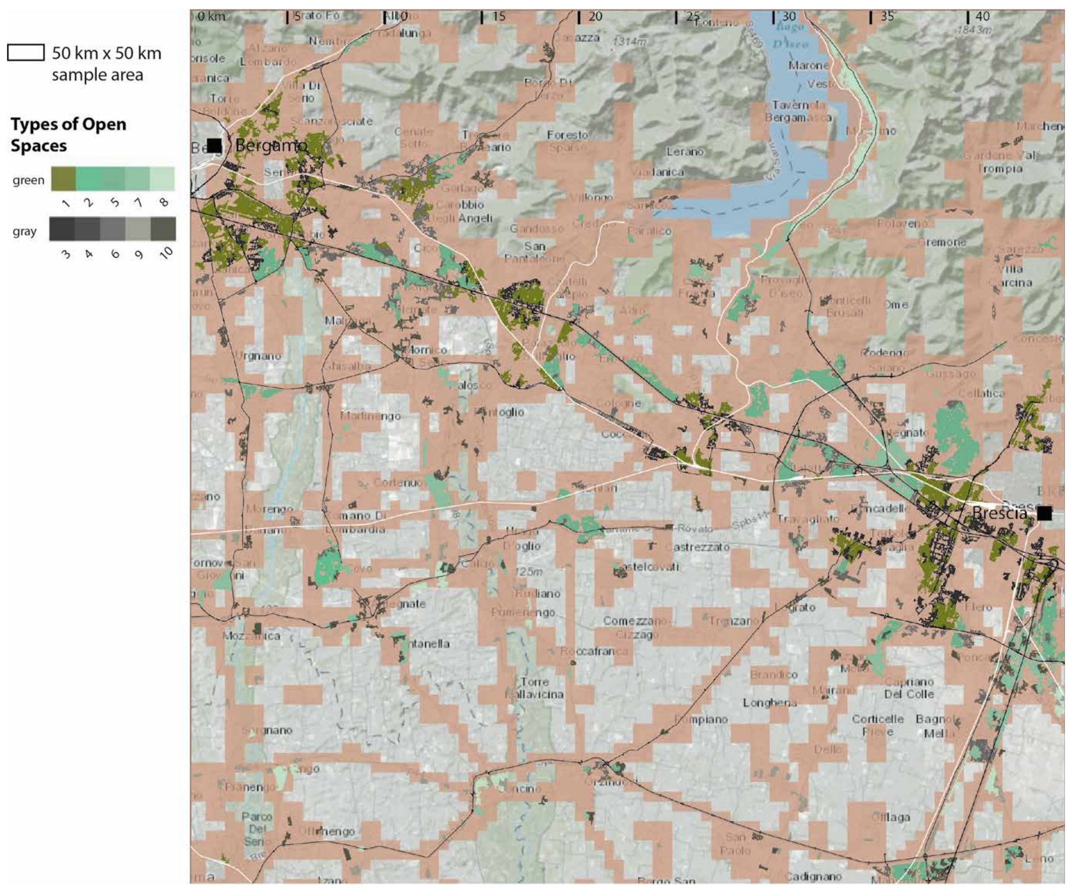

FIG. 4.14 The types of open spaces for the case of Bergamo–Brescia.

Our typology shows that the most common green spaces, but also a significant part of grey spaces, in TiB have the potential for multifunctionality as well as the potential for multiple ecosystem services (See FIG. 4.13). These results enforce the idea of Gallent et al. (2004) that multifunctionality is the key to sustainable development of TiB. Consequently, our typology also clearly supports Viganò’s (2011) claim to start with open spaces when designing within dispersed urban territories. To be able to put the potentials of open space on a map and thereby show the variety of ecosystem services that could be provided by open spaces in TiB, is a first step to

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bring TiB out of their shadow existence (Frijters et al., 2004) in contemporary regional spatial planning and design. This also supports our own decision to omit the function and ownership as necessary criteria for defining the different types of it. Because, instead of having several types with unclear functions and ownership status, we are able to present spatial types, which have clearly differentiated potentials of interaction with the operators of the contemporary networked territory and therefore sustainable development. However, we acknowledge that function and ownership have spatial consequences and are extremely relevant when spatial plans are made to actually develop the potentials for sustainable development that our typology presents.

Finally, we present one further possible application of the developed typology. The European Landscape Convention (ELC) (Council of Europe, 2000) defines the whole territory as landscape, explicitly including urbanized areas. For this article, it is relevant to point out that the ELC calls upon signatory states to identify their landscapes, and to explicitly include urban and peri-urban landscapes in the description, in addition to the ‘natural’ and ‘rural’ ones (ELC Article 2). If this identification is to go ‘beyond the traditional focus on individual parks and green spaces and the links between them’ (Stiles et al., 2014), then two challenges are crucial: (i) to include also non-green open spaces and (ii) to base the classification of open spaces in more than ecological and environmental aspects. The typology presented in this paper does both and goes beyond. Because, it not only allows to identify open spaces, green and grey, based on social–environmental aspects, but it also provides a tool to identify their potential for multifunctionality and can thereby inform planning decisions on multiple scales.

FIG. 4.14 presents this characterization of the landscape through types of open spaces for our demonstration case Bergamo–Brescia.

4.6 Atlas of territories-in-between Part C: A typology of open spaces

This section of the atlas of territories-in-between contains one thumbnail double-page:

1 Typology of open spaces overlaid on territories-in-between and overlaid by major transport infrastructure.

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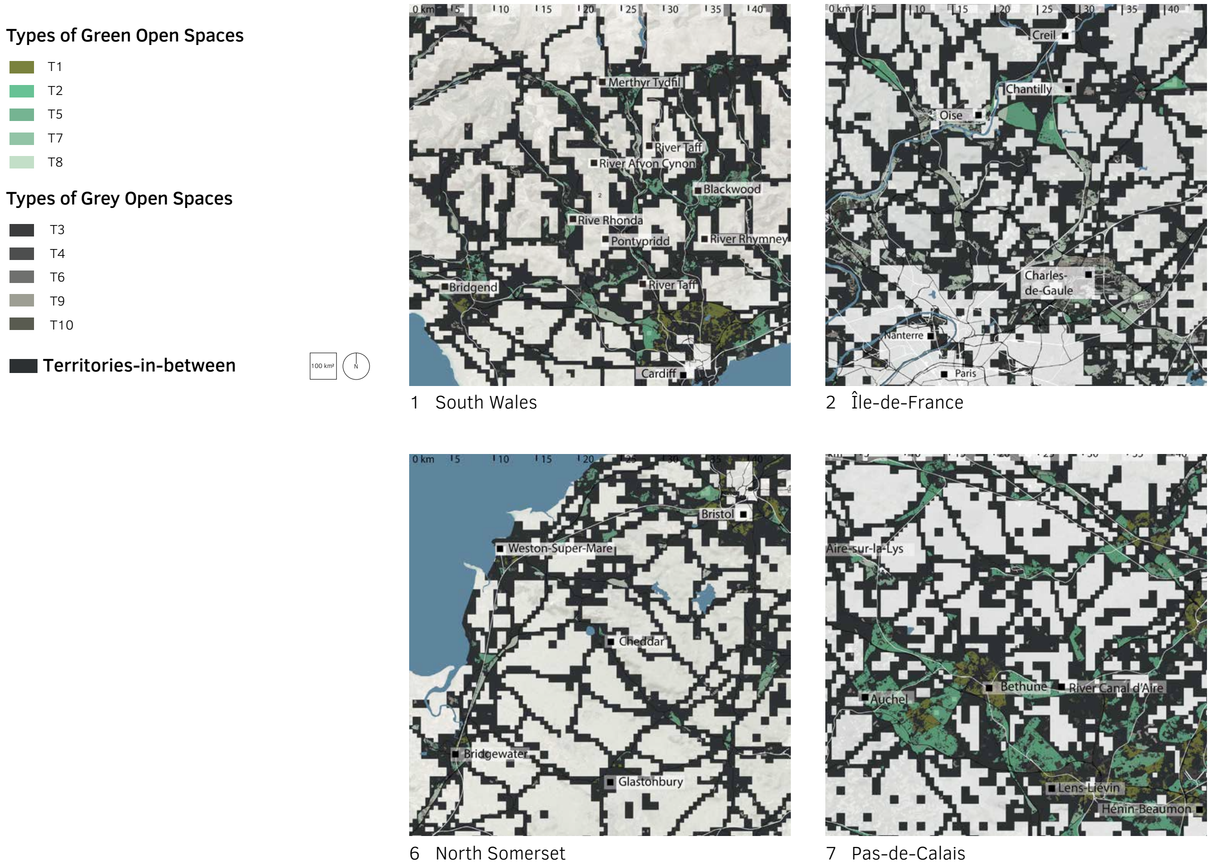
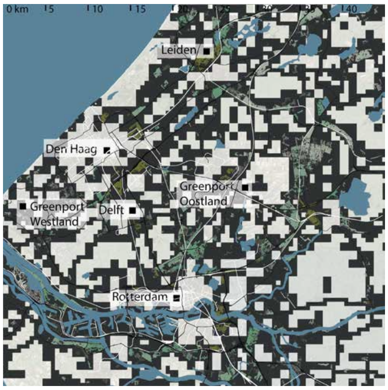
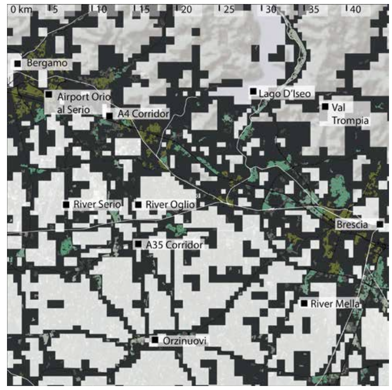


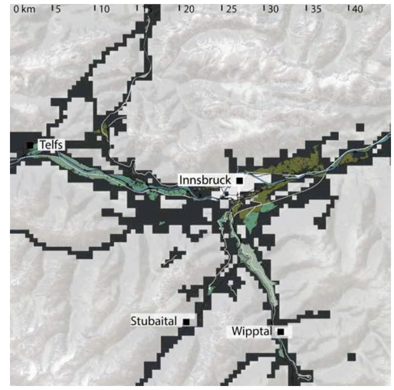
FIG. 4.15 Thumbnail maps of a cross European typology of open spaces overlayed on the territories-in-between. For larger maps and a more detailed description, see Atlas part G.



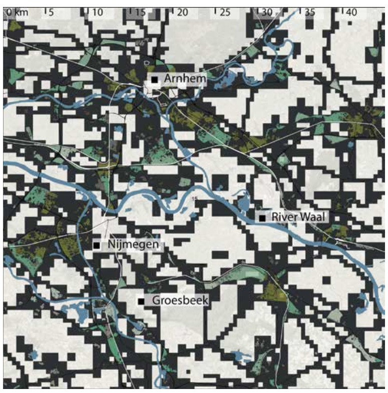
3 South-Holland



4 Bergamo-Brescia

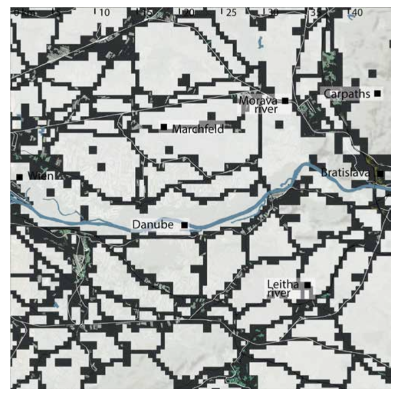


5 The Tyrol



8 Gelderland

9 Veneto



10 Vienna-Bratislava

5 Landscape Fragmentation and Accessibility of Green Spaces

Comparing the Landscape Fragmentation and Accessibility of Green Spaces in territories-in-between Across Europe

Wandl, A.

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KEYWORDS accesibility of green spaces; dispersed urban development; ecosystem services; landscape fragmentation

ABSTRACT To improve the positive effects provided by green spaces on human well-being in dispersed urban areas is a key challenge for sustainable spatial development in Europe. This article presents a methodology that allows for the comparison of the potential of green spaces in territories-in-between across Europe, in a way that crosses the fields of urban ecology and urbanism. The article adds to the existing knowledge and understanding of the relation between the spatial organisation of systems of green spaces and their accessibility to biodiversity and human well-being. Firstly, it adapts the fragmentation index in a way that it can be applied to the specific spatial characteristics of territories-in-between. Secondly, it combines the fragmentation index with an indicator for accessibility of green spaces, in order to integrate aspects of ecology, human well-being and the spatial heterogeneity of the relation between them. The methodology is applied to ten areas across western Europe in order to inform decision and policy makers including urban planners, designers and environmental agencies to be able to assess the potential of system of green spaces for biological diversity and human well-being in an integrated manner.

5.1 Introduction

The quality of urbanisation and related urban growth of cities are key challenges in securing and improving hu- man well-being, as well as protecting and establishing ecosystems and their biodiversity. The reasons that cities play a crucial role in the relationship between well-being and biodiversity are, according to Pickett et al. (2008), (i) most of the planet's population lives in cities and there- fore, human contact with nature is predominantly urban; and (ii) cities have impacts on regional and global eco- systems such as 'climate, atmospheric chemistry and hydrological systems' (p. 140), which go beyond the borders of urbanised areas. An increasing amount of literature within the field of biodiversity studies acknowledges that urban ecosystem structures such as green belts, parks of all sizes, rivers and creeks, private gardens, some derelict areas and brownfields, play a crucial role in pre- serving the planet's biodiversity (Eigenbrod et al., 2011; Parker, 2015). But the biodiversity benefits are unevenly distributed spatially, which raises questions concerning environmental justice. The 'increase in urbanization will result in spatial shifts in both supplies of ecosystem ser- vices and the beneficiaries of those services' (Eigenbrod et al., 2011). Who has access to which green spaces is a question that will challenge urban planning and design in the coming decades.

As much of the urbanisation of the last decades took place outside of the dense city cores (Kasanko et al., 2006), and it can be expected that the process of development of the 'horizontal metropolis' (Viganò, Arnsperger, Barcelloni Corte, Cogato Lanza & Cavalieri, 2017) will go on in the near future, it is crucial to look at this new form of 'diffused city' (Secchi in Viganò et al., 2017) toanswer the above question of environmental and human well-being. Wandl, Nadin, Zonneveld and Rooij (2014) used the term territories-in-between (TiB) as an umbrella term to characterise and map dispersed urban development across Europe, in order to compare them without favouring the cultural notions that come with some of the concepts. They include *Zwischenstadt* (D) (Sieverts, 2003), *città diffusa* (I) (Indovina, 1990), *annaehernd perfekte peripherie* (CH) (Campi, Bucher, & Zardini, 2000), *peri-urbanité* (F) (Le Jeannic & Vidalenc, 1997).

Urban areas are not homogeneous territories but have significant spatial differences in their demographic, physical and ecological structures. Metropolitan areas could be described in the words of Neutelings (1994) as a *Patchwork Metropolis*. Or as Huhlmann & Promski (2007, p. 7) put it, 'the sharp distinction between city and countryside has dissolved into an ecological and cultural continuum of a built structure between city and land- scape'. Therefore, it is not a surprise that this new spatial structure 'where we live now' (Sieverts, 2008) as well as the societal challenges and transformations that are related to the ongoing revolution towards the 'Industry 4.0' (Hermann, Pentek, & Otto, 2016), made scholars revisit (Wahler-Żak, 2017) a concept that was developed as an answer to the challenges of the first industrial revolution: Howard's Garden City.

Already Howard stated that there are not only the two poles of urban and countryside, but that there is or could be a third pole, illustrated in his Town-Country magnet, that combines the beauty of the nature with the possibilities provided by economic and societal activities (Wahler-Żak, 2017, p. 19). Could it be that, in contrary to the many attempts of implementing the Garden City, which resulted in often green but mono-functional housing areas (Wahler-Żak, 2017), the 'diffuse city', which according to Secchi was not born out of the expansion of the city but 'had its roots in the territory, its inhabitants, and their history' (Secchi in Viganò et al., 2017), has the qualities listed under the Town-Country magnet?

The above description of diffused areas is very similar to the idea of the 'landscape mosaic', commonly used in landscape ecology (Dramstad, Olson, & Forman, 1996), and is therefore a valid starting point for an integrated understanding of urbanised territories.

In order to inform decision and policy makers, including urban planners, designers and environmental agencies, it is crucial to be able to assess existing and pro- posed systems of green spaces in a way that integrates aspects of biological diversity and human well-being. Three aspects of TiB make them specifically relevant for the pro- vision of ecosystem services: their sheer spatial size, the theoretical challenges in relation to the urban-rural dichotomy and the ongoing discussion of densification versus decentralisation.

We first describe the effects that are provided by ecological structures for both aspects: human well-being and preservation of biodiversity in TiB. Afterwards, we introduce two indicators, landscape fragmentation and accessibility of green spaces and adapt their calculation to fit the assessment of TiB. We use these indicators to compare the landscape fragmentation of TiB and the accessibility of green spaces in ten areas across Europe. We finish with a discussion of the advantages and limitations of the methods presented in this article.

The article adds to the existing knowledge and understanding of the relation between biodiversity and human well-being in two aspects. First, it adapts the fragmentation index (Jaeger, 2002) in a way that can be ap- plied to the specific spatial characteristics of TiB. Second it combines the fragmentation index with an indicator for accessibility of green spaces, in order to integrate aspects of ecology, human well-being and the spatial het- erogeneity of the relation between them. With these adapted methods we then test whether the hypothesis that less fragmented green space systems provide better accessibility to green spaces can be supported or not. Furthermore, it allows to identify which settlement pat- terns, and therefore spatial planning approaches, com- bine both biodiversity and accessibility.

5.2 Green structures in TiB and their relation to human well-being and biodiversity

The integration of urban ecology and urbanism into a comprehensive regional planning approach is still a challenge in daily practice. Scott et al. (2013) even describe the disintegration (Shucksmith, 2010) of planning as a key characteristic of territories-in-between. Green spaces in TiB will be in the focus of both problems and potential solutions for environmental and social issues in the coming decades. According to Lovell and Taylor, urban green spaces are the key spatial structure of urban ecosystem services and 'will have a critical role to play in conserving biodiversity, protecting water resources, improving microclimate, sequestering carbon, and even supplying a portion of the fresh food consumed by urban dwellers' (2013, p. 1447). Moreover, green spaces, in the sense of public and private open spaces with a permeable and at least partly vegetation covered surface, continue to have to meet simultaneously cultural and esthetical needs of residents, encouraging leisure activities, and educating people about nature.

Large un-fragmented areas are crucial for biodiversity and health of plant and animal populations. Frag- mentation decreases biodiversity (Beninde, Veith, & Hochkirch, 2015; Dramstad et al., 1996; Faeth & Kane, 1978; Jaeger et al., 2008; Jaeger, Soukup, Madriñán, Schwick, & Kienast, 2011; Kane, Connors, & Galletti, 2014). Levels of fragmentation vary significantly in TiB, depending on the elements that fragment landscape, and thereby block species dispersion and human mobility. These fragmentation elements can be of human nature (e.g., highways or other infrastructures, buildings and densely build up areas), or natural elements (e.g., high mountains, seas and rivers). How fragmenting these elements are is of course species-dependent. The resulting spatial structure—of the web of infrastructure, as well as other human and natural fragmentation elements in TiB is a patchwork of patches with a variety of size.

Eco-corridors are particularly focused for species dispersion and genetic exchange. They are very often considered more crucial then stepping stones (Angold et al., 2006; Beninde et al., 2015; Dramstad et al., 1996; Marulli & Mallarach, 2005). In TiB, eco-corridors are of- ten established along infrastructures (train lines, high- ways) and rivers, the same infrastructures that are also acting as barriers. Another key indicator for biodiversity is the percentage of vegetation cover and vegetation diversity: less than 10% seems a critical value (Aronson et al., 2014; Beninde et al., 2015; Clauset et al., 2009). TiB are mosaics of grey and green open spaces with different percentage of vegetation cover. Significant parts of green spaces are private areas such as gardens and agricultural land. Furthermore, derelict areas and brown- fields are also usual on TiB.

Having defined three key characteristics of the structure of green spaces (patch size, corridors and vegetation cover), we can now relate them to the contributions to human well-being. The provision of healthy and afford- able food and the possibility to grow food for yourself is the first to consider. There is high potential in TiB for urban agriculture (subsistence) as well as local (organic) food production, because of the large amount of garden area and small public green spaces (Andersson et al., 2007; Gómez-Baggethun & Barton, 2013; Lerner & Eakin, 2011; Thompson, 2012). Whether this potential is used depends both on the accessibility of these areas and the possibility to facilitate local producer-customer contact. However, the risk of pollution because of specific functions (highways, heavy industry and similar), and there- fore a negative influence on the quality of food, is high in TiB.

Micro climate regulation, another relevant positive effect of green spaces, is related to the capacity of evapotranspiration of vegetation. The amount of sealed sur- face is crucial to mitigate the urban heat island effect (van der Hoeven & Wandl, 2013). TiB usually have a rather high amount of impervious areas, but are also of- ten the location of industrial areas or large infrastructure, which contribute to the urban heat island. Shop- ping malls and their large parking lots are also hotspots. This aspect is crucial when discussing future densification of TiB.

Air quality regulation is also directly related to the intensity of vegetation cover. Leaves reduce particulate matter, ozone, sulphur dioxide, carbon monoxide, and many more pollutants, but pollen can also cause allergies. These effects are very often local and need to take place close to the source of pollution. The intermingling of infrastructure, green spaces and housing areas in TiB is predesignated for that.

Green spaces are important for the development of educational, aesthetic and cultural values as well as improving recreation and physical and mental health. Experiencing (urban) biodiversity is a key to halting the loss of global biodiversity because people are most likely to take action for biodiversity if they have direct contact with nature (Beumer & Martens, 2014; Müller & Werner, 2010). Urban green spaces can contribute to human interaction by providing the possibility for both social interaction as well as privacy needs. Natural landscape features con- tribute to the development of aesthetic preferences and thereby contribute to a sense of community. Private gardens are one of the key attractors for people to move towards the edges of the cities and into TiB. On the other hand, TiB lack traditional urban landmarks, whilst landscape features are often contributing to a sense of place and community (Campi et al., 2000).

Green spaces in TiB provide possibilities for physi- cal exercise: staying in or close to green spaces reduces stress as well as the heart rate; trees contribute to the pu- rification of water and air as well as to balancing temperature; all these aspects are related to health issues such as respiratory diseases, obesity, sedentary lifestyles, cardiac diseases as well as loneliness. As most green spaces in TiB are either private gardens or privately owned agricultural areas, the relevance for this aspect is accessibility. Who has access with what means to which green spaces is crucial. Unclear ownership and responsibility for spaces provide both difficulties and potentials for accessibility.

Having discussed the relationship between the spatial structure of green spaces in TiB and their posi tive effects on human well-being and biodiversity we are able to identify indicators to empirically determine their relationship in reality. To summarize the content of the above, patch size, together with landscape fragmentation by infrastructure leads to a specific mosaic of patches in an area, which is very often brought into relation with the quality of ecosystems and their richness of habitats and species (Jaeger, 2002; Jaeger et al., 2011; Park, 2015). It is also increasingly recognised that the mosaic of patches is related to human well-being (Di Giulio, Holderegger, & Tobias, 2009; Girvetz, Thorne, Berry, & Jaeger, 2008) particularly to cultural and recreational aspects (Matsuoka & Kaplan, 2008) as well as physical and mental health (Pretty, Peacock, Sellens, & Griffin, 2005). Who has access to which green space is not covered by the description of the green space structure alone. It is relevant to know who can reach and profit from the relevant green spaces, that is, who lives within the service area of the different green spaces.

Therefore, we describe two indicators: landscape fragmentation and accessibility of green spaces, and how they have to be adapted to be used for the comparison of TiB. We also present the used data for calculating the indicators in the following paragraphs. Beforehand, the ten cases of the comparison of TiB across Europe are introduced.

5.3 Cases, methods and data

Left out to avoid duplication. Refer to Chapter 4.

5.3.1 Adapting Jaeger’s landscape fragmentation index for TiB

The European Environment Agency (EEA) report *Landscape Fragmentation in Europe* (2011) provided the first assessment of landscape fragmentation for all EU countries using the following two indicators:

- effective mesh size (m_{eff});
- effective mesh density (s_{eff}).

Both were introduced by Jaeger (2002) and further developed by Girvetz et al. (2008) and are an expression of the patch size of unfragmented areas. According to the EEA (2011, p. 17), ‘the effective mesh size (m_{eff}) serves to measure landscape connectivity, i.e. the degree to which movement between different parts of the landscape is possible. It expresses the probability that any two points chosen randomly in a region are connected; that is, not separated by barriers such as transport routes or built-up areas. The more barriers fragmenting the landscape, the lower the probability that the two points are connected, and the lower the effective mesh size. m_{eff} can be expressed in the following formula:

$$m_{eff} = \frac{1}{A_t} \sum_{i=1}^{n} A_i^2$$

Where n is the number of patches, A_i to A_n represent the patch sizes from patch 1 to patch n, and A_t is the total area of the region investigated. The effective mesh density (s_{eff}) gives the effective number of meshes per km², in other words the density of the meshes. This number is very easy to calculate from the effective mesh size. It is simply a question of how many times the effective mesh size fits into an area (EEA, 2011, p. 24):

$$s_{eff} = \frac{1}{m_{eff}}$$

To calculate the landscape fragmentation a fragmentation geometry, which is formed by the built and natural elements that are impassable borders in a specific area, has to be defined. In FIG. 5.1 we show a simple example how m_{eff} changes with different fragmentation geometries.

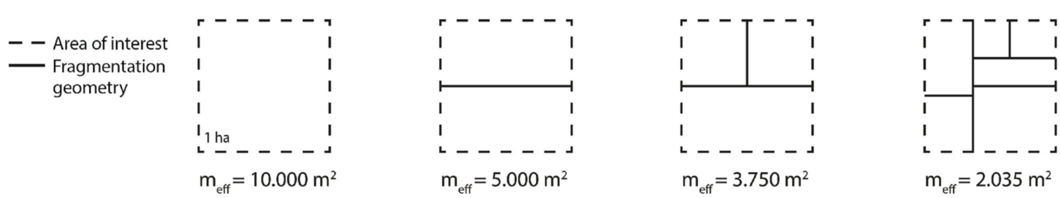


FIG. 5.1 Different fragmentation geometries and their effective mesh size.

Jaeger et al. (2011, p. 28) use a combination of CORINE land use data, data of the street network, elevation data expressing high non-passable mountains, as well as temperature and river catchment areas to define their fragmentation geometry (see Table 5.1). They also state that it is important to reconsider and adapt the fragmenting elements for studies with different scope. The following paragraphs present such an adaptation for studying TiB on a regional scale.

For the comparison of TiB, the inclusion of discontinuous urban fabric into the fragmentation geometry seems problematic, as this area often includes low density built up areas with a lot of green spaces, mostly private gardens, which have a high percentage of vegetation cover and are crucial for certain benefits as mentioned earlier. Another problematic aspect is the complete exclusion of industrial areas, commercial units, roads and railroads, because the vegetated areas along these areas are very often ecological corridors, and also create buffer zones which provide benefits for human well-being such as purifying air and water and adding to aesthetical aspects of the landscape.

Therefore, the fragmentation geometry that was used to compare TiB across Europe was adapted. As Jaeger et al., we use the continuous urban land cover and the street network as a basis. But instead of using the other types of CORINE land cover, we used areas without vegetation cover as fragmentation elements.

To do so, the normalized difference vegetation index (*NDVI*), which is an indicator for photosynthetic activity, was calculated. This was done using Landsat 5 images with 30 m resolution. This allows for the identification of landscape elements such as gardens or small areas of fallow land, which are often not blocking the dispersal of species, but are on the contrary, often important parts of an urban green network structure and exclude it from the fragmentation geometry.

The *NDVI* was acquired using the following equation:

$$NDVI = \frac{IR - R}{IR + R} \times 100 + 100$$

Where *R* and *IR* are the spectral reflectance in the TM red and near-infrared bands. The *NDVI* equation produces values in the range from 0–200, where values bigger than hundred indicate vegetated areas and values smaller than 100 signify non-vegetated surface features. These values vary of course, reflecting different states of the vegetation process over the year. Therefore, cloudless images at the beginning of the Summer of 2009 were selected for the analyses and the final selection of the pixel values that were used as fragmentation geometry.

The year 2009 was used as it was the last period where for all cases cloud free image could be obtained during the vegetation period. Table 5.1 presents all datasets that were used to construct the fragmentation geometry.

5.3.2 Accessibility of green spaces

The key spatial elements that provide benefits for human well-being are green spaces, therefore the accessibility of green spaces can be seen as key indicator for human well-being in TiB. There are several standards that describe how much green space should be accessible to inhabitants of the area. Natural England, for example, defines the following (Comber, Brundson, & Green, 2008, p. 104):

- No person should live more than 300 m from their nearest area of natural greenspace of at least 2 ha in size;
- There should be at least one accessible 20 ha site within 2 km from home;
- There should be one accessible 100 ha site within 5 km;
- There should be one accessible 500 ha site within 10 km.

TABLE 5.1 Fragmentation elements according to Jaeger et al. (2011) in comparison to the adapted method.

Jaeger et al. (2011)		Proposed in this article		Comments
Data set	Fragmentation elements	Data set	Fragmentation elements	
Landcover				
Corine Land Cover (CLC)	1.1 Continuous and discontinuous urban fabric	Landsat 5-5 TM. http://glovis.usgs.gov/	NDVI >100 and Area>200m2	
	1.2. Industrial, commercial and transport units			
	1.3 Mine, dump and construction sites			Re-cultivated parts have a NDVI>100 and are therefore not considered as fragmenting
	1.4 Artificial, non-agricultural vegetated areas			Have a NDVI>100; and form part of the system of urban green spaces, therefore not fragmenting
	4.2.2 Salines			NDVI<100
	5.1.2 Water bodies			
Transport Infrastructure				
Tele Atlas MultiNet ©	00. Motorways; (Buffer 30 m)	Open Street Map http://www.openstreetmap.org/	Motorway; Motorway Link (Buffer 50 m)	Buffers are wider, because line features were used
	01. Main Roads (Buffer 20 m)			
	02. Other Major Roads (Buffer 15 m)		Trunk; Trunk Link (Buffer 50 m)	
	03. Secondary Roads (Buffer 10 m)		Primary; Primary Link (Buffer 24 m)	
	04. Local Connecting Road (Buffer 5 m)		Secondary; Secondary Link (Buffer 24 m)	
	Railroads (Buffer 4 m)		Tertiary; Tertiary Link (Buffer 10 m)	
			Light rail/Mono rail (Buffer 10 m)	
			Tram (Buffer 5 m)	
Altitude, Slope and Temperature				
WorldClim	Mean temperature July<9.5 Celsius			Not within TiB
Nordregio	Elevation higher 2,500m			Covered by NDVI<100
	Elevation higher 1,500m and slope>2 degree			
CCM2: Catchment characterisation and modelling Version 2.1	Catchment areas greater than 3,000 km^2			Not relevant for TiB

Van Herzele and Wiedemann (2003), for example, propose a typology of green spaces and related sizes and distances of their service areas (see Table 5.2).

These approaches already demonstrate that there are quite some differences in the distances of service areas as well as sizes of green spaces. It is interesting also that none of the standards known to the author define precisely how to calculate these distances. Are those Euclidian, Manhattan or network distances? And from where to where is the distance measured, from access points of the green spaces or the centre of park?

According to Higgs, Fry and Langford (2012, p. 328) the identification of the following three elements has to be defined clearly in order to make a precise assessment:

1. an origin point, representing the geographical location of the population potentially seeking to access green space;
2. a destination point, representing the geographical location of the green space;
3. a distance measurement taken between these two points.

While we agree completely with points two and three, we would like to reconsider the first one. Defining an origin and destination matrix is a common approach for accessibility studies, but two aspects are critical. First, where should the point of origin within an analytical areal unit (municipality, census area or similar) be located? Second, the proposed method of point to point analysis does not allow drawing conclusions about which uninhabited areas have higher potential for future development, and therefore it has only limited value for planning. Therefore, we choose to use service areas, as these areas are within a specific network distance of a point of origin, instead of an origin to destination matrix.

In order to assess the accessibility of green spaces three groups of sizes of green spaces were chosen:

TABLE 5.2 Minimum standards for urban green spaces. Source: Van Herzele & Wiedemann (2003, p. 113).

Functional level	Maximum distance from home	Minimum surface (ha)
Residential green	150	
Neighbourhood green	400	1
Quarter green	800	10 (park 5)
District green	1,600	30 (park 10)
City green	3,200	60
Urban forest	5,000	300

- Green spaces between 1 and 10 ha, which are key for the provision of benefits for human well-being in the direct living surrounding, should be accessible in very short time and distance, and therefore also accessible for less mobile population groups like elderly and children;
- Green spaces between 10 and 30 ha, which serve bigger areas like districts in an urban environment, but also whole settlements in a more dispersed environment, with a bigger service area, but still used on a daily basis and should therefore be in a walking distance under 15 minutes (Matsuoka & Kaplan, 2008);
- Green spaces larger than 30 ha, which have a regional effect.

In order to assess how many people have access to green spaces we assigned service areas to each of the classes of green spaces. A service area is the area from which any access point of a specific green space is reachable within a certain distance along the network of streets. As Table 5.3 shows, bigger green spaces have multiple service areas, as they provide in their closer vicinity the same services as smaller ones.

The calculation and mapping of the service areas requires the following steps.

- Selecting relevant green spaces—those un-fragmented areas (patches) that are bigger than 1 ha;
- Using the intersection points of the street network with the green spaces as access points to these green spaces. We applied a 25 m threshold for passing bystreets and paths to also consider that it's not necessary to actually enter the green space to profit from it;
- Calculation of the service areas along the street network, using the ARCGIS network analyst for the radii in Table 5.3 , from each of the access points.

The service areas of the different green spaces may overlap and thereby create an intensity map of access to green spaces. This intensity map is than overlaid with a 1km grid which contains the size of population. The resulting map and dataset shows then where and how many people have which intensity of access to green spaces.

5.3.3 Combining the two indicators

The aim of the article is to draw conclusions on both ecological qualities of the system of green spaces—as well as on the benefits for humans the system of green spaces provides—in a way that regional planners and designers can assess future plans and projects. Therefore, two methods of combining the indicators were chosen. The first one combines both indicators on a systems level. It is a simple juxtaposition of the effective mesh size of a case and the intensity of access to green spaces. Intensity stands for the amount of green spaces a specific part of the population has access to: the more green spaces, the higher the intensity. This allows to consider if less fragmented green networks also provide a higher intensity of accessibility to green spaces.

The second method presents the amount of green space according to the three categories of size in Table 5.3 and relates them to the percentage of population for whom they are accessible. This provides a better understanding about the relation of accessibility and the size distribution of the green spaces in a system and allows us to reflect whether a green space system with a few large green spaces performs better than one that has a variety of sizes.

TABLE 5.3 The different sizes of green spaces and their service areas.

Size of green space in ha	Service area distance in m		
1 to 10	400		
10 to 30	400	800	
>30	400	800	3,500

5.4 Results

This section presents firstly the advantages of the above described method of defining the fragmentation geometry based on NDVI, using the case of South-Holland as an example. Second, the resulting landscape fragmentation is presented for all cases, as well as the distribution of the different patch sizes of green spaces in the ten TiB. Thereafter, the results of the accessibility of green spaces study, following the early described method, are presented. Finally, two ways of combining both indicators are presented: the first compares both on the level of the system of green spaces, the second investigates how the different distribution of patch sizes is related to the accessibility.

5.4.1 Refined fragmentation geometry based on NDVI

In the following we use the case South-Holland as a demonstration case to show the advantages of the methodology described above in representing the complex green structures in TiB. The following FIG. 5.2 andFIG. 5.3 present the two steps of building the fragmentation geometry for the case of South-Holland.

FIG. 5.4, which presents the comparison between fragmentation geometry using the datasets proposed by Jaeger et al. and our adapted method shows clearly the advantage of the latter. The large glasshouse areas south-west of The Hague for example, which fall in the CLC class non-irrigated arable land and do not, in the method of Jaeger et al., contribute to the fragmentation geometry, although they are completely built up areas and thus should be included in our fragmentation geometry. The green spaces at the edge of The Hague, which belong to the CLC discontinuous urban areas, are considered to be part of the fragmentation geometry according to Jaeger et al., although they play a crucial role as green corridor system of the The Hague-Rotterdam Metropolitan region. Our method identifies them as such and excludes them from the fragmentation geometry.

5.4.2 Comparing landscape fragmentation in TiB across Europe

Table 5.4 presents the effective mesh size as well as the mesh size density for the entire (urban, rural and TiB) case study areas as well as only for the TiB within the square of 50 by 50 km. As expected, Table 5.4 and FIG. 5.8 show that the two cases with the smallest population figures are the least fragmented and the one with the largest population density is the most fragmented. The ranking of the other cases does not show a relation to population density, which is an interesting outcome.

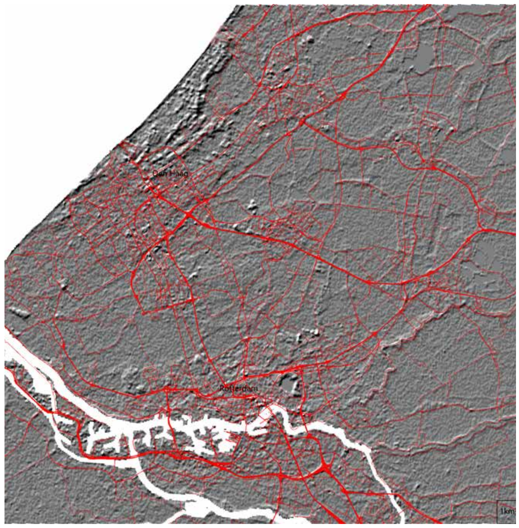


FIG. 5.2 The first step of the fragmentation geometry (in red) based on street and railway network obtained from open street map data for the 50 x 50 km square in the case of South-Holland. Source: author.

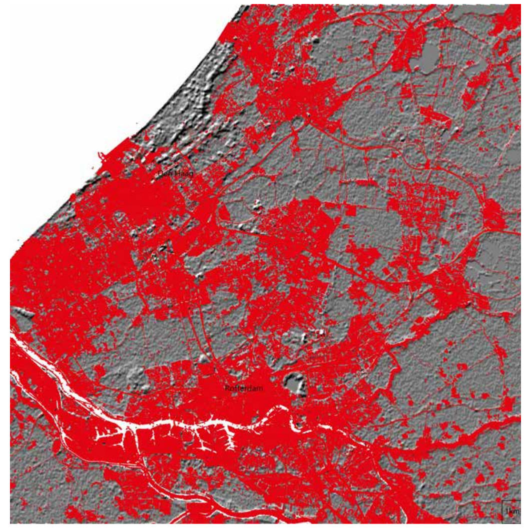


FIG. 5.3 The complete fragmentation geometry (in red), including the areas which were selected through adding the results from the NDVI analyses. Source: author.

Before comparing the fragmentation only within TiB, it is important to mention, that the cases are much less diverse considering the density of inhabitants, than for the whole case study area. Also, the ranking among the cases considering the population density changed. TiB in South-Holland are the most densely populated, followed by South Wales and Île-de-France (see Table 5.1). Onthe less dense end of the list the Tyrol overtakes Vienna- Bratislava. The Veneto, which has the smallest difference between the overall population density and the population density in TiB, has the third least dense TiB.

The landscape fragmentation across the cases is much less diverse. The effective mesh size in the Tyrol is 220 times bigger than the one in Île-de-France. This factor shrinks to four, when only comparing the effective mesh sizes of the TiB in those two cases. Considering only TiB, no relation between the population density and landscape fragmentation can be observed. The case with the lowest population density, Vienna-Bratislava, still performs best but the three most densely populated TiB are in the middle of the ranking. Therefore, it can be concluded that natural topography, as well as elements like technical and green-blue infrastructures and the resulting settlement patterns and metropolitan structures, which are influenced by planning and design, have an influence on this indicator.

FIG. 5.4 The comparison of different ways of building the fragmentation geometry. On the right-hand side using a NDVI based analyses and on the left-hand side using CORINE land cover classes according to Jaeger et al. (2011). The black square shows the location of the bird's eye view of Figure 5.6.

FIG. 5.5 Bird's eye view over the TiB around The Hague showing the glass house areas on the left and the green buffer zone surrounding the suburban settlements. Source: Google Earth.

TABLE 5.4 Comparison of effective mesh size and mesh size density in the ten cases.

Case study name	Total case study area			TiB within case study area		
	m_{eff}	S_{eff}	Rank	m_{eff}	S_{eff}	Rank
Bergamo-Brescia	21.912	0.046	3	0.405	2.468	10
Gelderland	9.191	0.109	8	0.956	1.046	7
Île-de-France	0.875	1.142	10	1.485	0.673	4
North Somerset	20.162	0.050	4	1.721	0.581	3
Pas-de-Calais	9.694	0.103	7	2.303	0.434	2
South-Holland	10.668	0.094	6	0.477	2.098	9
South Wales	13.553	0.074	5	1.224	0.817	6
The Tyrol	199.320	0.005	1	1.459	0.685	5
Veneto	1.672	0.598	9	0.865	1.156	8
Vienna-Bratislava	22.917	0.044	2	2.782	0.359	1

The overview of number and total size of green spaces per category, in Table 5.5, shows that in all cases but South-Holland, a few large (>30ha) green spaces count in total for more area of green spaces than all small and medium sized green spaces together. The accessibility of these large green spaces is therefore crucial when combining both indicators to understand the relation between the spatial structure of the system of green spaces and effects on human well-being.

Small green spaces account for more hectare than medium size green spaces in all cases. For the majority of cases, the smallest class of green spaces accounts for more than 97% of the number of green spaces. Exceptions are Pas-de-Calais and Gelderland, which count relatively more medium sized green spaces as well as large green spaces, namely around 3%, compared to the mean of all cases, which is 1.9%. Moreover, The Tyrol's share of medium (6%) and large (10%) green spaces is significantly different to all other cases.

Both Dutch cases have a significantly higher area of mid-sized green space. In contrast, the two Austrian cases have significantly less area that falls into this category. Within the TiB of Pas-de-Calais, The Tyrol andVienna-Bratislava are significantly more hectare of green spaces, which are classified as large green spaces compared to all other cases.

To summarize, if the hypothesis is correct that the amount of large green spaces is not only crucial for the landscape connectivity, but also for the accessibility of green spaces, then Vienna-Bratislava, The Tyrol and Pas- de-Calais should perform best, and South-Holland should perform worst for the indicator accessibility of green spaces. If we follow the above argument that the effective mesh size is a better measure, also for the accessibility of green spaces, then Vienna-Bratislava, Pas-de- Calais and North Somerset should perform best, whereas Bergamo-Brescia and South-Holland are expected to perform worst concerning the accessibility of green spaces.

TABLE 5.5 Comparison of the number, area and size of green spaces according to small, medium and large size. As well as the percentage of each in relation to the total.

Case	Green space < 10ha				10ha < Green spaces < 30ha				Green spaces > 30ha			
	Nr.	% of total Nr.	Area in ha	% of total area	Nr.	% of total Nr	Area in ha	% of total area	Nr.	% of total Nr.	Area in ha	% of total area
Bergamo-Brescia	8,015	97.8	3,657	29.2	93	1.14	1,653	13.2	85	1.0	7,217	57.6
Pas-de-Calais	5,260	93.7	3,101	11.9	158	2.81	2,746	10.5	198	3.5	20,213	77.6
Île-de-France	7,113	96.7	3,577	20.7	121	1.65	2,048	11.9	119	1.6	11,632	67.4
The Tyrol	374	83.3	557	9.0	27	6.01	527	8.5	48	10.7	5,112	82.5
Gelderland	4,169	94.0	2,135	13.6	127	2.86	2,372	15.1	140	3.2	11,199	71.3
North Somerset	2,531	96.5	1,122	15.2	41	1.56	701	9.5	50	1.9	5,537	75.2
South-Holland	9,789	97.9	4,598	36.0	134	1.34	2,300	18.0	81	0.8	5,883	46.0
South Wales	6,296	96.6	2,737	19.7	117	1.80	1,947	14.0	102	1.6	9,213	66.3
Veneto	7,210	96.0	3,719	19.3	145	1.93	2,700	14.0	154	2.1	12,826	66.6
Vienna-Bratislava	2,921	97.1	1,295	12.8	28	0.93	455	4.5	58	1.9	8,406	82.8

5.4.3 The comparison of accessibility of green spaces in the territories-in-between

Before interpreting the data below, it is important to keep in mind that a minimum size of 200m2 was chosen as lowest threshold to include a green space into the study. This means that isolated small green spaces, such as courtyards and small private gardens, are not considered. A general observation is that in all cases, except the Île-de- France, in both dense urban areas and TiB more than 50% of the population has access to at least one type of green space. For TiB this is true for all cases. Across all cases the percentage of population that has access to more than one type of green space is at least double the amount for TiB than for dense urban areas. The population within TiB that has access to at least one type of green space ranges from around 50% (Bergamo-Brescia and Pas de Calais) to close to 90% in Gelderland. In the majority of cases (7 of 10) more than half the population of TiB has access to more than one type of green space. A comparison of the two metropolitan cases, the Île-de-France and South- Holland shows that the latter performs nearly twice as well. Cases from the same country perform rather similarly, again with the exception of France. The following Table 5.6 and Table 5.7 present the number of people living in different zones of intensity of accessibility to green space in the different case study areas.

5.4.4 Combining the two indicators and interpreting the results

In the following the two indicators are combined and interpreted in two different ways. The first combination, investigates, which category of size of green spaces serves the highest percentage of population. If the biggest green spaces serve the highest share of population, then the least fragmented TiB should be those with the highest accessibility of green space as well.

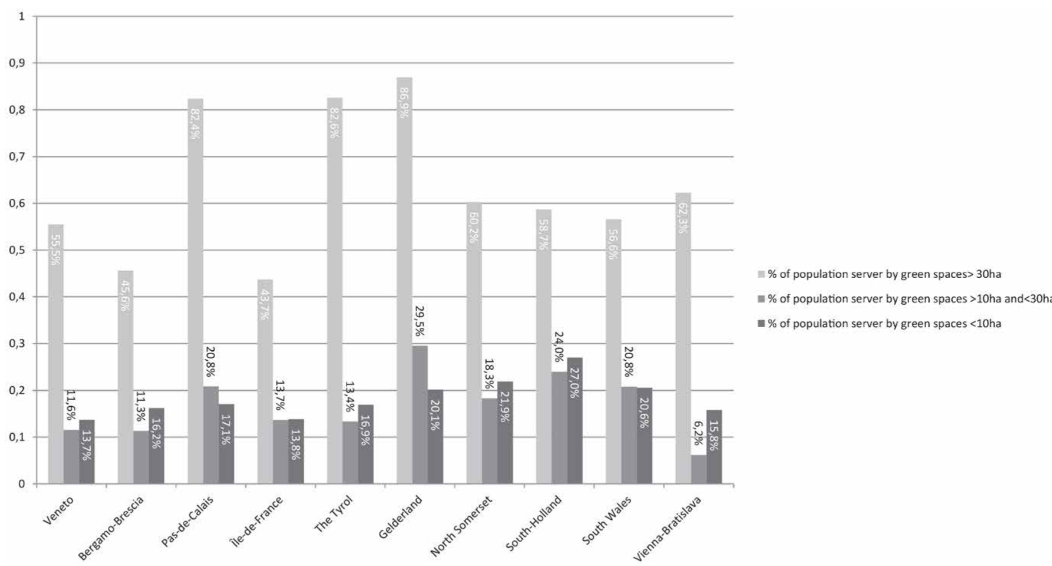


FIG. 5.6 Name and location of the ten case studies.

FIG. 5.6 presents the percentages of population in TiB within the service areas of a specific size category of green spaces. Mind that percentages add up over 100%, because certain parts of the population are served by more than one type of green space, which was expressed in the above described intensity of accessibility.

In all cases the largest category of green spaces serves the highest amount of population. In three cases The Tyrol, Gelderland and Pad-de-Calais, more than 80% of the population are served by large green spaces. In the Ile-de-France, as well as in Bergamo-Brescia, relatively few, below 50% of people are served by large green spaces. In the two Dutch cases relatively many people are served by medium sized green spaces. In the case of Vienna-Bratislava, the mid-sized green spaces only serve around 6% of the population and both Italian cases with around 11% also score rather low. South-Holland stands out with 27% of population served by small green spaces. The Veneto and the Ile-de-France perform the weakest in this category.

TABLE 5.6 Intensity to accessibility to green spaces in urban areas and TiB in ten cases.

Case study name	Urban areas in case study areas			TiB within case study areas		
	Access to at least one type (%)	Access to more than one type (%)	Rank	Access to at least one type (%)	Access to more than one type (%)	Rank
Bergamo-Brescia	47	7	9	53	24	10
Gelderland	92	20	2	89	58	1
Île-de-France	11	1	10	52	28	9
North Somerset	53	9	8	68	40	4
Pas-de-Calais	96	35	1	83	52	3
South-Holland	57	8	7	68	40	4
South Wales	66	6	4	63	43	7
The Tyrol	95	18	3	83	53	2
Veneto	62	6	5	62	29	8
Vienna-Bratislava	65	3	6	66	29	6

TABLE 5.6 Intensity to accessibility to green spaces in urban areas and TiB in ten cases.

Case study name	Urban areas in case study areas			TiB within case study areas		
	Access to at least one type (%)	Access to more than one type (%)	Rank	Access to at least one type (%)	Access to more than one type (%)	Rank

Table 5.7 and Figure 10 present both indicators combined and show that there is not a clear relation between the performance of one indicator and the other. There are cases that perform relatively poorly (Bergamo-Brescia) or well (Pas-de-Calais) for both indicators, but there are also cases that perform relatively well for one and relatively poorly for the other (Gelderland). Therefore, an interpretation of the results needs always at least the combination of landscape morphological aspects, economic development performance, as well as an understanding of the varying regional planning and design approaches.

Pas-De-Calais is the overall strongest performing case. This is the result of a settlement pattern that is characterised by rather compact towns and villages that are embedded in and separated from each other by an agricultural platform, which has rather small grainsize and a dense accessible network of agricultural paths. The compactness of the settlements is partly also the result of the economic decline of this former mining area during the last decades of the twentieth century. A network of green spaces that follows the rivers through towns and countryside functions as eco-corridors and increases the accessibility of green spaces. Finally, the ongoing transformation of mining brownfields into parks and leisure areas since the 1990s has contributed to the high performance of system of green spaces in the case of Pas-de-Calais.

TABLE 5.7 Accessibility of green spaces as well as landscape fragmentation in TiB across Europe.

Case study name	Percentage of population with			Landscape fragmentation	
	Access to at least one type	Access to more than one type	Rank	m_{eff}	Rank
Bergamo-Brescia	53	24	10	0.405	10
Gelderland	89	58	1	0.956	7
Île-de-France	52	28	9	1.485	4
North Somerset	68	40	4	1.721	3
Pas-de-Calais	83	52	3	2.303	2
South-Holland	68	40	4	0.477	9
South Wales	63	43	7	1.224	6
The Tyrol	83	53	2	1.459	5
Veneto	62	29	8	0.865	8
Vienna-Bratislava	66	29	6	2.782	1

Gelderland, which performs best for accessibility of green space but rather weak concerning landscape fragmentation, has also a compact settlement pattern with agricultural areas, which are highly accessible, specifically by bike, between each city or village. But the road network is much denser than in Pas-de-Calais and therefore, Gelderland shows a higher landscape fragmentation.

The second French case, which is situated at the northern border of the Île-de-France, performs relatively well concerning the landscape fragmentation but relatively poor concerning the accessibility of green spaces. This result can be explained by the fact that most of the big green areas are large forests, mostly former feudal estates, which form large patches of un-fragmented areas and are also accessible by the public, but have rather few entrances, reducing their service areas. The enormous continuous settlement pattern of single family houses at the outskirts of Paris lacks a developed network of small and mid-sized green spaces. Here also rather large forests or parks are the dominant green spaces, which are again not accessible by many people within a short distance. Furthermore, business parks and infrastructure facilities are very often located at the edges of the settlements which may have curbing effects on future settlement development, whilst also blocking access to the agricultural platform and its ecosystem services.

A further interesting case is South-Holland. As one of the most densely populated cases it performs as expected, that is relatively poorly, concerning landscape fragmentation, and surprisingly relatively well concerning the accessibility of green spaces. The latter is the result of the ongoing protection of buffer zones between the cities, which are slowly developing into leisure areas, and the very dense network of regional bike paths that make this and other agriculturally used areas highly accessible. The extensive zone of dunes along the coast that are protected for their natural value and for flood defence reasons have only limited accessibility, but provide still benefits to big parts of the population. This coastal zone is, specifically in the post war areas of The Hague, connected to a well-developed network of green corridors and parks with many small and mid-sized green spaces.

The green belt around Cardiff and Newport, which forms the biggest part of the green space structure in the case of South-Wales, performs relatively and to a certain extent surprisingly weak, considering the idea of the green belt is one the originated from the garden city and should provide accessible countryside. The reason for the rather bad performances, is that the settlement pattern next to the green belt is a suburban cul-de-sac pattern, which means, low density and little possibility to walk through. Moreover, highways are fragmenting the green belt heavily.

The relative poor performance of the two Italian cases can be explained on the one hand by the dense infrastructure network in the areas, which leads to high landscape fragmentation, and on the other hand, the few large green areas. The green areas are often under natural protection and rather distant from larger settlements and not very well connected to them.

The Tyrol is a case where the influence of topography is very apparent. The fact that the TiB are all located within the valleys where also the infrastructure is concentrated, leads to a highly fragmented territory. However, the ribbon structure of the settlement pattern, has the consequence that big green spaces are very close to the settlements. This spatial configuration combined with a dense network of agricultural and touristic paths and streets—the result of a flourishing tourism industry of the last 50 years—provides a very high accessibility of green spaces.

5.5 Conclusions

We come back to the simple hypothesis set out: Do less fragmented greenspace systems in TiB provide also better accessibility to green spaces? And can we identify, which settlement patterns and therefore spatial planning approaches, combine both biodiversity and accessibility the best? The answer is, for the ten tested cases, that there is not a clear relationship between landscape fragmentation and accessibility of green spaces. There is the same amount of cases that perform equally weak/strong for both indicators, as there are cases that perform contrasting for both indicators.

Clear conclusions can be drawn for the settlement patterns that perform best. A large and un-fragmented regional network of greenspaces as backbone is crucial. Whether this is in the form of green belts, green fingers, buffer zones or landscape parks, does not make a big difference. Crucial is that these large green spaces are easily accessible, preferably by foot, bike or public transport. Furthermore, it is important that traffic and other infrastructures are located and designed in a way that they fragment the big green spaces as little as possible and do not block access to these large green spaces. It is also important to avoid cul-de-sac settlement patterns and gated communities, as well as impermeable industrial or business parks at the edge of the settlements.

Cases that have a more compact settlement pattern—where individual cities, towns and villages are separated by medium sized greenspaces—tend to perform better on both indicators. Crucial here is to make sure that the medium sized green spaces are easily accessible. In contrary to large green spaces, the midsized green spaces are often not part of national planning or environmental protection, therefore regional and cross municipal cooperating is essential to establish this part of a regional green system.

Finally, a large amount of fair distributed small green spaces is crucial as well. This is specifically relevant for TiB, as ongoing densification is often related with a change of housing typology from single family housing with private gardens to flat buildings without private gardens. Moreover, densification transforms green spaces, which are often considered as underused, but are nevertheless essential for biodiversity and human well-being.

The presented results and maps have the potential to facilitate and inform discussion across the many fields of expertise and actors involved in protecting and assist in developing system of green spaces in TiB. This is specifically important for TiB, where the expected future densification of urban uses and the protection of (urban) biodiversity are causing and will continue to cause conflict among different groups of interest.

The above examples of the interpretation of the two indicators, with admittedly limited knowledge about the local specificities, provides an idea about their usefulness and limitations. The indicators, landscape fragmentation and accessibility to green spaces as well as their combination can be used to compare the potential benefits of green spaces on a regional or metropolitan scale, and thereby compare the performance of different settlement structures. The presented methodology allows for comparison of historic, present and proposed alternative future settlement patterns, and can inform regional planning and design as well as other policy fields.

The key advantage of the method described is the use of NDVI to identify green spaces instead of using CORINE land cover data, because remote sensing allows a more fine-grained identification of green spaces. Satellite data is readily available across the globe and allows, therefore, the methods to be applied worldwide. But there are also limitations as it is difficult to find satellite images, which have no cloud cover. Also, the time of the year the satellite image has been taken has an influence on the indicators. Only images during the vegetation period should be used and harvesting times of agricultural crops have to be considered otherwise barren land is not identified as green space.

A further limitation is that indicators express the potential effects of green spaces. As fieldwork shows, the actual access to specifically agriculturally used areas is often forbidden—this is specially true for the Italian cases. A similar aspect is that the method does not distinguish between private and public spaces, which means that private gardens are included in the assessment, not considering if they or the streets next to them are actually accessible or not. This is critical for gated communities with limited access and therefore, for aspects of spatial justice.

The last limitation leads to a crucial field of further research, which is to combine the indicators with additional demographic data, (e.g., income, ethnicity or level of education), relating the accessibility of greenspaces and their positive human impacts more clearly to aspects of spatial justice. This kind of studies have been done for urban areas but not for TiB yet. The article also considers only the service areas of green spaces in relation to resident population, but it would be equally interesting and important to extend the assessment to the working population, as a large part of the population is not home throughout much of the day.

Finally, we can conclude that several of the qualities Howard formulated for his Town-Country magnet are present in TiB: beauty of nature and societal opportunity; fields and parks of easy access, pure air and water and good drainage. Those qualities are also related to the key benefits of green structures described in this article and shows how timeless Howard’s vision is. It also shows that it is worth using both indicators in combination and look at TiB as distinct and separated from urban areas and understanding them as places in their own right, as this helps to leave behind a discussion: whether further densification or dispersion is the key to solving challenges related to sustainable development, and that they are different within urban and dispersed areas.

5.6 Atlas of territories-in-between Part D: Landscape fragmentation and accessibility of green spaces

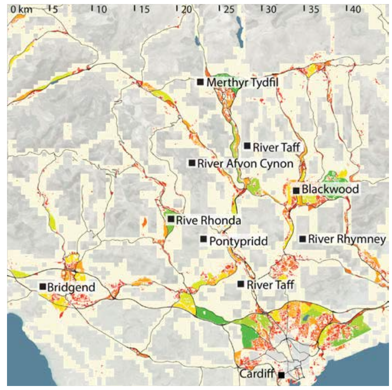
This section of the Atlas of territories-in-between contains three thumbnail double-pages with:

1. Ten maps which present the size of the different green spaces overlaid on to the territories-in-between. The maps were used to calculate the effective mesh size of the ten cases.
2. Ten maps illustrating the number of residents in TiB with access to green spaces.
3. Ten maps showing the intensity of access to green spaces which demonstrate how much of the territory is within the service area of green spaces.

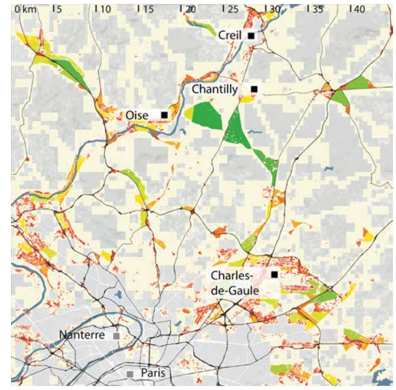
Area of unfragmented greenspace in km²

- 0,0001 < 0,05
- 0,05 < 0,2
- 0,2 < 0,5
- 0,5 < 1,0
- 1,0 < 1,5
- 1,5 < 2,0
- 2,0 < 3,0
- 2,5 < 3,0
- 3,0 < 3,5
- >3,5

Territories-in-between



1 South Wales



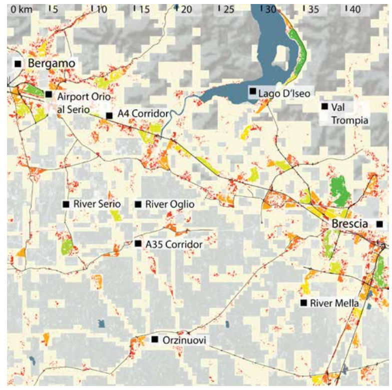
2 Île-de-France

6 North Somerset

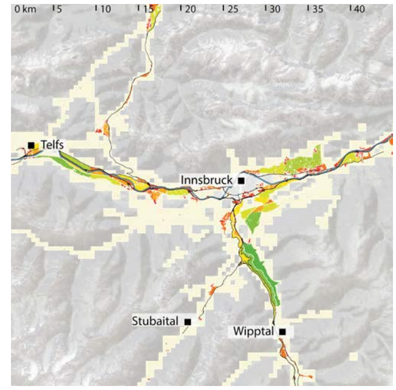
7 Pas-de-Calais

FIG. 5.7 The thumbnail maps show the area of unfragmented greenspace in square kilometre in all ten cases, as an indication for the landscape fragmentation of territories-in-between. For larger maps and more detailed description, see atlas part G.

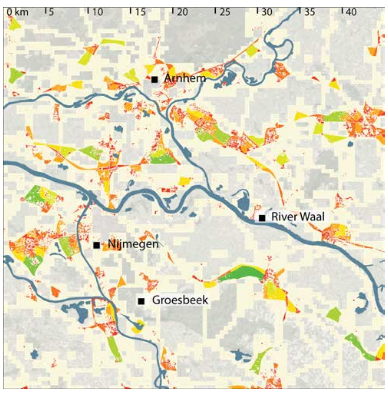
3 South-Holland



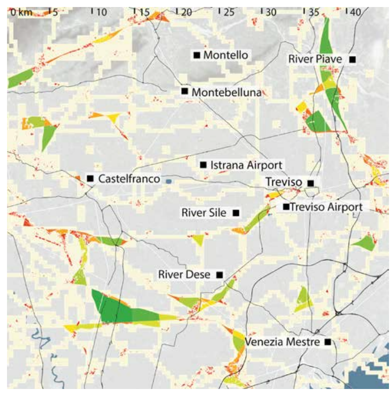
4 Bergamo-Brescia



5 The Tyrol



8 Gelderland



9 Veneto

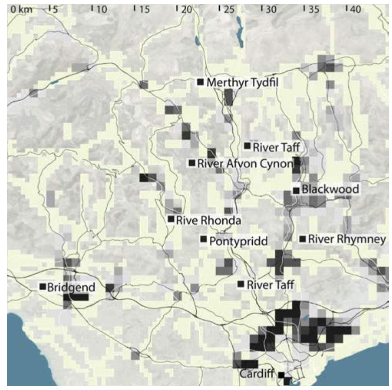
10 Vienna-Bratislava

ACCESSIBILITY TO GREEN SPACES

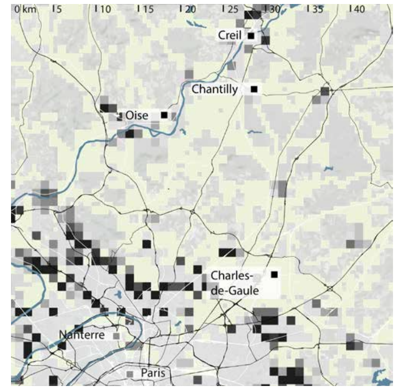
Number of inhabitants per sq. km with access to green spaces within TiB

- 10 < 500
- 500 < 1.000
- 1.000< 1.500
- 1500 < 2.000
- 2.000 < 2.500
- 2.500 < 3.000
- 3.000 < 3.500
- 3.500< 5.000

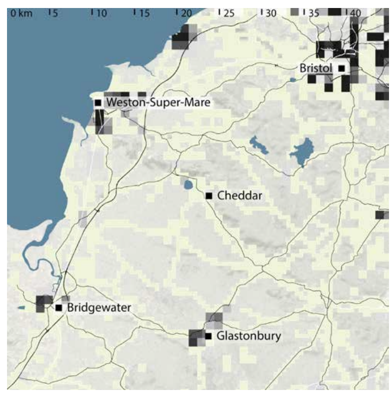
Territories-in-between



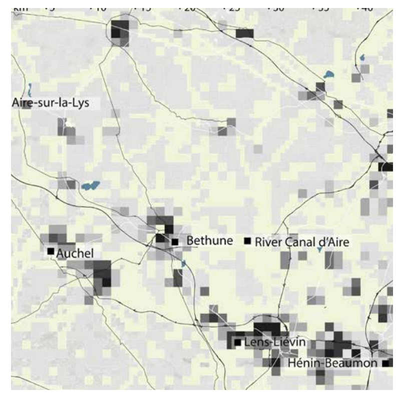
1 South Wales



2 Île-de-France

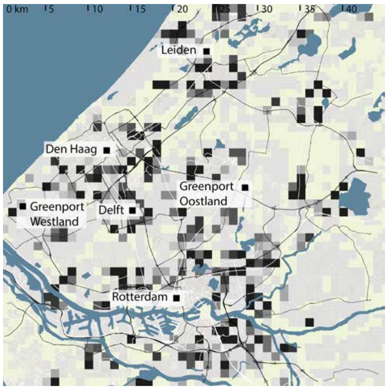


6 North Somerset

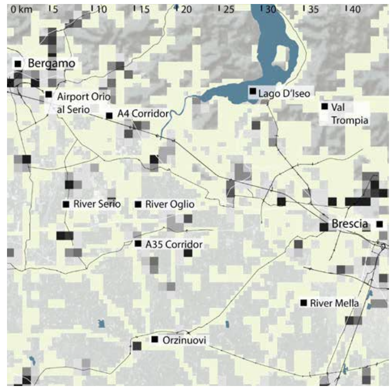


7 Pas-de-Calais

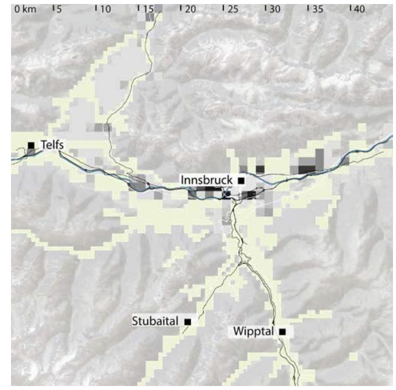
FIG. 5.8 The thumbnail maps show how many people per square kilometre have access to at least one green space. For larger maps and more detailed description, see atlas part G.



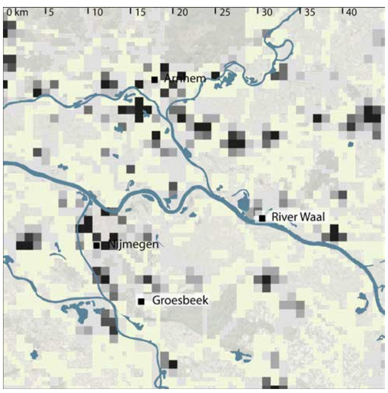
3 South-Holland



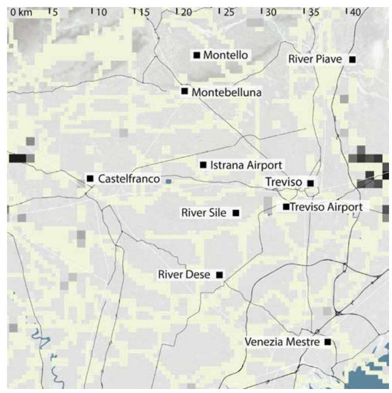
4 Bergamo-Brescia



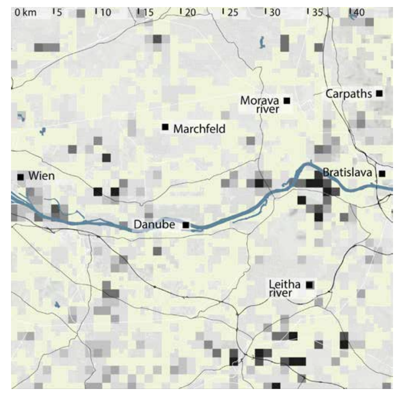
5 The Tyrol



8 Gelderland



9 Veneto



10 Vienna-Bratislava

INTENSITY OF ACCESS TO GREEN SPACES

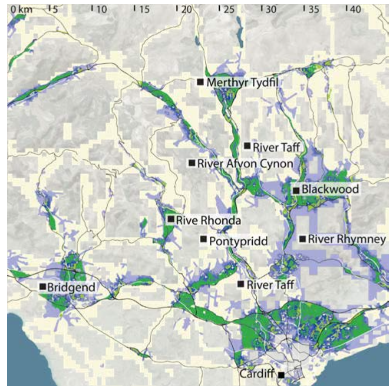
Number of green space an area is served by

1
2
3
4
5
6
7

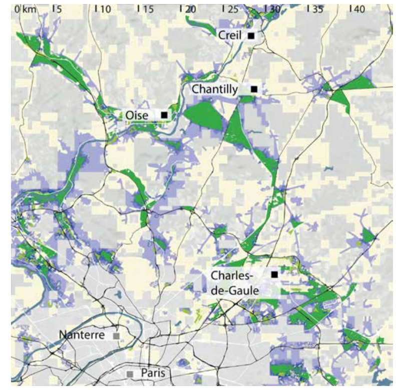
Size of green spaces in hectare

<10
>10 and <30
>30

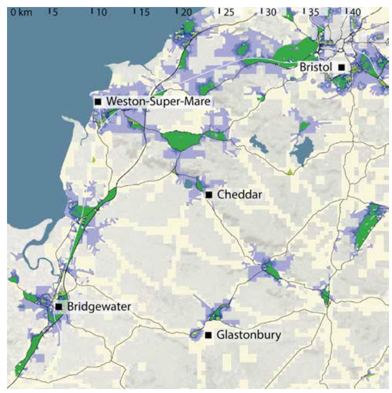
Territories-in-between



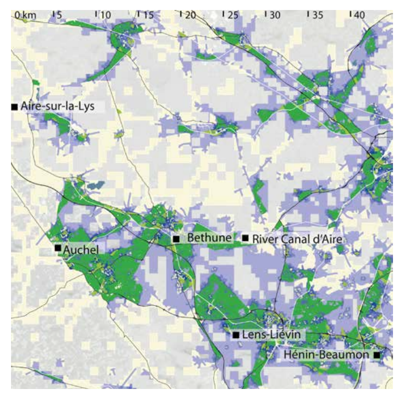
1 South Wales



2 Île-de-France



6 North Somerset



7 Pas-de-Calais

FIG. 5.9 The thumbnail maps show the number of green spaces an area is served by. For larger maps and more detailed description, see atlas part G.

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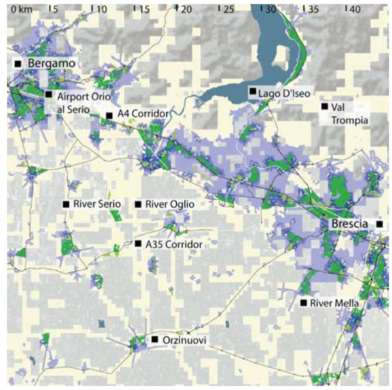
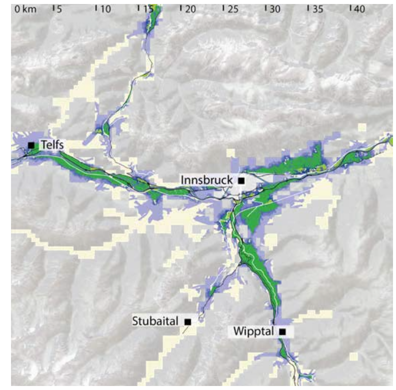
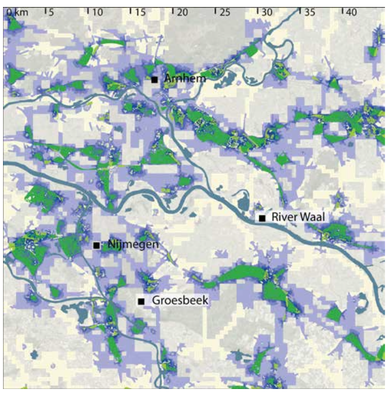
3 South-Holland



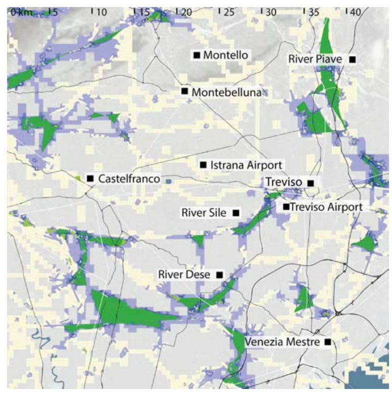
4 Bergamo-Brescia



5 The Tyrol



8 Gelderland



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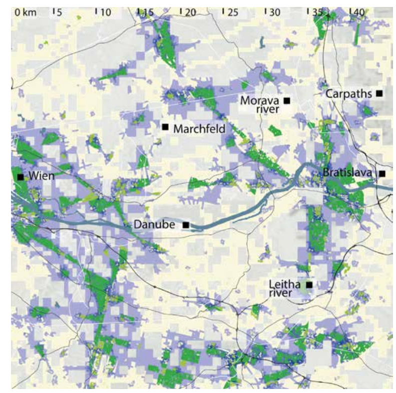

10 Vienna-Bratislava

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6 Mixed-use and Settlement Structure

Territories-in-between: Investigating forms of mixed-use in Europe’s dispersed urban areas

Wandl, A. , Hausleitner, B.

under review

KEYWORDS Mixed-use, spralws, dsiperesed urban development, settlement strucutres, Europe

ABSTRACT A large part of Europe inhabitants lives in dispersed urban settlements, much of it labelled as sprawl, monofunctional low-density areas. There is increasing evidence though that this may be a too simplistic way of describing them, as some of these territories-in-between (TiB) urban and rural underwent a process of densification and diversification. This paper investigates whether and how mixed-use appears in TiB. The paper uses data on the location of economic activities and the residential population at a 500 m times 500 m resolution and concludes that in the eight cases in four European countries mixed-use is widespread and that more than 65 per cent of the areas is mixed. Moreover, the paper demonstrates, by developing a multi-scalar typology of settlement characteristics including measures of grain, density, permeability and centrality, that local and regional settlement characteristics can explain the location and intensity of mixed-use areas. Although the building types and local urban tissues vary significantly in mixed-use areas, it can be concluded that across all four countries, the cross-scale settlement characteristics are similar.

6.1 Introduction

Over the last decades, a significant amount of urban growth in Europe has taken place in a dispersed form (Hanzl, 2010; Kasanko et al., 2006; Salvati, 2016; Salvati & Tombolini, 2018). Much of the growth is labelled as sprawl, suggesting that urban development was predominantly low density, functionally segregated or mono-functional and therefore, is considered unsustainable. On the other hand, authors (Borsdorf, 2004; Phelps & Wood, 2011; Viganò, Cavalieri, and Barcelloni Corte 2018) also report that some dispersed areas in Europe have entered a state of post-suburbia, which goes hand in hand with densification, complexification and diversification of the suburbanisation process' (Charmes & Keil, 2015:581). This paper investigates the type and location of economic and residential activities, their mix and spatial relationship to different settlement structures in eight Territories-in-Between (TiB) (Wandl, Nadin, Zonneveld, & Rooij, 2014) across Western Europe to explore whether and how mixed-use is manifested within TiB. Territories-in-between are highly typical for Europe with its dispersed settlement patterns which morphologically as well as functionally are neither distinctly urban nor rural but ,' something in-between'. Territories-in-Between do not just exist in metropolitan regions but also along many of Europe's coasts and rivers, along transport arteries - pre-industrial as well as modern 'corridors' - and in valleys of European mountain chains (Zonneveld, Nijhuis, & Wandl, 2018).

The call for urban expansion, which has hardly slowed down by economic stagnation (EEA 2016) between 2008 and 2016, will rise significantly in the following years, triggered by a shortage of houses in many European countries. Therefore, it is timely to investigate the current state of dispersed urban areas to understand which spatial configurations of mixed-use areas are there and where are potentials to develop mixed-use areas and thereby increase the potential sustainable development of TiB. The findings are relevant for both the planning and design of the transformation and expansion of dispersed urban areas. This paper answers the following three research questions:

1. Do mono-functional areas dominate dispersed urban areas in Europe?
2. How is functional mix manifested in TiB?
3. Are there differences in settlement structures between mixed and mono use areas, which can be used to inform planning and design?

This paper describes first the key concepts used in the paper: sprawl, mixed-use and territories-in-between. Second, the explanation of the spatial analytical methods, the data used to develop the typology of settlement structures and the characterisation and mapping of mixed-use is explained. Third, the result section presents a typology of settlement structure, which includes measures of grain, accessibility of transport infrastructure, density, centrality and permeability and relates to mixed-use.

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6.2 Key Concepts: Sprawl, mixed-use and territories-in-between

6.2.1 The European dimension of sprawl

The most comprehensive European research investigating sprawl over the last couple of years resulted in the EEA-FOEN report (2016) Urban sprawl in Europe. Besides demonstrating that sprawl is an issue addressed in many European programmes and projects, such as the 7th Environment Action Programme, the Roadmap to a Resource Efficient Europe as well as the European Landscape Convention it also defines sprawl:

'Urban sprawl is a phenomenon that can be visually perceived in the landscape. A landscape is affected by urban sprawl if it is permeated by urban development or solitary buildings and when land uptake per inhabitant or job is high. The more area built over in a given landscape (amount of built-up area) and the more dispersed this built-up area in the landscape (spatial configuration), and the higher the uptake of built-up area per inhabitant or job (lower utilisation intensity in the built-up area), the higher the degree of urban sprawl. The term 'urban sprawl' can be used to describe both a state (the degree of sprawl in a landscape) as well as a process (increasing sprawl in a landscape)'(Jaeger & Schwick, 2014 p).

Two aspects are notable in this definition:

1. It understands sprawl as a state and process;
2. It does not rely on an urban-rural dichotomy but uses the concept of landscape.

The high-resolution understanding is crucial to relate mixed-use to spatial structures, as demonstrated in the next subsection. It is important to note that in the EEA-FOEN report (2016), the number of jobs accounted for was only included in the mapping and analyses of the drivers of sprawl at the country and NUTS2 level, but not at the smallest aggregation unit (1 km x 1 km) due to the lack of data availability. This paper presents a way to use the number of jobs in the spatial analyses at the 500 m x 500 m resolution. The same report also provides a comprehensive review of positive and negative effects associated with sprawl, which is summarised and slightly extended below in tables 6.1 and 6.2. horizontal metropoli

Sprawl is often associated with more negative effects than positive ones. Taking a critical look at table 6.1 and table 6.2 show that most of the positive impacts of sprawled urban development could also be achieved in more compact and dense urban areas with a more sustainable urban and regional design. On the other hand, most of the adverse effects associated with sprawl are higher or more of generally unsustainable effects of urbanisation processes, independent if compact or dispersed. Furthermore, there is a dispute on whether the replacement of intensively used agricultural areas, which per se is also not a sustainable land use, with low-density urban development containing a higher share of vegetation and urban ecosystems, is more sustainable. It boils down to the fact that the compact city is not the answer to the transformation of the dispersed city and vice versa but that there need to be more specific answers to the challenge for more sustainable development in both.

A rather undisputed principle in sustainable urban planning is the concept of mixed land use, which the next subchapter is going to investigate more in detail. It is, though crucial to consider the difference between urban and dispersed city conditions. As Grant (2002 in Hoppenbrouwer & Louw, 2005) stated, mixed-use promises economic vitality, social equity, and environmental quality, but mixed-use cannot readily deliver such benefits in a context where cultural and economic forces promote the separation of land uses. However, two positive aspects of mixed-use are rather undisputed, (i) it reduces car dependency, CO_2 emissions and related climate change and health issues and (ii) it plays a crucial role in providing access to essential functions and facilities for parts of the population that has, no access to a car, and thereby increases spatial justice. A functional mix is often named as a precondition to counteract car dependency.

TABLE 6.1 Adverse effects of sprawl based on EEA-FOEN (2016) and extended by the authors.

Positive effects associated with sprawl	Sources
Affordable single-family homes, with green surroundings and ample space, which offers more privacy and freedom	Nivola, 1999; Bruegmann, 2005
Prevent exposure to urban stress factors such as noise and bad air quality and to allow people to experience the restorative effects of nature	Galea and Vlahov, 2005; Berry, 2007; Moudon, 2009; Hartig et al.,1991; Grahn and Stigsdotter, 2003
Providing the possibility to have contact with nature and thereby contribute to the experience and physical education	Wells and Evans, 2003; Miller, 2005
More space available for measures needed to adapt to climate change for both extreme precipitation events and urban heat island.	Hoeven and Wandl, 2013; Hoeven and Wandl, 2018
More space and better access to a broader transport system for companies like logistic centres	Ingram, 1998
Less conflict between companies and residents because of the distance between residents and nuisance generated by production activities and logistics.	Own addition

TABLE 6.2 A selection of adverse effects associated with sprawl, based on EEA-FOEN (2016) and adapted by the authors..

Adverse effects associated with sprawl	Sources
Soil compaction, sealing of soil surfaces, loss of ecological soil functions, loss of water permeability, reduction of groundwater regeneration and reduced evapotranspiration, and desertification	Ewing, 1994; Scalenghe and Marsan, 2009; Siedentop and Fina, 2010; Barbero-Sierra et al., 2013
Higher energy consumption and higher greenhouse gas emissions per person	Kenworthy et al., 1999; Borrego et al., 2006; Duffy, 2009; Waitt and Harada, 2012; Jones and Kammen, 2014 Mashhoodi, B., 2018 Mashhoodi, B.et al, 2018
Higher air pollution per capita as a result of vehicle exhausts, fertilising substances, dust, particles, road salt, oil, fuel and other substances which cause air and water pollution, and eutrophication	Borrego et al., 2006; Rich and Loncore, 2006; Navara and Nelson, 2007; Tu et al., 2007; Bart, 2010;
Higher light pollution, modification of light conditions and other visual stimuli	Bennie et al., 2014
The decoupling of material cycles of waste treatment (i.e. longer distances for waste transport and treatment counterbalance the positive effects of material recycling)	EEA, 2006b
A higher risk of water leakages per capita (there will be more leakages as the network of pipes increases)	Pauliuk et al., 2014
Increased water consumption per capita	March and Saurí, 2010
The reduction of habitat areas below the required minimum area, the loss of species and biodiversity	Alberti, 2005
The reduced resilience of ecosystems	Scalenghe and Marsan, 2009; Shochat et al., 2010
Higher costs for transportation associated with commuting for households	Camagni et al., 2002; Bento et al., 2005; Travisi et al., 2010
Higher costs related to traffic congestion and the extension of urban infrastructure in newly developed regions	Hortas-Rico and Solé-Ollé, 2010; Klug and Hayashi, 2012; Cinyabuguma and McConnell,2013
Higher public service costs and higher expenditure for construction and maintenance of infrastructure per capita (roads, electricity, water provision pipes, wastewater collection pipes, municipal garbage collection, snow removal, etc.)	Ewing, 1997; Kenworthy et al., 1999; Pauliuk et al., 2014
Longer commuting times and a reduction in social interaction	Putnam, 2000

6.2.2 The spatial structure of mixed-use

Mixed-use is addressed in two primary forms. First, in referring directly to the mix of activities at a minimum level of scale. Second, in describing the main spatial morphological properties of land use, namely grain size and fragmentation, density and distribution of the built form, accessibility of a location as part of the urban street system, and the diversity of spatial structures.

The most cited definition of mixed-use is from Rowley, (1996:87) who defines 'mixed-use as involving different uses that occupy discrete parts of a building, block or area. As a result, people come and go for differing reasons and on varying time-schedules'. Herndon (2011) adds based on literature and planning documents that multiple functions have to be physically and functionally integrated in a substantial way to attract their markets, as well as that mixed-use, must maximise space through intensive land use and be pedestrian-oriented.

Rowley (1996) also states that mixed-use 'essentially is an aspect of the internal texture of settlements'. He identifies 'grain, density and permeability - derived from the layout of roads, streets and paths' as essential features of a settlement's internal texture. Hoppenbrouwer & Louw (2005) built, based on Rowley, a typology of mixed-use developments considering four aspects: function, scale, dimension and urban texture. These were used to analyse the urban extension and transformation projects of Amsterdam from the 1980s to the early 2000s, using housing and working to address 'function'. The scales considered ranged from the building to the block, the district and city. They considered horizontal, vertical and time-dependent mix. Hausleitner and Berghauser Pont (2017) developed an integrated spatial structural typology that allows for the assessment of programmatic performance, like mixed-use. Such a typology allows a systemic – multi-scalar and multi-variable - understanding of the different urban conditions.

Hausleitner et al (2017) used built density with the measures of compactness (GSI) and intensity (FSI) of space and openness to describe the distribution of built form within an urban block. Furthermore, they used, building on work of Vaughan, Emma Jones, Griffiths, & Haklay, (2010) and Crucitti, Latora, & Porta (2006), topological choice to understand the centrality of a location within the urban street network system. Hausleitner and Berghauser Pont (2017) also used the plot-density to understand the grain of land-division. Lucan (2012) emphasises the diversity of urban form as a key for mixed-use and highlights that the edges of French cities built in the 20th century show high homogeneity, with little variation in urban form as well as function.

6.2.3 Territories-in-between

Left out to avoid repetition.

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6.3 Cases, methodology, and data

This section introduces the eight cases investigated and explains how the typology of settlement structure, as well as the degree of thr mix, is based on analyses through three different scales. Furthermore, spatial proxy variables for both settlement characteristic as well as mixed-use are introduced. Finally, the section explains the development of a typology of settlement structures and elaborates how different types of settlement structure show different levels of mixed-use.

6.3.1 Cases

This section was left out to avoid repetition. Note that this paper did not include the French cases due to the limitations in data availability.

6.3.2 Spatial levels

The above-introduced cases are analysed using three spatial scales as mixed-use can be achieved in and across multiple spatial scales. In an urban context, the scales used are commonly the building, the block, the district and the city. As this paper aims to understand the organisation of mixed-use at the regional scale and to inform regional planning, three scales of analyses have been defined:

1. The first scale is 50 km by 50 km squares, of dispersed urban development in Europe, which differ in planning culture, topography and history. The squares are subdivided in TiB, as well as urban and rural areas.
2. The second scale is the areas classified TiB within the 50 km by 50 km.
3. 500 m x 500 m grid cells are the smallest resolution for the spatial analyses. The rationale behind this is: (i) 500 m is a feasible distance to integrate different uses for pedestrians; (ii) a smaller resolution would imitate a sense of preciseness, which the current data available does not allow; (iii) a bigger spatial unit may, because of aggregation of data, lead to the situation that results are not spatially differentiated.

6.3.3 Measures of mixed-use

The review of the definition of mixed-use showed that mixed-use is generally present if more than two functions are mixed. Two measures are used to describe mixed-use (i) the diversity of economic activities, and (ii) the share of the work population to residential population within one area. Therefore, each spatial unit was assigned the following two values:

1. The jobs to residents ratio (M)
2. The number of different types of economic uses (mix)

The jobs to people ratio (M) is calculated according to the following formula:

$$M_a = \frac{J_a}{R_a}$$

Where the jobs to people ratio as expression mixed-use M of an area a is the number of Jobs J in the area a divided by the number of Resident R in the area a. Population data was retrieved from the GHS population grid (2016). Data about economic activates and the number of jobs was retrieved from the ORBIS database (2018).

The number of different types of economic activities (mix) expresses the number of distinct types of functions within one spatial unit. To specify the number of different functions, the statistical classification of economic activities (NACE) in the European Community (EUROSTAT; 2008) was used. EUROSTAT (2008:p 43) also provides a standardised aggregation of eleven groups of economic activities. In all eight case studies, information of all registered and active companies comes from the ORBIS database (BVDI, 2018)were retrieved. This database provides for each company a four-digit NACE code as well as information about the main section a company belongs to, as presented in table 6.3.

TABLE 6.3 Aggregation of NACE sections to groups of activities.

NACE Rev. 2 sections aggregated to one class	Sources
A	Agriculture, forestry and fishing
B, D and E	Mining and quarrying and other industry
C	Manufacturing
F	Construction
G, H and I	Wholesale and retail trade, transportation and storage, accommodation and food service activities
J	Information and communication
K	Financial and insurance activities
L	Real estate activities
O, P and Q	Professional, scientific, technical, administration and support service activi-ties
O, P and Q	Public administration, defence, education, human health and social work activities
R, S, T and U	Other services

Additionally, the address for all companies is registered in the database. This data was used to generate a point shapefile that represents the geographic location of each company as a point on the map. The information on the specific activity is aggregated to the different spatial aggregation units and allowed us to assign a value of mixed-function between 0 and 12 to each spatial unit. If mix_a = 0, then there is neither an economic activity nor residential population present in areas a. If mix_a = 12, then all eleven groups of economic activities, as well as residential population, are present in the area a.

6.3.4 Measures describing the settlement structures

In the following, a set of measures for, grain, density, permeability, centrality and accessibility, that were used to describe the settlement structures of TiB are presented in order to understand whether specific settlement structures perform differently according to the above-described indicators of mixed-use. All these measures were calculated for the 500 m x 500 m grid cells and were combined in a spatial database.

6.3.4.1 Grain

Settlements are interwoven in the urbanised landscape. Hausleitner, Berghauser Pont (2017) define grain via size, fragmentation, density and edge condition of land, which in the urban context is related to the urban block. On the regional scale, the blocks are not only formed by the streets but also by other dividing features like rivers, infrastructures. In this research focus is laid on the fragmentation between land and density and size of grain, which can be described and measured with the Splitting Index originating from the field of landscape ecology.

The splitting index S (Jaeger et al., 2008) is a measure of the grain. It is defined as the number of blocks one gets when dividing the total grid cells into parts of equal size in such a way that a new configuration leads to the same degree of division as observed for the block. It is calculated by dividing the square of the total Area A_t through the sum of the Squares of the individual sub-areas A_i of the blocks within the total area using the following formula:

$$S = \frac{A_t^2}{\sum A_i^2}$$

The higher the value for S, the smaller the grain size of an area. To be able to calculate S, a fragmentation geometry has to be established. We used Urban Atlas data (EEA, 20016) and complemented it with data from the open street map for areas that were not covered by the Urban Atlas.

6.3.4.2 Density

The positive effects of mixed-use like liveliness are less likely in cases with a low amount of people and businesses in contrary to where the densities of one or the other are higher. For this reason, we used the population density and density of jobs at the 500 m to 500 m resolution as a measure.

6.3.4.3 Permeability

Permeability P refers to the notion that good urban development allows a 'democracy' of choice in a pedestrian or individual traffic movements through it, as derived from the layout of roads, streets and paths. The simplest indicator to describe permeability is the link (L) to node (N) ratio of an area :

$$P_a = \frac{L_a}{N_a}$$

The larger P, the more permeable a cell is. L_a is the number of links (street segments between crossings), and N_a is the number of street crossing in an area a. We used the open street map data (2018) to calculate P.

6.3.4.4 Centrality

Following (Crucitti et al., 2006), we used 'centrality measures to quantify that in a network, some nodes are more important (central) than others'. Centrality is a measure addressing the local place and its embeddedness in the neighbourhood and region. Therefore, this aspect is compiled by multiple individual measures. We used the Centrality toolbox (Sevtsuk and Mekonnen 2012) to compute four types of network analysis measures on the street networks: reach, betweenness, closeness, and straightness. The following descriptions are adapted based on Sevtsuk and Mekonnen (2012):

- The reach R measure (Sevtsuk, 2010) captures how many surrounding nodes each node reaches within a given search radius r on the network.
- The betweenness B of a node is defined as the fraction of the shortest paths between pairs of other nodes in the network that pass by nodes (Freeman 1977).
- The closeness C of a node is defined as the inverse of the cumulative distance required to reach from a node to all other nodes in the system that fall within the search radius along the shortest paths (Sabidussi 1966).
- The Straightness (ST) metric (Vragovic, Louis, et al. 2005) captures the positive deviations in travel distances that result from the geometric constraints of the street network in comparison to straight-line distances in a featureless plane.

For all measures, three search radii were calculated: 500 m, 5 km and 25 km. After carrying out a collinearity test, the following measures were included in the clustering procedure:

- for B 500 m and 25 km;
- for C 500 m;
- for ST 500 m;
- for R 500m and 25 km.

All values were normalised by the total number of node weights around each node within the given search radius to allow for a comparison across cases. All centrality measures were calculated using a street network of an area that is 25 km wider than the case study area to avoid having incorrect results around the case study boundaries. For each value within the 500 m to 500 m grid cell, the maximum value of the segments in the grid cell was used.

6.3.4.5 Closeness to transit stations and motorway entries

The closeness of motorway entries measure was calculated using the following steps:

- building the network dataset of the road network using OpenStreetMap data;
- selecting links (streets) that form the fast network (motorways and national roads);
- selecting the entry and exit points to the fast network;
- calculating the service areas - the areas that can be reached within a specific network distance (1500 m; 3000 m; 6000 m; 12000, >12 000 m);
- for every 500 m by 500 m grid cell, the area weighted mean was calculated.

A similar procedure was done to calculate the closeness to transit stations measure:

- obtaining tram and railway stations locations from OpenStreetMap data;
- generating ring buffers around the stations with following break values: 250 m; 500 m; 750 m; 1000 m; 1500 m; 2000 m; 3500 m; 4000 m; 5000 m; >5000 m;
- for every 500 m by 500 m grid cell, the area weighted mean was calculated.

The rationale of choosing for this measure buffers as the crow flies instead of service areas along the street network is because the OSM data is incomplete concerning over and underpasses and paths, which would lead to too small service areas.

6.3.5 Building a typology of internal settlement characteristics

We assigned the values for all of the above-described measures of inner settlement structure to all 500 m to 500 m grid cells, which were classified as TiB, for all cases and stored them in a geodatabase. Using SPSS, a two-step cluster analysis was performed with that database to identify different types of internal settlement structures. This exploratory statistical method allows running cluster analyses on large data sets that are not normally distributed and include categorical variables. Other commonly used clustering methods cannot be applied under these circumstances. The resulting typology consists of eight clusters, which represent different types of the typology of settlement characteristics.

To understand whether or not the different types of settlement structures perform differently concerning mixed-use, we carried out a Kruskal-Wallis H test. This is a rank-based nonparametric test that can be used to determine if there are statistically significant differences between two or more groups of an independent variable, in our case the ratio between jobs and inhabitants as indication for mixed-use, on a continuous or ordinal dependent variable, in our case, the cluster of internal settlement structure.

TABLE 6.4 The mix of residents to jobs and the functional mix of inhabited 500 x 500 m cells for the eight case studies. Marked in red are the most frequent classes of the functional mix in TiB per case.

Case	Classification	Nr. Residents	Nr of Jobs	M_a	Part-time %	
South Wales	Rural	21.691	8.063	0,37	23,5	
	TIB	950.499	316.935	0,33	23,5	
	Urban	95.655	87.091	0,91	23,5	
	Grand Total	1.067.845	412.089	0,39	23,5	
North Somerset	Rural	77.965	68.993	0,88	23,5	
	TIB	603.046	464.460	0,77	23,5	
	Urban	91.602	100.385	1,10	23,5	
	Grand Total	772.613	633.838	0,82	23,5	
South-Holland	Rural	28.127	44.781	1,59	46,6	
	TIB	1.353.784	1.832.065	1,35	46,6	
	Urban	1.545.175	1.412.109	0,91	46,6	
	Grand Total	2.927.087	3.288.955	1,12	46,6	
Gelderland	Rural	131.322	75.068	0,57	46,6	
	TIB	821.067	721.715	0,88	46,6	
	Urban	66.724	63.294	0,95	46,6	
	Grand Total	1.019.113	860.077	0,84	46,6	
Bergamo – Brescia	Rural	113.570	31.203	0,27	18,5	
	TIB	915.943	334.341	0,37	18,5	
	Urban	59.587	35.970	0,60	18,5	
	Grand Total	1.089.099	401.514	0,37	18,5	
Veneto	Rural	212.166	75.431	0,36	18,5	
	TIB	795.512	311.326	0,39	18,5	
	Urban	71.362	115.950	1,62	18,5	
	Grand Total	1.079.040	502.707	0,47	18,5	
The Tyrol	Rural	31.523	5.054	0,16	28,2	
	TIB	216.204	85.630	0,40	28,2	
	Urban	41.203	16.124	0,39	28,2	
	Grand Total	288.930	106.808	0,37	28,2	
Vienna-Bratislava	Rural	47.144	9.161	0,19	28,2	
	TIB	211.749	60.846	0,29	28,2	
	Urban	24.308	2.852	0,12	28,2	
	Grand Total	283.201	72.859	0,26	28,2	

% of 500m x500 m pixels with Nr. of functions											
1	2	3	4	5	6	7	8	9	10	11	12
80,87%	8,58%	4,62%	2,17%	0,85%	1,60%	0,47%	0,47%	0,28%	0,09%	0,00%	0,00%
35,61%	9,87%	7,32%	7,32%	6,86%	6,90%	6,57%	6,25%	4,99%	4,40%	2,65%	1,26%
1,92%	0,00%	0,00%	0,00%	0,00%	1,92%	3,85%	5,77%	7,69%	26,92%	15,38%	36,54%
46,62%	**9,42%**	**6,54%**	**5,93%**	**5,26%**	**5,50%**	**5,00%**	**4,78%**	**3,83%**	**3,59%**	**2,14%**	**1,38%**
69,52%	13,96%	6,67%	4,36%	1,93%	1,15%	1,09%	0,62%	0,41%	0,22%	0,06%	0,00%
28,58%	10,24%	7,84%	6,35%	5,90%	6,35%	6,35%	7,26%	7,13%	6,22%	4,93%	2,85%
0,00%	0,00%	0,00%	0,00%	2,17%	0,00%	0,00%	2,17%	8,70%	13,04%	28,26%	45,65%
55,69%	**12,63%**	**6,98%**	**4,96%**	**3,21%**	**2,81%**	**2,77%**	**2,77%**	**2,65%**	**2,27%**	**1,90%**	**1,35%**
54,57%	8,03%	7,40%	6,77%	5,75%	5,12%	4,17%	2,99%	3,15%	1,34%	0,47%	0,24%
20,33%	4,91%	5,16%	4,65%	5,08%	4,43%	6,42%	7,89%	11,41%	15,48%	11,63%	2,60%
0,00%	0,24%	0,00%	0,12%	0,24%	0,24%	0,60%	3,21%	12,26%	33,10%	35,12%	14,88%
24,69%	**4,91%**	**4,91%**	**4,47%**	**4,55%**	**3,99%**	**5,15%**	**6,22%**	**9,80%**	**14,96%**	**12,55%**	**3,81%**
53,94%	13,17%	9,02%	6,13%	5,12%	3,53%	3,04%	2,34%	1,82%	1,01%	0,81%	0,08%
25,49%	7,54%	6,68%	4,30%	4,88%	4,92%	6,02%	7,17%	10,82%	13,69%	7,21%	1,27%
0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	2,33%	16,28%	44,19%	32,56%	4,65%
42,61%	**10,91%**	**8,05%**	**5,39%**	**4,99%**	**4,04%**	**4,17%**	**4,20%**	**5,39%**	**6,19%**	**3,49%**	**0,57%**
71,30%	13,36%	6,12%	3,54%	2,06%	1,29%	1,24%	0,72%	0,17%	0,10%	0,07%	0,02%
20,16%	10,23%	9,07%	8,95%	8,06%	9,33%	9,18%	8,95%	6,56%	5,02%	3,41%	1,09%
0,00%	0,00%	0,00%	6,25%	0,00%	0,00%	0,00%	6,25%	12,50%	15,63%	21,88%	37,50%
50,70%	**12,05%**	**7,26%**	**5,70%**	**4,42%**	**4,47%**	**4,38%**	**4,01%**	**2,76%**	**2,12%**	**1,50%**	**0,62%**
36,75%	21,89%	17,33%	11,16%	6,06%	3,69%	1,83%	0,70%	0,38%	0,19%	0,02%	0,00%
13,68%	11,48%	12,90%	12,22%	11,38%	9,89%	8,81%	7,38%	5,27%	4,22%	2,26%	0,50%
0,00%	0,00%	0,00%	0,00%	0,00%	2,50%	2,50%	0,00%	10,00%	25,00%	37,50%	22,50%
26,67%	**17,31%**	**15,34%**	**11,55%**	**8,31%**	**6,34%**	**4,83%**	**3,56%**	**2,53%**	**2,05%**	**1,18%**	**0,33%**
0,00%	45,03%	22,74%	12,14%	8,83%	6,18%	3,31%	0,66%	0,66%	0,44%	0,00%	0,00%
0,00%	17,07%	13,20%	10,63%	10,31%	11,11%	11,11%	8,37%	8,37%	8,21%	1,29%	0,32%
0,00%	0,00%	0,00%	0,00%	5,00%	0,00%	0,00%	10,00%	10,00%	50,00%	20,00%	5,00%
0,00%	**28,34%**	**16,91%**	**11,06%**	**9,60%**	**8,87%**	**7,68%**	**5,21%**	**5,21%**	**5,76%**	**1,10%**	**0,27%**
68,32%	9,92%	6,63%	3,89%	4,18%	2,45%	2,09%	1,37%	0,72%	0,36%	0,00%	0,06%
22,52%	7,23%	9,19%	9,92%	9,30%	10,85%	8,78%	5,99%	6,71%	5,27%	2,89%	1,34%
0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	18,18%	9,09%	9,09%	54,55%	9,09%
51,32%	**8,90%**	**7,54%**	**6,07%**	**6,03%**	**5,51%**	**4,52%**	**3,13%**	**2,94%**	**2,19%**	**1,28%**	**0,57%**

6.4 Results

The first subsection presents two mixed-use measures to answer the questions: are TiB functionally segregated (as generally assumed) when put equal to sprawl? By mapping the two measures of mixed-use, the jobs to people ratio (M) and the number of different types of economic uses (Mix), an answer is presented to the second question: how is functional mix spatially manifested in TiB? If this differentiation is related to the characteristics of the spatial structure will be answered in the second section.

6.4.1 Mixed-use in territories-in-between

Table 6.4 shows the two mixed-use indicators, the job to people ratio and the number of different functions aggregated for three spatial units, the whole case study area, the areas classified according to Wandl et al. (2014) as rural, urban and territories-in-between for the inhabited 500 m x 500 m grid cells. Conclusions across all cases are: Mixed-use is an incremental characteristic of European urbanised areas, being dispersed or not. In six case more than 65 per cent of grid cell host three or more functions. The exception is the British cases, with 61 per cent for North Somerset and 55 per cent for South Wales. An apparent result is that there are in all instances apparent differences in the frequency distribution for urban, TiB and rural areas. Most cases show that in rural areas, low mix classes (1-4) are dominant. The TiB shows a more equal, distribution across all mix function classes often with a peak around class six. In the urban areas, the highly mixed classes (9-11) dominate in all cases. The Tyrol and the two Dutch cases show the highest mix in TiB. The Dutch cases show a higher overall mixed-use with grid cells hosting ten functions being the most frequent. Although North Somerset has the most mono-functional grid cells it nevertheless shows also a high frequency of rather high functional mix, with grid cells hosting eight functions being the most frequent.

Figure 6.3 presents the spatial distribution of the mixed-function classes within TiB in the eight cases.

6.4.2 Typology of settlement characteristics

We used the above-described measures of the characteristics of the settlement's structure as input variables for a stepwise-cluster analysis to answer the second research question of the paper. Is there a spatial-structural difference between mixed, mono and multi-use areas, which can be used to inform planning and design? The result is eight clusters types with significantly different spatial settlement characteristics. Table 6.5 describes the key characteristics of the different clusters.

Table 6.6, presents the frequency of the clusters for each case and shows that the clusters I, IV, V, VI, VII and VIII are found in all cases. Cluster II is only present in the Dutch and Austrian cases. Whereas cluster III is only present in South Wales. The most frequent clusters overall are cluster I and cluster VIII. Figure 6.x (moved to atlas part E) presents the spatial distribution of the clusters in the case study areas. It shows that clusters II and VII concentrate around the larger urban areas. Clusters I, III and VIII can be found in and around the smaller towns. Cluster V seems to concentrate on the edge of smaller villages. Cluster IV describes towns and villages and cluster VI concentrates at the edges of Bristol and Rotterdam.

The Kruskal-Wallis H test showed that there is a statistically significant difference in mixed-use between the types of settlement structure, H (7) = 815.729, p =.0005. Pairwise comparisons were performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons, which showed that out of the 27 pairs, only three pairs did not show significant differences according to mixed-use, notably cluster pairs III-VIII; IV-I and V-II. Therefore, we can conclude that mixed-use is significantly different in the settlement type across all eight cases.

The question now is, do the clusters perform similarly concerning mixed-use in all cases? In all cases cluster VII shows the highest functional mix as it is the cluster with the highest residential density, good accessibility by public transit, vicinity to motorway entrances and high permeability and small grain.

Cluster II, which can only be found in the Dutch and Austrian cases, is the second cluster with a rather high functional mix. However, in contrary to cluster VII, this cluster also includes monofunctional areas. Cluster VI, which is the smallest cluster class, shows in all cases an exclusively high functional mix, being located at the edge of the main cities in NL and England. Cluster III, only present in Wales, also shows a rather high functional mix but also includes monofunctional grid cells. Cluster V is the cluster with the least functional mix in all cases. Cluster I is the largest cluster class overall and is less functionally mixed. Cluster VIII shows a rather indifferent image with a rather high share of monofunctional classes but also many cells with a functional mix around seven.

TABLE 6.5 Key characteristics based on mean values of each cluster and examples of aerial views from the different cases. The 500 m x 500 m squares in red represents the specific cluster.

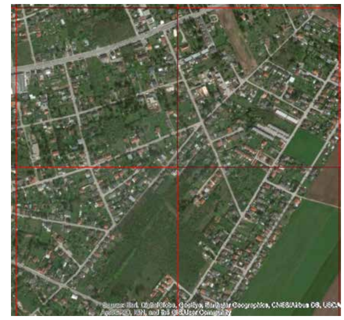
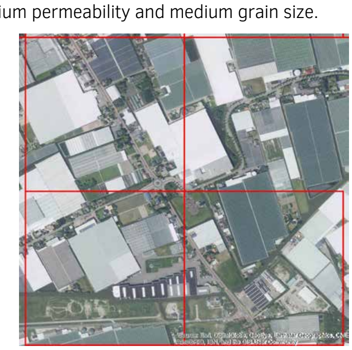
CLUSTER NR.	KEY CHARACTERISTICS
I	Low accessibility to the fast street network (FSN) but good accessibility by public transit (PT). Low on all centrality measures. A rather high permeability but big grain size. Low density on jobs but medium density on residents.   
II	Good accessibility for both FSN and PT. Medium on local and regional betweenness and high on local straightness and regional reach centrality and high local straightness. Medium permeability and medium grain size. Low on population density and medium on job density.   
III	Medium accessibility to FSN good accessibility to PT. Low on all regional centrality measure and high on local centrality measures. Highest permeability and medium grains size. High on population density and medium on job density. 
IV	Lowest accessibility for both mobility measures. Medium on local and regional betweenness and high on local straightness and low on regional reach centrality. Low on population density and medium on job density. Medium permeability and medium grain size.   

TABLE 6.5 Key characteristics based on mean values of each cluster and examples of aerial views from the different cases. The 500 m x 500 m squares in red represents the specific cluster.

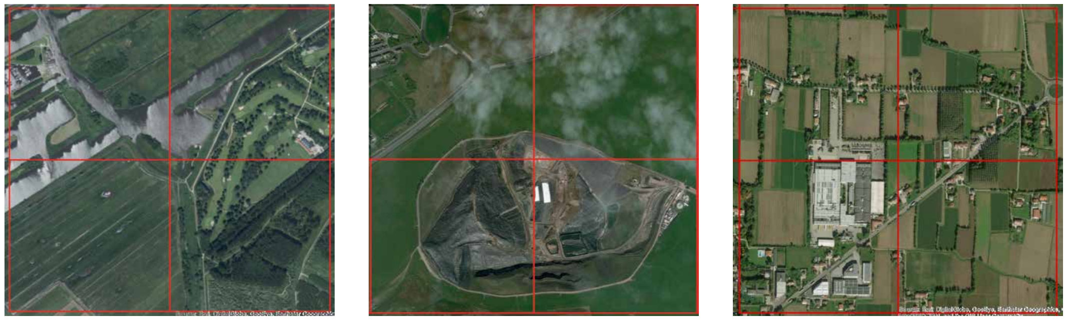
CLUSTER NR.	KEY CHARACTERISTICS
V	Low accessibility to FSN and medium accessibility to PT. Very low on all centrality measures. Low density on residents and jobs as well as low permeability and big grain size. 
VI	Good accessibility to FSN and excellent accessibility to PT. High on local and regional betweenness and high on local straightness and regional reach centrality. Medium permeability and small grain size. High on population density and very high in job density. 
VII	Good accessibility to both FSN as well as PT. Very high on local and regional betweenness and high on local straightness and medium on regional reach centrality. Very high population density and high job density. High permeability and small grain size. See figure 7 for examples of cluster VII.
VIII	Low accessibility to FSN and good accessibility to PT. Very high on local and regional betweenness and high on local straightness and low on regional reach centrality. High permeability and medium grain size. Medium on job density medium on population density. 

TABLE 6.6 Frequency distribution of mixed-function over clusters of settlement structure.

South Wales

NR. of different Function		0	1	2	3	4	5	6	7	8	9	10	11	12
Cluster frequency	I	194	554	185	136	149	124	120	110	91	58	49	27	9
	II	16	96	45	49	39	57	67	69	83	78	69	48	24
	III	70	123	39	30	32	19	19	11	6	5	7	4	3
	IV	498	327	35	11	5	6	3	2	1	1	1		
	V			1									1	1
	VI						6	4	11	10	11	9	2	2
	VII					1				2	1	1		
	VIII	194	554	185	136	149	124	120	110	91	58	49	27	9

North Somerset

NR. of different Function		0	1	2	3	4	5	6	7	8	9	10	11	12
Cluster frequency	I	19	119	55	23	21	16	16	15	10	9	8	2	1
	II													
	III													
	IV	14	125	50	40	35	32	22	22	16	10	10	6	4
	V	78	112	18	8	2	3	4				2		
	VI												7	14
	VII						2	3	4	10	22	22	34	16
	VIII	13	85	35	50	40	38	53	57	76	69	54	27	9

South-Holland

NR. of different Function		0	1	2	3	4	5	6	7	8	9	10	11	12
Cluster frequency	I	6	9	32	58	43	50	40	46	39	50	47	33	4
	II		7	52	48	39	53	51	95	110	136	138	94	18
	III													
	IV		8	37	34	27	28	29	29	56	75	69	55	10
	V	402	772	21	14	14	13	9	12	9	7	4		
	VI					1	1		2	7	12	18	25	13
	VII								3	21	73	215	180	38
	VIII		8	52	50	60	56	46	67	70	98	121	73	20

Gelderland

NR. of different Function		0	1	2	3	4	5	6	7	8	9	10	11	12
Cluster frequency	I	20	201	67	57	36	33	44	50	49	42	48	23	2
	II	8	27	8	19	11	23	21	23	40	49	47	29	2
	III													
	IV	14	93	40	24	13	17	22	27	26	37	28	9	1
	V	60	159	20	16	9	12	4	5	1	1			
	VI								2	3	4	14	10	4
	VII		29		1	2		2	3	12	68	130	68	13
	VIII	9	113	49	46	34	34	27	37	44	63	67	37	9

>>>

TABLE 6.6 Frequency distribution of mixed-function over clusters of settlement structure.

Veneto														
NR. of different Function		0	1	2	3	4	5	6	7	8	9	10	11	12
Cluster frequency	I	4	159	148	166	150	136	127	92	51	29	12	5	1
	II													
	III													
	IV	1	34	35	49	54	48	42	32	35	16	10	2	
	V	29	145	91	92	68	38	20	11	5	1	1		
	VI						1					2	2	
	VII						2	2	8	13	21	29	19	5
	VIII	4	103	96	109	122	142	128	141	134	103	82	45	10

The Tyrol														
NR. of different Function		0	1	2	3	4	5	6	7	8	9	10	11	12
Cluster frequency	I	77	18	5	8	4	2	6	2		1			18
	II	83	51	51	41	36	46	42	25	18	10	1		51
	III													
	IV	15	5	7	2	4	2			1				5
	V	58	3	2	1	4	2			2				3
	VI								1		1	2		
	VII		1			1	2	13	20	24	39	5	2	1
	VIII	52	28	17	14	15	15	8	4	7				28

Vienna-Bratislava														
NR. of different Function		0	1	2	3	4	5	6	7	8	9	10	11	12
Cluster frequency	I	88	108	30	28	32	30	37	19	10	9	3	2	
	II	11	10	4	9	7	7	6	3	3	5	1	1	
	III													
	IV	4	5	5	7	8	6	6	9	6	7	6	1	
	V	104	49	3	5	1		1		1				
	VI								2					
	VII					2	4	7	12	9	13	18	9	10
	VIII	24	46	28	40	46	43	48	40	29	31	23	15	3

In the following, we present examples of how areas with high functional mixed-use look like and how the mix is spatially arranged. For Cluster VII, four exemplary cases were selected. Illustrated in figure 6.1 A to D. The most common mixed-use area is the historic (founded before World War I) town centre. All of them show a form of main or high streets which are often also connected to a market or crossings of roads of regional importance. Figure 7A shows the town centre of Mogliano (Veneto) as an example. It displays how diverse the functional mix is and how it is arranged along the main streets and the squares of the town. Economic activities are also, to a certain extent, integrated with residential use, although the single-family house areas host rather few economic activities. The railway station is close-by, and at the edges of the historic centre, larger parking lots are situated.

The second type of mixed-use areas that can be found in cluster seven is post-war suburban centres. Also, they can be found in all cases, but are typically in the Dutch and UK cases. In Figure 6.1.B, which shows Hartcliffe, an outer suburb of the city of Bristol, demonstrates that most economic activities, specifically related to retail and other daily needs, are concentrated in a retail centre. Moreover, a variety of economic functions situates in the areas dominated by terraced or free-standing houses, which in the case of cluster VII are hardly ever cul-de-sac developments. Although the areas are catered towards the car, all functions are also integrated for pedestrian uses.

The third type of highly functional mixed-use areas of cluster seven is rather multi-use and not mixed-use because the areas are not integrated for pedestrians. Figure 6.1.C presents a typical example of a business or industrial park next to residential areas in Concesio, north of Brescia (Italy).

The fourth type of mixed-use is rather rare and concentrated explicitly on the Slovakian part of the Vienna - Bratislava case. It is mixed-use within areas dominated by multi-storey slabs. See Figure 4D. In this case, service and support functions with rather a low number of employees are dominating.

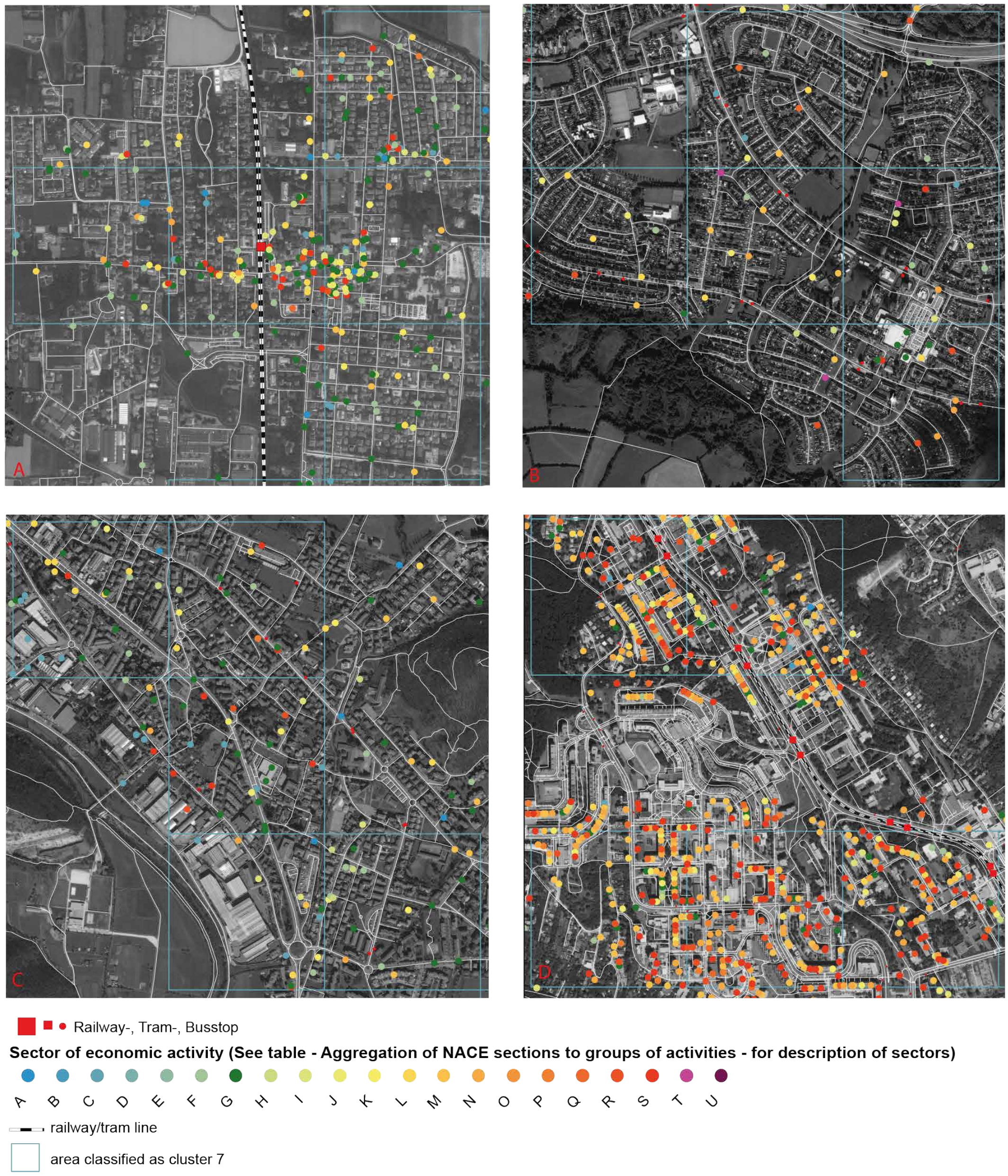


FIG. 6.1 A-D: Examples of different types of mixed-use areas within cluster VII..

These examples show that similar structures and related mixed-use can be generated by very differently looking urban tissues and building typologies. Besides, when looking at aspects of sustainable urban planning and design, it is crucial to do so in a systematic way through scales, as the proposed typology did, by investigating three different scales, and not only at the local urban tissue. Although this research did not specifically look at the building scale of mixed-use, the variety of building types in the four examples seem to either suggest that it is of less relevance. Alternatively, as the authors instead think, the existing building types in TiB with high mixed-use are relatively flexible in hosting different economic activities.

6.5 Conclusions and discussion

Do monofunctional areas dominate dispersed urban areas? The answer to the first research question is evident: More than 65 per cent of the 500m to 500 m grid cells host three or more functions and this means that a certain functional mix is characterising TiB in Europe. The functional mix is manifested in TiB in two principle different forms. One, where both the density of inhabitants and jobs is rather low, and the second, where the density of residents is comparatively high and accompanied by a mix of economic activities.

Is there a spatial-structural difference between mixed and mono-use areas, which can be used to inform planning and design? The typology of inner settlement characteristics presented in this article shows that mixed-use is significantly diverse between different types of settlement characteristics. The types with the highest mixed-use are characterised by (i) good accessibility to both the motorway system and public transport, (ii) a very high local and regional betweenness, (iii) a higher population density and higher job density as well as (iv) high permeability and small grain size.

In the Dutch and Austrian cases, areas with medium local and regional betweenness, medium permeability and medium grain size, as well as low population density and medium job density, show a rather high mixed-use. This outcome may allow the conclusions that in both countries, policies and practices are in place that support mixed-use in less densely populated areas. Moreover, the typology shows that in types with high population density, this factor compensates for lower accessibility and centrality values.

A key recommendation for planning and regional design is to establish or further develop already at present mixed-use areas. Actions should preferably aim for better integration of adjacent neighbourhoods, by increasing permeability and decreasing grain size as well as improving the accessibility by public transit. High Streets are one logical structure to build upon for such extensions.

For establishing new areas as mixed-use centres, it is reasonable to start from areas that already perform well in some of the settlement characteristics and improve the others, which in most case will require a collaboration of planning bodies from the local to at least the regional but often even national scale. As permeability and grain size can be influenced by the local government, changes in the centrality measures typically require cooperation across multiple municipalities or regional planning authorities. Changes in both public transit and motorways, accessibility values often require even national planning authorities to act, as they often plan the main transport infrastructure.

To summarise the findings of the article, mixed-use is an intrinsic component of European TiB. The level of functional mixed-use can be related to the settlement characteristics: permeability, grain size, centrality and accessibility and connectivity. Meaning mixed-use is not a result of local urban morphology or planning instruments but systemic qualities of a location. Therefore, there is a requirement for planning and design to be coordinated through different scales if mixed-use areas are one strategy to achieve a more sustainable spatial development.

6.6 Atlas of territories-in-between Part E: Mixed-use and Settlement Structure

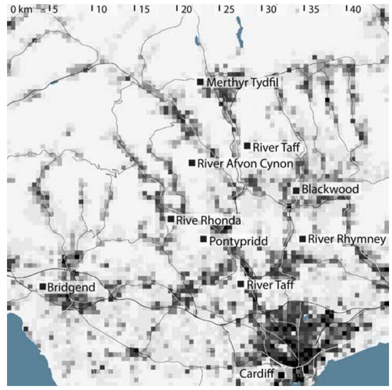
This section of the atlas of territories-in-between contains three thumbnail double-pages with:

1. Eight maps presenting the number of different functions per 500 m x 500 m grid cell as one indicator for the presence of mixed-use. These maps cover the whole case study area, which includes urban and rural areas.
2. Eight maps presenting the number of different functions per 500 m x 500 m grid cell as one indicator for the presence of mixed-use. These maps cover only the territories-in-between.
3. Eight maps illustrating the typology of settlement structure as described in chapter 6.

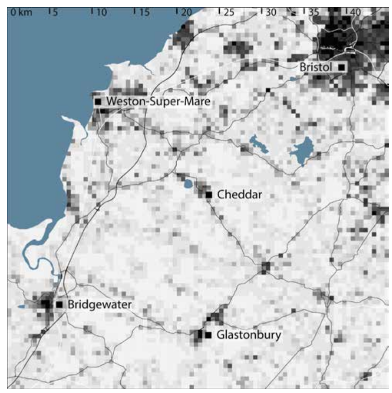
MIXED-USE

Number of different functions within one 500 m x 500 m grid cell

1
2
3
4
5
6
7
8
9
10
11
12

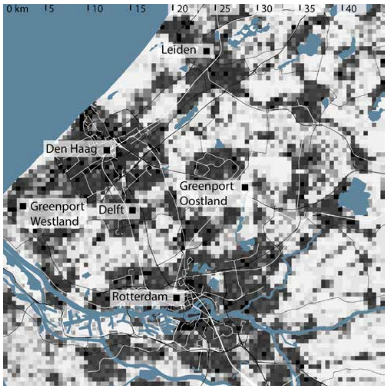


1 South Wales

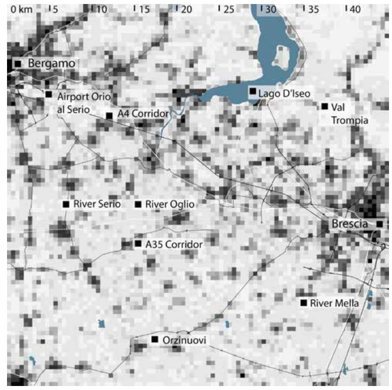


6 North Somerset

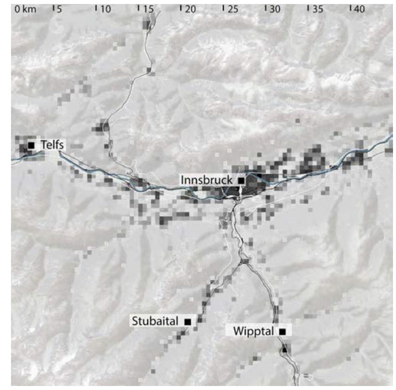
FIG. 6.2 The thumbnail maps show the number of different functions within one 500 m x 500 m grid cell for urban, rural and territories-in-between. For larger maps and more detailed description, see atlas part G.



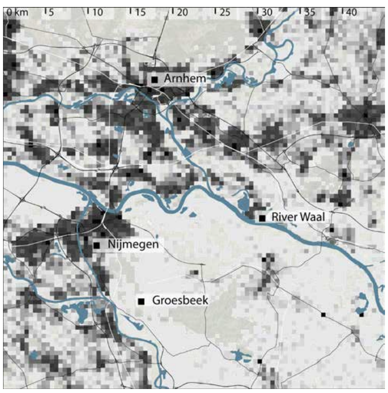
3 South-Holland



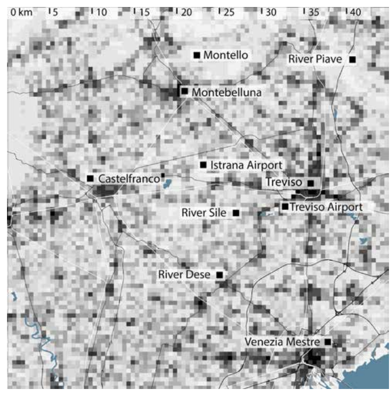
4 Bergamo-Brescia



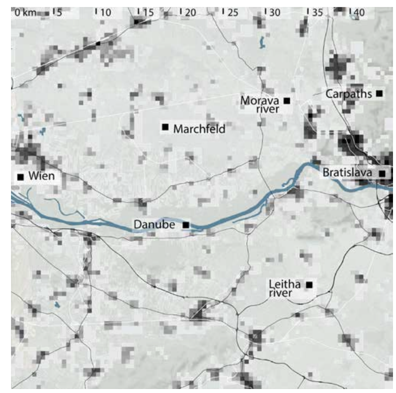
5 The Tyrol



8 Gelderland



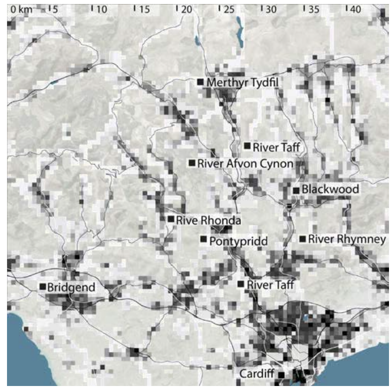
9 Veneto



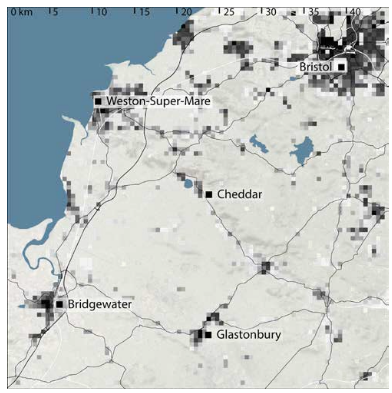
10 Vienna-Bratislava

Number of different functions within one 500 m x 500 m grid cell

1
2
3
4
5
6
7
8
9
10
11
12



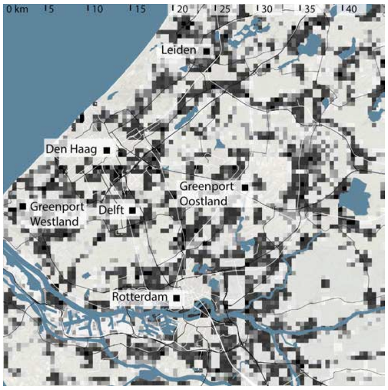
1 South Wales



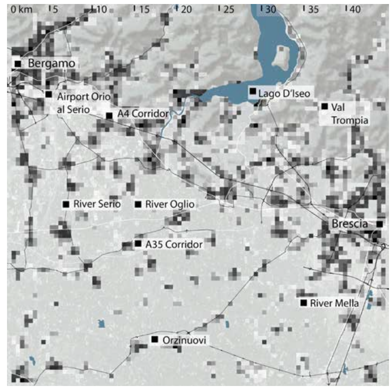
6 North Somerset

FIG. 6.3 The thumbnail maps show the number of different functions within one 500 m x 500 m grid cell for territories-in-between. For larger maps and more detailed description, see atlas part G.

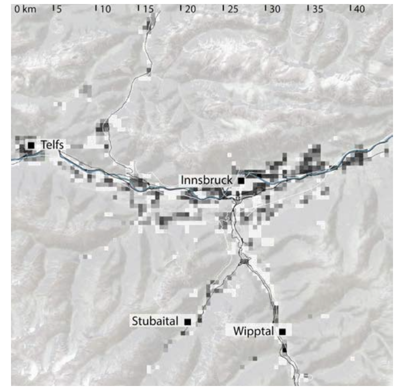
TOC



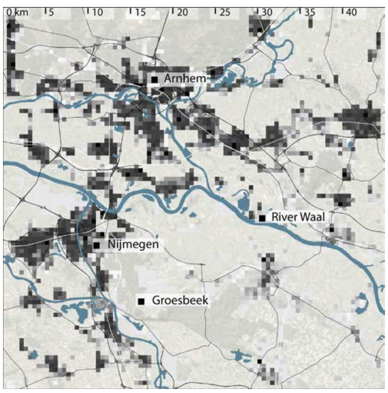
3 South-Holland



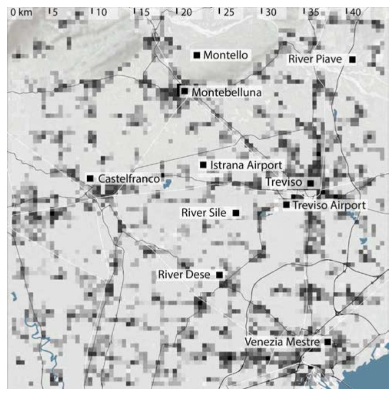
4 Bergamo-Brescia



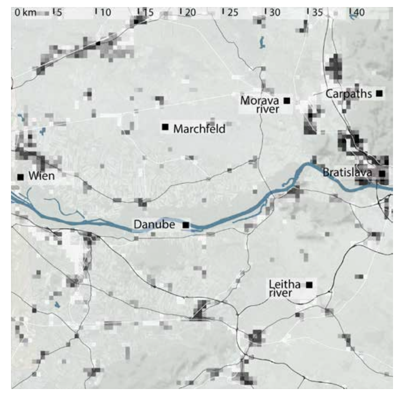
5 The Tyrol



8 Gelderland



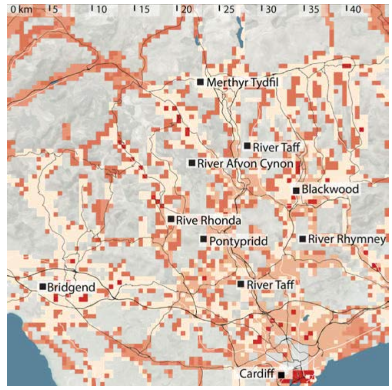
9 Veneto



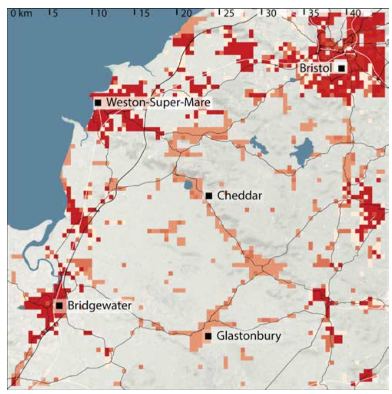
10 Vienna-Bratislava

Typs of settlement structure

- I
- II
- III
- IV
- V
- VI
- VII
- VIII

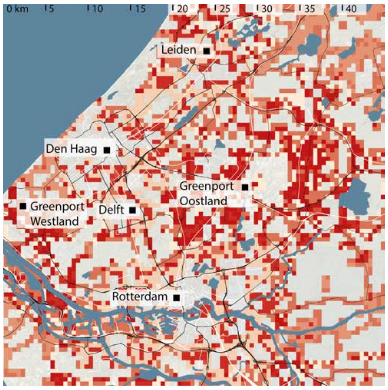


1 South Wales

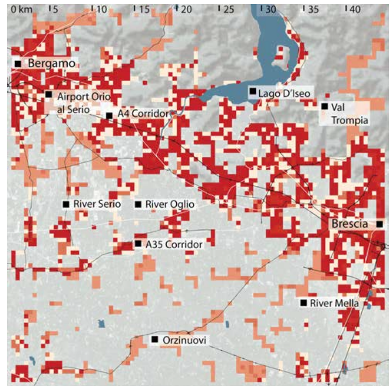


6 North Somerset

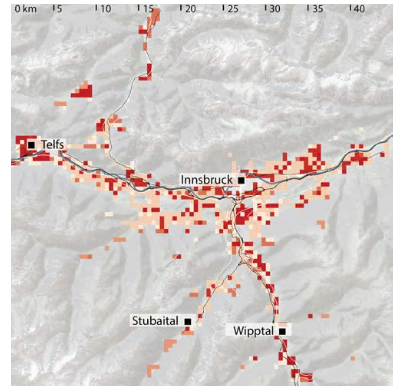
FIG. 6.4 The thumbnail maps show the spatial distribution of the different types of the typology of settlement structure. For larger maps and more detailed description, see atlas part G.



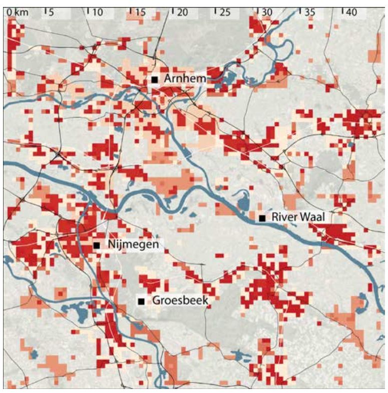
3 South-Holland



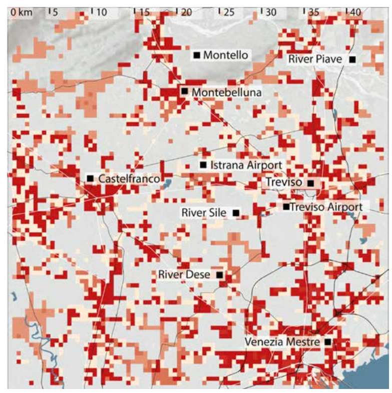
4 Bergamo-Brescia



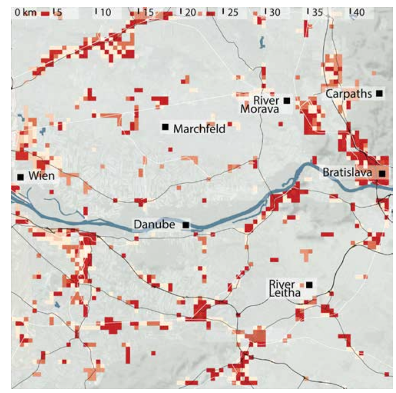
5 The Tyrol



8 Gelderland



9 Veneto



10 Vienna-Bratislava

7 Cross-case Comparison

Are there similarities and dissimilarities concerning potentials for sustainable development in dispersed urban areas in different locations, planning cultures, topographies and histories? This question is relevant to be able to contribute to the theory of settlement structure and planning in Europe. Furthermore, it is crucial to understand similarities across cases to identify general strategies for more sustainable development of areas with dispersed settlement patterns that go beyond a single project or location and thereby, inform policymaking.

Three types of comparison are conducted to answer the final research question: (i) a national pairwise comparison of all variables used in the research, to understand similarities and differences of cases within the same country, (ii) a cross-national comparison of all the variables in all case studies to understand similarities and differences across the five countries,; (iii) a cross-case comparison of all cases using a limited set of variables, to investigate the current state of sustainability as well as the most significant potentials for sustainable development.

A radar diagram is used as a tool to compare the multivariate data of the different indicators and typologies developed across cases. The diagram shows six thematic sectors as illustrated in Figure 7.1. These are, starting from 12 o'clock in a clockwise direction: density, the composition of green spaces, ecosystem services, multi-functionality, settlement structure and mixed-use. In total, 29 variables along the spokes from the centre to the perimeter of the diagram are displayed. The 29 variables come from the four papers presented earlier. The colours in the radar diagram represent three thematic groups. Group one includes the sectors settlement structures, and mixed-use and density which represents the sustainability potentials of the built-up area. Group two consists of the sector composition of the green spaces and ecosystem services, which represents the sustainability potentials of green spaces and the green infrastructure. Group three includes the sector multi-functionality and represents the sustainability potentials of grey open spaces.

Figure 7.1 presents the basic radar diagram. The length of a spoke is proportional to the magnitude of a specific variable in the case relative to the maximum magnitude of the variable across all cases. A line is drawn to connect the data values for each spoke. If this is done for more than one case, then the star plots can be used to answer the following questions:

- Which observations are most similar?
- Are there outliers?

Figure 7.4 presents the radar diagram with the values of the individual cases. The diagram also helps to assess the existing sustainability and the potentials for future sustainable development. The indicators displayed from 10 o'clock to 2 o'clock describes the current situation, whereas the three typologies in the rest of the diagram allows for an interpretation of the potentials for the future.

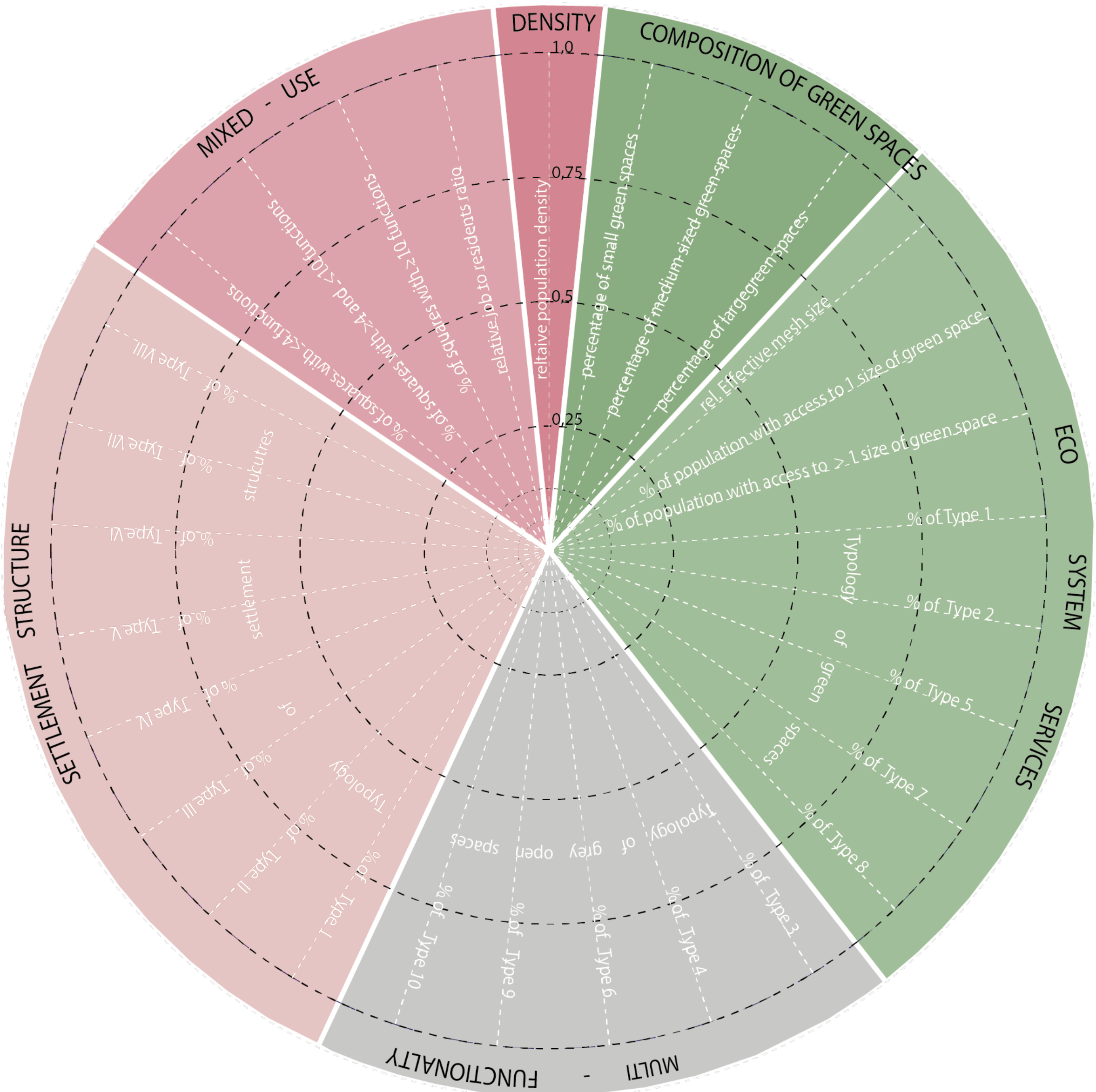


FIG. 7.1 The radar diagram showing the different variables, wich are organised in sectors and thematic groups.

Those variables that did not have a ratio as a unit are displayed as relative within the cases, The variables that did not have a ratio as a unit are displayed relative within the cases, meaning that the maximum value among the ten cases is one. The values of the variable for mixed-use, density, the composition of green spaces as well as the accessibility to green spaces and landscape fragmentation are easy to interpret. However, the interpretation of the open space typologies requires additional information on three aspects for green spaces. See Figure 7.2:

— Under which level of development pressures are green spaces?
— Are they contributing to ecosystems services on the local and/or regional scale?
— How great is their potential in providing provisional, regulatory and cultural ecosystem services?

FIG. 7.2 Overview of the types of green spaces in TiB compared to the level of development pressure they are under. In addition, their relevance concerning ecosystem services on the regional and local scale and the potential for different types of ecosystem services. See chapter 4 for a detailed description of the different types.

Figure 7.2 shows that there is a diversity in development pressure on the types of green spaces and that their contribution to regional and local ecosystems services is diverse, as well as their importance in contributing to provisioning and cultural ecosystem services. But all types of green spaces are almost equally important for the provision of regulating ecosystem services.

Two aspects are essential for the interpretation of the grey open space typology FIG. 7.3:
— Under which level of development pressure are those grey spaces?
— For which function is the potential for multifunctionality high or low?

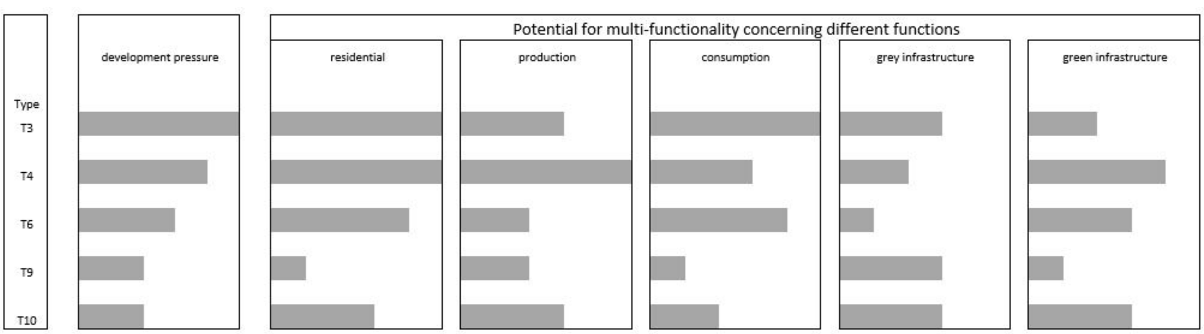
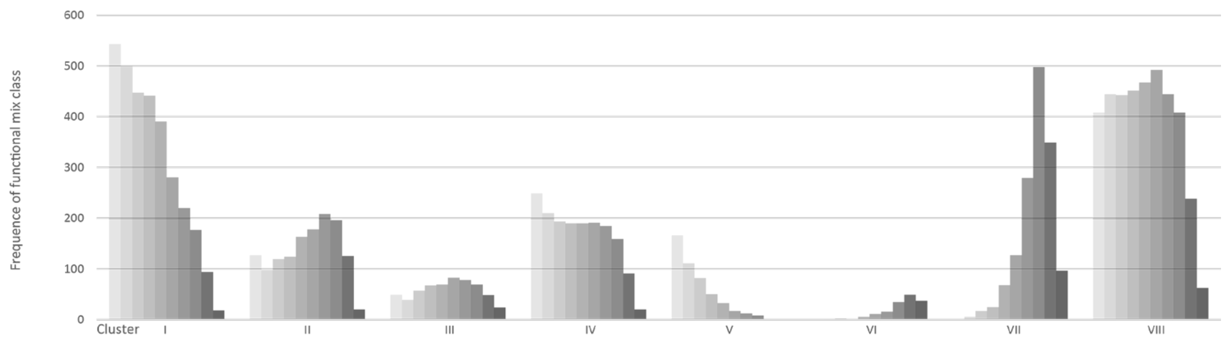


FIG. 7.3 Overview of the types of grey open spaces in TiB compared to the development pressure on them, their relevance concerning ecosystem services on the regional and local scale as well as the potential for different types of ecosystem services. See chapter 4 for a detailed description of the different types.

Figure 7.3 shows that the grey open space types show a variety of functions available to generate multi-functionality.

The distribution of mixed functions across all cases, presented in figure 7.4. The different types are crucial for the interpretation of the settlement typology.

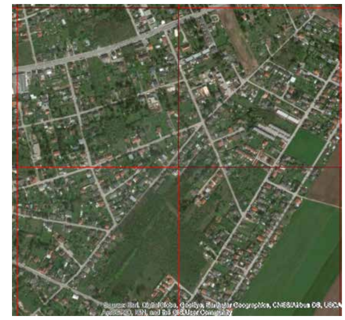
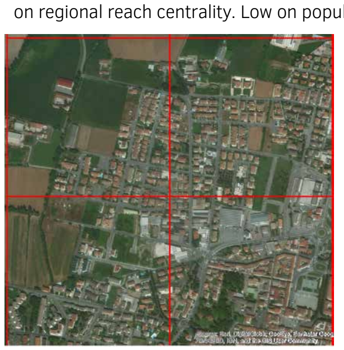
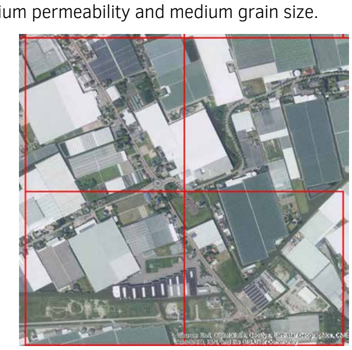
Table 7.1, which was already presented in chapter 6, is shown below again to allow for a comparison of the settlement structures.



Number of different functions within one grid cell / Cluster	I	II	III	IV	V	VI	VII	VIII
3	543	127	49	249	166		1	408
4	499	98	39	210	111	1	6	444
5	447	119	57	193	82	2	17	442
6	441	124	67	190	50		25	451
7	390	163	69	190	32	6	68	467
8	280	178	83	191	17	11	127	492
9	220	208	78	184	12	16	279	444
10	177	196	69	159	8	35	498	408
11	94	125	48	91		49	349	238
12	18	20	24	20		37	96	62

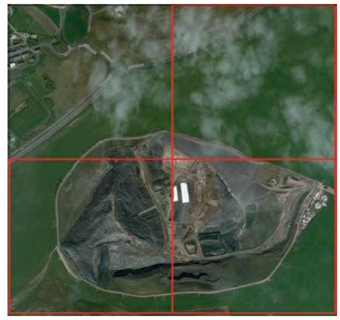
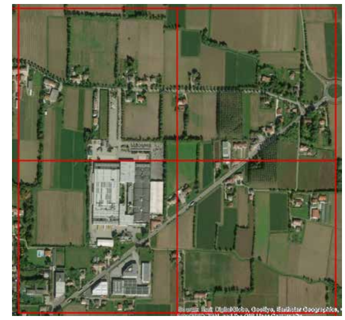
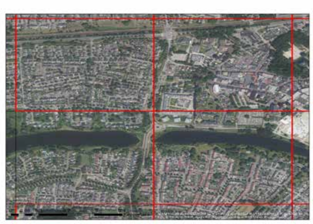
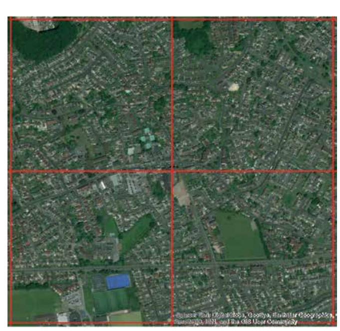
FIG. 7.4 The frequency distribution of 500 m x 500 m grid cells with the amount of functions over the types of settlement structure.

TABLE 7.1 Key characteristics based on mean values of each cluster and examples of aerial views from the different cases. The 500 m x 500 m squares in red represents the specific cluster.

CLUSTER NR.	KEY CHARACTERISTICS
I	Low accessibility to the fast street network (FSN) but good accessibility by public transit (PT). Low on all centrality measures. A rather high permeability but big grain size. Low density on jobs but medium density on residents.
	  
II	Good accessibility for both FSN and PT. Medium on local and regional betweenness and high on local straightness and regional reach centrality and high local straightness. Medium permeability and medium grain size. Low on population density and medium on job density.
	  
III	Medium accessibility to FSN good accessibility to PT. Low on all regional centrality measure and high on local centrality measures. Highest permeability and medium grains size. High on population density and medium on job density.
	
IV	Lowest accessibility for both mobility measures. Medium on local and regional betweenness and high on local straightness and low on regional reach centrality. Low on population density and medium on job density. Medium permeability and medium grain size.
	  

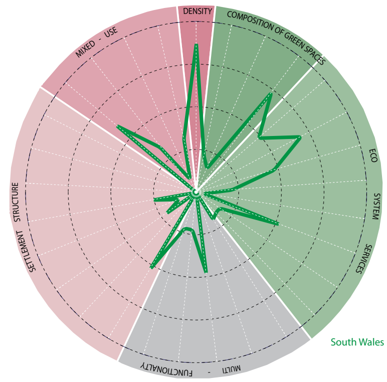
TOC

TABLE 7.1 Key characteristics based on mean values of each cluster and examples of aerial views from the different cases. The 500 m x 500 m squares in red represents the specific cluster.

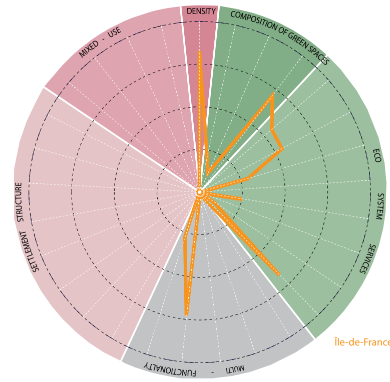
CLUSTER NR.	KEY CHARACTERISTICS
V	Low accessibility to FSN and medium accessibility to PT. Very low on all centrality measures. Low density on residents and jobs as well as low permeability and big grain size.   
VI	Good accessibility to FSN and excellent accessibility to PT. High on local and regional betweenness and high on local straightness and regional reach centrality. Medium permeability and small grain size. High on population density and very high in job density.   
VII	Good accessibility to both FSN as well as PT. Very high on local and regional betweenness and high on local straightness and medium on regional reach centrality. Very high population density and high job density. High permeability and small grain size.   
VIII	Low accessibility to FSN and good accessibility to PT. Very high on local and regional betweenness and high on local straightness and low on regional reach centrality. High permeability and medium grain size. Medium on job density medium on population density.   

7.1 National pairwise comparison

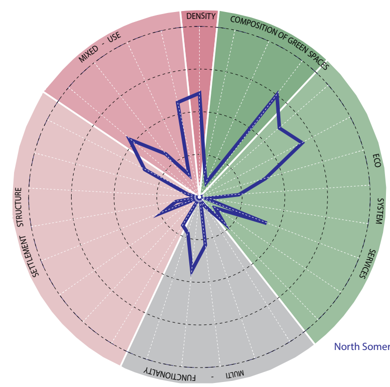
Before comparing all the cases with each other, a pairwise comparison of the cases for each of the five countries in the study is presented. This is done to understand if cases with a similar cultural background are more similar to each other. Figure 7.5 gives an overview of all radar diagrams for the cases.



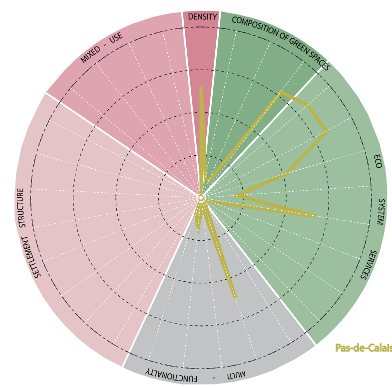
1 South Wales



2 Île-de-France

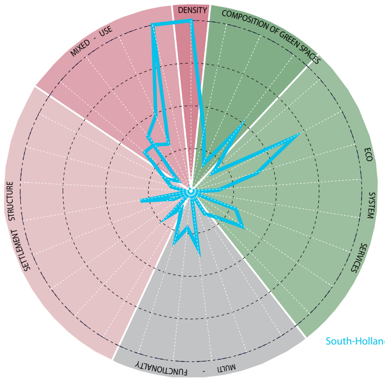


6 North Somerset

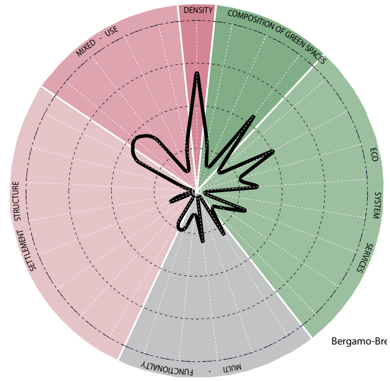


7 Pas-de-Calais

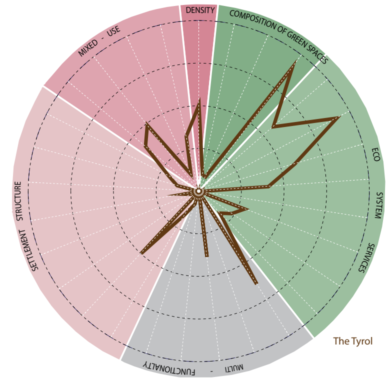
FIG. 7.5 Individual radar diagrams of all ten cases.



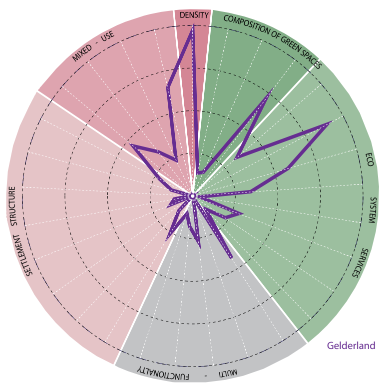
3 South-Holland



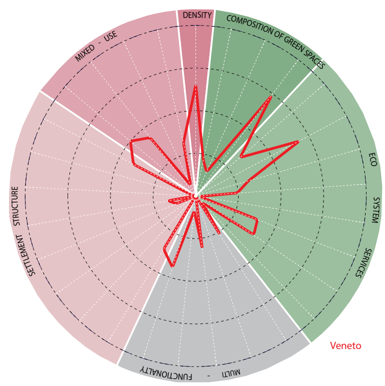
4 Bergamo-Brescia



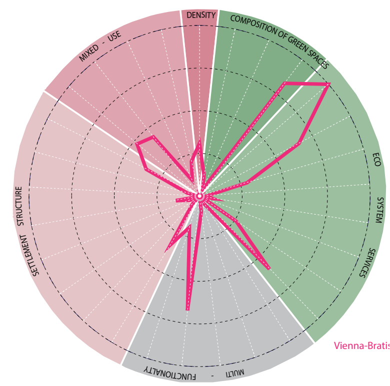
5 The Tyrol



8 Gelderland



9 Veneto



10 Vienna-Bratislava

7.1.1 Italy

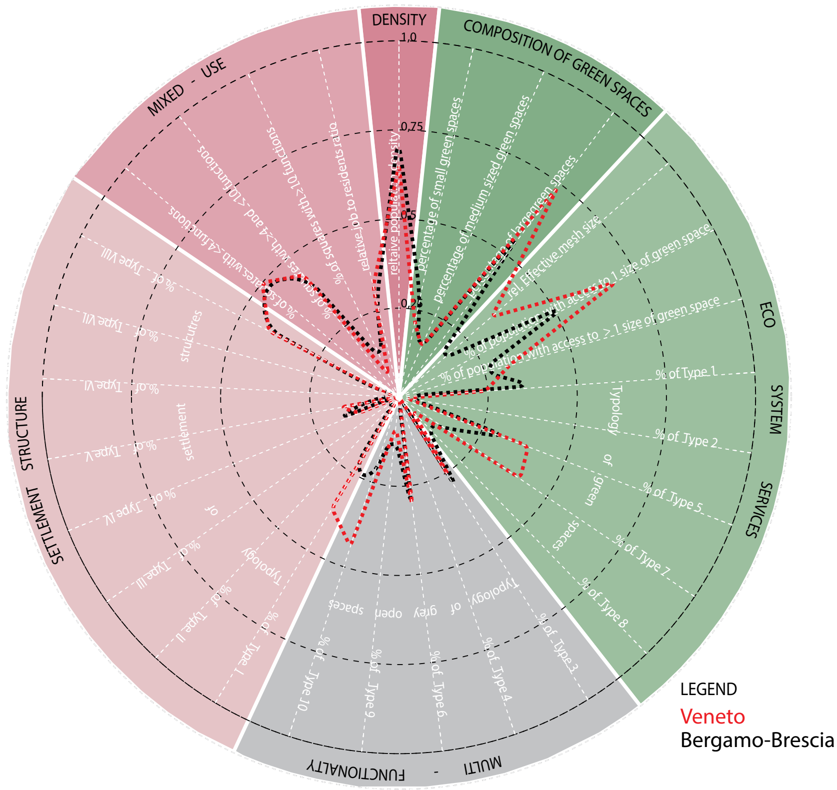


FIG. 7.6 Radar diagram of the two Italian cases, Bergamo-Brescia and Veneto.

Figure 7.6 shows the radar diagram of the two Italian cases, Bergamo-Brescia and Veneto. The star diagram of the two cases look very similar. Nevertheless, there are differences in the composition of green spaces, with Vento scoring higher percentages of large green spaces as well as more ecosystem services related to landscape fragmentation and accessibility of green spaces. Concerning the types of green spaces, Bergamo-Brescia peaks at type 1 and type 5, whereas Veneto peaks at type 5 and type 7. Type 1 shows a specifically high potential for cultural ecosystem services at the local scale and is under high urbanisation pressures, while type 7 is under little urbanisation pressure, and shows medium potential for all ecosystem services, specifically on the regional scale.

Concerning the potential for multi-functionality, the graph shows that in the Vento, type 10, which is the most undifferentiated type, shows medium potential for multi-functionality across all sectors, and is relatively frequent. Both cases show a very similar result concerning mixed-use, with the Veneto showing a slightly higher frequency in the less mixed classes and overall a slightly higher job to residents ratio. This is the result of a higher ratio of settlement type I in the Vento.

7.1.2 The Netherlands

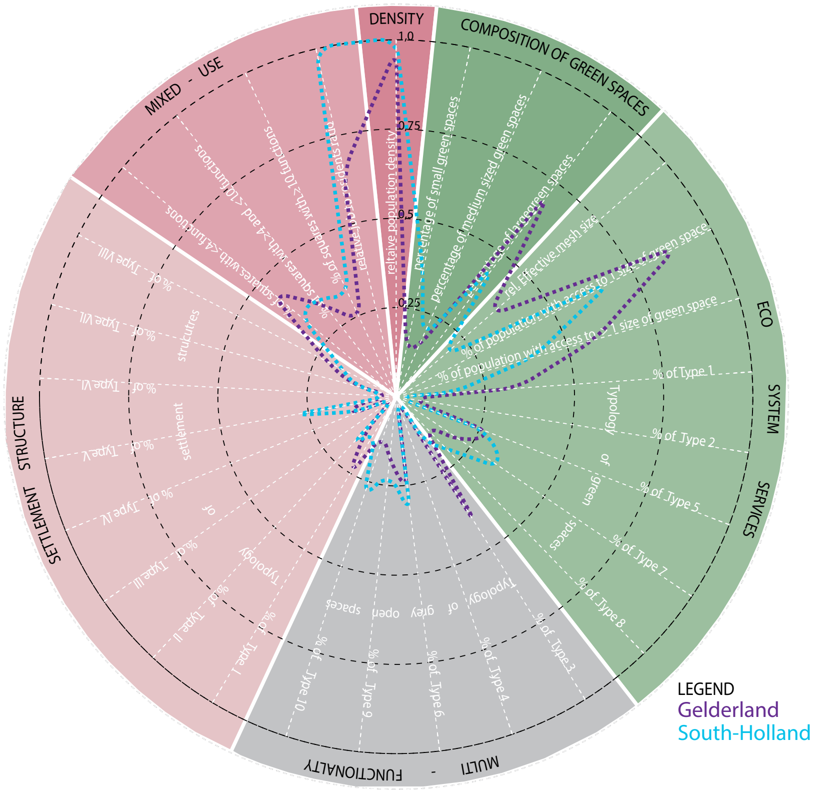


FIG. 7.7 Radar diagram of the two Dutch cases, Gelderland and South-Holland.

FIG. 7.7 shows the radar diagram of the two Dutch cases, Gelderland and South-Holland. The star diagram of the two cases looks rather similar. The significant differences between the two case are that South-Holland shows higher values for mixed-useand density, Gelderland a higher percentage of large green spaces and higher values for the accessibility to green spaces and a lower landscape fragmentation.

Concerning the types of green spaces, Gelderland peaks at type 1 and type 5, whereas South-Holland peaks at type 5 and type 7. Type 1 shows a specifically high potential for cultural ecosystem services at the local scale and is under high urbanisation pressure, while type 7 is under little urbanisation pressure, and shows medium potential for all ecosystem services but is specifically relevant on the regional scale.

Concerning multi-functionality, the critical difference is that Gelderland peaks at type 3, which is under high development pressures and has a high potential of multi-functionality between the residential and consumption sector. The most frequent grey open space in South-Holland are types 6, 9 and 10, therefore showing shows a more diversified potential for multi-functionality.

Both cases show different peaks concerning the most frequent settlement structures. The largest share of settlement type in South-Holland belong to types V, II and VIII. type I, VIII and IV are the most frequent in Gelderland.

The United Kingdom

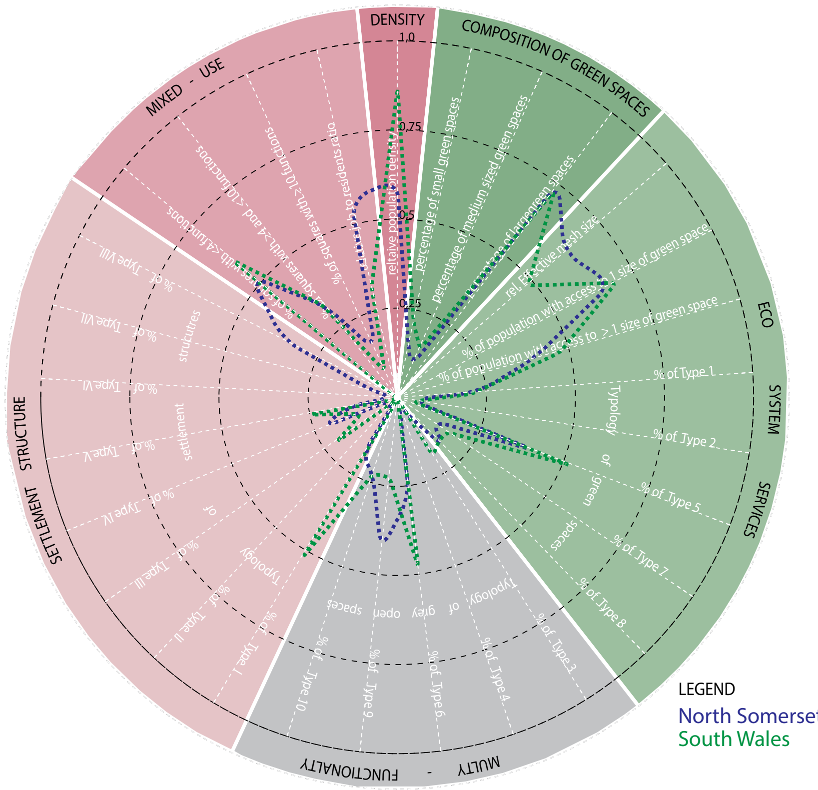


FIG. 7.8 Radar diagram of the two British cases, North Somerset and South Wales.

The radar diagram of the two British cases, North Somerset and South Wales also shows a somewhat similar star diagram. The significant differences are the higher population density in South-Wales and the lower landscape fragmentation of North Somerset.

Concerning the types of green spaces, both cases peak at type 5, which is under medium urbanisation pressure and shows medium potential for all ecosystem services equally at the local and regional scale.

Concerning multi-functionality, the key difference is that South-Wales peaks at type 6, which is under medium development pressure and has a medium potential of multi-functionality between the residential, consumption sector and green infrastructure. The most frequent grey open space in North Somerset is type 9, which has a rather limited potential for multi-functionality, and there is a reduced potential of multi-functionality between the production sector and grey infrastructure.

Both cases show different peaks concerning the most frequent settlement types. The largest share of settlement type in South-Wales belongs to type I. The most frequent settlement type in North Somerset is type VII.

7.1.4 Austria

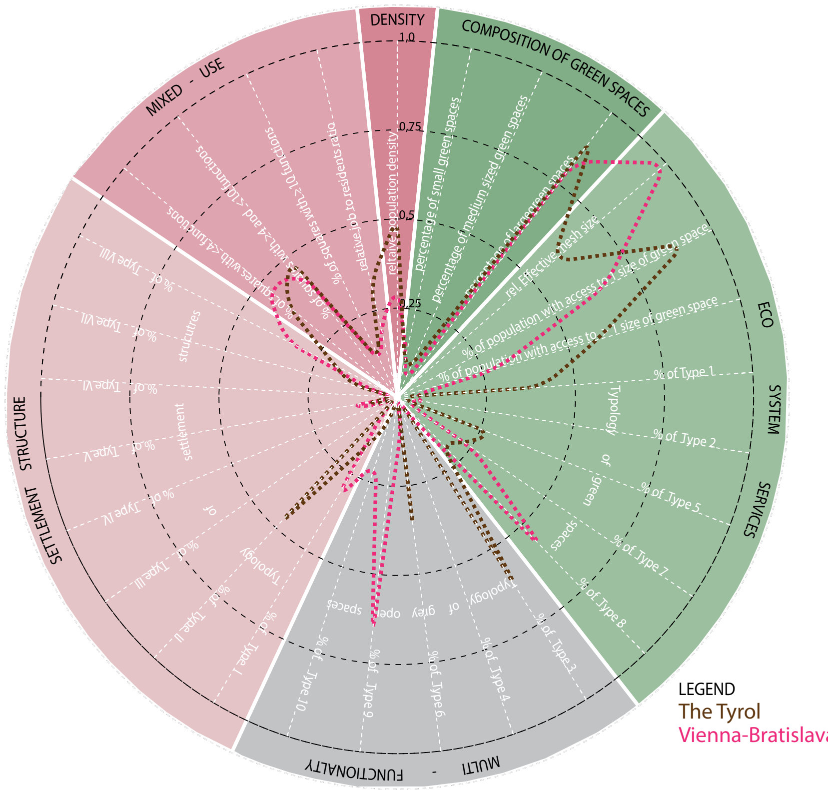


FIG. 7.9 Radar diagram of the two Austrian cases, Vienna-Bratislava and The Tyrol.

The two Austrian cases show a less similar graph than the pairs of cases presented before. Specifically, the relation between the composition of green spaces and accessibility to green spaces and landscape fragmentation are different. While in the earlier pairs, the case with the higher amount of large green space also showed higher accessibility to green spaces and had less landscape fragmentation, but in this case, it is different.

Vienna shows a single peak at type 8 green spaces, while The Tyrol shows a flatter graph with peaks at type 1 and 5, which means that The Tyrol has a more diverse potential of ecosystem services.

Concerning multi-functionality, the critical difference is that Vienna-Bratislava peaks at type 6, which is under medium development pressure and has a high potential of multi-functionality between the residential, consumption sector and green infrastructure. Type 3 and Type 6 are the most frequent grey open spaces in The Tyrol. Type 3 is under high urbanisation pressures and provides a high potential for multi-functionality in residential and consumption functions.

7.1.5 France

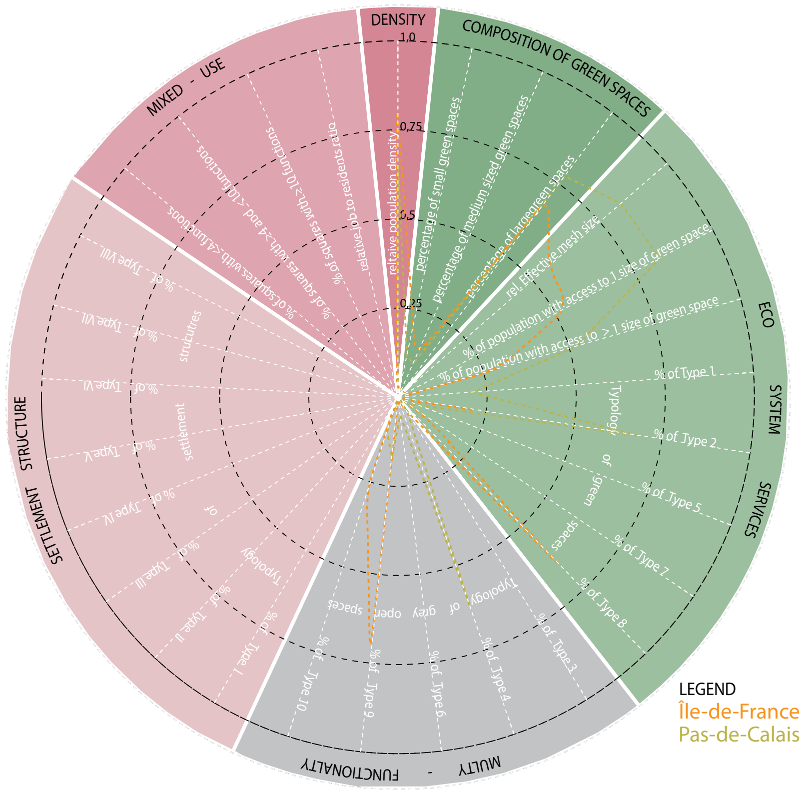


FIG. 7.10 Radar diagram of the two French cases, Pas-de-Calais and Ile-de-France.

The French cases show less similarity than the first three pairs. The Pas-de-Calais case performs higher on the ecosystem related indicators, even though the composition of green spaces is similar between the two cases. It is important to note that the French cases, due to lack of equivalent data to the other cases, they were not included in the mixed-use study. Therefore, they also do not show values in the sectors mixed-use and settlement structures.

Both cases show clear and different peaks within the frequency of greens spaces. The most frequent type in Pas-de-Calais is type two, which is under relatively high urbanisation pressures. It is equally highly relevant for the provision of ecosystem services at the local and regional scale. Type two has a specifically high potential for provisioning and regulating ecosystem services. The Ile-de-France case peaks at Type 8, which is the type under the least development pressure with medium potential across all types of ecosystem services, specifically at the regional scale.

The five national pairwise comparisons show that in three countries, Italy, the Netherlands and the UK, the cases have many similarities in both the indicators for sustainable development and the frequency distribution of the settlement and open space types. Nevertheless, there are also notable differences between these three pairs. For example, South-Holland scores higher when concerning mixed-use compared to Gelderland. The Vento scores higher in concerning accessibility and landscape fragmentation than Bergamo-Brescia and so does North Somerset in comparison to South Wales. In the other two countries, the cases show more differences in the relation to green space composition, its effects on the accessibility of green spaces and landscape fragmentation.

7.2 Cross-national comparison

The radar diagram allows for several ways to cross-compare all of the cases. First, the comparison of all sectors in the diagram is used to understand if some cases show similar or different results. Second, to have investigated similarities by each sector. Figure7.11 presents cases that have similar overall results which means peaks at the same spokes. Seven cases show a rather similar result. The French cases and Vienna-Bratislava show a different pattern in comparison to the others and show little similarity between each other. See figure 7.12 for the radar diagram of the outlier cases.

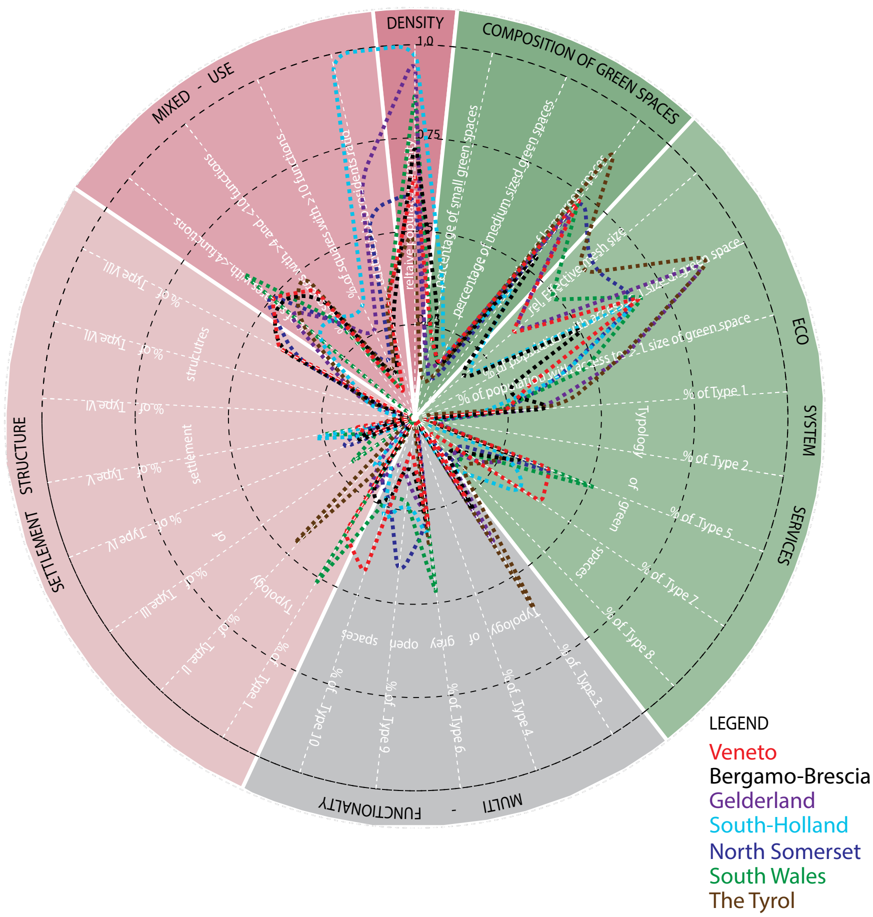


FIG. 7.11 Radar diagram of the seven cases with a similar overall result.

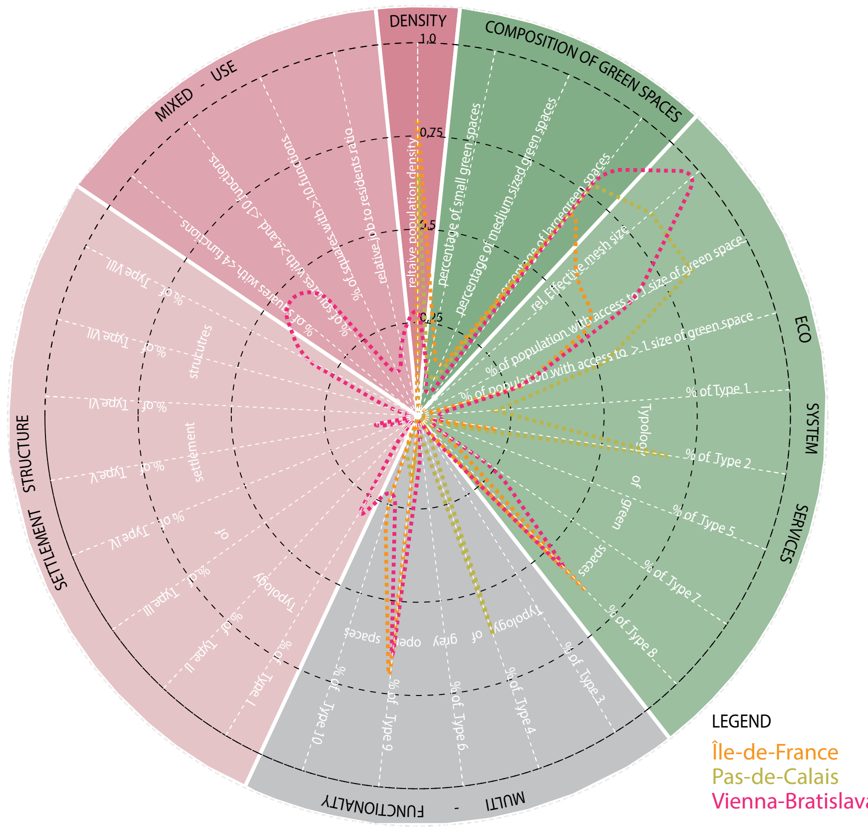


FIG. 7.12 Radar diagram of the three outlier cases.

Looking at the overall graph does, not give attention to the detailed differences. Therefore, the following section looks at the radar diagram using variables belonging to three thematic groups. Group one includes the sectors settlement structures, mixed-use and density, and represents the sustainability potentials of the built-up area. Group two consists of the sector composition of green spaces and ecosystem services, both represent the sustainability potential of the green spaces and the green infrastructure. Group three includes the sector multi-functionality, representing the sustainability potentials of grey open spaces. We consider cases similar if they have peaks along the same spokes and if the peaks are not more than 20 % of the spoke length from each other.

Figure 7.13 presents all the similarities in the analysis for all the cases in thematic group one, which includes the sector settlement structures, mixed-use and density. This thematic group contains 13 variables. Values from ten to 13 were considered to indicate two similar cases.

Case	Veneto	Bergamo – Brescia	The Tyrol	Vienna-Bratislava	South-Holland	Gelderland	South Wales	North Somerset	Île-de-France	Pas-de-Calais
Veneto		13	10	12	7	11	10	12		
Bergamo – Brescia	13		10	11	8	8	10	11		
The Tyrol	10	10		11	8	10	8	10		
Vienna-Bratislava	12	11	11		9	11	10	10		
South-Holland	7	8	8	9		12	6	9		
Gelderland	11	8	10	11	12		9	12		
South Wales	10	10	8	10	6	9		9		
North Somerset	12	11	10	10	9	12	9			
Île-de-France										
Pas-de-Calais										

FIG. 7.13 presents all the similarities in the analysis for all the cases for thematic group one, which includes the sector settlement structures, mixed-use and density. This thematic group contains 13 variables. Values from ten to 13 were considered to indicate two similar cases.

Figure 7.13 shows 18 similar pairs. Three of the pairs in the same country show high similarity. The Italian and Dutch cases showed the highest similarities; the British pair shows no similarity. But figure 7.13 also shows that there is a similarity of the same level among cases from different countries. For example, Gelderland shows high values for similarity with four other cases: Veneto, Vienna-Bratislava, The Tyrol and North Somerset. The Veneto shows high similarity with all other cases but South-Holland. South-Holland is the least similar to the other cases, followed by South Wales. The main conclusion is that for the aspects of settlement structure and mixed-use, there is a high similarity across all cases.

Figure 7.14 presents the similarity analysis conducted for all the cases for thematic group two, which includes the sectors composition of green spaces and ecosystem services. This thematic group consists of eleven variables. Values equal and bigger than nine were considered to indicate two similar cases.

Case	Veneto	Bergamo – Brescia	The Tyrol	Vienna-Bratislava	South-Holland	Gelderland	South Wales	North Somerset	Île-de-France	Pas-de-Calais
Veneto		10	7	8	9	9	10	9	5	5
Bergamo – Brescia	10		6	6	9	8	10	10	6	5
The Tyrol	7	6		5	7	11	9	11	5	8
Vienna-Bratislava	8	6	5		5	5	8	8	9	7
South-Holland	9	9	7	5		8	6	7	4	5
Gelderland	9	8	11	5	8		10	9	4	7
South Wales	10	10	9	8	6	10		11	7	7
North Somerset	9	10	11	8	7	9	11		7	8
Île-de-France	5	6	5	9	4	4	7	7		5
Pas-de-Calais	5	5	8	7	5	7	7	8	5	

FIG. 7.14 The similarity analyses of all case for thematic group two. Red indicates cases with high similarity. The number indicates the amount of indicators two case show a similar result.

From figure 7.14 it can be inferred that, with the 15 similar pairs, there is in total less similarity across the cases for thematic group two than for thematic group one. The British and Italian cases are the only similar national pairs. This two pairs also show a high similarity across the countries and form together with Gelderland and The Tyrol a similarity cluster. South-Holland is similar to the two Italian cases. Vienna-Bratislava and the Ile-de-France show high similarity. Pas-de-Calais shows no similarity to any other case.

Figure 7.15 presents the similarity analysis conducted for all the cases for the thematic group two, which includes the sectors, composition of green spaces and ecosystem services. This thematic group consists of eleven variables. Values equal and bigger than nine were considered as indicated two similar cases.

Case	Veneto	Bergamo – Brescia	The Tyrol	Vienna-Bratislava	South-Holland	Gelderland	South Wales	North Somerset	Île-de-France	Pas-de-Calais
Veneto		4	2	1	4	3	3	4	2	2
Bergamo – Brescia	4		3	1	4	4	4	2	1	2
The Tyrol	2	3		2	2	5	3	3	1	2
Vienna-Bratislava	1	1	2		3	3	3	4	5	3
South-Holland	4	4	2	3		3	5	4	3	2
Gelderland	3	4	5	3	3		4	3	2	2
South Wales	3	4	3	3	5	4		4	3	3
North Somerset	4	2	3	4	4	3	4		3	2
Île-de-France	2	1	1	5	3	2	3	3		3
Pas-de-Calais	2	2	2	3	2	2	3	2	3	

FIG. 7.15 The similarity analyses of all case for thematic group three. Red indicates cases with high similarity. The number indicates the amount of indicators two case show a similar result.

From figure 7.15 it can be inferred that, with the 15 similar pairs, there is in total less similarity across the cases for thematic group two than for thematic group one. The British and Italian cases are the only similar national pairs. This two pairs also show a high similarity across the countries and form together with Gelderland and The Tyrol a similarity cluster. South-Holland is similar to Italian cases. Vienna-Bratislava and the Ile-de-France show high similarity. Pas-de-Calais shows no similarity to any other case.

Figure 7.16 shows the aggregation of the similarity analyses. The value depicted between a pair of cases reflects the number of thematic groups for in which two cases show a similarity with each other.

Case	Veneto	Bergamo – Brescia	The Tyrol	Vienna-Bratislava	South-Holland	Gelderland	South Wales	North Somerset	Île-de-France	Pas-de-Calais
Veneto		3	1	1	2	1	2	3	0	0
Bergamo – Brescia	3		1	1	2	1	3	2	0	0
The Tyrol	1	1		1	0	3	1	2	0	0
Vienna-Bratislava	1	1	1		0	1	1	2	1	0
South-Holland	2	2	0	0		1	1	1	0	0
Gelderland	2	1	3	1	1		2	2	0	0
South Wales	2	3	1	1	1	2		3	0	0
North Somerset	3	2	2	2	1	2	3		0	0
Île-de-France	0	0	0	1	0	0	0	0		0
Pas-de-Calais	0	0	0	0	0	0	0	0	0	

FIG. 7.16 The similarity analyses of all case over all three thematic groups Red indicate cases with high similarity. The number indicates the amount of thematic groups two case have been considered similar.

Figure 7.16 shows that the Italian and Britsh cases have the highest possible similarity within national pairs. Both pairs also show high similarity between each other. Gelderland is similar to both British cases. The Tyrol shows a high similarity with Gelderland. North Somerset shows a high similarity with most cases. The French cases show neither a similarity among each other nor with any other case but Vienna-Bratislava.

The following are four major conclusions that were drawn from the cross-national similarity comparison:

- Dispersed urban areas show higher similarity to each other when comparing built structures than when comparing landscape structures.
- Only the British and the Italian cases are consistently more similar to each other than to cases from other countries.
- North Somerset is the case that is more often similar to cases from other countries.
- The French cases show hardly any similarities with each other or cases from other countries.

7.3 Cross-case comparison of current sustainability and sustainability potential

The third part of the cross-comparison investigates (i) the sustainability of TiBs, and (ii) which cases show potential for future sustainability. A selection of spokes of the radar diagram is used for this analysis. For the assessment of the existing state of sustainability, the following four indicators are selected:

- The percentage of 500 m x 500 m squares with more than four and less than ten functions;
- The percentage of 500 m x 500 m squares with more than ten functions;
- The relative effective mesh size;
- The percentage of the population with access to more than one size of green space.

To assess the potential for sustainable development, types which have the highest potentials were selected from the three typologies

For the typology of green spaces, these are:

- type 1, which has the highest potential for local ecosystem services and is specifically important for cultural and regulating ecosystem services;
- type 2, which is the type with the highest potential for all ecosystem services on both the local and regional scale and therefore of strategic importance.

For the typology of grey spaces, these are:

- type 3, which has the highest potential of multi-functionality with most functions, and is under a high level of urbanisation pressure;
- type 4, which has similar potentials as type 3 but has more potential towards multifunctional useages that includes green infrastructure.

For the typology of settlement structure these are:

- type II, which has good accessibility to both the fast street network and to public transit; a medium local and regional betweenness and high local straightness, regional reach centrality and local straightness; a medium permeability and medium grain size; and is low on population density and medium on job density;
- type III,which has medium accessibility to the fast street network, good accessibility to public transit, it is low on all regional centrality measure and high on local centrality measures, it has the highest permeability and medium grains size, is high on population density and medium on job density.
- type VI, which has good accessibility to the fast street network and excellent accessibility to public transit, it is high on local and regional betweenness and high on local straightness and regional reach centrality, and it has medium permeability and small grain size, is high on population density and very highvon job density.
- type VIII, because it has good accessibility to public transit. It is very high on local and regional betweenness and high on local straightness and low on regional reach centrality. It has high permeability and medium grain size, medium job and population density.

The variables above are again displayed with a radar diagram. Figure 7.17 shows the sustainability comparison of all 10 cases in one diagram.

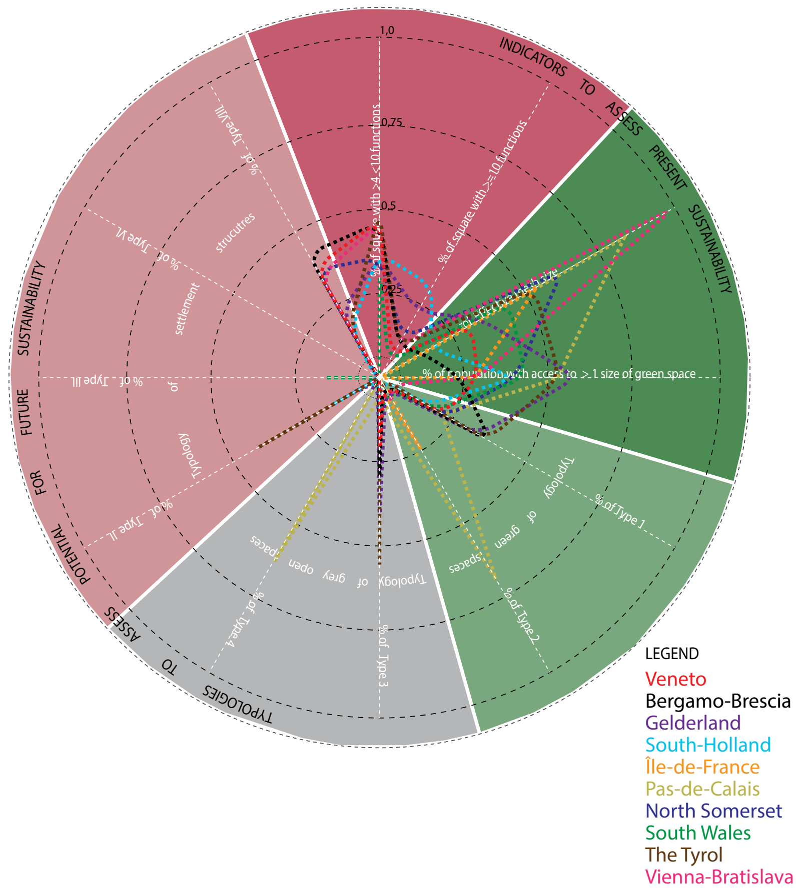


FIG. 7.17 Radar diagram with the twelve indicators for the assessment of the potential of present and for future sustainable development.

When looking at the green subsection of the diagram, which presents the present sustainability concerning ecosystem services, it becomes apparent that Pas-de-Calais scores the best. It also has the highest percentage of green space types with a high potential for sustainable development. The three cases Tyrol, Gelderland and North Somerset, score middle-range concerning landscape fragmentation and high on accessibility of green spaces. Moreover, they also score high for the potential of future sustainable development provided by green spaces. South Wales scores concerning the present sustainability similar to the three cases named before but shows a lower potential for future sustainability. The Ile-de-France and Vienna-Bratislava have a good score for landscape fragmentation but score rather poorly for accessibility to green spaces and potential ecosystem services provided by green spaces. South-Holland and Veneto rank in the bottom three for landscape fragmentation. The latter also concerns accessibility to green spaces, while South-Holland's score for accessibility to green spaces is in the middle. For the future potential of sustainability-related ecosystem services, it is the opposite. South-Holland scores in the lowest third tier and Veneto is in the middle. Bergamo-Brescia scores the worst for the existing sustainability but has the second-highest potential in concerning future sustainable development.

Concerning the potential contributions grey spaces may have on future sustainability, Pas-de-Calais performs the best due to a high share of grey open space from type 4. The Tyrol and Gelderland follow with the second and third highest potential for future sustainable development. The next highest are Bergamo-Brescia and Veneto based on the possibilities for multifunctionality provided by grey spaces. South-Wales and South Holland have minimal potential and the other three cases have nearly none.

Concerning the existing sustainability in relation to mixed-use, little differences between the cases can be identified. Only South-Holland's scores are slightly better than the rest of the cases. The Austrian and Italian cases show a somewhat higher potential for mixed-use and related future sustainable development.

The radar diagram presented provides an aggregated assessment of the existing and potentials for sustainability. Both are not equally distributed across space within the cases. Therefore, the following part of the Atlas of territories-in-between presents three maps for each case illustrating the spatial differentiation of the existing and future potentials for sustainability.

7.4 Atlas of territories-in-between Part F: Present and potential for future sustainability

This section of the Atlas of territories-in-between contains ten double-pages with two thematic maps at the scale of 1: 500.00 with separate legends and captions on the right page. On the left page, there is one map of a 50 km x 50 km square at the scale of approximately 1: 310.000. Underneath it is a legend and one additional radar diagram. In addition, there is a legend and caption for the whole page. The above map on the left page shows the indicators that were used to assess the present situation. On the left page, the bottom map shows the specific types of the three typologies introduced earlier, which have the highest potential for future sustainability.

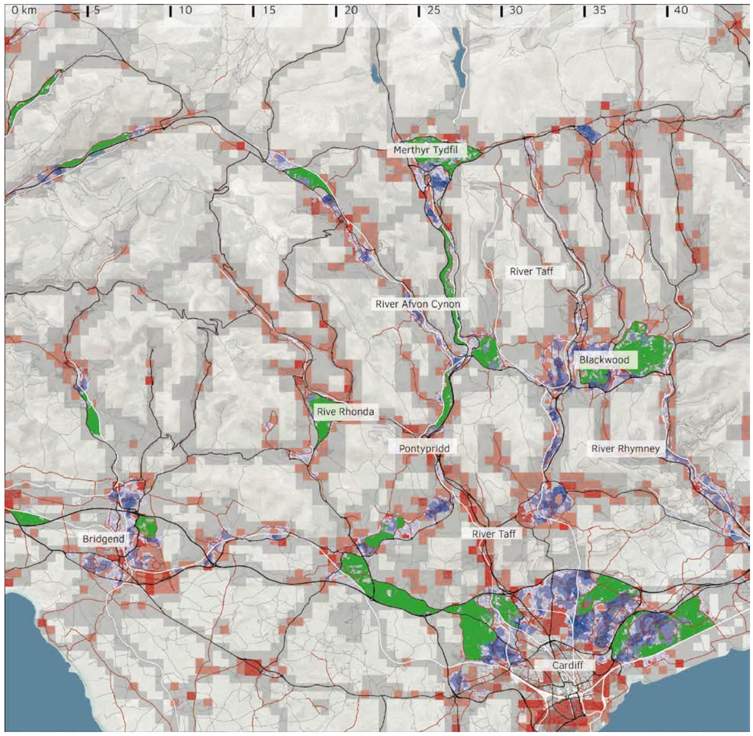
The map on the existing sustainability includes the following variables:

- the 500m x 500 m cells with more than four but less than ten different functions different functions;
- the of 500m x 500 m squares with ten or more different functions;
- the unfragmented green spaces larger than one square kilometre;
- the areas where the population has access to more than two different sizes of green space.

The map showing the potential for future sustainable development includes:

- from the typology of open spaces: type 1, type 2, type 3 and type 4;
- from the typology of settlement structure: type II, type III, type VI, and type VIII.

SOUTH WALES



Existing sustainability

Intensity of accesibility to green spaces

- 3
- 4
- 5
- 6

Unfragmented green spaces larger than one square kilometre

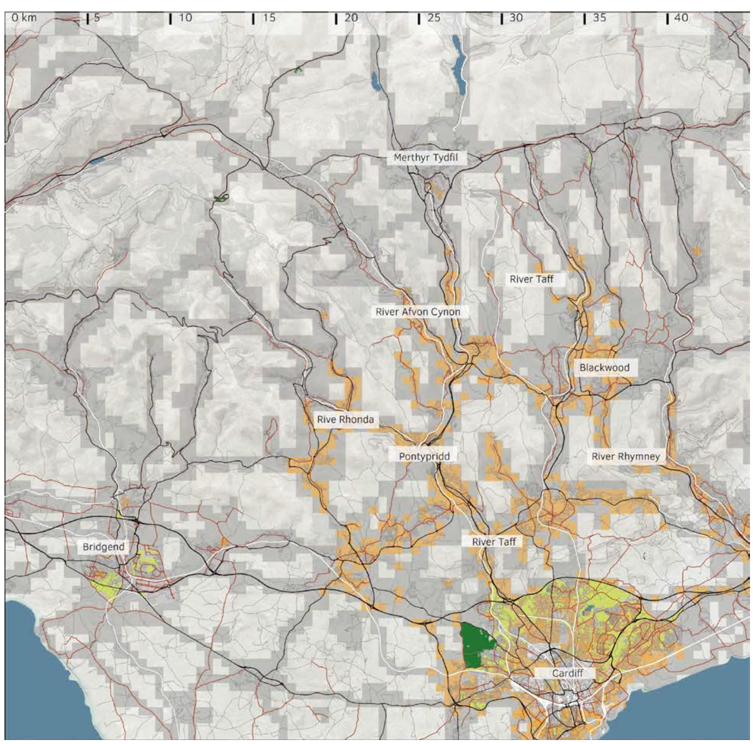
500 m x 500 m cells with more than four different functios but less than ten functions

500 m x 500 m squares with more than ten functions

Territories-in-between

1ha

FIG. 7.18 When looking at the sustainability indicators for the existing situation, then they area with high valuesare located at the periphery of Cardiff and in the valleys specifically around Pencode, Proth, Glyncach Treharris and Blackwood and Merthyr Tydfil.



Future sustainability

Typology of settlement structure

- type II
- type III
- type VI
- type VIII

Typology of open spaces

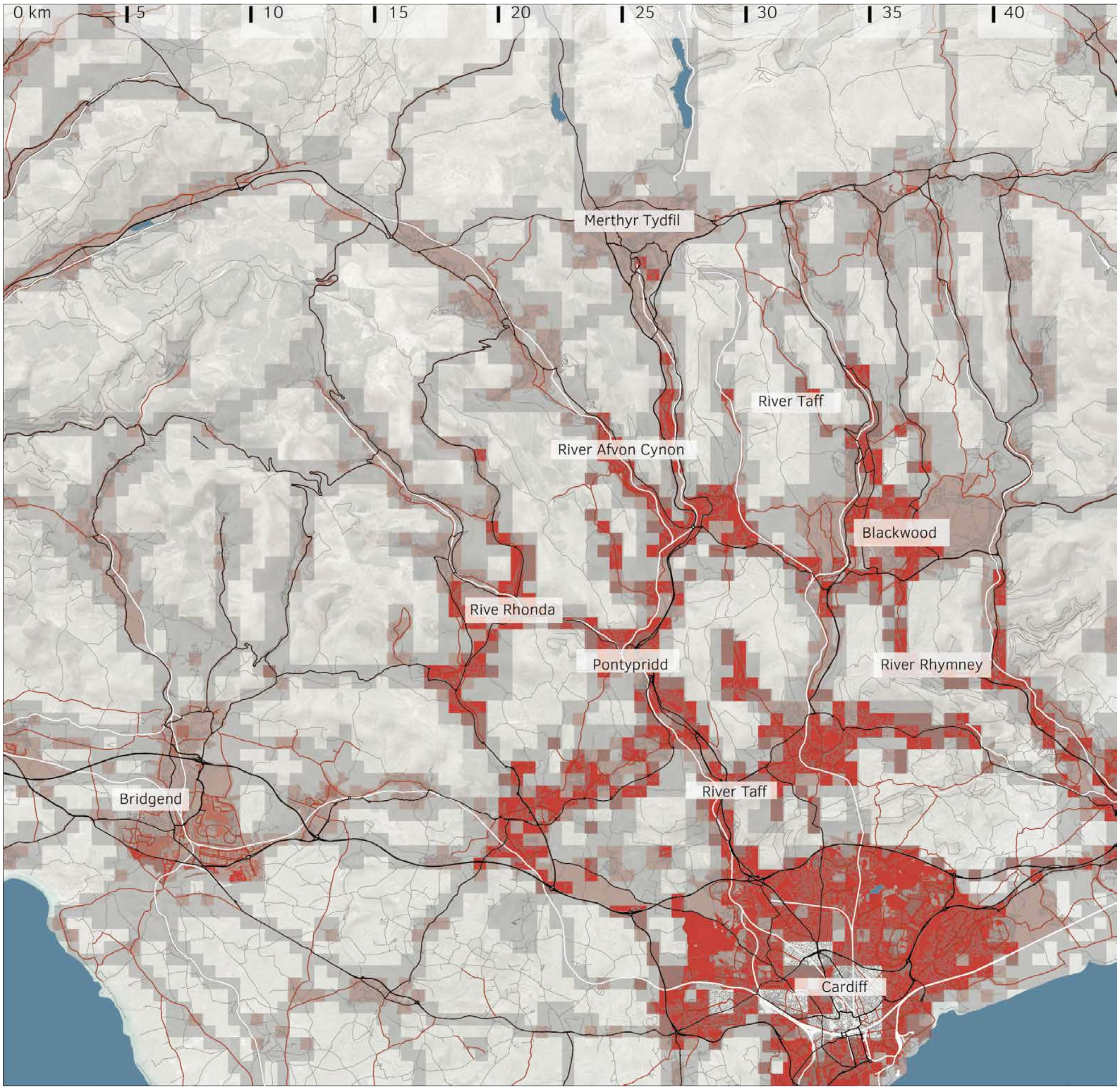
- type 1
- type 2
- type 3
- type 4

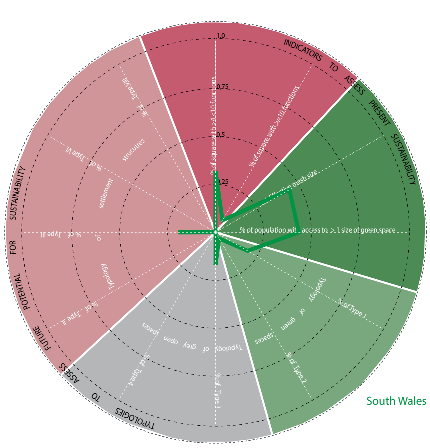
Territories-in-between

1ha

FIG. 7.19 The potential for future sustainable development seems to be limited to the periphery of Cardiff and Bridgend.

TOC





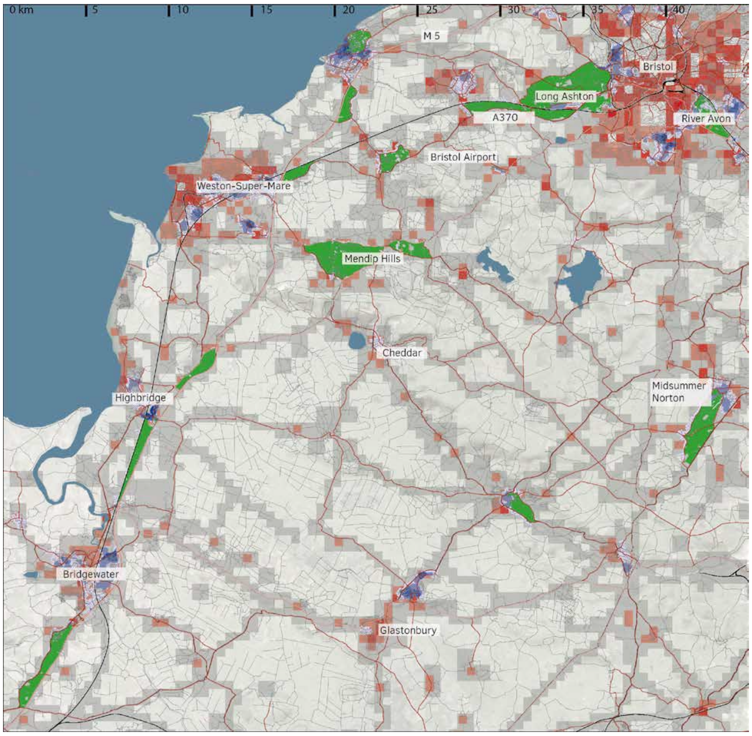
Sustainability Potential

- High values for existing sustainability indicators
- High potential for future sustainable development
- Areas with both present and future sustainability potential
- Territories-in-between

N

1km²

FIG. 7.20 The areas with overlapping potentials for current and future sustainability in South Wales are located at the periphery of Cardiff, in the towns just north of the greenbelt and in the towns along the slower South Wales Valleys.



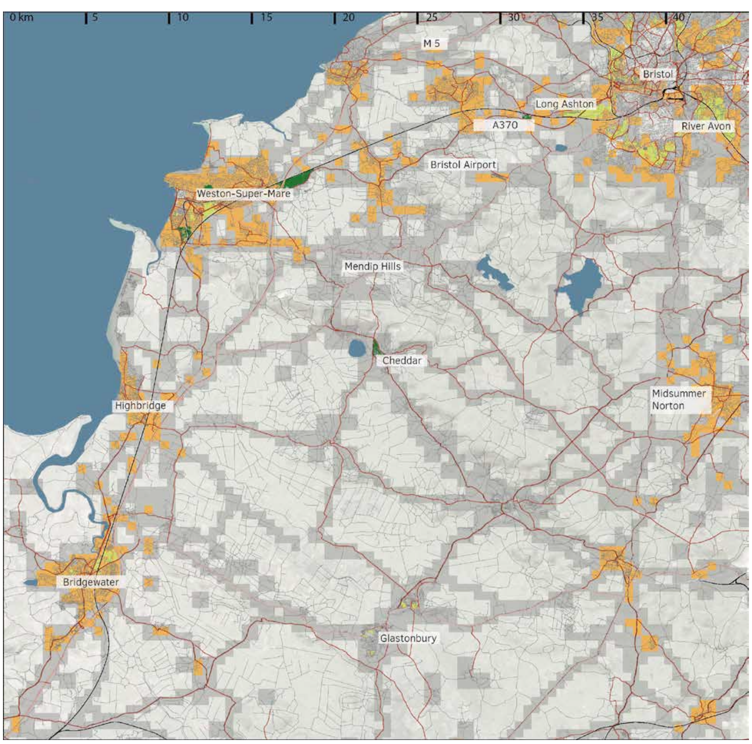
Existing sustainability

Intensity of accesibility to green spaces

- 3
- 4
- 5
- 6
- Unfragmented green spaces larger than one square kilometre
- 500 m x 500 m cells with more than four different functios but less than ten functions
- 500 m x 500 m squares with more than ten functions
- Territories-in-between

1ha

FIG. 7.21 High scoring areas concerning the indicators describing the existing situation are at the periphery of Bristol, the areas along the A370 towards Long Ashton and in the east along the River Avon, further close to Clevedon and in the Mendip Hills around Sandford and Midsummer Norton.



Future sustainability

Typology of settlement structure

- type II
- type III
- type VI
- type VIII

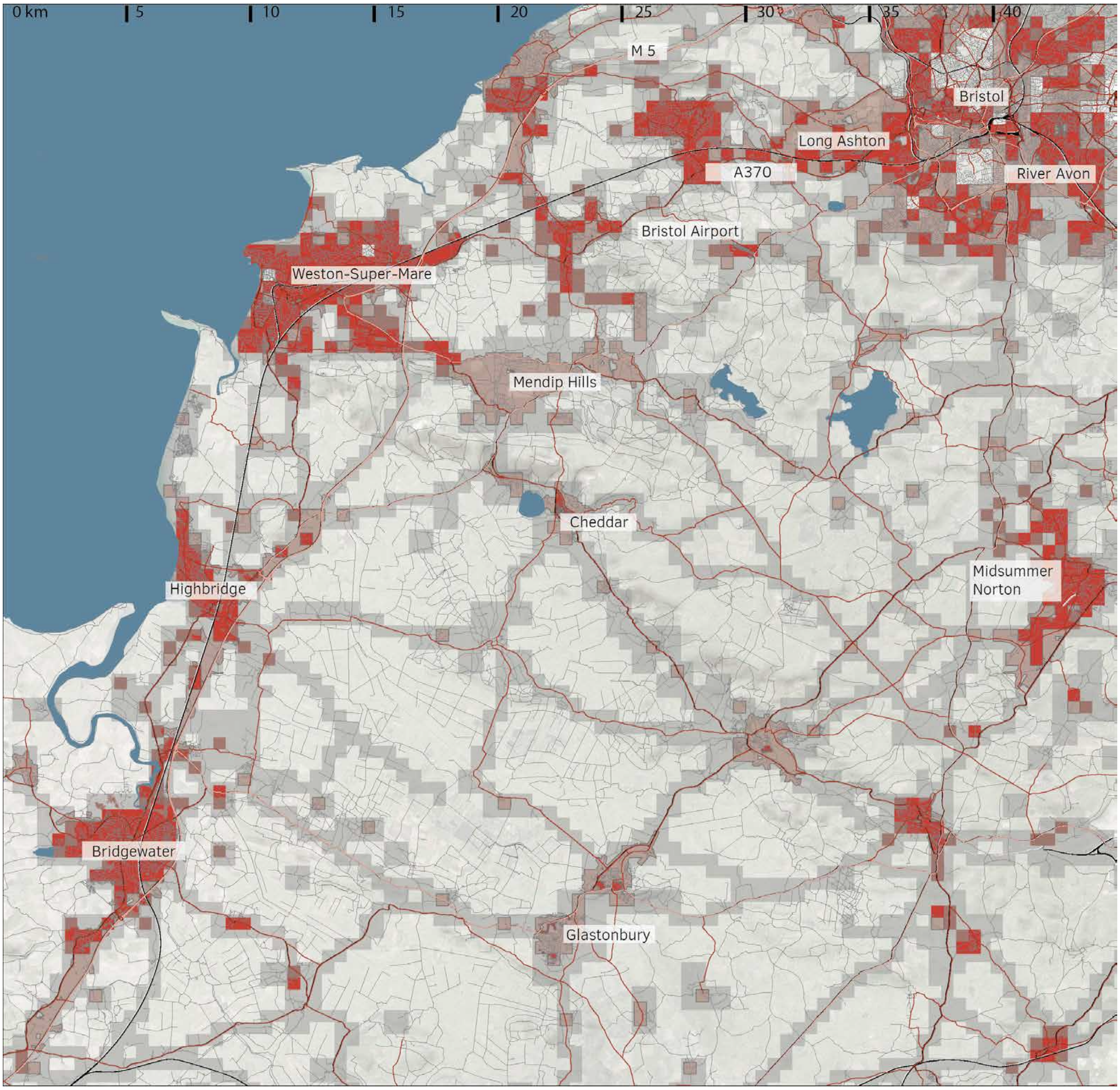
Typology of open spaces

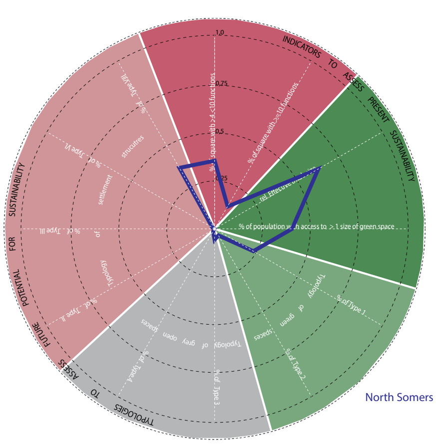
- type 1
- type 2
- type 3
- type 4

- Territories-in-between

1ha

FIG. 7.22 In this case, the areas with high potential differ more than in other cases in comparison with the areas that already perform well. While the periphery of Bristol has high potential, the other areas with high potential are Weston Super Mare and the area around Highbridge.





Sustainability Potential

- High values for existing sustainability indicators
- High potential for future sustainable development
- Areas with both present and future sustainability potential
- Territories-in-between

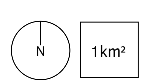
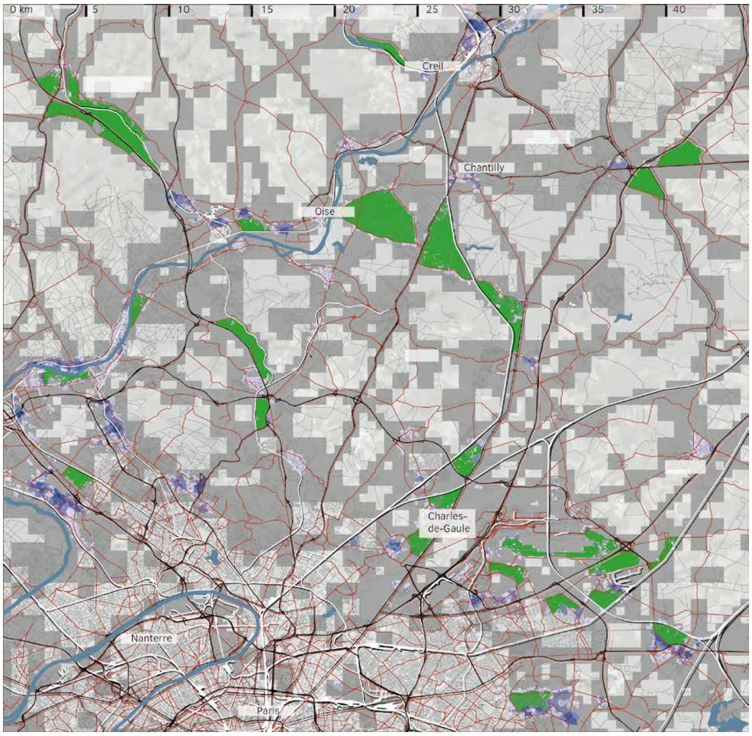


FIG. 7.23 The areas with overlapping potentials for current and future sustainability in North Somerset are located predominantly in and around the cities along the coast. Inland, there are only significant areas of overlapping potential in and around Midsummer Norton.



Existing sustainability

Intensity of accesibility to green spaces

- 3
- 4
- 5
- 6

Unfragmented green spaces larger than one square kilometre

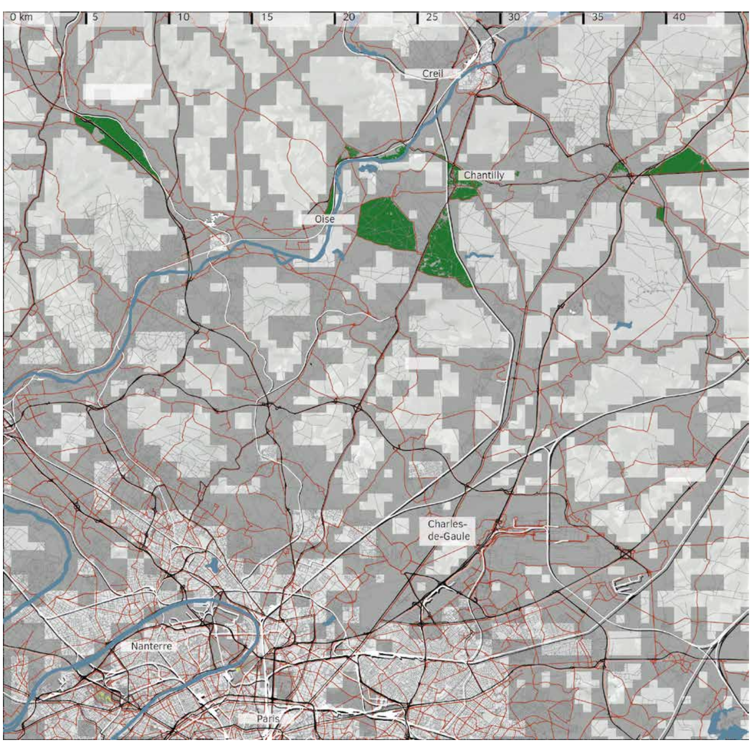
500 m x 500 m cells with more than four different functios but less than ten functions

500 m x 500 m squares with more than ten functions

Territories-in-between

1ha

FIG. 7.24 There are rather few areas with present potential for sustainability in the TiB in the case study area. They are located predominantly around Charles-de Gaulle Airport in the Oise valley and south of Chantilly. Note that due to the lack of data, the zones with mixed-use are not displayed.



Future sustainability

Typology of settlement structure

- type II
- type III
- type VI
- type VIII

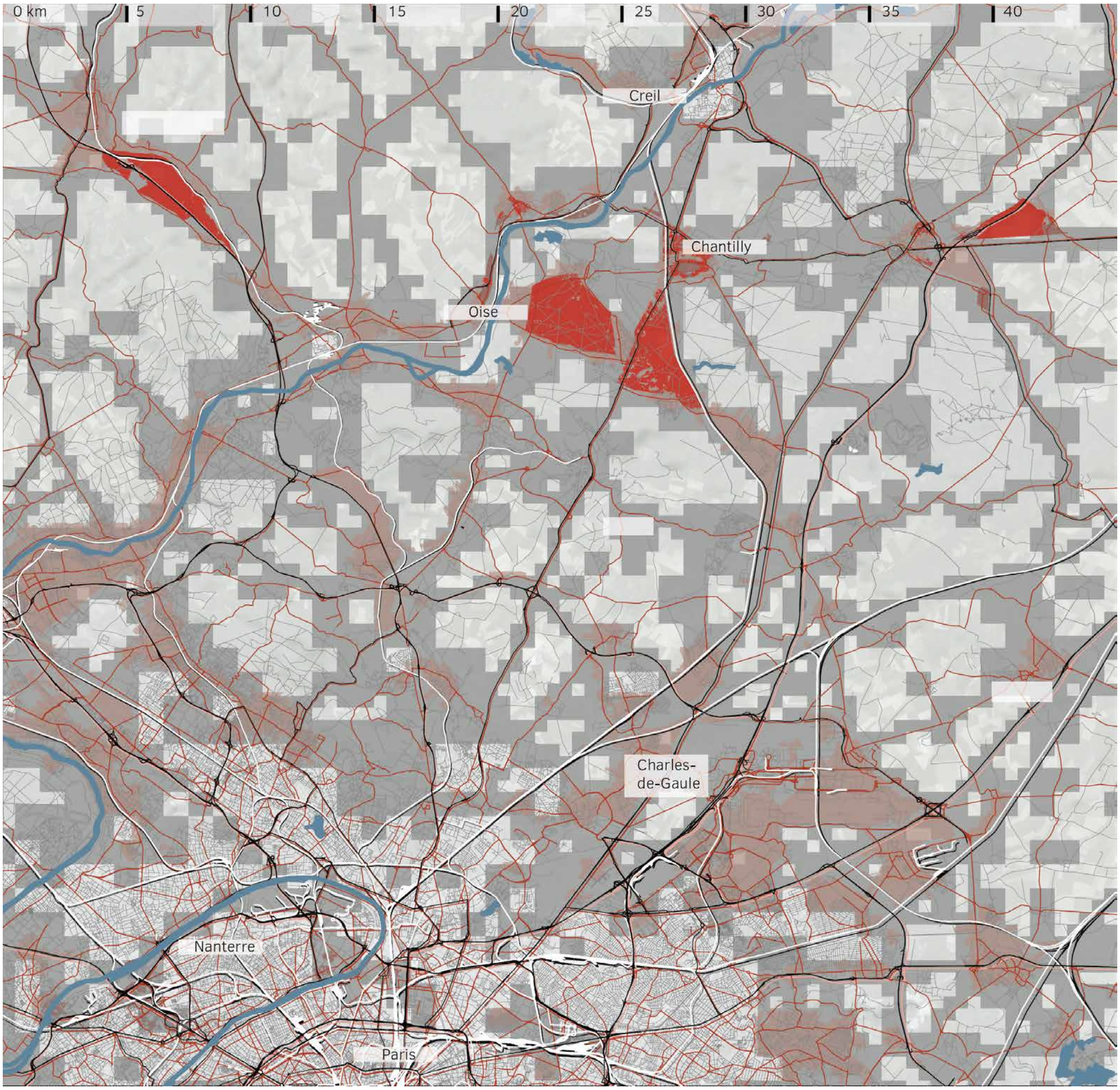
Typology of open spaces

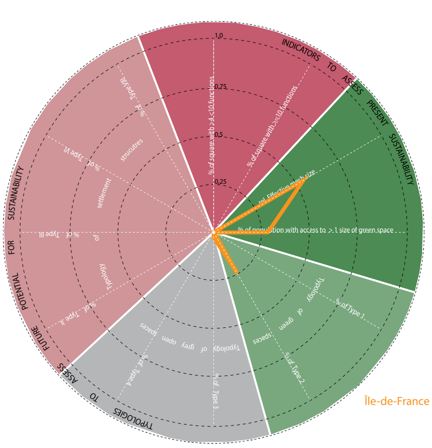
- type 1
- type 2
- type 3
- type 4

Territories-in-between

1ha

FIG. 7.25 There are also rather few areas with future potential for sustainability in the TiB in the case study area. They are predominantly the ones that have a current potentials and additionally green and grey spaces close to Nanterre. Note that because due to lack of data, the zones with sustainability potential related to settlement structure are not displayed.





Sustainability Potential

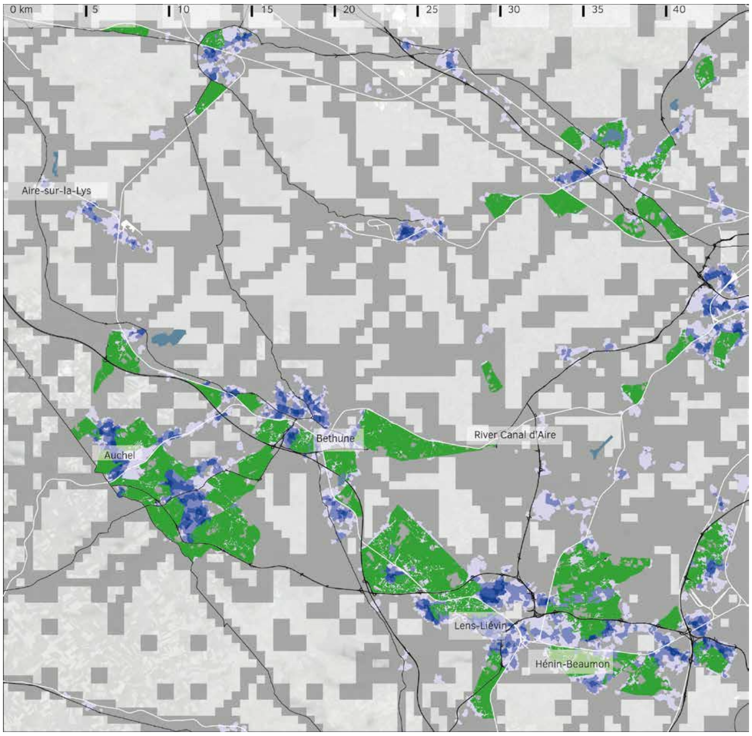
- High values for existing sustainability indicators
- High potential for future sustainable development
- Areas with both present and future sustainability potential
- Territories-in-between

N

1km²

FIG. 7.26 The areas with overlapping potentials for current and future sustainability in the Ile-de-France are located predominantly around the cities in the north. Note that this map shows significant less overlap as other cases because of the lack of data, the zones with sustainability potential related to settlement structure and mixed-use are not displayed.

PAS-DE-CALAIS



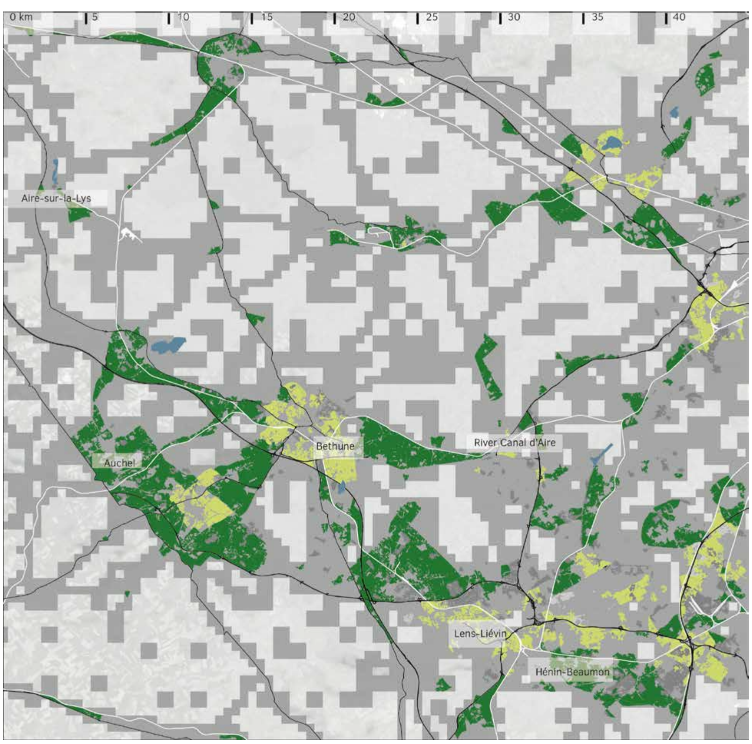
Existing sustainability

Intensity of accesibility to green spaces

- 3
- 4
- 5
- 6
- Unfragmented green spaces larger than one square kilometre
- 500 m x 500 m cells with more than four different functios but less than ten functions
- 500 m x 500 m squares with more than ten functions
- Territories-in-between

1ha

FIG. 7.27 The areas showing high values for the sustainability indicators are mostly located at the transition area from the Alps into the river plain specifically around the towns of Torre Boldone, Gorlago nad Grumella del Monte. Another area is the western and southern periphery of Brescia. The east coast of the Iseo lake also shows high values for all indicators. The only area in the river plain highlighted is around the city of Romano di Lombardia.



Future sustainability

Typology of settlement structure

- type II
- type III
- type VI
- type VIII

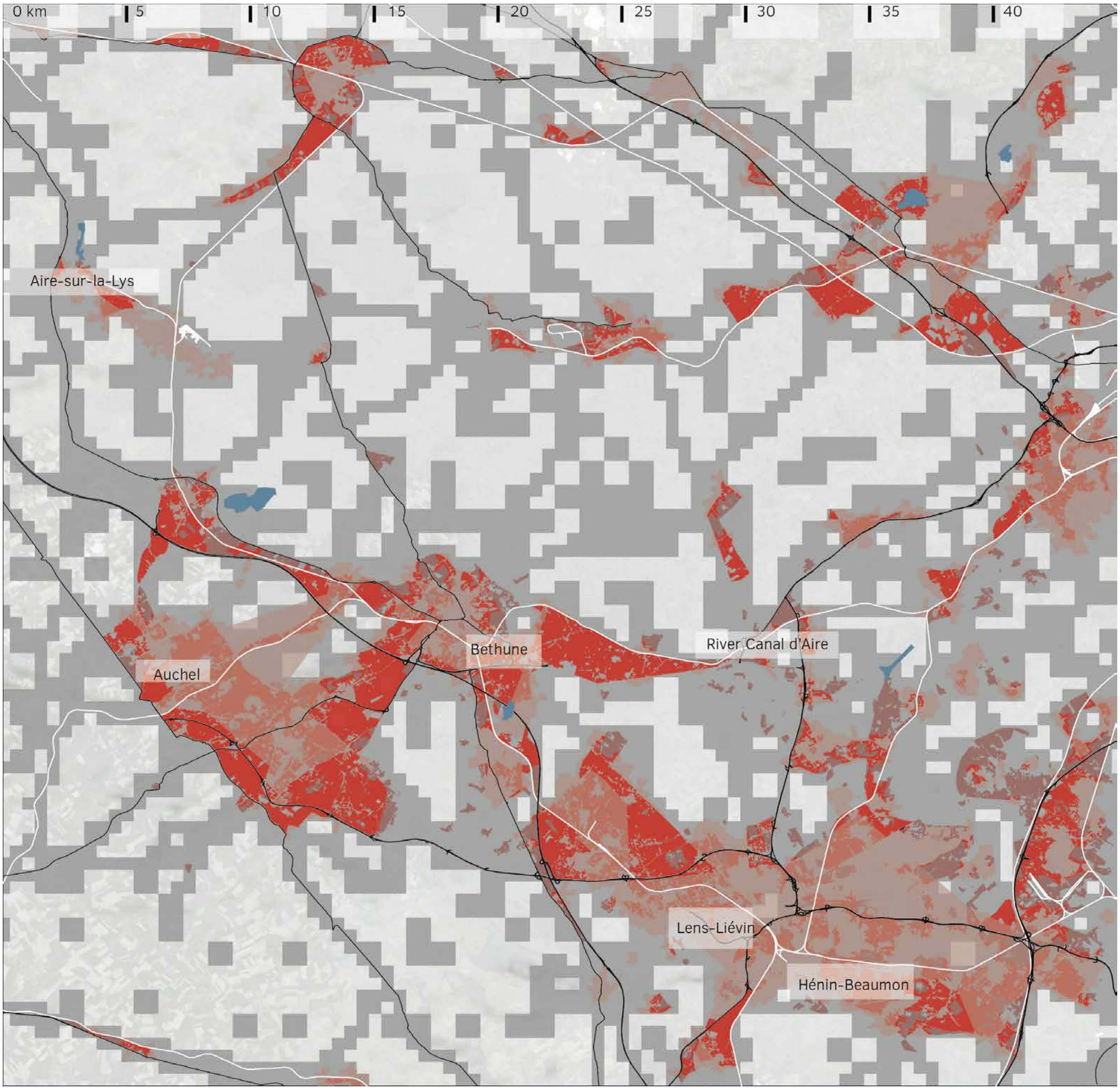
Typology of open spaces

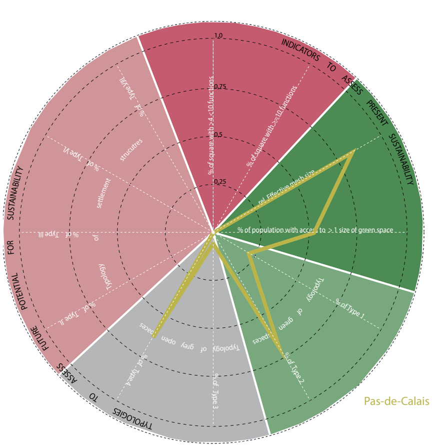
- type 1
- type 2
- type 3
- type 4

- Territories-in-between

1ha

FIG. 7.28 Most areas that present high values for the sustainability indicators also show potential for future sustainable development. Due to the lack of data, zones with sustainability potential related to settlement structures are not included.





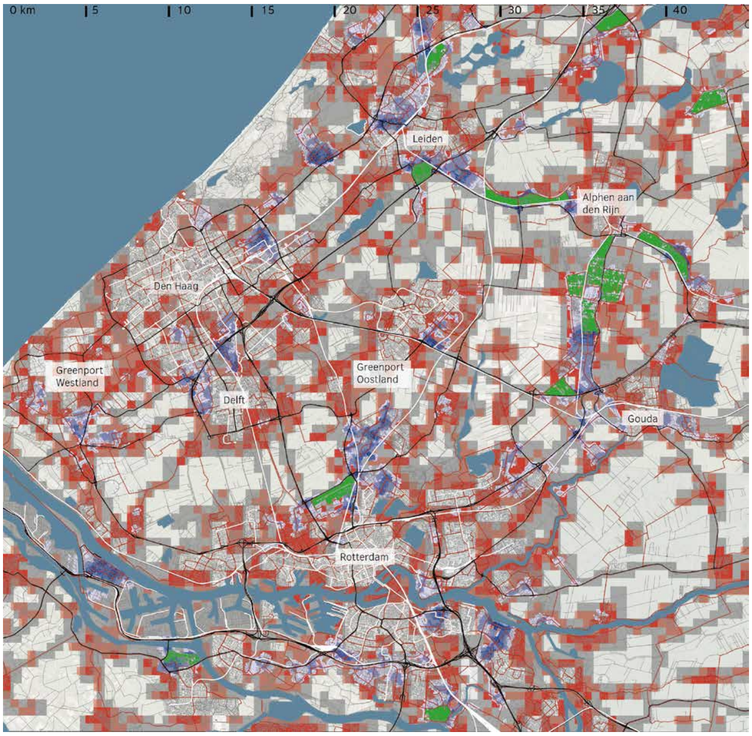
Sustainability Potential

- High values for existing sustainability indicators
- High potential for future sustainable development
- Areas with both present and future sustainability potential
- Territories-in-between

N

1km²

FIG. 7.29 TThe areas with overlapping potentials for current and future sustainability are widespread in the TiB in the case study area. They are following the network of towns and cities and the infrastructure connecting them. Note that this map does not include the zones with sustainability potential related to settlement structure and mixed-use because of lack of data.



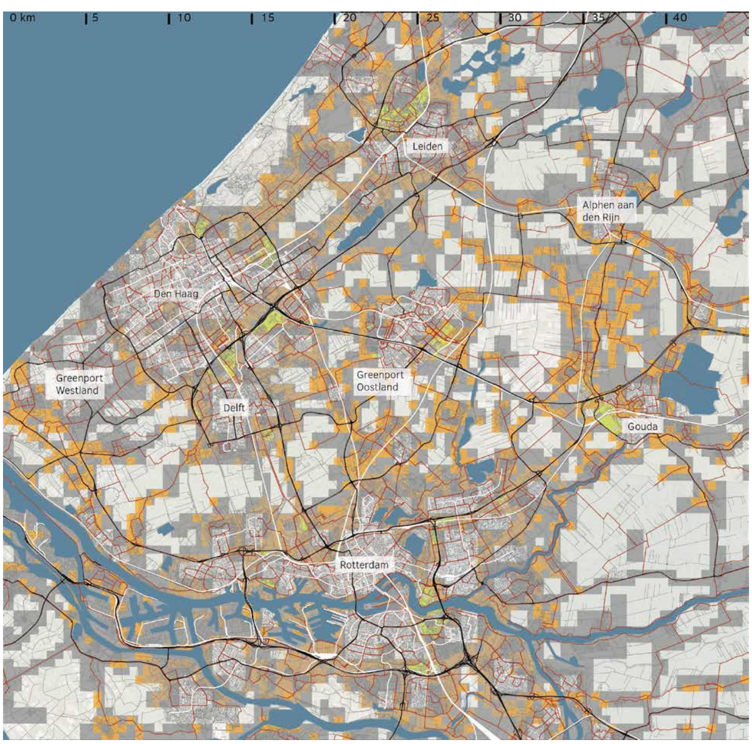
Existing sustainability

Intensity of accesibility to green spaces

- 3
- 4
- 5
- 6
- Unfragmented green spaces larger than one square kilometre
- 500 m x 500 m cells with more than four different functios but less than ten functions
- 500 m x 500 m squares with more than ten functions
- Territories-in-between

1ha

FIG. 7.30 The areas with high values for the sustainability indicators are mostly located are located in the northeast of Rotterdam and from north of Gouda via Alphen aan den Rijn towards Leiden.



Future sustainability

Typology of settlement structure

- type II
- type III
- type VI
- type VIII

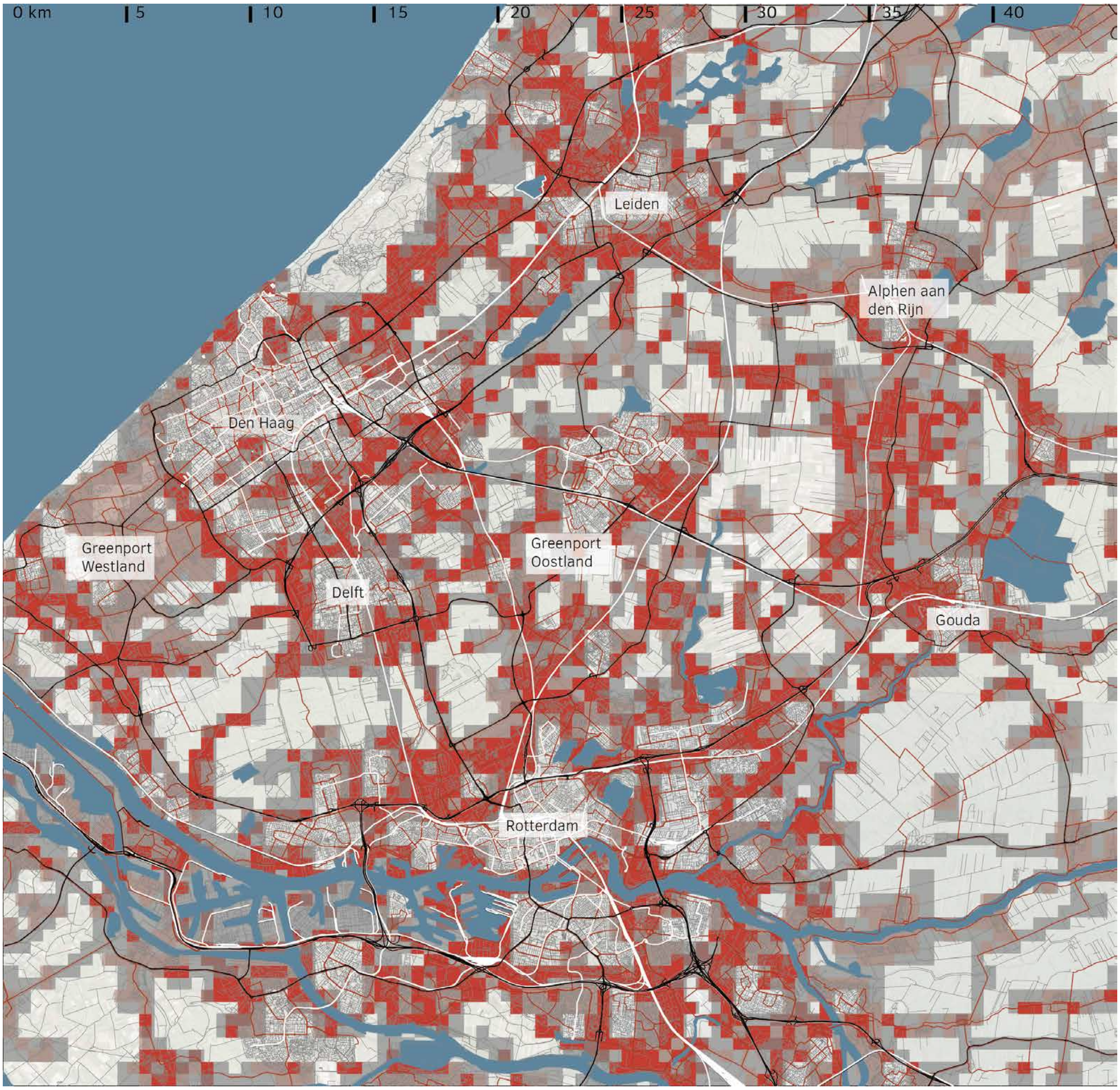
Typology of open spaces

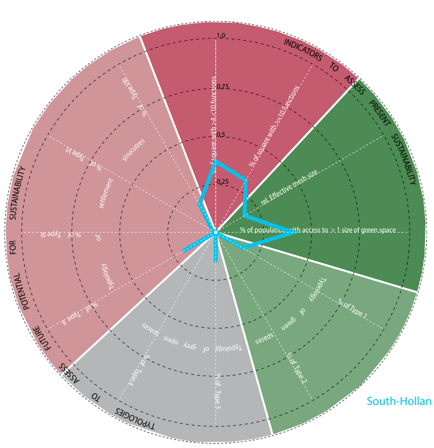
- type 1
- type 2
- type 3
- type 4

- Territories-in-between

1ha

FIG. 7.31 The areas with the highest potential for future sustainable development are located in the peripheries of Delft and Den Haag, in Rotterdam around De Esch and Groot-IJsselmonde and IJsselmonde as well as in Leiden and Gouda.





Sustainability Potential

- High values for existing sustainability indicators
- High potential for future sustainable development
- Areas with both present and future sustainability potential
- Territories-in-between

N

1km²

FIG. 7.32 The areas with overlapping potentials for current and future sustainability in South-Holland are located in the municipalities south of Rotterdam, along the Old Rhin River between Gouda and Leiden, as well as more scattered in the Den Haag-Rotterdam metropolitan area.

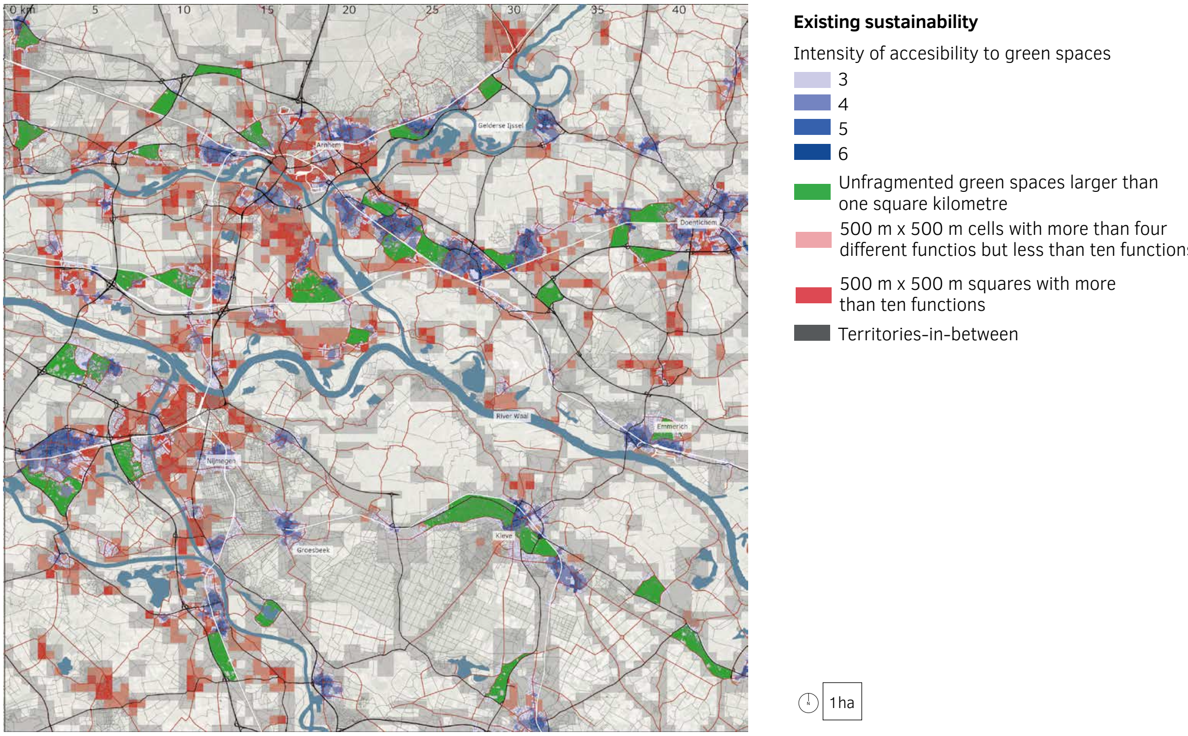


FIG. 7.33 When looking at the sustainability indicators for the existing situation, five areas show high values across all three aspects: The landscape along the Gelderse Ijssel in the northeast of the case study area, the area in the west of Nijmegen, the periphery of Arnhem, the area around the city of Kleve in the German part of the case study area, and the corridor along the A12 motorway and the parallel railway line.

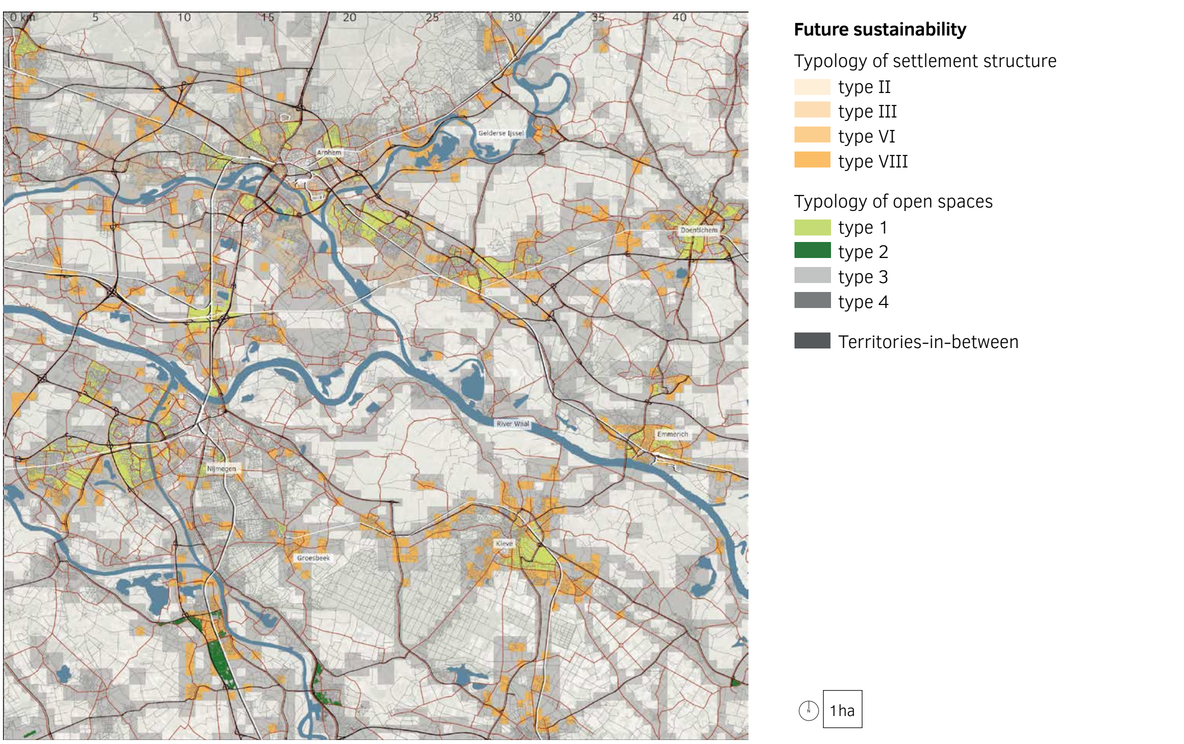
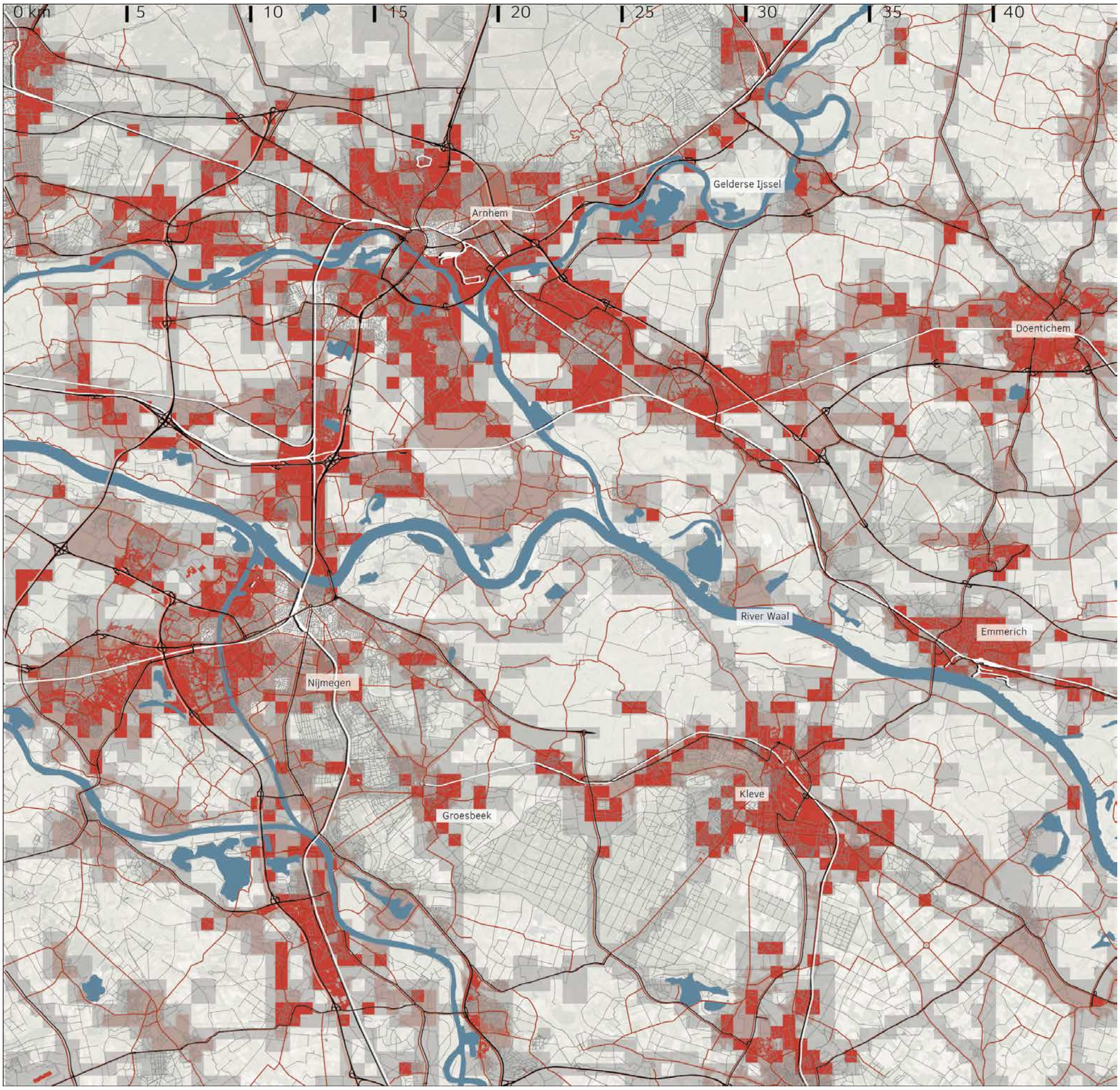
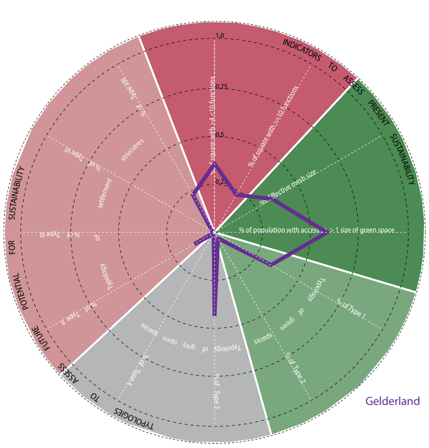


FIG. 7.34 Most areas with present high values for the sustainability indicators also show the potential for future sustainable development. Additional areas with high potential for future sustainable development are Doentichem and Emmerich both in the eastern part of the case study area, as well as the Cuijk.





Sustainability Potential

- High values for existing sustainability indicators
- High potential for future sustainable development
- Areas with both present and future sustainability potential
- Territories-in-between

N

1km²

FIG. 7.35 TThe areas with overlapping potentials for current and future sustainability in Gelderland are located predominantly north of the River Waal around Arnhem and along the infrastructure corridor towards Emerich and Doentichem. There isless potential South of the Waal and it is predominately concentrated around larger towns.

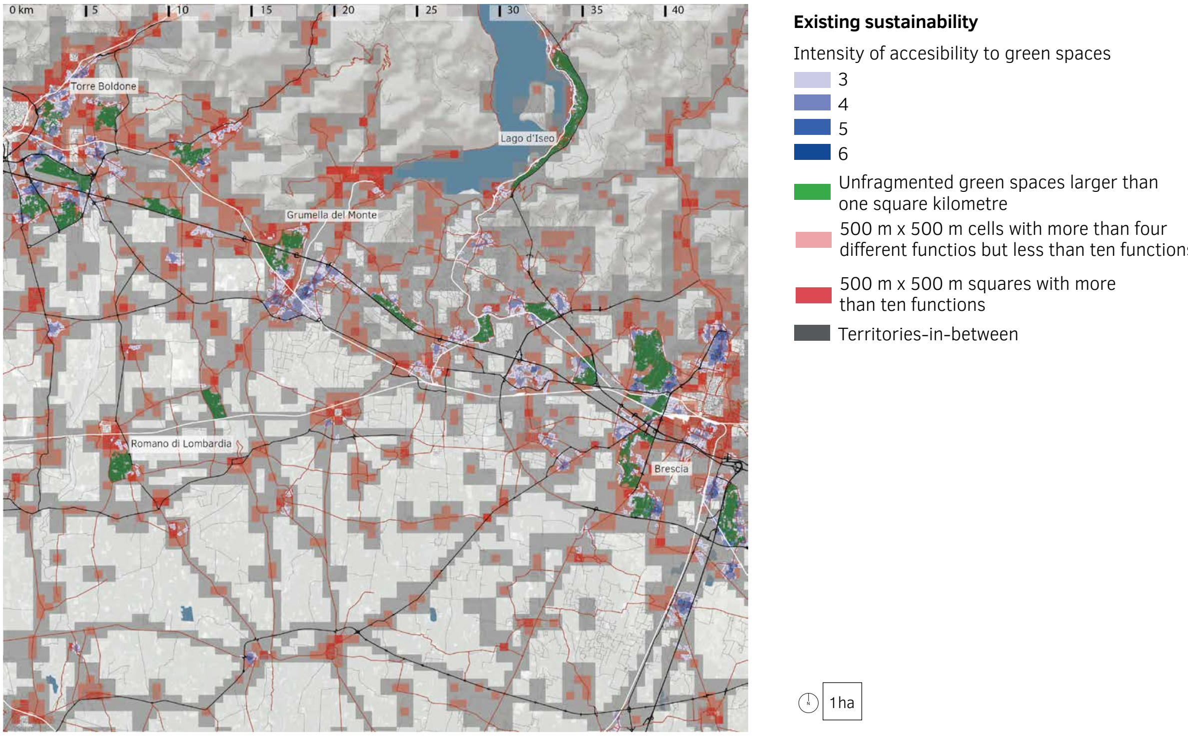


FIG. 7.36 The Areas with high values for indicators for existing sustainability are mostly located at the transition area from the Alps into the river plain specifically around the towns of Torre Boldone, Gorlago nad Grumella del Monte. Another area is the western and southern periphery of Brescia. The east coast of the Iseo lake also shows high values for all indicators. The only area in the river plain highlighted is around the city of Romano di Lombardia.

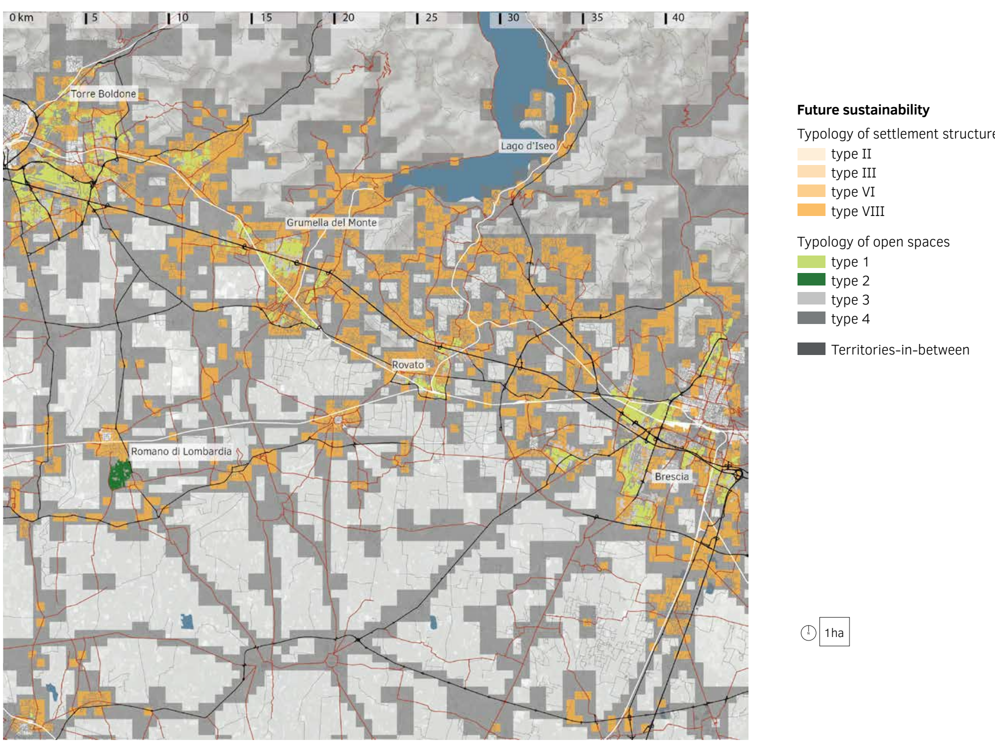
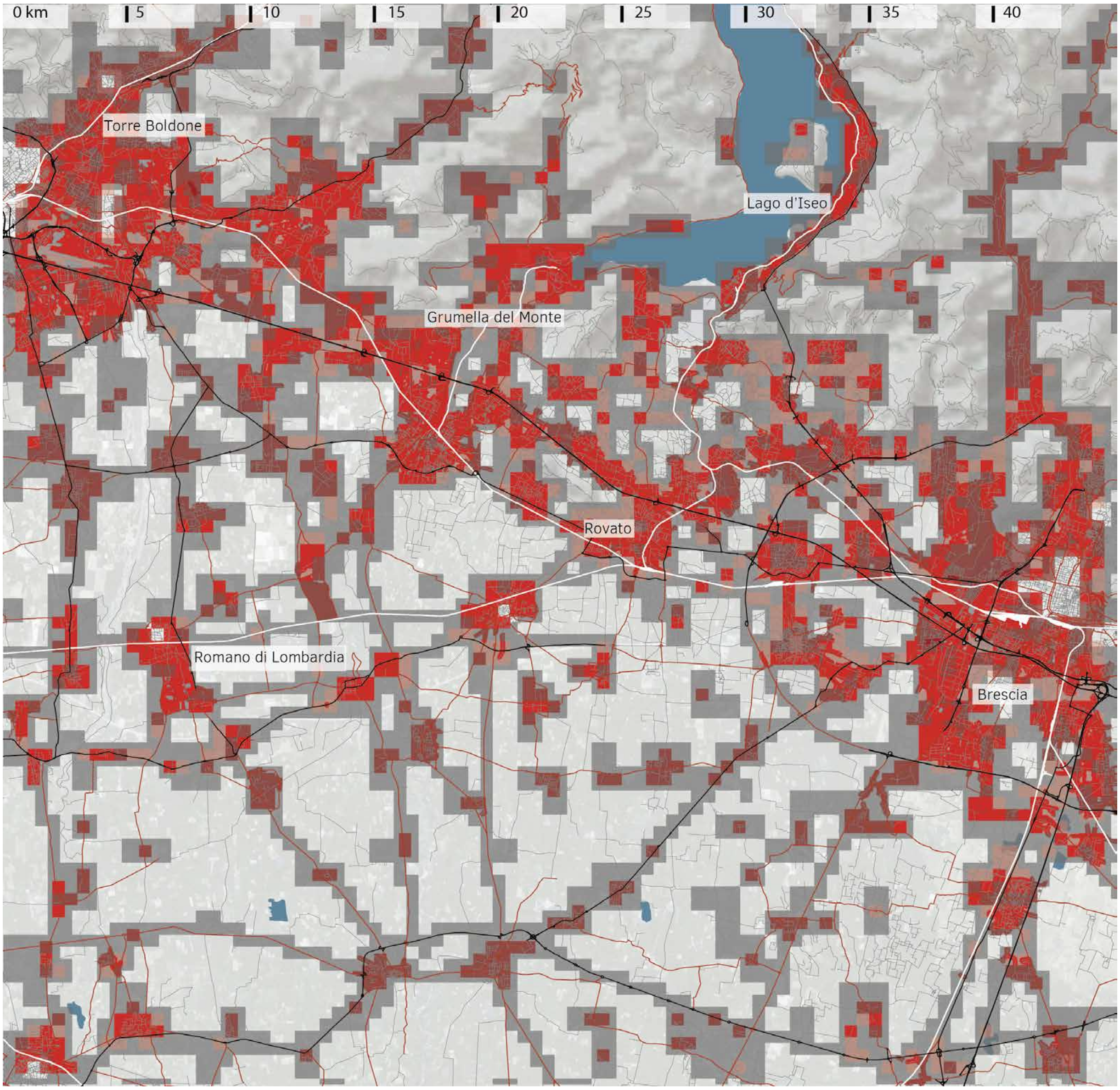
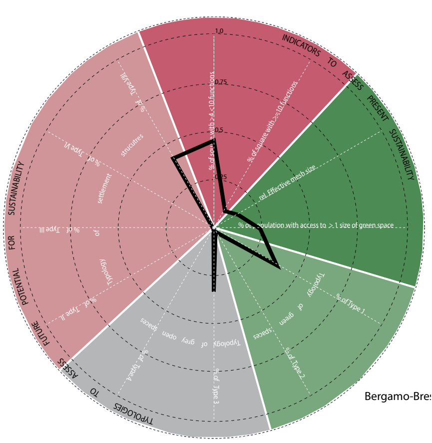


FIG. 7.37 Most areas with high values for indicators for existing sustainability also show the potential for future sustainable development. Additionally, the area around Rovato, which lies between the A4 and the railway line Milano-Verona, have a high potential for future sustainability.





Sustainability Potential

- High values for existing sustainability indicators
- High potential for future sustainable development
- Areas with both present and future sustainability potential
- Territories-in-between

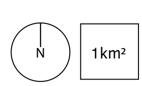


FIG. 7.38 The areas with overlapping potentials for current and future sustainability are locate along the infrastructure corridors at the edge of the Alps predominately concentrated around the larger towns. In the river plain significant areas of overlap can only be found along the line from Rovato to Romani die Lombardia.

FIG. 7.39 The areas with the highest present sustainability can be found along the corridor of the Road SS13 and the parallel railway line from Metsre to Treviso and then further towards Montebelluna; as well as to the west of Treviso and around Mestre, Camposampiero and Cittadella.

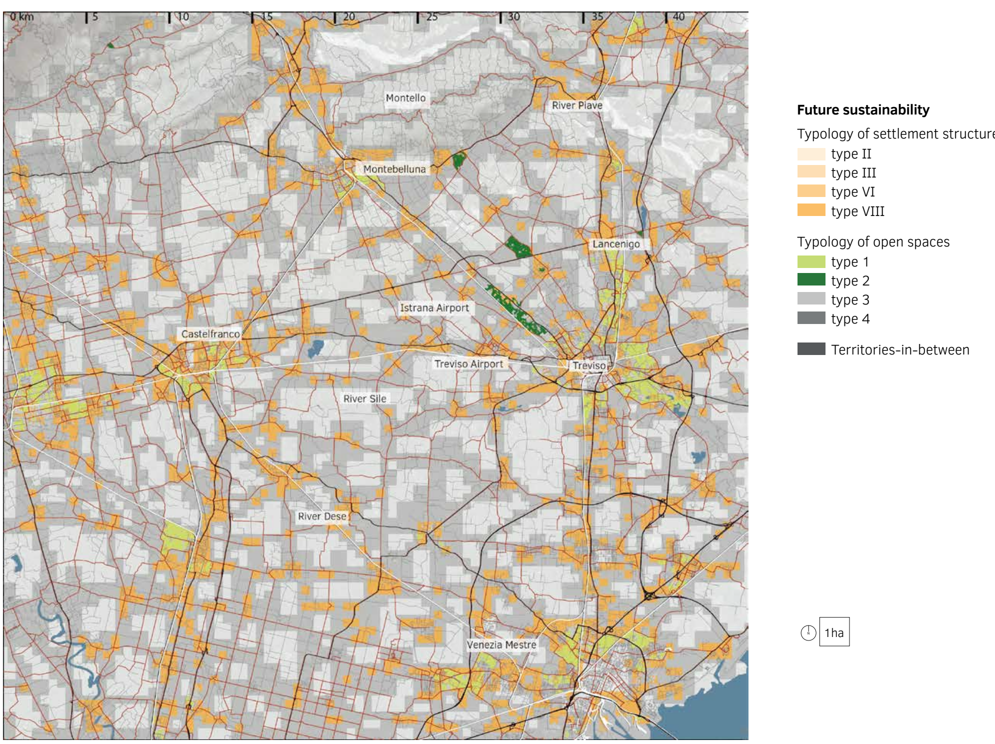


FIG. 7.40 The areas with the highest potential for future sustainable development coincide with the areas described above, but additionally, the area around Lancenigo and Castelfranco Veneto score high.

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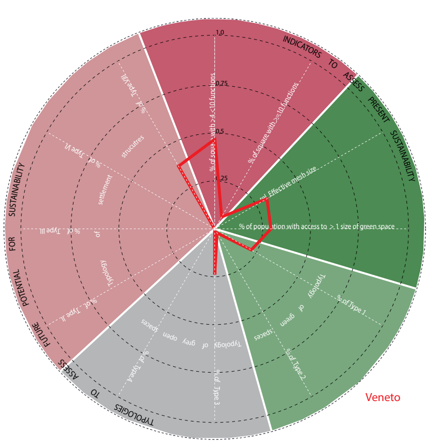


Sustainability Potential

- High values for existing sustainability indicators
- High potential for future sustainable development
- Areas with both present and future sustainability potential
- Territories-in-between

N

1km²

FIG. 7.41 The areas with overlapping potentials for current and future sustainability in the case of the Veneto are located predominantly along the infrastructure corridors between Mestre, Treviso, Castelfranco and Montebelluna. Inbetween this quadrangle there is a field of small overlapping areas.

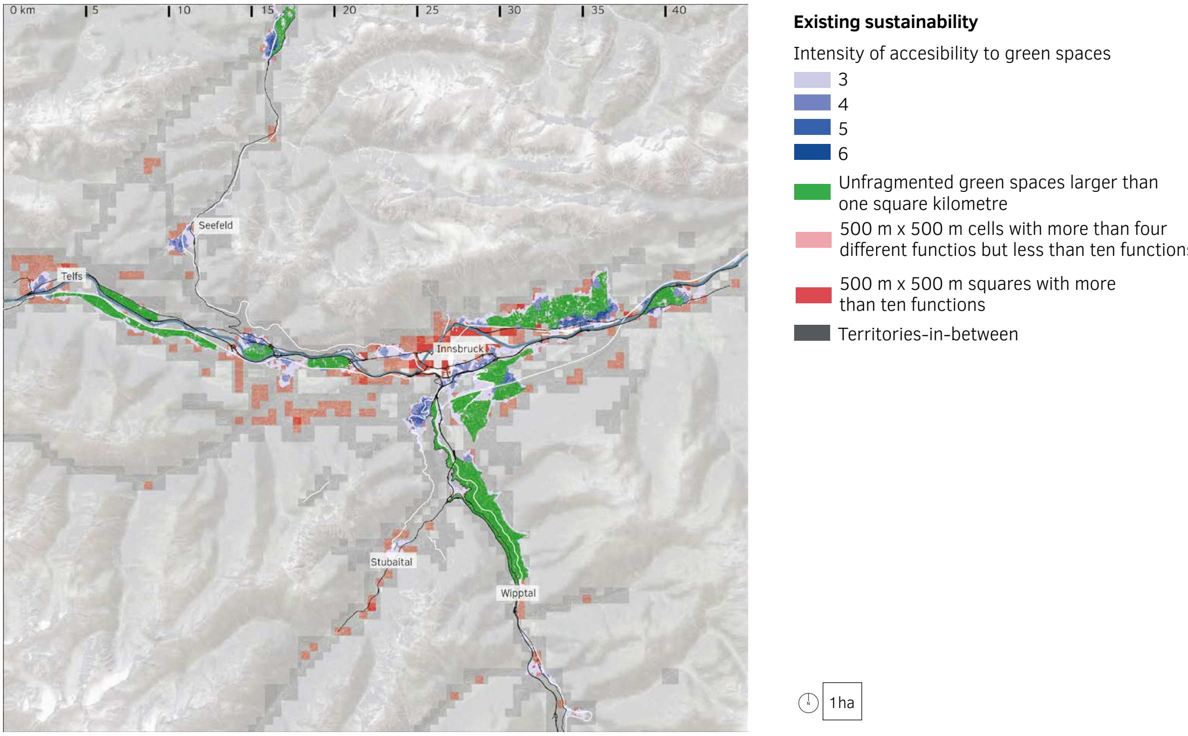


FIG. 7.42 The areas with the highest values of existing sustainability are located to the east and west of Innsbruck in the Inn valley as well as at the entry of the Wipp valley and in Mittenwald in the German part of the case study.

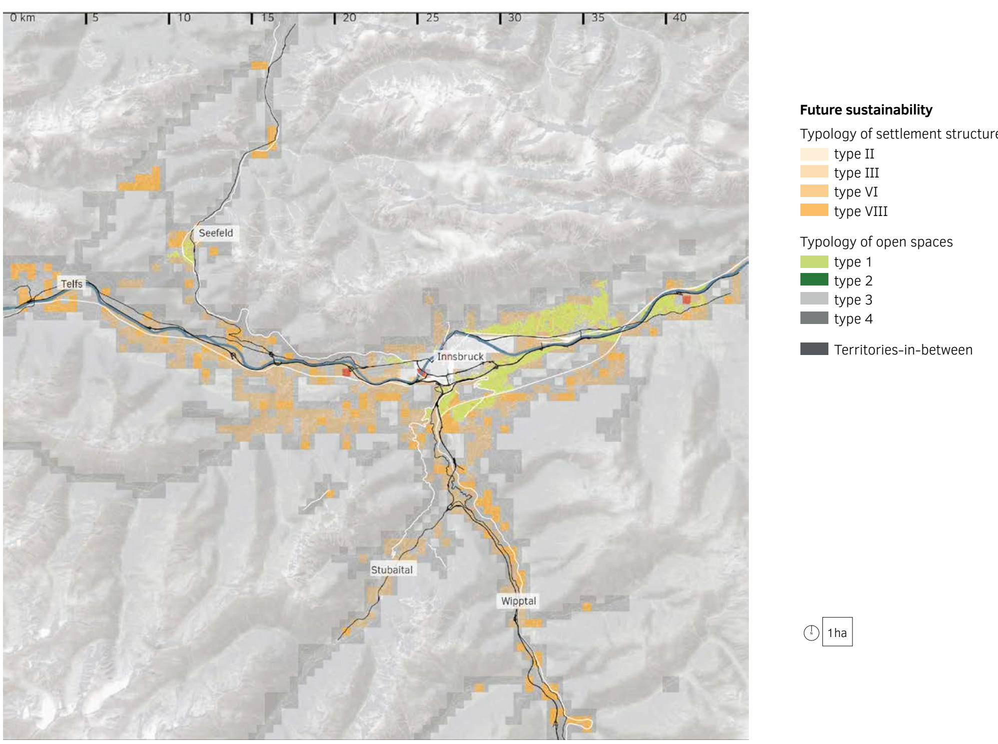
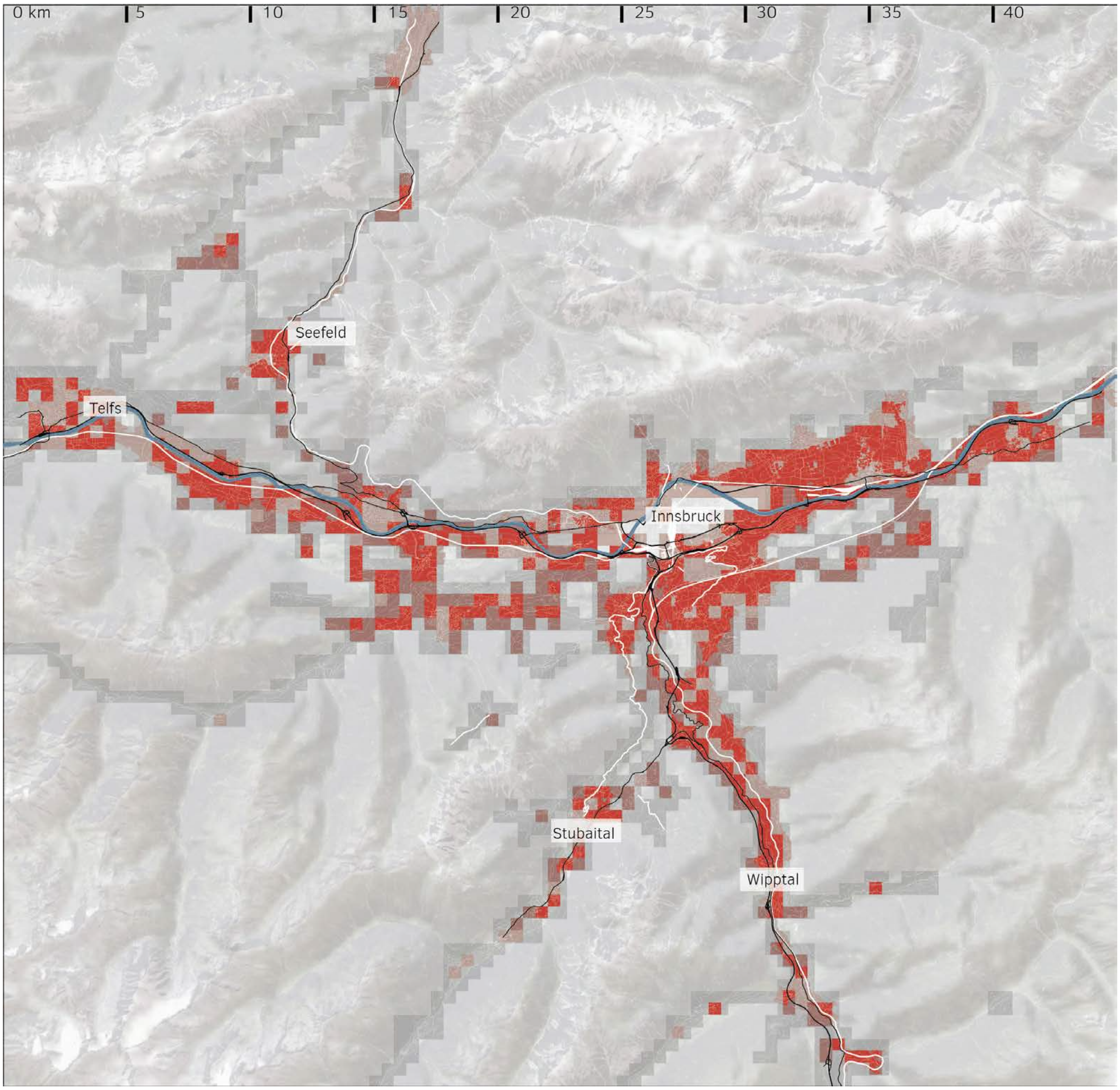
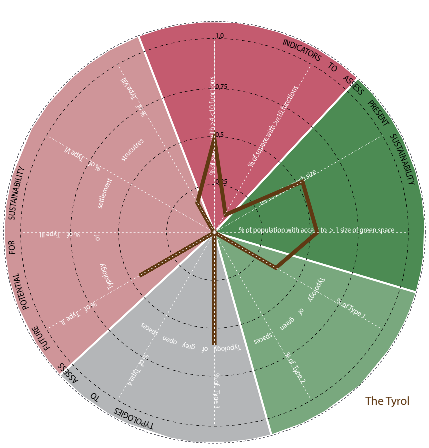


FIG. 7.43 The potential areas are in the east of Innsbruck, specifically at the “Mittelgebiere” in the south of the Inn and around Seefeld.

TOC





Sustainability Potential

- High values for existing sustainability indicators
- High potential for future sustainable development
- Areas with both present and future sustainability potential
- Territories-in-between

1km²

FIG. 7.44 The areas with overlapping potentials for current and future sustainability in the case of the Tirol cover most parts of TiB In the Inn valley in the east of Innsbruck north of the river, in the west of Innsbruck south of the river. Additional overlapping areas can be found on the so-called Mittgelgebirge as well as along the valleys to the south.

TOC

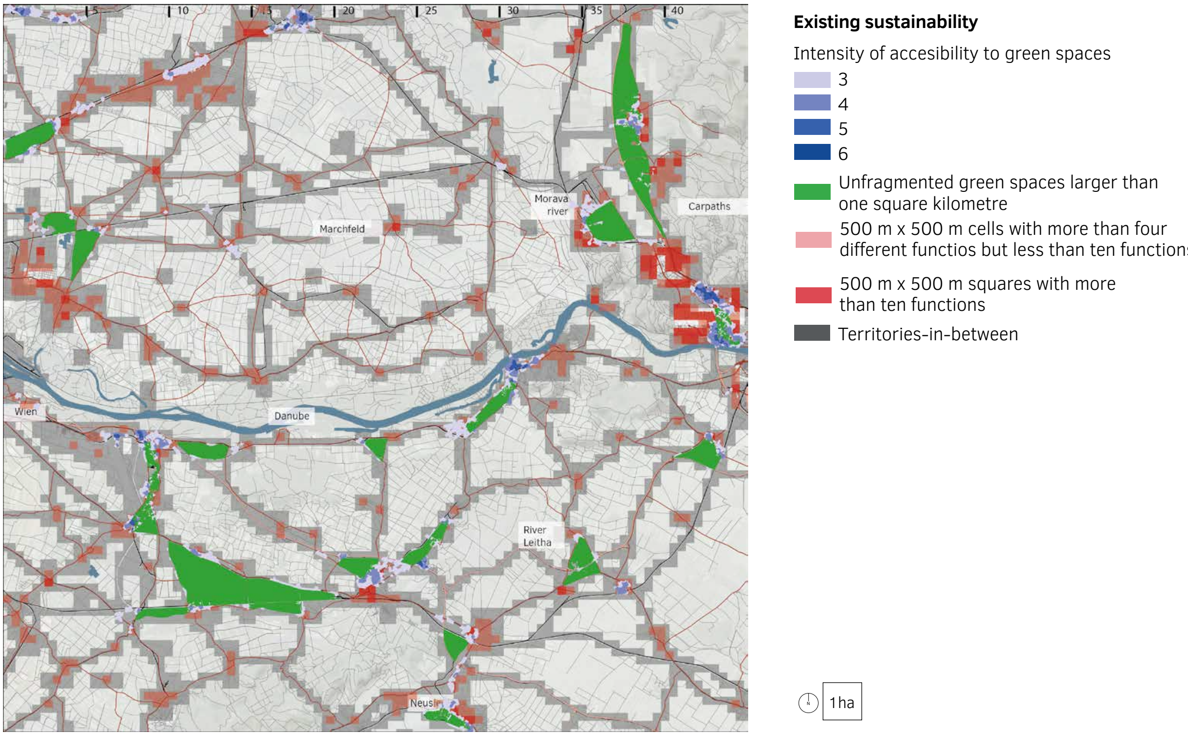
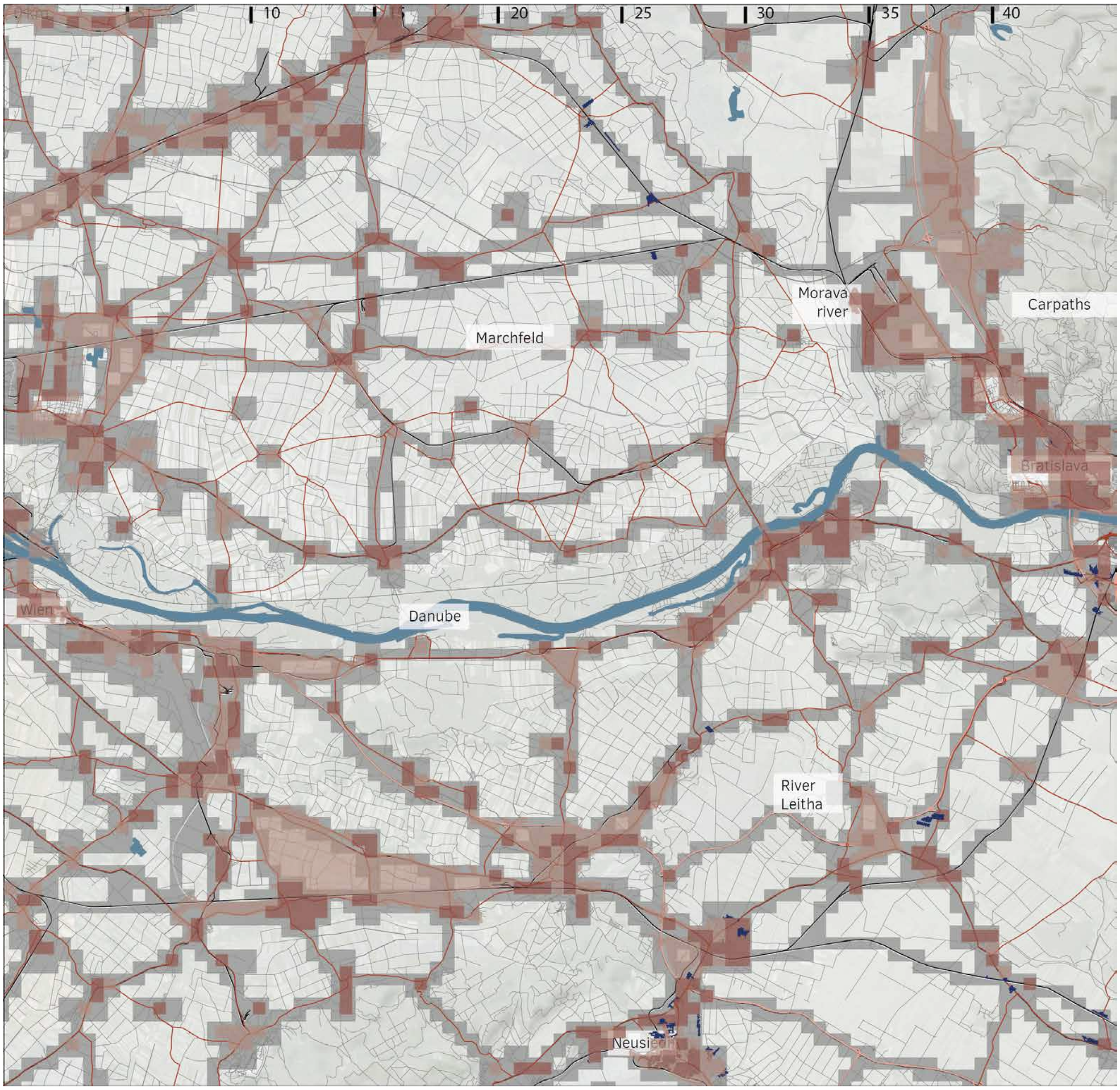
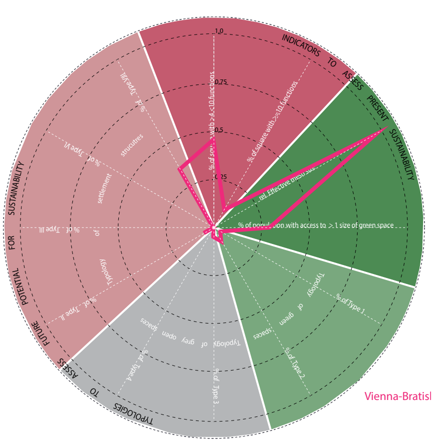


FIG. 7.45 The areas with the highest values for the sustainability indicators of present sustainability are located north of Bratislava, along the rivers Leitha and Fisha and on the south banks of the river Danube, as well as around and in the villages and towns in the periphery of Vienna.

FIG. 7.46 The potentials areas are few and are locate close to Neusiedl and north and south of Bratislava.





Sustainability Potential

- High values for existing sustainability indicators
- High potential for future sustainable development
- Areas with both present and future sustainability potential
- Territories-in-between

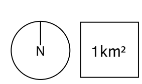
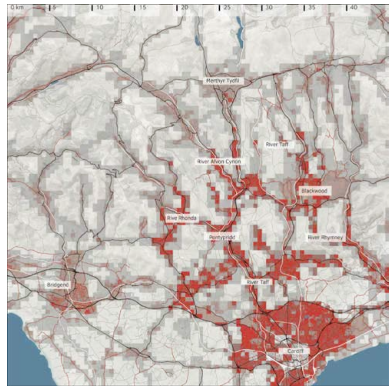


FIG. 7.47 There are few areas with overlapping potentials for current and future sustainability in the case of Vienna-Bratislava. Larger concentrations can be found north and west of Bratislava and around Neusiedl am See. The rest of overlapping potentials are scattered loosely across the area .

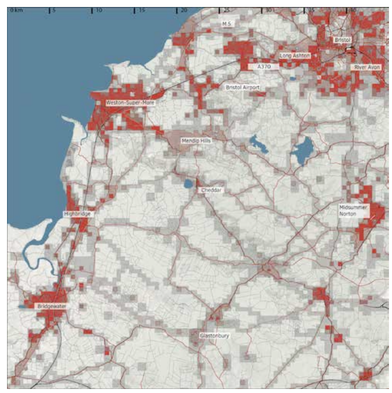
SUSTAINABILITY POTENTIAL

- High values for existing sustainability indicators
- High potential for future sustainable development
- Areas with both present and future sustainability potential
- Territories-in-between

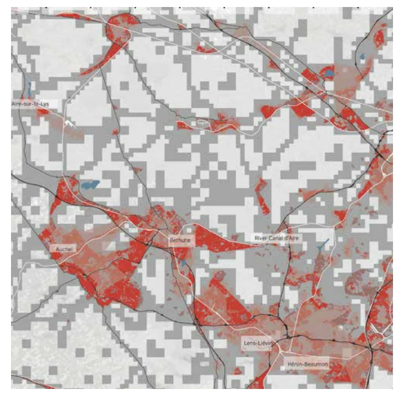


1 South Wales

2 Île-de-France

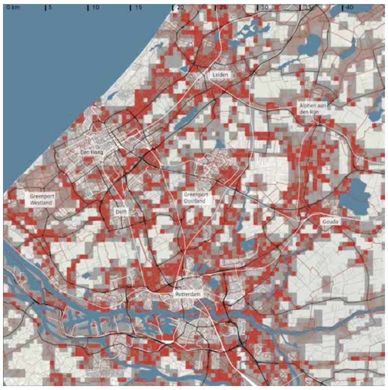


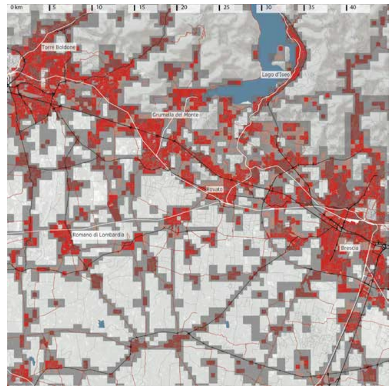
6 North Somerset

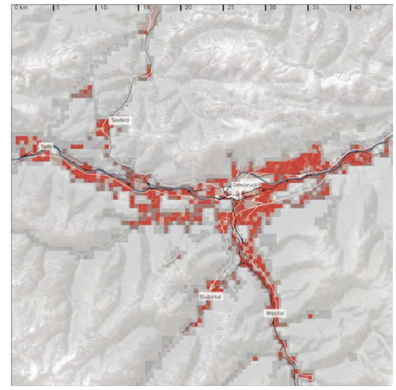


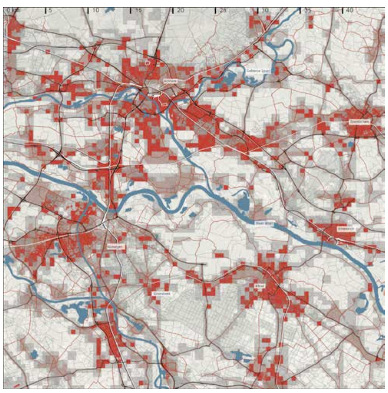
7 Pas-de-Calais

FIG. 7.48 The thumbnail maps of the overlay of the potential of existing and future sustainability show that in most cases large parts of the TiB show potentials for sustainable development. Exceptions are the case of Vienna-Bratislava and the case of Ile-de-France. The latter result may be explainable by the lack of data. The maps also show that there is a difference in how the potentials are distributed. In some cases, North Somerset, Bergamo-Brescia the potentials are concentrated along corridors. Others show a more dispersed pattern of potentials for sustainability, like South-Holland, the Vento and the Tyrol. In all cases, a concentration of potential sustainable development is specifically related to rail infrastructure. The fieldwork showed, that in many cases, the rail infrastructure is not very well maintained and that the harvesting of this potentials requires a lot of public investment. Exceptions are South-Holland and to a lesser extent, the Tyrol, the Vento and Gelderland.

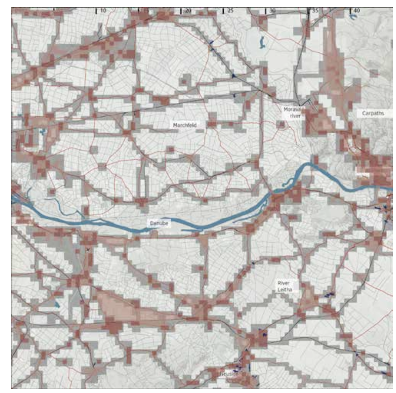

3 South-Holland


4 Bergamo-Brescia


5 The Tyrol


8 Gelderland


9 Veneto


10 Vienna-Bratislava

8 From Dispersed Urban Areas to Territories-in-between

The dissertation began with the observation that there is an increasing body of literature suggesting that the conventional idea of a gradual transition in spatial structure from urban to rural does not properly reflect contemporary patterns of urban development and their potential for sustainable development. Furthermore, it was argued that large parts of the urbanised areas of Europe are dispersed and that these are neglected in urban and spatial planning policies. Such areas tend to be labelled simply as sprawl, though there is little evidence about whether such dispersed development is more or less sustainable than other forms of urban development. Moreover, evidence points in the direction that large amounts of dispersed urban development ask for different planning instruments which reflect the complexity and network structure of theses specific settlement patterns.

At the turn of the millennium and across Europe, concepts describing dispersed urban areas, like Zwischenstadt, città diffusa or tussenland gained some attention. They share an understanding of design and planning for the territory based on seeing the 'urban landscape as a large interlocking system rather than as a set of discrete cities surrounded by countryside' (Bruegmann, 2005). Nevertheless, none of the concepts influenced mainstream planning policy beyond a few individual plans and projects.

To summarise, there is a limited understanding of the nature of dispersed urban development, uncertainty about how the sustainability of such areas can be assessed, and few policy instruments that would achieve any sustainability potential they offer.

The dissertation sets out to contribute to an improved understanding of these issues by answering the following three research questions.

1. What spatial structures characterise dispersed urban areas in Europe?
2. Which morphological and functional structures of dispersed urban areas offer the potential for more sustainable development? If so, how can this potential be mapped and measured to inform regional planning and design?
3. Are there similarities and dissimilarities concerning potentials of dispersed urban areas in different locations, planning cultures, topographies and histories?

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8.1 Review of research design and process

Figure 8.1 shows how the three different questions were answered and how they informed each other. First, a literature study on dispersed urban development and urban-rural classifications was Figure 8.1 shows how the three different questions were answered and how they informed each other. First, a literature study on dispersed urban development and urban-rural classifications were conducted to identify characteristics that distinguish certain dispersed areas from others which were primarily ‘urban’ or ‘rural’ areas. Four aspects have been identified:

1. a distinctive residential and job density;
2. an intermingling of built and unbuilt land;
3. the presence of a large number of infrastructures and other facilities;
4. a distinctive functional mix.

Spatial analysis was conducted at the European scale, regional and local level in two extremely different dispersed urban areas. Tyrol in Austria and South-Holland in the Netherlands were used to define spatial proxies for the four characteristics. This enabled the mapping of ‘territories-in-between’ (TiB). TiB is an umbrella term that avoids the simple distinction of spatial structure into ‘urban’ and ‘rural’, which avoids the urban-rural continuum, and which is not limited by cultural connotations that come with some other terms like Zwischenstadt, because those terms belong to a specific place and are not generic.

Answering research questions two and three was an iterative process. The literature on planning cultures provided a framework for the selection of ten case study areas in five countries across western Europe. See figure x for the names and location of the case studies. The literature on sustainability assessment and dispersed urban development provided a framework to develop a better understanding of the potential for sustainable development, specifically for TiB. The following four aspects came forward as specifically crucial and were further investigated:

- a multi-functionality
- b mixed-use
- c landscape permeability
- d accessibility to green spaces and their ecosystem services.

A series of spatial analyses and mapping exercises were conducted to identify and estimate the potential for sustainable development in each case. A cross-case comparison was used to distinguish which potentials are case-specific and which can be generalised, to a certain degree, across the cases. Field trips completed the investigations of the ten TiB and confirmed the reasonableness of the spatial analyses from data.

The iterative process described above allows for conclusions to be reached on four aspects:

1. a theory of European dispersed urban development;
2. methods of sustainability assessment;
3. estimation of the potential for sustainable development in dispersed urban areas;
4. understanding of (dis)similarities between dispersed urban areas in western Europe

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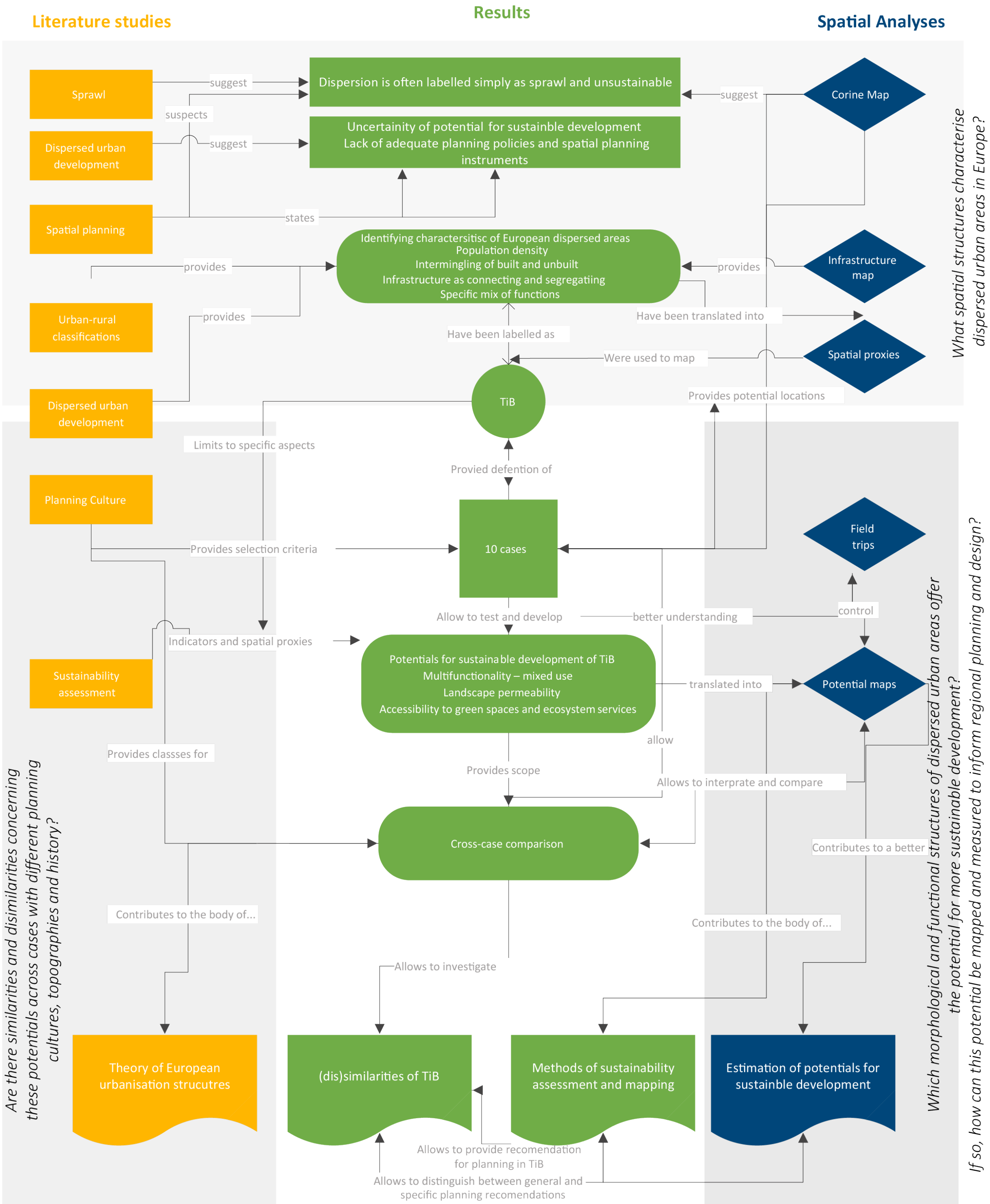

FIG. 8.1 Diagram illustrating the research process.

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The following sections report first on the results concerning the distinctive characteristics that identify TiB, and second, the spatial attributes that have the potential to support sustainable development. Finally, the key conclusion and recommendations for planning practice and research from the dissertation are presented.

8.2 The distinctive characteristics of TiB

Do dispersed urban areas have characteristics that are distinct from urban and rural? The evidence points strongly to the finding that TiB have a large spatial extent and that a significant share of the EU population lives and works in them. Therefore, it was crucial to be able to bring them on the table by distinguishing and mapping them. To be able to map TiB a definition and characterisation were necessary. The dissertation investigated the spatial characteristics of TiB with three aims, to first understand whether and to what extent dispersed urban development has similarities across Europe; second, to be able to map and thereby identify the cases for the cross-case study, and third to be able to relate these characteristics with the potential for sustainable development.

Four aspects proved to be critical for the distinction of TiB: (i) a specific range of density of living and working population, (ii) a complex interlocking system of built and open spaces, (iii) that their existence is highly influenced by the connecting and separating role of infrastructure at different spatial scales; and (iv) they often exhibit a complex mix of functions.

The territories-in-between mapping approach begins with the living and working population. The analysis needs to address three limitations of standard approaches, (i) it goes beyond relying only on the use of residential population density as the prime indicator as this indicator goes hand in hand with often entirely arbitrary cut-off points; (ii) population density approaches predominantly depart from administrative or statistical boundaries (the European NUTS system) because these delimit the areas about which international comparative data are available; (iii) the working population, traditionally excluded in urban-rural classifications, was one way to consider the high temporality and movement of the population during day times. Other temporary types of population, like tourist or pupils, could not be considered. We concluded that TiB have a characterising total (living and working population) density of between 150 to 5,000 people per square km.

5,000 people per square km may suggest an urban settlement patterns but the territories-in-between approach adds to the quantitative aspects a quintessential spatial approach, based upon the identification of the above listed critical spatial qualities. The intermingling of built and unbuilt is a morphological criterion. A combination of different CORINE land cover classes was used to proxy this variable. The maps of TiB, see chapter 3, show the typical ground figures of dispersed development and allow an interpretation of the relation between built and open spaces, green or grey, on the local scale as well as on the regional scale. Three types of ground figure have been identified in all cases. The first is a field like form of development that often followed the historic street and agricultural parcel patterns. In these fields, very often some of the historic towns or villages show a concentration of densities and functions. See FIG. 8.2.1 for an example. The second are corridors along infrastructure lines, predominantly motorways, with concentrations of densities of built form and functions at the entrance and exit points of motorways. See FIG. 8.32.2 for an example. The third concerns TiB in mountain valleys where, because of the limited space availability, a more equal and intense ground figure with an apparent linear form next to each other off built and unbuilt is visible. See FIG. 8.42.3.

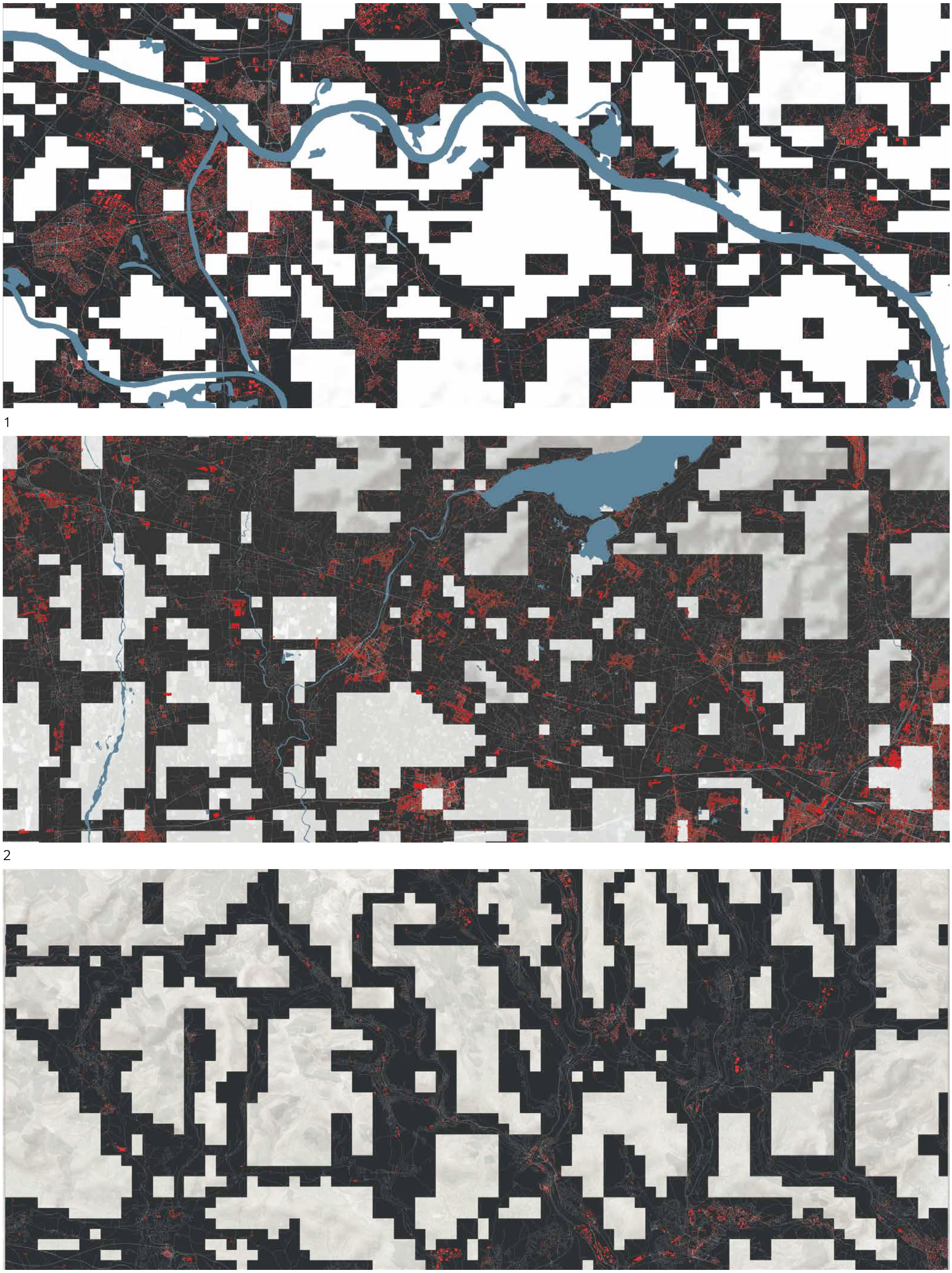

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FIG. 8.2 The three different ground figures of TiB: (1) the network of towns and cities, here a zoom into the case of Gelderland; (2) the corridor type, here a zoom into the case study of Bergamo-Brescia, (3) the valley type, a zoom into the case study area of South Wales.

Infrastructure plays different roles at different scales. At the local scale infrastructure divides the territory, physically separating adjacent land uses. At the regional scale infrastructure has a connecting role – linking places and functions. Infrastructure and related connectivity, centralities and accessibilities are crucial for the development potential of different places considering specific economic development possibilities.

The outcome for territories-in-between is that they form a network of distant but functionally connected areas at the regional scale, but a patchwork of proximate but sometimes functionally disconnected areas at the local scale. In other words, adjacent land uses may not have any spatial or functional interconnection, whereas there are closer socio-economic functional relations between areas that are not in the same local area. Infrastructure does not only play a different role in the socio-technical system of TiB but also for the socio-ecological system. While large scale infrastructures like motorways and rail lines disconnect ecological relations locally, some of them, where they are accompanied by buffer zones that allow animal migration, function as eco-corridors at the regional scale. Including infrastructures into the mapping exercise has one specific advantage over other urban-rural classifications. Namely, it amplifies the network nature of TiB, showing their interconnectedness independent of urban centres.

The results of the analysis of the four indicators for the potential for sustainable development are presented in the following section. For each indicator I consider how different aspects of form and function are related to each other and how these relations have been used to derive indicators for the potential of sustainable development.

8.3 Form and function and their relations as indicators for the potential for sustainable development

The second research question asks which morphological and functional structures of dispersed urban areas provide a specific potential for more sustainable development, and how can these potentials be mapped and measured to inform regional planning and design? The question was investigated using a series of spatial analyses on aspects of the morphology of TiB. Morphology was considered in terms of infrastructure networks and the open space system. Different types of function were expressed in economic and residential activities, and land cover. These aspects are used to calculate and map indicators for the potential of sustainable development. Four indicators have been selected: Landscape Fragmentation, availability of ecosystem services, multi-functionality of open spaces and mixed-use;

The results of the analysis of the four indicators for the potential for sustainable development are presented in the following section. For each indicator I consider how different aspects of form and function are related to each other and how these relations have been used to derive indicators for the potential of sustainable development.

8.3.1 Landscape fragmentation

Landscape fragmentation, as an indicator of social and environmental sustainability, is the most straightforward to calculate and map. It is defined as the relation between the segregating function of infrastructure networks and settlement structures on the permeability of the green open space structure. It is mapped and expressed by the effective mesh size. See FIG. 5.1 for a simplified explanation.

The results presented in chapter three show that an effective mesh size between 0,7 square kilometers and 1,8 square kilometers is typical for TiB for eight out of ten cases, only Vienna-Bratislava and Pas-de-Calais have an effective mesh size above 2 square kilometers. Furthermore, there is no apparent relation between population density and landscape fragmentation. The case with the lowest population density, Vienna-Bratislava, still shows the least landscape fragmentation, but the three most densely populated TiB are in the middle of the ranking. Therefore, the sustainable development of TiB is influenced by a combination of factors including topography, technical and green-blue infrastructure, the resulting settlement patterns, and by spatial planning policy and decisions.

TABLE 8.1 Comparison of effective mesh size in the ten cases.

Case study name	Total case study area		TiB within case study area	
	m_{eff}	Rank	m_{eff}	Rank
Bergamo-Brescia	21.912	3	0.405	10
Gelderland	9.191	8	0.956	7
Île-de-France	0.875	10	1.485	4
North Somerset	20.162	4	1.721	3
Pas-de-Calais	9.694	7	2.303	2
South-Holland	10.668	6	0.477	9
South Wales	13.553	5	1.224	6
The Tyrol	199.320	1	1.459	5
Veneto	1.672	9	0.865	8
Vienna-Bratislava	22.917	2	2.782	1

8.3.2 Availability of ecosystem services

The availability of ecosystem services is a more complex aspect to evaluate. It requires consideration of the morphology and diversity of green spaces in an area; the connectivity and accessibility that is provided or hindered by the infrastructural system; and the composition and density of the population that could profit from the ecosystem services. The analysis employed two methods to investigate the potential availability of ecosystem services: i) the accessibility of green spaces, which takes into account their size and the residential population that has access to them; and ii) a typology of green (and grey) land uses so as to address how the availability of ecosystem services is structured by the connectivity of green spaces with economic functions.

People living in TiB have access to more green spaces than those living in urban areas. In urban areas in eight out of ten cases more than 50 per cent of the population has access to at least one type of green space. For TiB, this is true for all ten cases. This confirms one of the significant factors of population migration towards TiB, they offer better access to more green space, but this quality is only available for a rather low share of the population. The population within TiB that has access to at least one type of green space ranges from around 50% (Bergamo-Brescia and Pas de Calais) to close to 90% in Gelderland. In the majority of cases (six out of ten), more than 40 per cent of the population of TiB has access to more than one type of green space.

TABLE 8.2 Accessibility to green spaces in TiB across Europe.

Case study name	Percentage of population with		
	Access to at least one type	Access to more than one type	Rank
Bergamo-Brescia	53	24	10
Gelderland	89	58	1
Île-de-France	52	28	9
North Somerset	68	40	4
Pas-de-Calais	83	52	3
South-Holland	68	40	4
South Wales	63	43	7
The Tyrol	83	53	2
Veneto	62	29	8
Vienna-Bratislava	66	29	6

A comparison of the two metropolitan cases, the Île-de-France and South-Holland, shows that the latter performs nearly twice as well. This is interesting because large green spaces dominate the green network structure of the Île-de-France, while in South-Holland small and medium-sized green spaces cover a larger area. These different patterns are probably mostly a result of different historic evolution of the settlement patterns.

The Potential for ecosystems services varies according to the spatial relation of a specific open space to its centrality. The centrality is a function of the street network, accessibility to and connectivity of services as well as densities of services, production and consumption. The type of green space that covers the largest area in all cases has a high potential to develop especially provisioning and regulating ecosystem services. Furthermore, they are close to the backbone of the existing regional ecological network. Therefore, these spaces play an important role in completing a regional green network which also integrates urban ecosystem services.

8.3.3 Multi-functionality of open spaces

Multi-functionality is the capacity of an area to provide more than one function, either at the same time or at different times. But the potential for multi-functionality is difficult to assess. The typology of green spaces presented in chapter four assumed that the potential is very distinct based on the spatial relation of a specific open space to its centrality as a resulting characteristic of the street network, accessibility to and connectivity of services as well as densities of services, production and consumption. The results show that grey open spaces, which are defined by Swanwick et al. (2003) as 'land that consists of predominantly sealed, impermeable "hard" surfaces' show high potential for multi-functionality. See FIG. 4.13 for amount and type of grey spaces within the ten cases.

8.3.4 Mixed-use

Mixed-use is defined as the presence of more than two uses within one spatial unit (building, block or neighbourhood) and is an indicator of economic and social sustainability. The dissertation presented two mixed-use indicators, (i) the job to residents ratio and (ii) the number of different economic functions per spatial unit.

The results showed that mixed-use is a property of European urbanised areas, whether dispersed or not. In six cases, investigated at a resolution of 500 m x 500 m cells, more than 65 per cent of grid cell host three or more functions. The exception is the British cases, with 61 per cent for North Somerset and 55 per cent for South Wales. An apparent result is that there are in all instances obvious differences in the frequency distribution for urban, TiB and rural areas. Most cases show that in rural areas, low mix classes (1-4) are dominant. The TiB shows a more equal, distribution across all mix function classes often with a peak around class six. In the urban areas, the highly mixed classes (9-11) dominate in all cases. See figure 8.3. A further aspect to note is that there are mixed-used areas where both, the density of inhabitants and jobs is rather low, as well as, in areas where the density of residents is comparatively high.

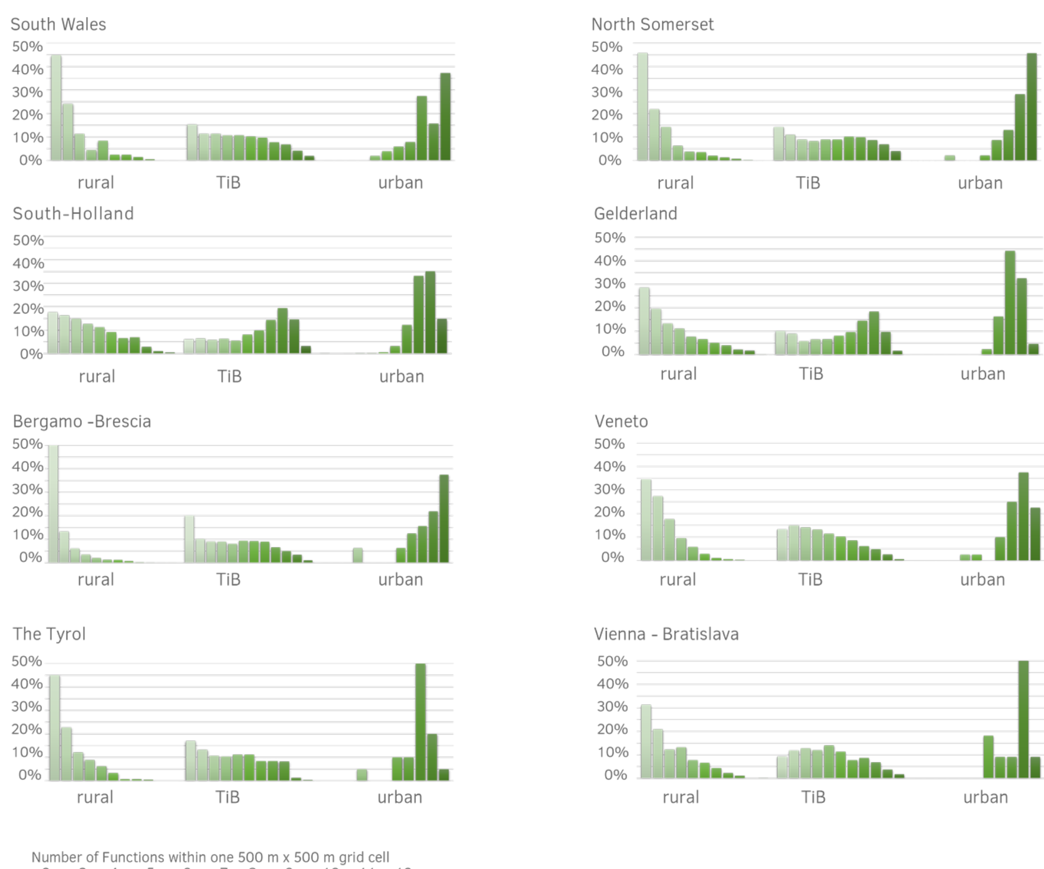

FIG. 8.3 Frequency distribution of mix function classes over urban, TiB and rural for all eight cases. Note that the French cases were not included in the mixed-use study.

Indicators are correlated with five settlement characteristics, grain, density, permeability, centrality and accessibility to understand why certain areas are mixed-use and others not. The typology of settlement characteristics developed shows that mixed-use is significantly diverse between different types of settlement characteristics. The types with the highest mixed-use are characterised by (i) good accessibility to both the motorway system and public transport; (ii) a very high local and regional betweenness; (iii) high population and job density; and (iv) high permeability and small grain pattern of the street network. In the Dutch and Austrian cases, a rather high mixed-use is present in areas with medium local and regional betweenness, medium permeability and medium grain size as well as low population density and medium job density. It leads to the conclusion that in both countries, there may be policies and practices in place that support mixed-use in less densely populated areas. Moreover, the typology shows that in settlement typs with a high population density, this factor compensates for lower accessibility and centrality values.

8.4 Conclusions and Recommendations

Do dispersed urban areas have distinct characteristics? In sum, the findings show that dispersed urban areas in Europe are quite distinct from urban and rural areas and that they share characteristics from one place to another. The findings also show that the well-worn notion of a continuum from urban to rural does not stand up to the evidence, and is a crude simplification of the complexities and socio-ecological systemic relations which characterise TiB. It follows that effective spatial planning for such areas needs to be built on a more careful analysis of characteristics and potential for sustainable development.

Although the ten cases have very different local identities, they share similar landscape morphological structures but even more characteristics of settlement structures as well as economic and residential location patterns.

Sub-areas, such as zones around low-cost carrier-dominated airports (to name an extreme example) are more similar between cases than with other parts of TiB in the same case. Shopping areas, business and industrial parks also share similar characteristics across the cases. Another similarity is development corridors along with technical infrastructures, as well as networks of towns and villages. Therefore it is possible to draw conclusions and recommendations for assessing potentials for sustainable development across all cases.

The following section explains four main conclusions from the research:

- The potential for sustainable development is underestimated.
- To understand and harvest the potential for sustainable development, analytical and planning approaches need to consider both local and regional aspects in an integrated manner, as well as strategic and regulating aspects.
- Planning for TiB should use specific planning and design principles that go beyond the simple application of the compact city.
- TiB deserve an adequate place in planning theory.

8.4.1 Underestimated potential of sustainability

The research investigated three aspects of sustainable spatial development, the potential of multi-functionality, the provision of ecosystem services and the presence and potential for mixed-use.

Gallant et al. (2004) argue that multifunctionality is the key to the sustainable development of TiB, because, their unique characteristics offer potential to lessen the negative impacts of built structures by enabling them to perform additional desirable functions and objectives. The potential for photovoltaic panels on the vast areas of flat roofs of industrial and business parks is a simple but often named example for multi-functionality. Chapter 4 shows that potentials for multi-functionality in TiB go beyond the buildings. Especially grey open spaces provide a significant potential for multifunctionality. Examples like parking lots that become food or flea markets at specific times can be found in all cases and play an essential role in the provision of the goods of daily need. There is also large potential multi-functionality that integrates multiple functions at a location at the same time. Examples that were observed were more informal ones, like using parking lots as a playground or to produce and exhibit art as well as using parts of grey spaces for gardening or food production. This confirms Viganò (2011), who proposes beginning with open spaces when designing within dispersed urban territories. Particularly as the analyses show that the amount of open grey spaces is large and that many of them are located in central and highly accessible places, which provide the possibility to contribute to multifunctionality also at the regional scale.

Greenspaces have an inherent potential through multifunctional use to not only lessen the negative impact of climate changes but also to provide a positive impact on the liveability of citizens. Concepts like green infrastructure or ecosystem services focus on developing these positive effects.

The maps presented in this study show that the most common green spaces, but also significant parts of grey spaces in TiB have the potential for multiple ecosystem services. The form of the potential is very distinct according to the spatial relation of a specific open space to its centrality as a resulting characteristic of the street network, accessibility to and connectivity of services as well as densities of services, production and consumption. The type of green space that covers the largest area in all cases has a high potential to develop multifunctionality since these open spaces are under a rather low level of development pressure because they have lower accessibility to the fast transport network. Then again, they are very close to the backbone of existing green infrastructure and the regional ecological network, which makes them specifically crucial to develop provisioning and regulating ecosystem services. In this way, they provide the strategic potential to contribute to a regional green network which also integrates urban ecosystem services. There is a significant potential to develop green and grey open spaces along with the network of grey infrastructures, to provide ecosystem service but also facilitate multi-functionality. To develop this network, which very often is located crisscrossing the existing blue-green infrastructures, is essential for regenerative development of dispersed areas.

Chapter 5 added a more systemic analysis of the multi-functionality of the regional system of green spaces and answered whether less fragmented greenspace systems in TiB also provide better accessibility for the population of TiB to green spaces? Moreover, which settlement patterns and therefore, spatial planning and design approaches, combine both biodiversity and accessibility more successfully? These questions are relevant as access to green space is essential for the development of educational, aesthetic and cultural values as well as improving recreation and physical and mental health. Experiencing (urban) biodiversity is a key to halting the loss of global biodiversity because people are most likely to take action for biodiversity if they have direct contact with nature. Who has access to which green spaces is, therefore, a question that will challenge

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urban planning and design in the coming decades? Moreover, the unevenly distributed benefits of green space raise questions concerning environmental justice.

The answer to these questions is for the ten tested cases, that there is no clear relationship between landscape fragmentation and accessibility of green space. There is the same amount of cases that perform in the same direction for both indicators, as there are cases that perform for both indicators in the opposite direction. Certain conclusions have been drawn for the settlement patterns that perform best. An extensive and un-fragmented regional network of green spaces as the backbone is crucial. Whether this is in the form of green belts, green fingers, buffer zones or landscapeparks, does not make a big difference. It is crucial that these large green spaces are easily accessible, preferably by foot, bike or public transport.

It is essential that traffic and other infrastructures are located and designed in a way that they fragment the big green spaces as little as possible and do not block access to large green spaces. It is also essential to avoid cul-de-sac settlement patterns and gated communities, as well as impermeable industrial or business parks at the edge of the settlements. Although often intended to curb urban development and thereby aim to protect green spaces, they often limit pedestrian access to leisure spaces and may enforce the use of cars.

Cases that have a more compact settlement pattern—where medium-sized greenspaces separate individual cities, towns and villages—tend to perform better on both indicators as these structures allow a greater interweaving of built and unbuilt spaces. An encouraging result, as most of Europe, is formed by a network of towns and small to medium-sized cities. Crucial here is to make sure that the medium-sized green spaces are easily accessible. In contrast to large green spaces, the midsized green spaces are often not part of national planning or environmental protection policies, therefore, regional and cross municipal cooperation is crucial to establish this part of a regional green system.

Moreover, a large amount of well-distributed small green space is crucial for a fair distribution of ecosystem services. Specifically, relevant is that ongoing densification often goes hand-in-hand with a change of housing typology from family housing with private gardens to single-occupancy flats without private gardens. Moreover, the densification efforts often transform green spaces, which are considered as underused but are nevertheless essential for biodiversity and human well-being.

The results and maps presented here have the potential to facilitate and inform discussion across the many fields of expertise and actors involved in protecting and assist in developing a system of green space in TiB. This is specifically important for TiB, where the expected future densification of urban uses and the protection of (urban) biodiversity are causing and will continue to cause conflict among different groups of interest.

Mixed-use, preferably integrated into a pedestrian-oriented environment, is a further aspect of sustainability. Chapter six investigates mixed-use further. The typology presented in this paper showed that mixed-use in TiB could be related to specific settlement characteristics. The characteristics investigated were: grain, density, permeability, centrality and closeness to transit stations and motorway entries.

The areas with the highest mixed-use are characterised by good accessibility to both the motorway system as well as to public transport, and a very high local and regional betweenness centrality. Furthermore, a high population density and high job density as well as high permeability and small grain size of the block structure support mixed-use. The Dutch and Austrian cases show a rather high mixed-use in areas with medium local and regional betweenness, medium permeability and medium grain size as well as low population density and medium on job density. The last two may lead to the conclusion that in both countries, there are policies and practice in place that support mixed-use in areas with lower population densities. The typology also shows, that in the areas with high population density, this factor compensates for lower accessibility and centrality values. The research clearly shows that mixed-use is related to both local and regional settlement characteristics.

8.4.2 The importance of a cross-scale analytical approach

The chapter on underestimated potentials for sustainability clearly revealed that in order to be able to profit from the potentials for future sustainable development, which are present in TiB, it is crucial to understand that, because of the networked structures of TiB, elements of the regional structure influence the potential for sustainable development of local structures and vice versa.

The indicators and typologies presented in this research were all built on types of spatial analysis that considered these systemic relations. The landscape fragmentation of a region may change significantly by local interventions, like a street or an ecoduct. To determine if a plot has the potential to house mixed-use is highly dependent on its centrality within the regional street network or how accessible it is by public transit. Local small grain sizes of the street network and pedestrian-friendly local streets in multiple places contribute to a more livable region. Further, the provision of ecosystem services shows the same pattern when positive effects are dependent on the characteristics of the open space system at multiple scales.

The analytical methods developed and presented in this research respect this need for developing knowledge and understanding through scales. This is done by always choosing a minimum of at least three scales. First, a 50 km x 50 km square, spanning across local, regional and in some cases even national administrative borders. Second, the sub-areas classified as urban, rural and TiB are within these squares in order to understand and make specificities of TiB apparent. Lastly, all analyses worked with a resolution of 500 m x 500 m and in many cases, even higher. The resulting maps and quantitative findings aim to inform spatial planning and policymaking at different territorial scales. This is essential as it is apparent that (spatial) planning and policymaking needs to work through scales for future sustainable TiB.

8.4.3 TiB require specific planning approaches and adequate place in planning theory

European mainstream planning is concentrated on prolonging and promoting the success of the compact, sustainable European city model. Neglecting that Paris, Milan, Madrid, Vienna, Copenhagen and Amsterdam (only seen within their city boundaries), to only name some icons of the compact city, are only home to less than half of the EU's population. However, a large part of the population lives and works in areas, that somewhat resembles the Ruhrgebiet, the Veneto, the Silesian Metropolitan Area, the Ile de France, the Alpine valleys, the Mediterranean coasts or networks of small and midsized towns and villages. The literature on metropolitan dynamics and metropolitan planning acknowledges the differences of metropolitan areas in Europe but concentrates on the urban centres within the metropolitan areas as engines of economic growth and wealth. They are ignoring or underestimating the potential of dispersed urban territories, which are demonstrated in this dissertation.

However, forgotten or neglected only covers half of the story because of plentiful research and planning policies highlight the growing area of dispersed urban development and the negative impacts of suburbanisation. However, often it is labelled as sprawl, with all its connotations that originate predominantly from Anglo-Saxon dominated research and theory development, ignoring the cultural and spatial specificities of continental European urban development.

Therefore, at the beginning of this millennium, planning theory and practice are largely detached from the spatial reality of Europe's settlement pattern. MCRIT (2010) documented this mismatch and confirmed the need for a distinctive reading and planning of dispersed territories. The financial and related public debt crises of the 2010s have significantly reduced the capacities of planning authorities as well as academia. This has resulted in little progress in developing pathways to address the mismatch as mentioned above. That dispersed urban areas, and planning approaches that are specifically tailored to them, are absent in textbooks on the city of the twentieth century worsen this situation.

There are also indications that mainstream spatial planning research and policymaking is attempting to consider TiB. The peri-urban became more prominent in academic literature and the web of science database shows an increase from ten papers published in 1990 to more than 500 published in 2018. However, many of the papers understand the peri-urban as an area that depends on a city and not the way TiB was described here, which is an independent spatial form.

Another way of shedding light on these forgotten spaces is to include them in the landscapes regulated by the European Landscape Convention (ELC), which defines the whole territory as a landscape, and explicitly includes urbanised areas. The ELC calls upon signatory states to identify their landscapes and to explicitly include urban and peri-urban landscapes in the description, along with the ‘natural’ and ‘rural’ ones (ECL Article 2). If this identification is to go ‘beyond the traditional focus on individual parks and green spaces and the links between them’ (Stiles et al., 2014), then two challenges are crucial: (i) to also include non-green open spaces and (ii) to base the classification of open spaces in more than just ecological and environmental aspects. The typology presented in the second paper did both and went beyond. It not only identifies green and grey open spaces based on social-environmental aspects, but it also provides a tool to identify the potentials for multi-functionality and can thereby inform spatial planning decisions at multiple scales.

Although the study of different planning cultures, approaches and instruments were not part of the research, nevertheless, it is essential to provide some thoughts concerning a possible contribution to regional planning. The inter-scalar, networked nature and of TiB and the lack of a vision for them ask for a strategic spatial planning approach, which as a defined by Albrechts (2004) ‘is a public-sector-led (Kunzmann, 2000) sociospatial (see Healey, 1997a for the emphasis on the social) process through which a vision, actions, and means for implementation are produced that shape and frame what a place is and may become’. A crucial first step in the strategic planning process is the development of a vision, which is grounded in the social values of a particular TiB. These are hardly ever developed, and the specific characteristics, needs and potentials for sustainable development of TiB are not very prominently represented in regional strategic plans. There is no simple answer to this question, but the situation asks for a regional planning body as the facilitator of a strategic planning process within TiB to bring them out of their shadow life.

As stated in the introduction, the vision for sustainable development of TiB cannot be found in fundamental principles of urban planning and design that stem from the compact city idea and its application to ‘sprawl’. The dissertation clearly showed that TiB have similarities across Europe and that therefore, general planning and design principles can be concluded from the study.

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However, the author is aware that the similarities and difference go beyond the morphological and functional aspects investigated in this study. In addition, there are diversities in the institutional and values settings in different places, which play an important role. Moreover, it is also apparent that the dissertation only tackled certain aspects of sustainable development and in the strategic spatial planning process, those have to be brought into alignment with other aspects of sustainability. Table 8.3 presents being aware of the limitations of the study with an attempt to counteract compact city-based planning and design approaches with approaches that are based on the findings presented in this study. In accordance with the plea for strategic planning before those recommendations should not be understood as to be followed dogmatically, but to provide a starting point for strategic planning in TiB from an informed and critical point of view.

TABLE 8.3 Often recommended compact city based planning and design principles and possible alternatives when planning in TiB.

Compact city principle applied to sprawl	Alternative proposed principles based on the characteristics of TiB
Increasing population density around transit stops, to provide the potential for mixed-use.	Increase the accessible density of population and jobs around public transit stops (but also highway entries) by modes of soft transport and thereby increase catchment areas and the potential for mixed-use.
The concentration of development on dedicated growth centres with a focus on vertical development;	Use historic linear development axes, like high streets to allow stepwise and gradual (through time) densification. Accept and use the high centralities provided by the regional road network and highway entries to support multifunctional land use, using the full potential of green and grey open spaces.
Curbing sprawling urban extension by concentrating infrastructures and uses with negative environmental impact at the outskirts of settlements.	Integrate unwanted uses with green and blue buffers zones that provide ecological permeability as well as better access and distribution of ecosystem services.
Curb sprawling development by green belts, fingers or similar.	Interweave greenspaces with urban areas, using among other the transformation of brownfields and the further needs to adapt specifically the water infrastructure to be able to handle higher peak charges.
Provide large urban parks as the core of urban green systems.	Improve the accessibility to large green spaces, specifically forest and agricultural areas, by further developing bike and pedestrian paths. Secure a large amount of small and medium-sized green spaces, in an interconnected network, during development processes to provide a diversity of ecosystem services and ecological permeability.

8.4.4 Limitation of the research and recommendations for further research

With ten cases across western, central and southern Europe, this research covers only a selection of dispersed settlement patterns in Europe. Although the variety of case locations offers a broad picture of conditions, further research is needed to test the applicability of the findings elsewhere. There are two pathways to understanding whether the findings of the research can be generalised beyond the cases involved, and therefore support the proposed theory on dispersed urban development. First, as data availability and calculation capacities become better by the day, it should be soon possible to perform most of the spatial analyses for all EU countries at least. However, research at this scale has the disadvantage that the cross-scale analyses become very difficult and also require many people on the ground to check whether the desk results are reasonable.

Second, the study could be extended with further cases, specifically with Scandinavian and eastern European cases. The Scandinavian cases are of interest because of their particular settlement pattern, which is in general low rise and low density with vast extents of almost uninhabited landscape. Moreover, the rather strong welfare state and trust in public planning and decision making are rather unique. Eastern European countries are of interest as spatial development after the fall of the Iron Curtain was predominantly driven by market liberalism. Trust in state-led planning and decision-making is very low because of the communist past of the countries.

The study clearly states that networks and flows are key features of TiB, but the analysis is limited to the use of physical infrastructures that facilitate those flows. The primary reason is that there is minimal data availability that goes beyond flows of energy, water and people. Only recent studies have developed methods that allow spatial analyses and mapping of material and waste flows.

Another limitation of the research is that it is solely a synchronic inventory of the state of dispersed urban development, that is, a picture of conditions at one point in time. A diachronic study would be necessary to understand the morphogenesis of TiB. The research relies heavily on data sets that are provided by the European Environmental Agency and other EU institutions. Those data are usually updated every ten years, which means that further updated data will be available soon. This should allow investigation of other questions about whether TiB are a growing or shrinking phenomenon, and whether they are becoming more sustainable or not.

A diachronic study would also be necessary to deepen the understanding of the relation of sustainability and potentials for the sustainability of TiB with spatial planning approaches and histories of specific places, and with changing periods of different economic development.

Finally, one aim of the study is to inform regional and local spatial planners and designers. Although, I had the possibility to participate and advise regional planning practitioners, this was, because of time limitations and the amount of cases, not done in a structured and replicable way. Therefore it would be of great interest to test how and to what extent the results of the spatial analyses of the research can be integrated into strategic planning processes.

8.5 Atlas of Territories-in-between Part G

This section presents primarily maps from parts B to E, which were generated originally from this research. An additional aerial view, as well as photos of example green and grey spaces are provided. The maps are presented case by in the following order:

1. Aerial view of the case study area.
2. The areas classified as territories-in-between, with an overlay of buildings and transport infrastructures.
3. A map presenting the typology of open spaces overlaid on territories-in-between, as well as photos illustrating examples.
4. A Map illustrating the number of residents with access to green spaces;
5. A Map illustrating the intensity of access to green spaces, which demonstrate how much of the territory is within the service areas of green spaces.
6. A Map presenting the number of different functions per 500 m x 500 m grid cell as one indicator for the presence of mixed-use. These maps cover only the territories-in-between.
7. Maps illustrating the typology of settlement structure as described in chapter 6.

8.5.1 South Wales

SOUTH WALES

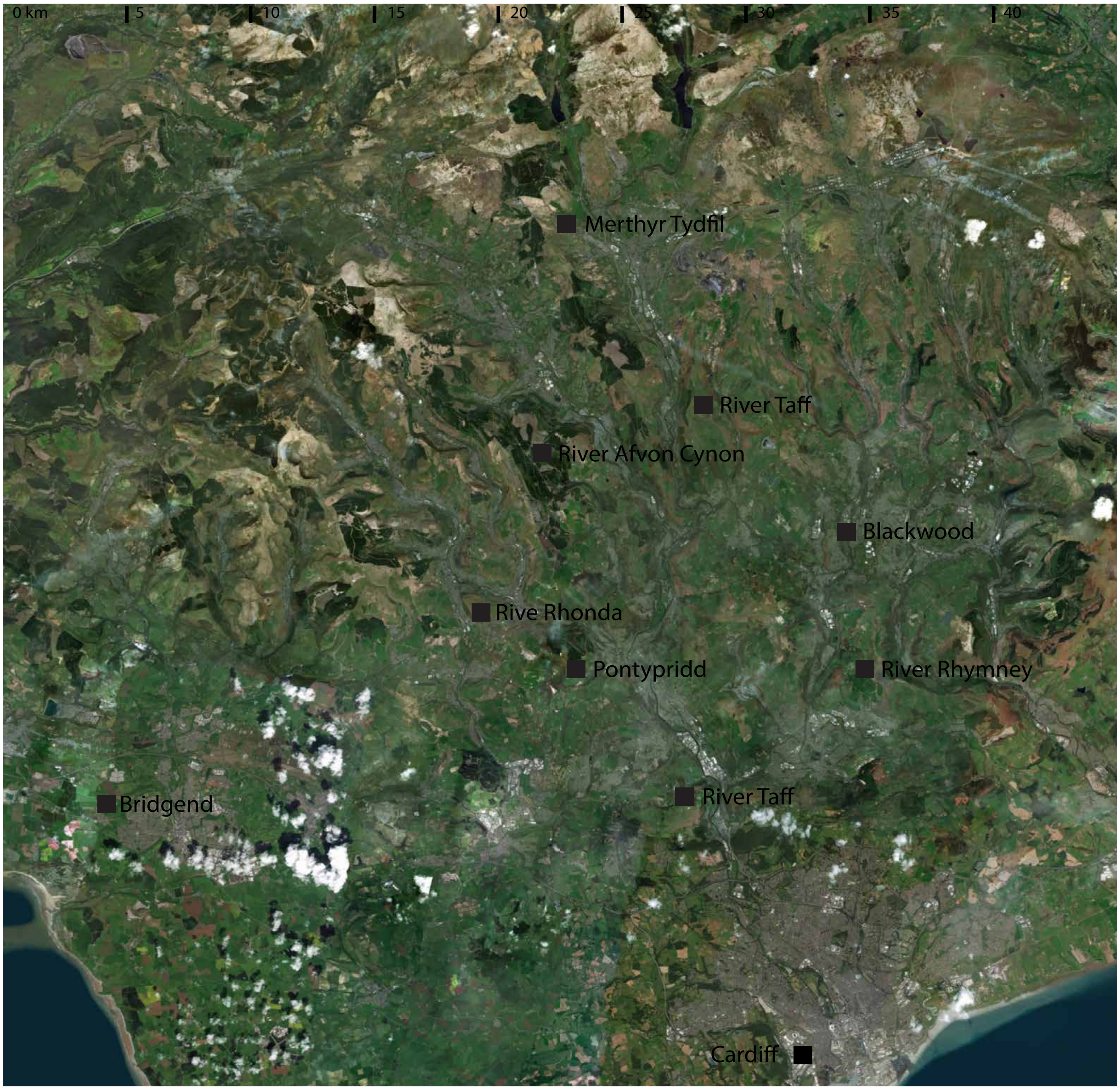

FIG. 8.4 The case study area of South Wales, with the capital city Cardiff in the south-east, Bridgend in the south-west and the rest is covered by the 'South Wales Valleys'. Source: Google Earth. Image Source: Google Earth.

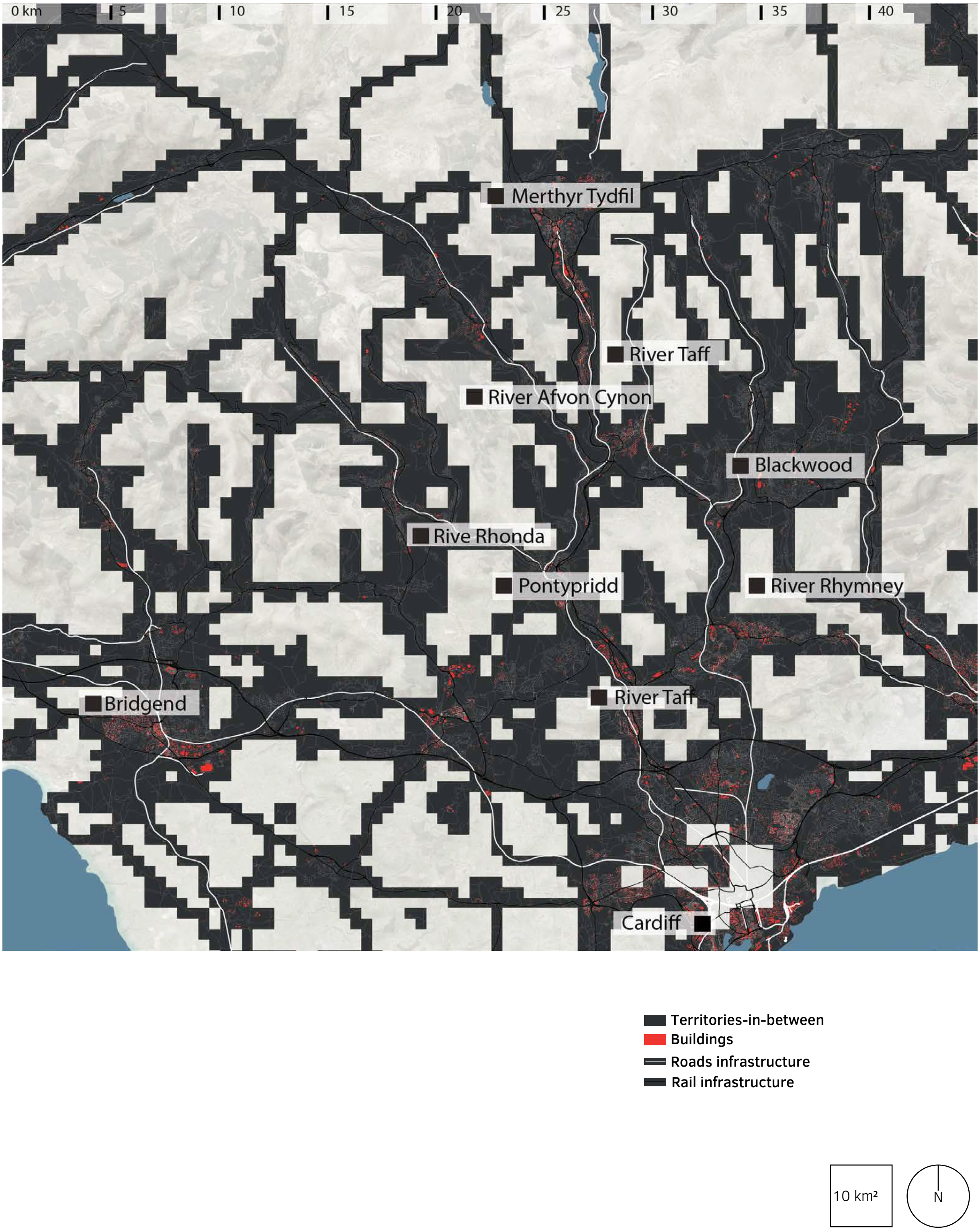

FIG. 8.5 Two different forms of TiB can be observed, one more field like around Cardiff and along the sea, and the typical linear valley type.

TYPOLOGY OF OPEN SPACES

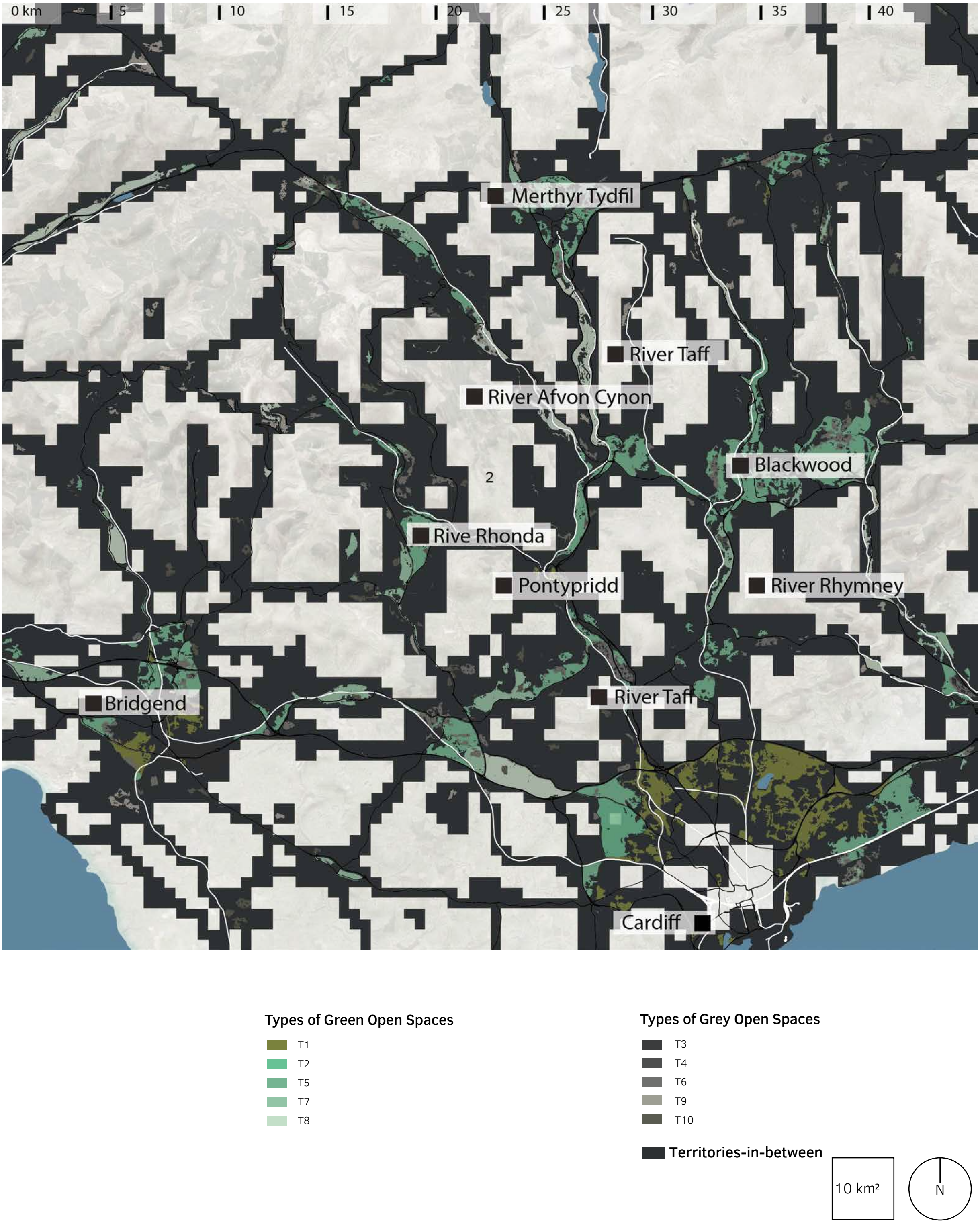

FIG. 8.6 Type 5 is the most common green space in South Wales and type 6 is the most common grey space. Both have a high potential for multifunctionality and are under limited development pressure which is specifically important for ecosystem services in relation to provisioning and regulating. They are crucial areas for the establishment of an ecological network that connects rural and suburban ecosystems.

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FIG. 8.7 (1) A buffer zone around a suburban settlement is not accessible but provides regulating ecosystem services. (2) A playground is placed into meadows between two settlements. (3) A typical grey space, a parking lot at a retail center.

NUMBER OF RESIDENTS WITH ACCESS TO GREEN SPACES

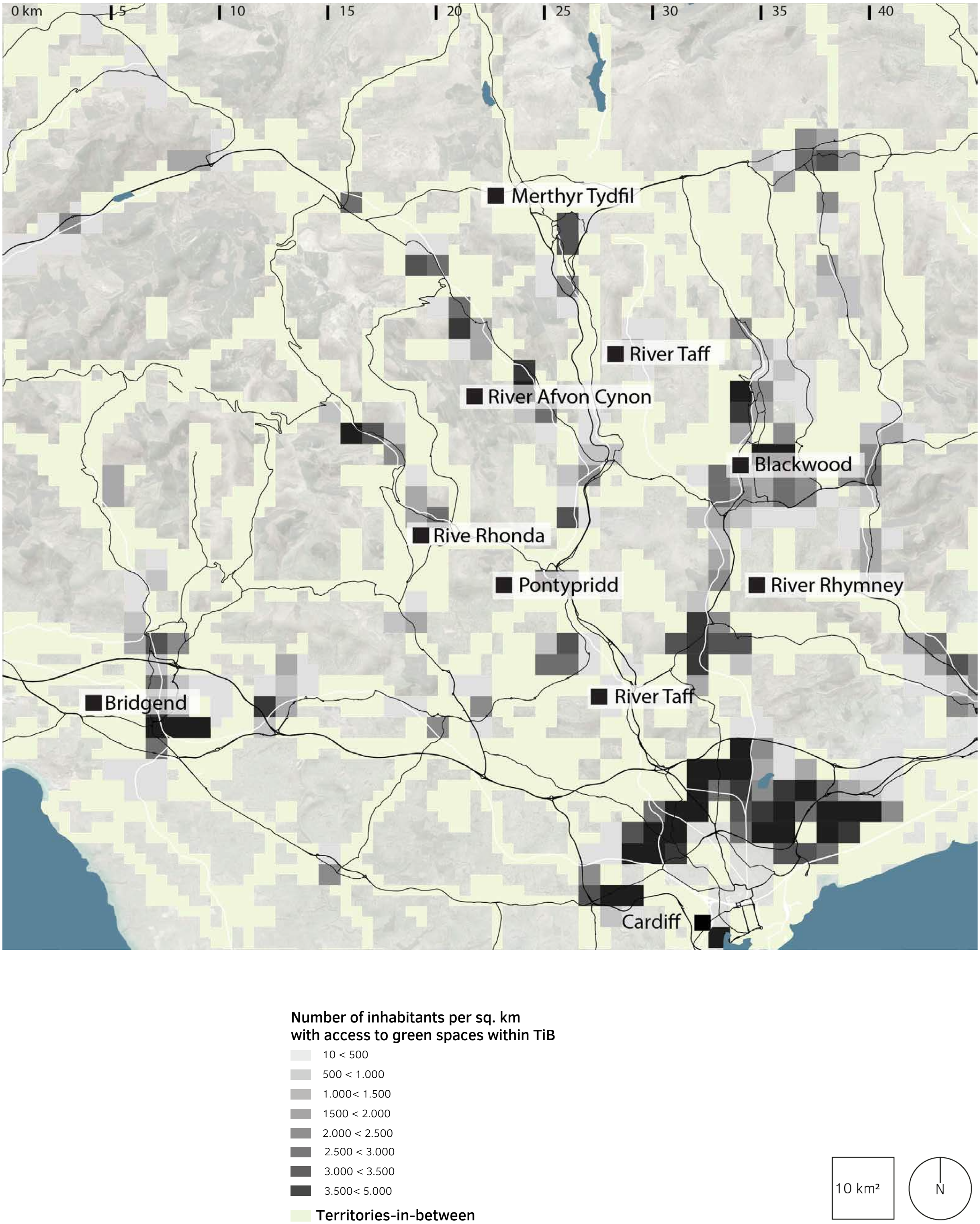

FIG. 8.8 Around 43 % of the inhabitants in the TiB in South Wales have access to more than one size of green spaces.

NUMBER OF RESIDENTS WITH ACCESS TO GREEN SPACES

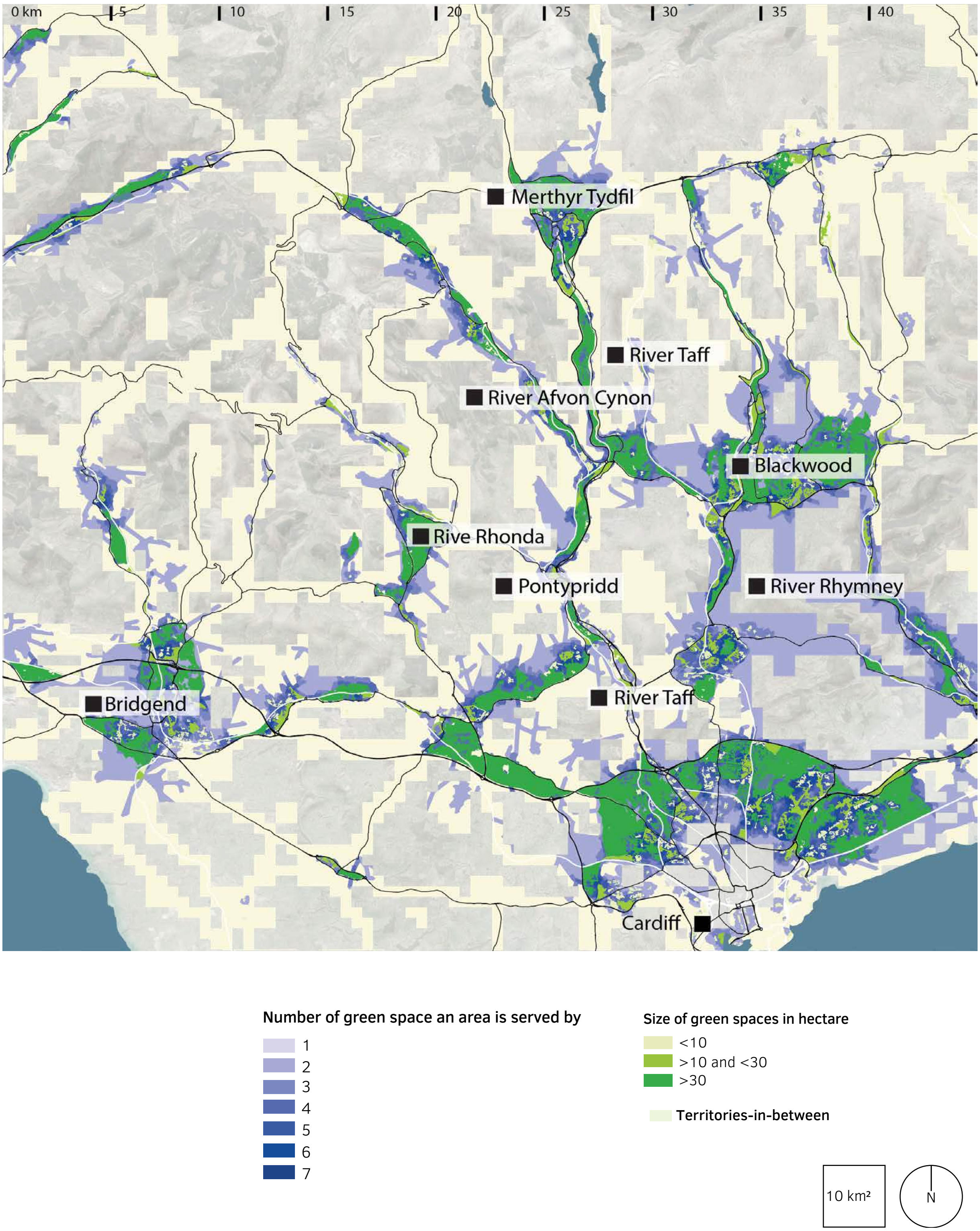

FIG. 8.9 The intensity of access to green space is at the highest in the periphery of Cardiff as well as in the other bigger cities like Bridgend or Blackwood.

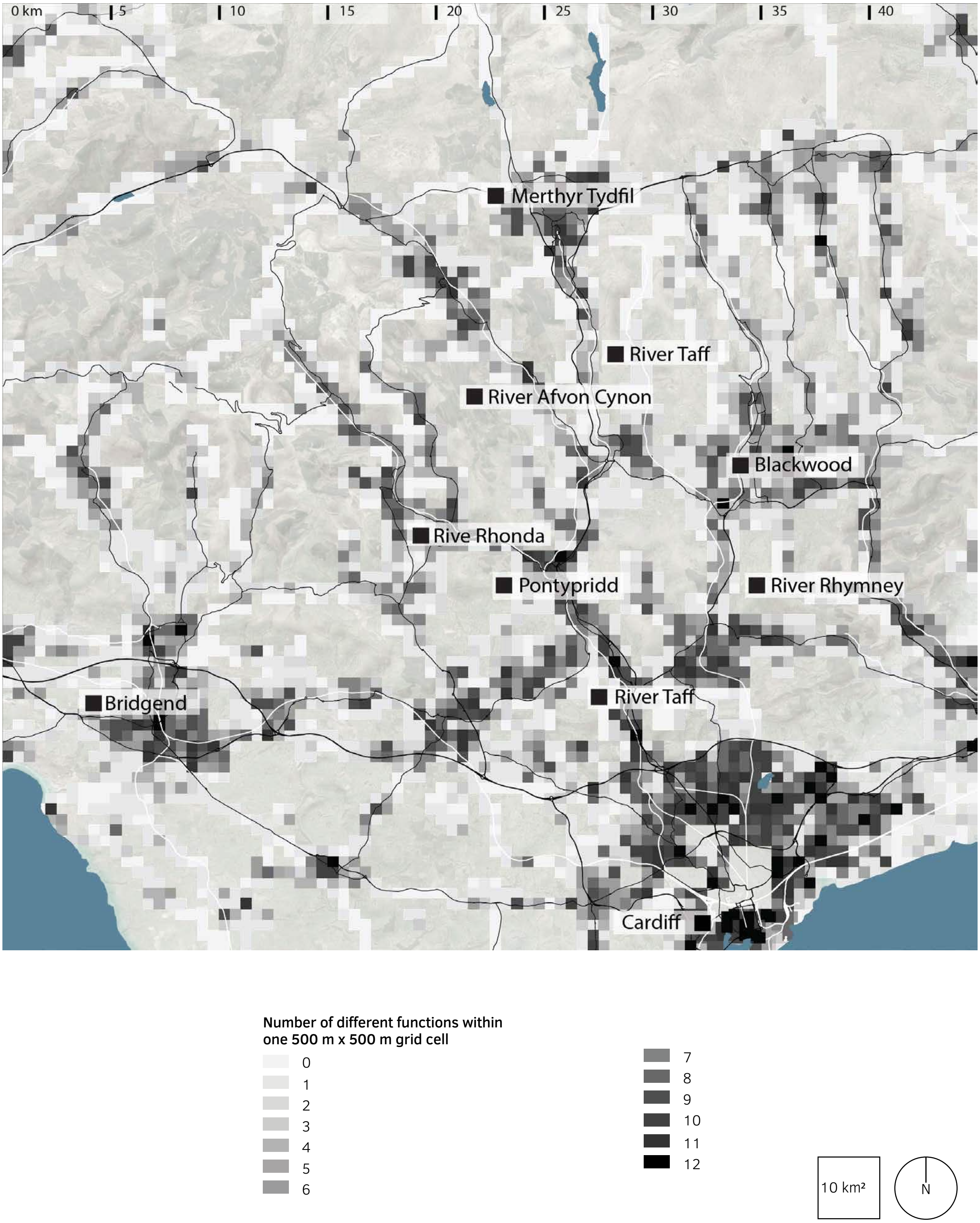

FIG. 8.10 More than 52 per cent of the inhabited grid cells host three or more functions. The highest mix of function is located in the towns in the valleys, the harbour area of Cardiff and parts of the peripheries of Cardiff and Bridgend.

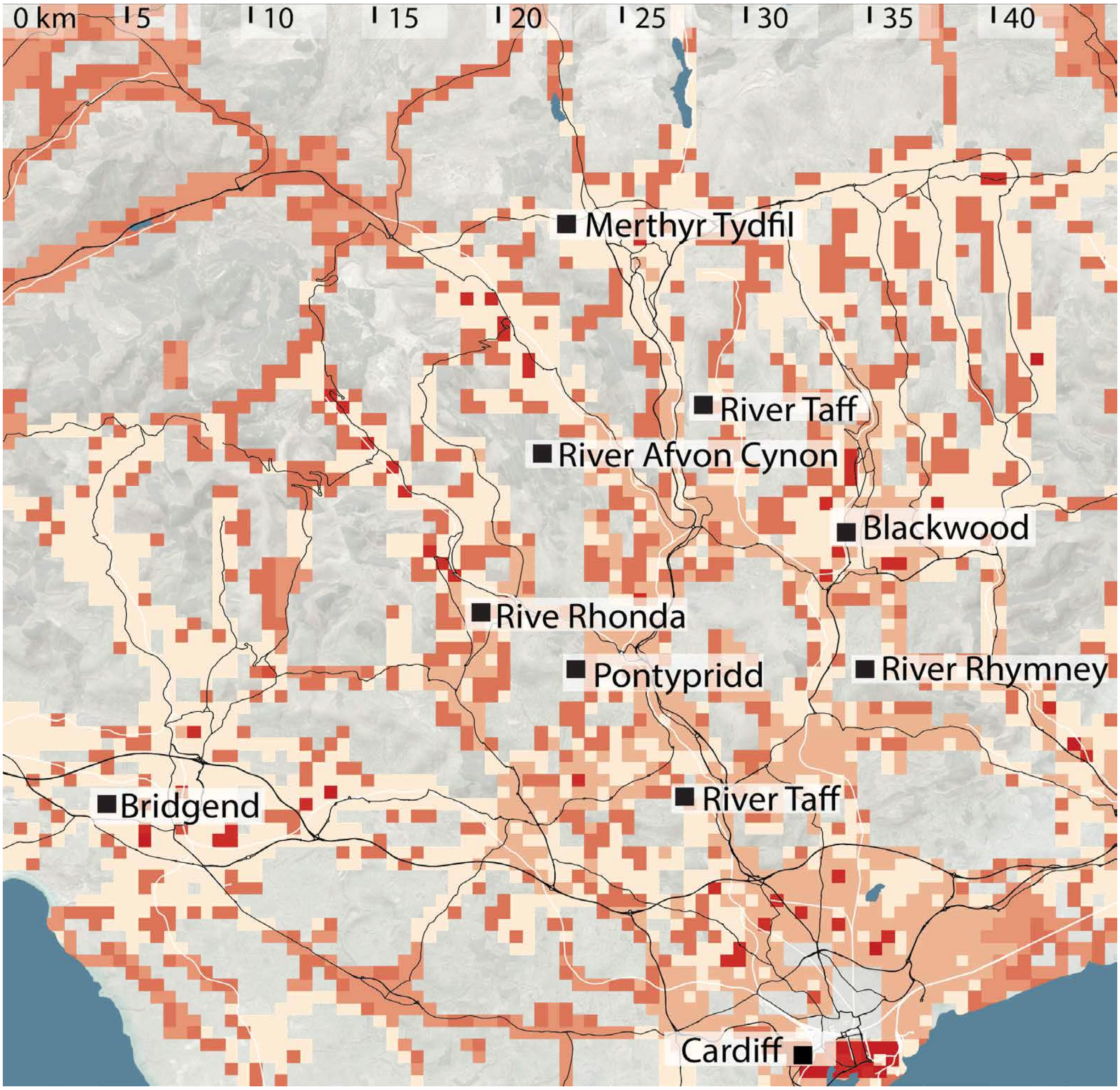

FIG. 8.11 The most frequent (47 per cent) settlement type is I, which has around 50 per cent of mono-functional cells but also 45 per cent of cells with more than three but less than ten different functions, as well as five per cent of cells with ten or more functions. Type III, which accounts for roughly 20 per cent, has more than 80% cells which host 3 or more functions. See table 6.6 for further detail.

8.5.2 North Somerset

NORTH SOMERSET

FIG. 8.12 The case study area of North Somerset, stretches from Bridgewater and the mouth of the River Parrett in the south-east of the square via the Somerset Levels to Bristol in the north-east of the square. The largest town along the coast is Weston-Super-Mare. At the edge of the Somerset levels and the surrounding hills are cities, which have a rich history like Glastonbury and Cheddar. Image Source: Google Earth.

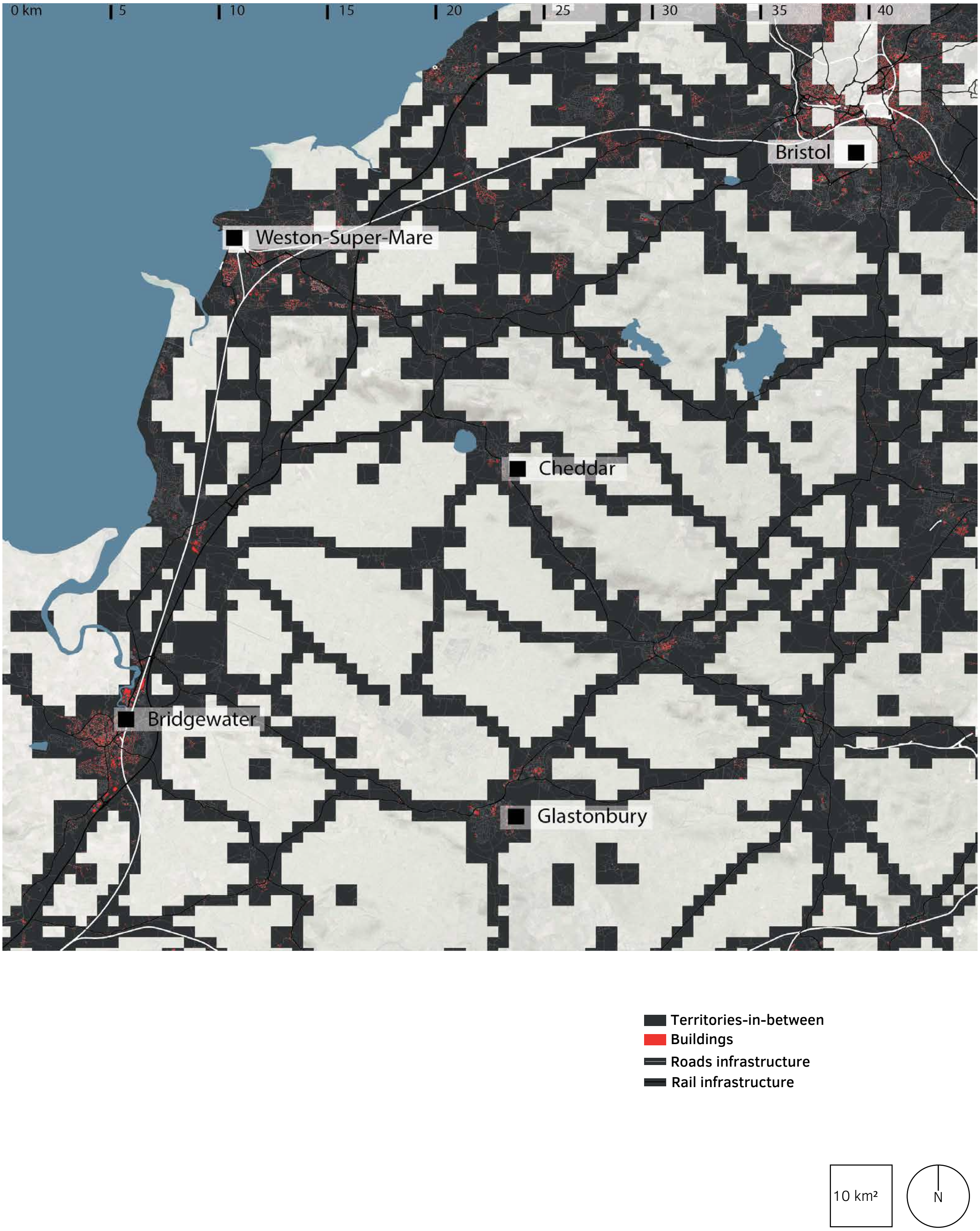

FIG. 8.13 Two different forms of TiB can be observed. One corridor like along the sea, and one network type connecting the towns inland.

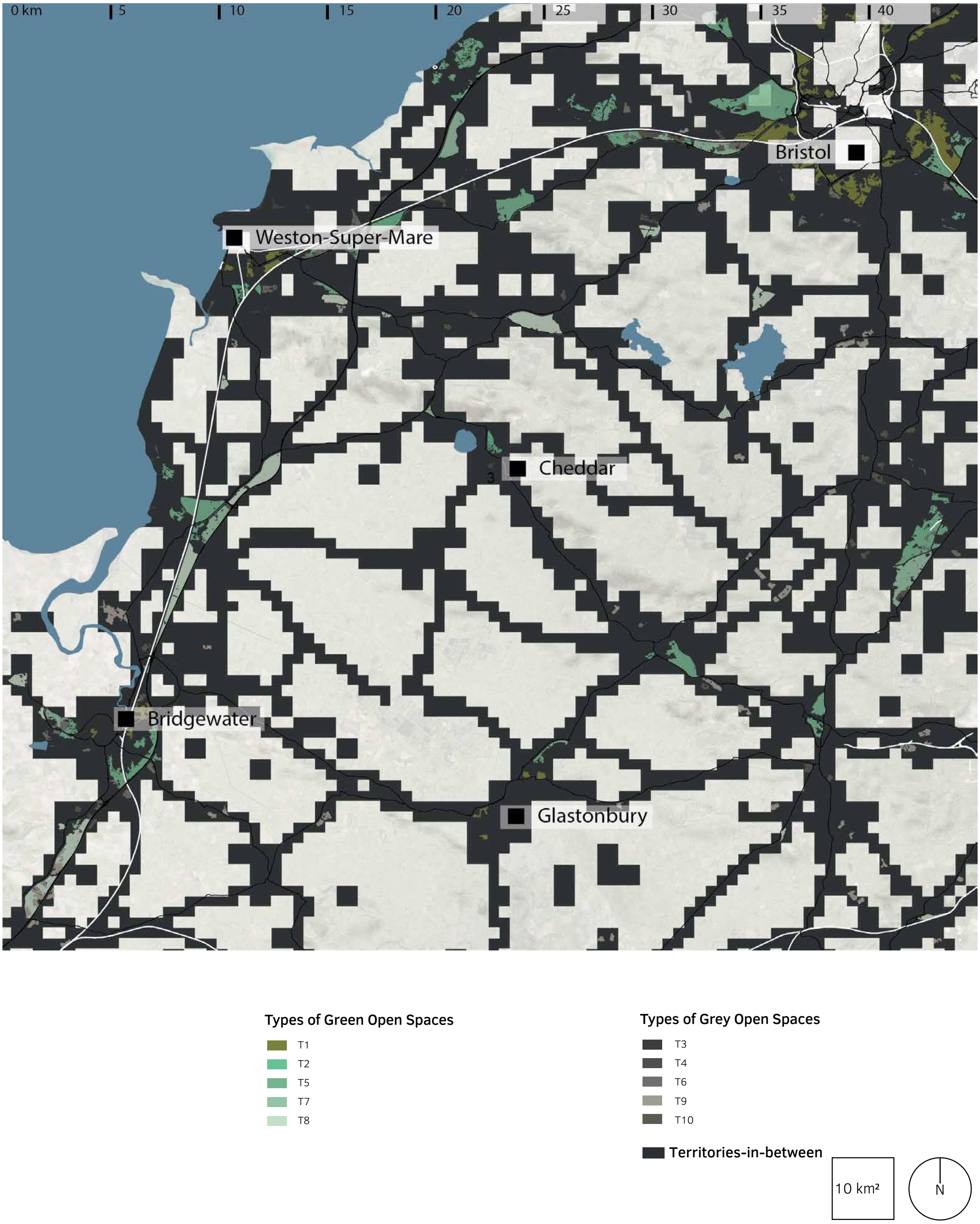

FIG. 8.14 Type 2 is the most common green space in Somerset. Green spacesin type 2, covers the largest area, andare in very central locations of the street network, with high potential aof multifunctionality between operators of production and residential use. Type 6 is the most common grey space, which has a high potential for multifunctionality and is under limited development pressure. They are crucial areas for the establishment of an ecological network that connects rural and suburban ecosystems.

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FIG. 8.15 (1) A park along a river, providing regulating and cultural ecosystems that crosses the town. (2) A residual green space between different types of settlements. (3) A typical grey space, a parking lot at the edge of the historical centre of a town.

NUMBER OF RESIDENTS WITH ACCESS TO GREEN SPACES

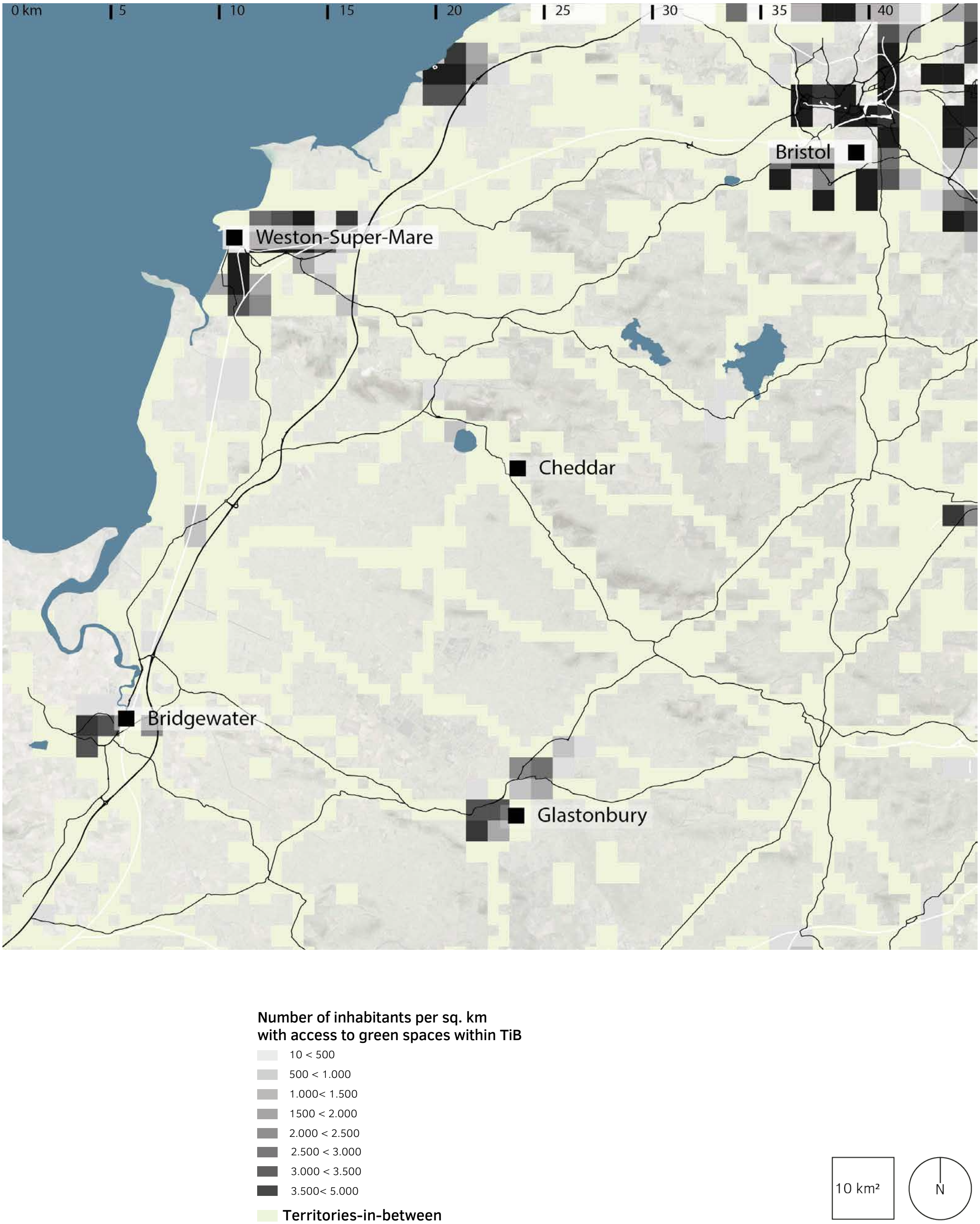

FIG. 8.16 Around 40 per cent of the inhabitants of the TiB in North Somerset have access to more than one size of green space.

NUMBER OF RESIDENTS WITH ACCESS TO GREEN SPACES

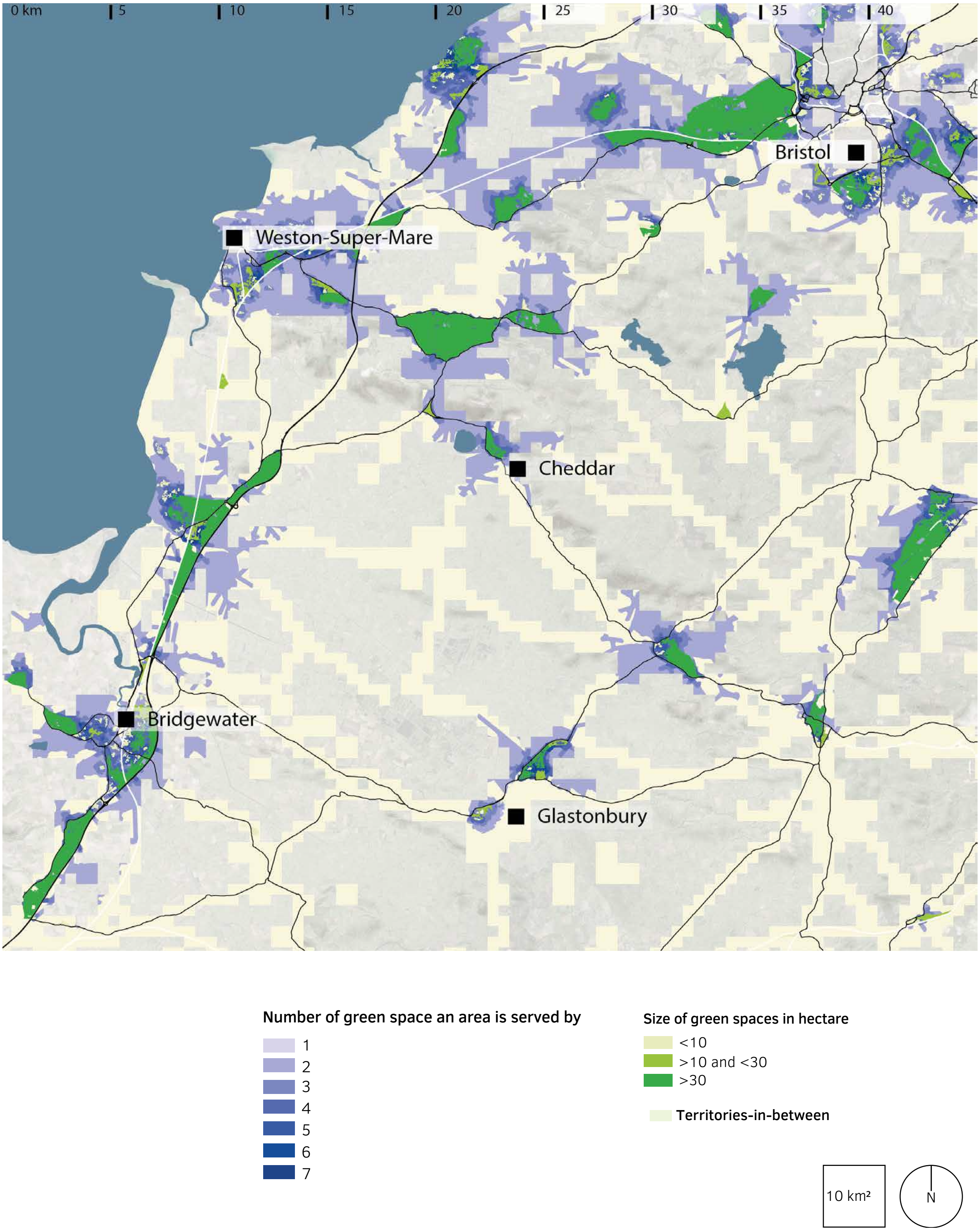

FIG. 8.17 The intensity of access to green space is highest in the periphery of Bristol as well as in and around the cities along the sea.

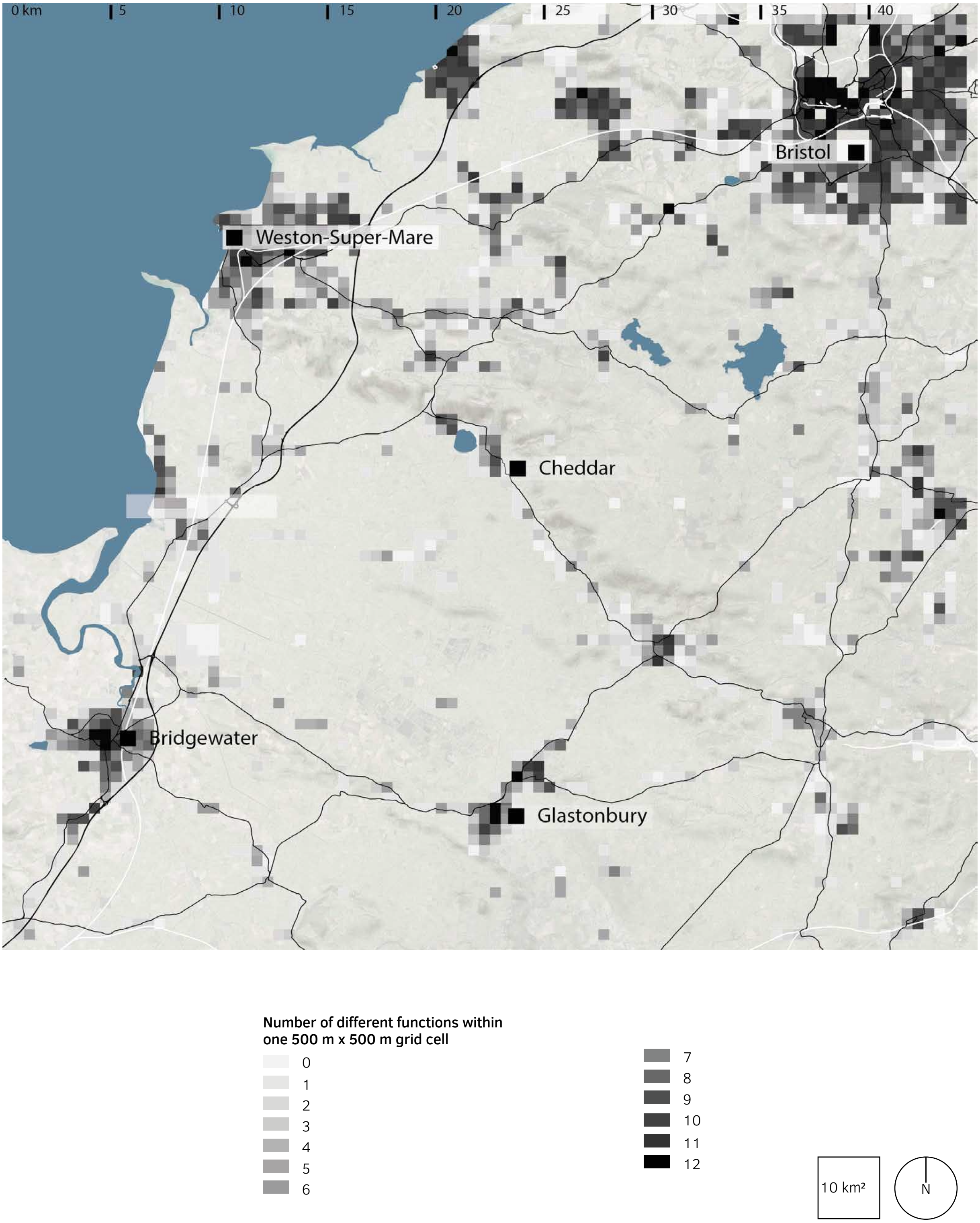

FIG. 8.18 More than 61 per cent of the inhabited grid cells that host three or more functions. The highest mix of function is located in Bristol and the cities along the sea but also the smaller inland located towns.

SETTLEMENT STRUCTURE

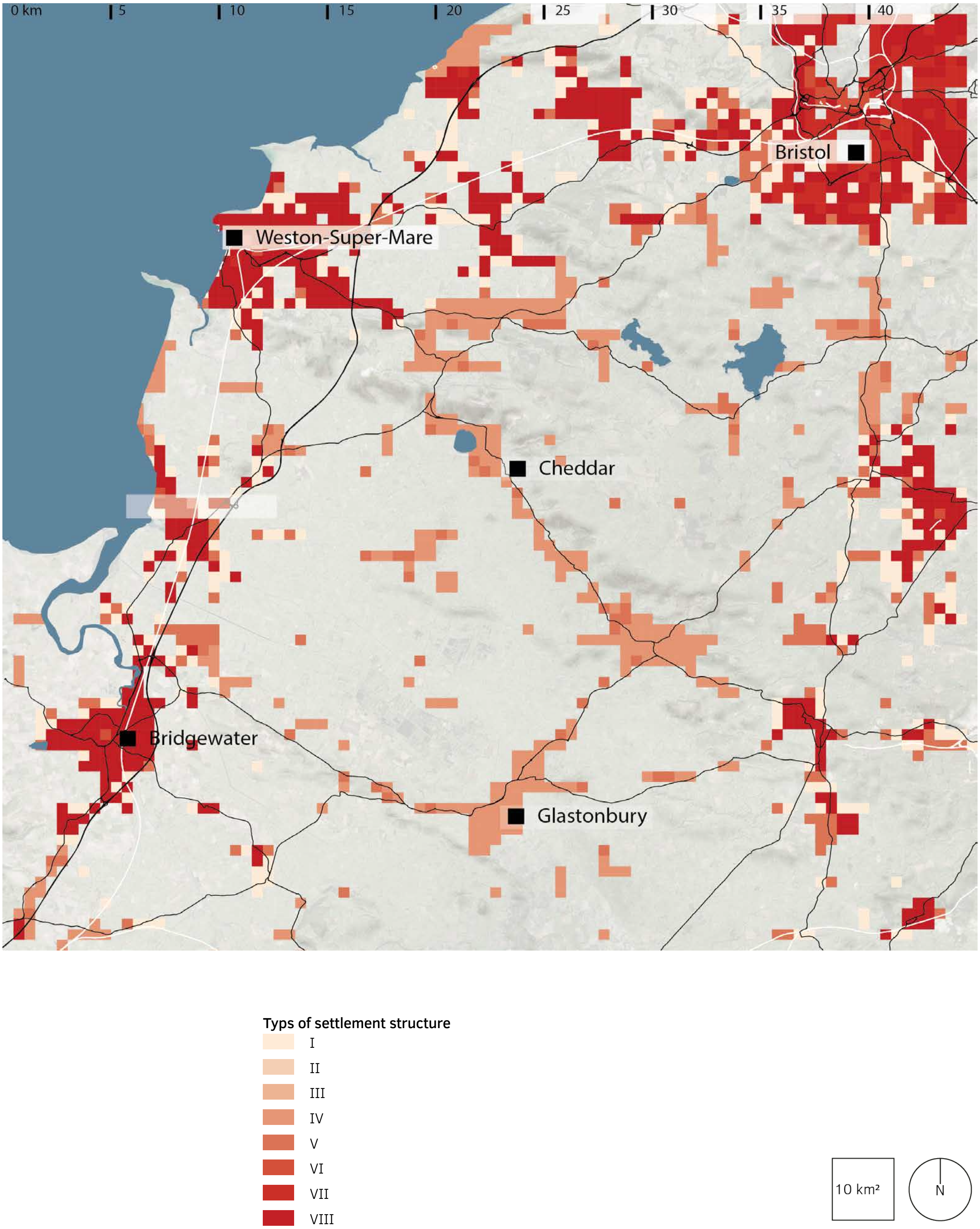

FIG. 8.19 The most frequent (36 per cent) settlement type is type VIII, which has around 20 per cent of mono-functional cells but 65 per cent of cells with more than three but less than ten different functions, as well as fifteen per cent of cells with ten or more functions. Type IV, which accounts for roughly 23 per centof all cells, includes around 50 per cent of mono-functional cells and 45 per cent of cells with more than three but less than ten different functions, as well as five per cent of cells with ten or more functions. See table 6.6 for details.

8.5.3 Île-de-France

ÎLE-DE-FRANCE

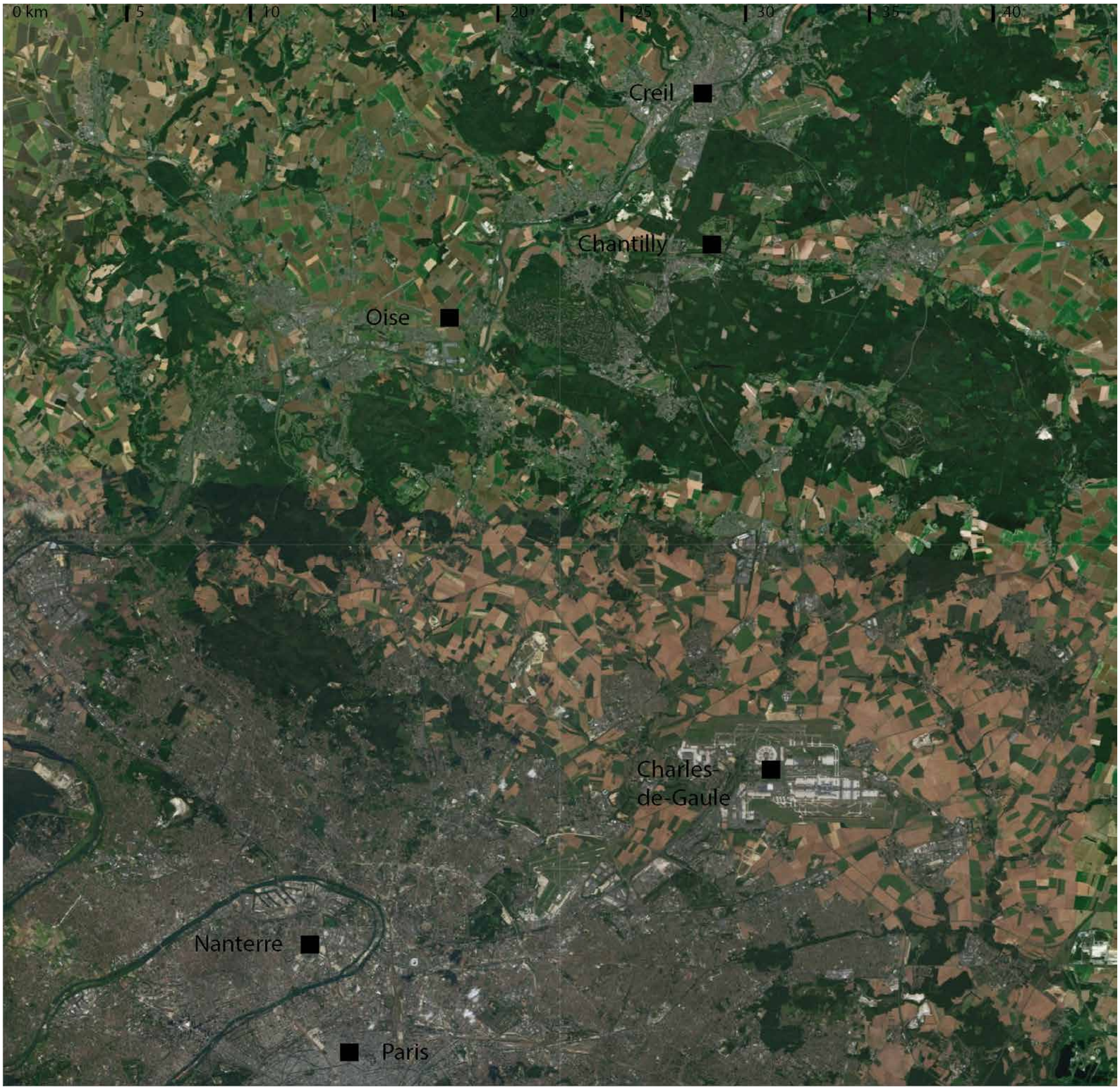

FIG. 8.20 The case study area Ile-de-France, stretching from the North of Paris to Creil in the North. With the Oise Valles crossing from south-west to northeast. The airport, Paris-Charles de Gaulle is a clearly visible in the South-eastern quadrant. Image Source: Google Earth.

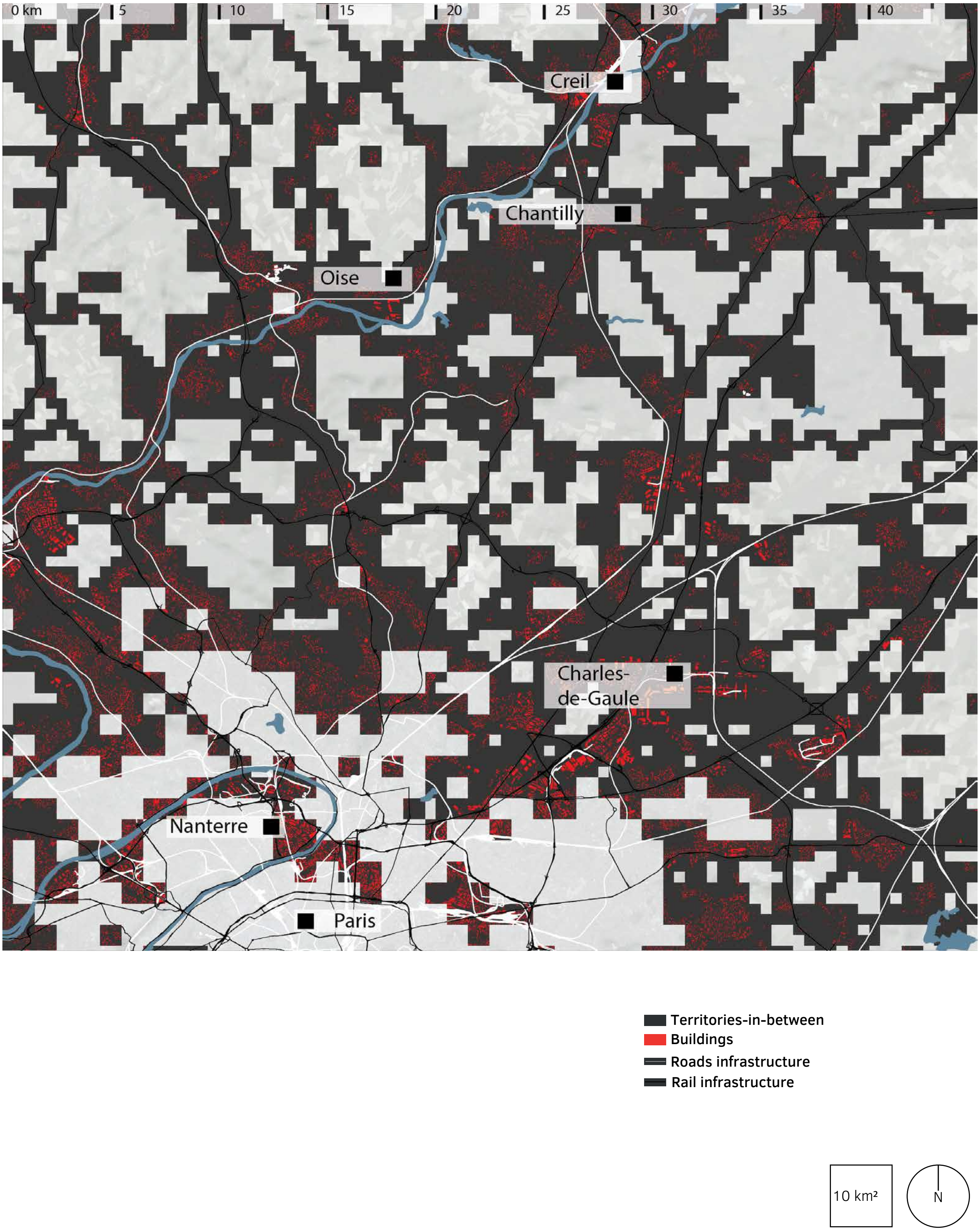

FIG. 8.21 All three types of TiB are observable which are: the field in the periphery of Paris, the network of cities and towns around Chantilly and the valley type along the river Oise.

TYPOLOGY OF OPEN SPACES

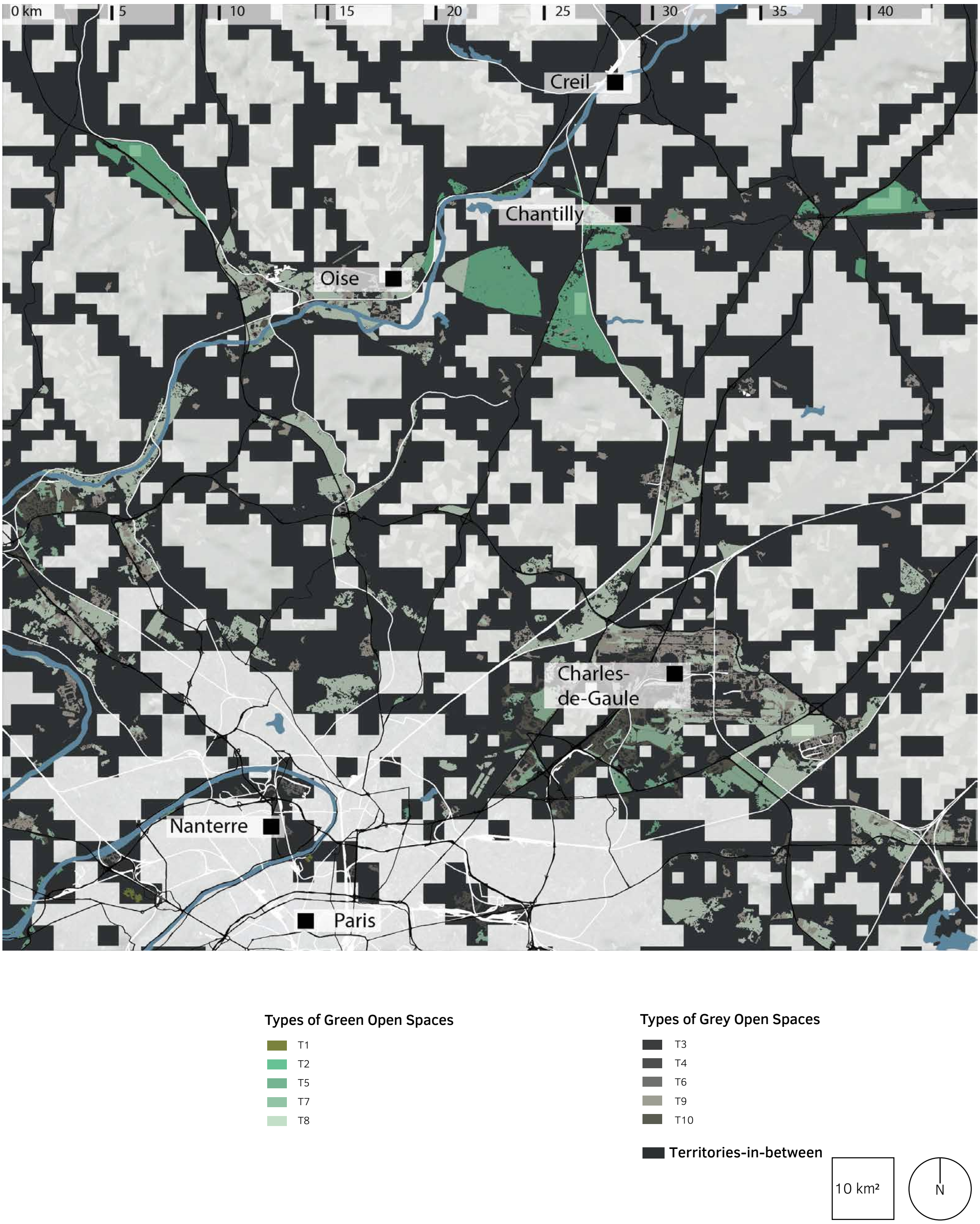

FIG. 8.22 The most frequent green space is type 8, which plays as a key role acting as buffer areas between industrial areas and intensive agricultural areas, but also as ecological corridors that connects the backbone of the existing green infrastructure with the urban green network. They are relevant for regulating and providing provisional ecosystem services. The most frequent grey open space is type 9, which is the grey type with the lowest potential of multi-functionality. They are often located in smaller settlements or industrial areas with automated functions like ports. They are seen as crucial open spaces for the provision of regulating and cultural ecosystem services.

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FIG. 8.23 (1) The Hippodrome in Chantilly as an extreme example of a green space with high cultural and economic value. (2) A grey space between industrial and residential areas. (3) Allotment gardens, green spaces provide provisioning ecosystem services, in the flood plain of the Oise river.

NUMBER OF RESIDENTS WITH ACCESS TO GREEN SPACES

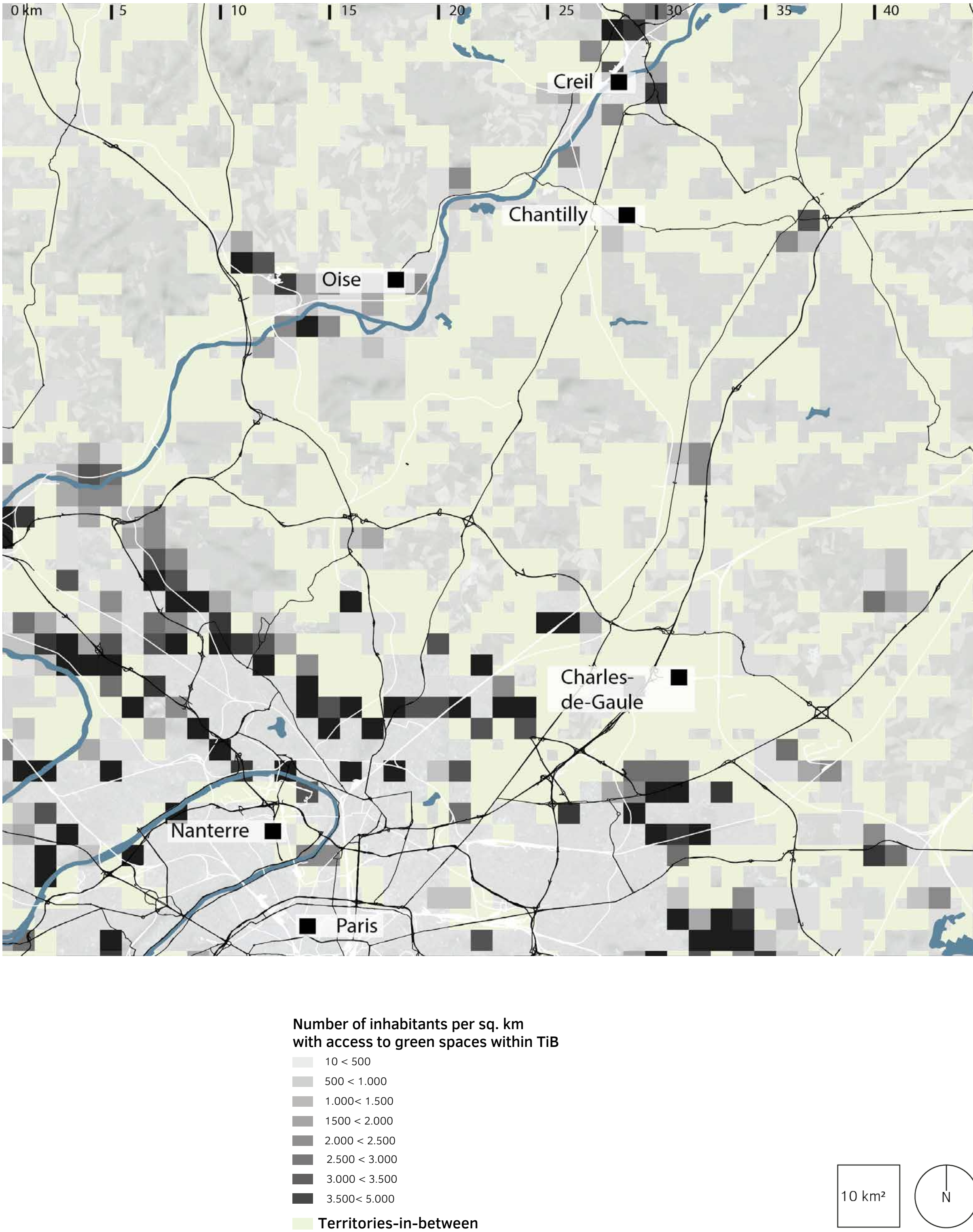

FIG. 8.24 Only around 28 per cent of the inhabitants of the TiB in the Ile-de-France have access to more than one size of green space.

NUMBER OF RESIDENTS WITH ACCESS TO GREEN SPACES

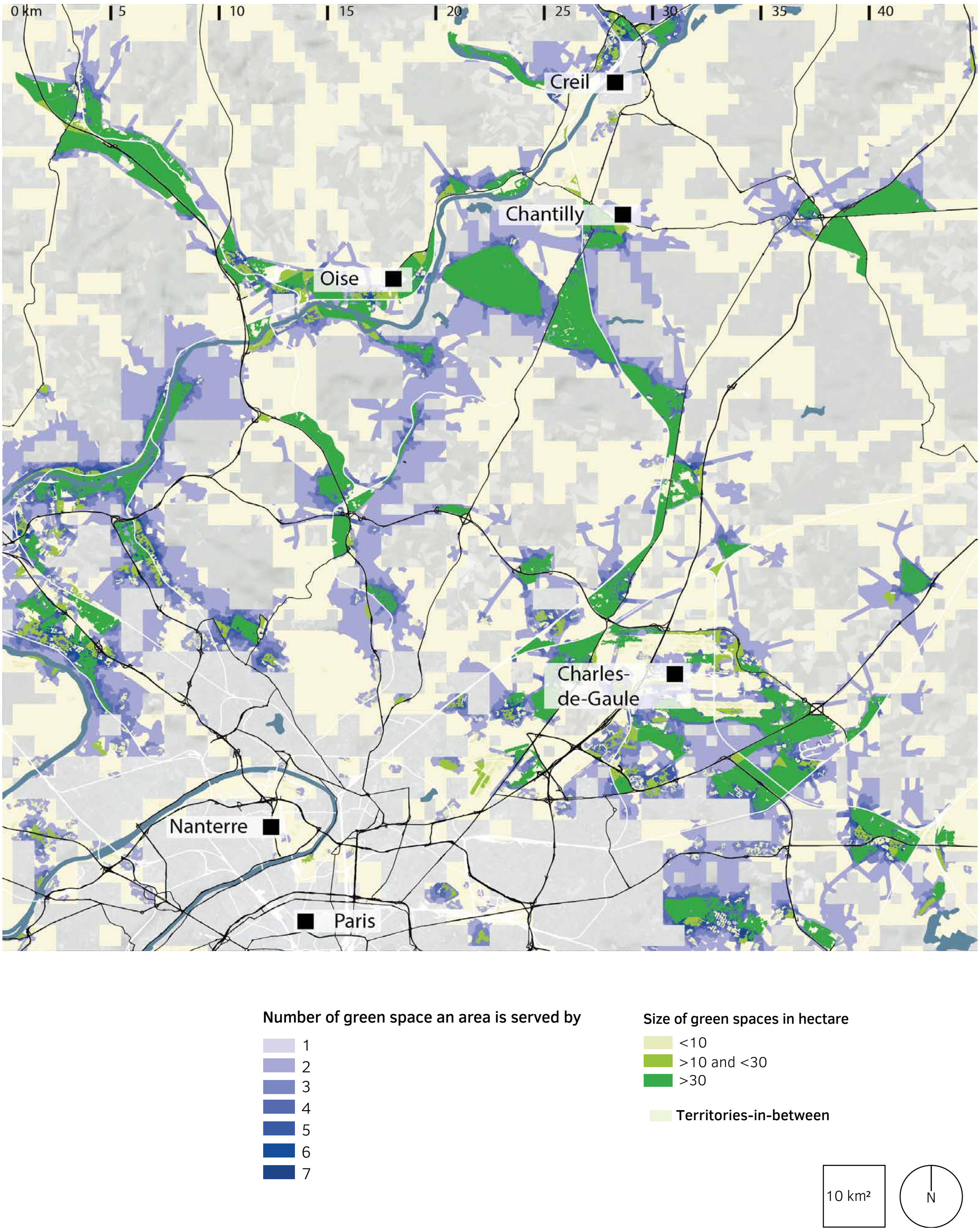

FIG. 8.25 The intensity of access to green spaces is at the highest in the Oise valley and around small and medium-sized towns and cities.

8.5.4 Pas-de-Calais

FIG. 8.26 The case study area Pas-de Calais is situated just east of Lille, with the city of Bethune in the middle of the case study area. The Canal d'Aire crosses the case study area from Northeast to Southwest. In the west of Bethune around Auchel is a former mining area. The former military Airport of Merville-Calonne is located in the centre of the caste study area. Image Source: Google Earth.

TOC

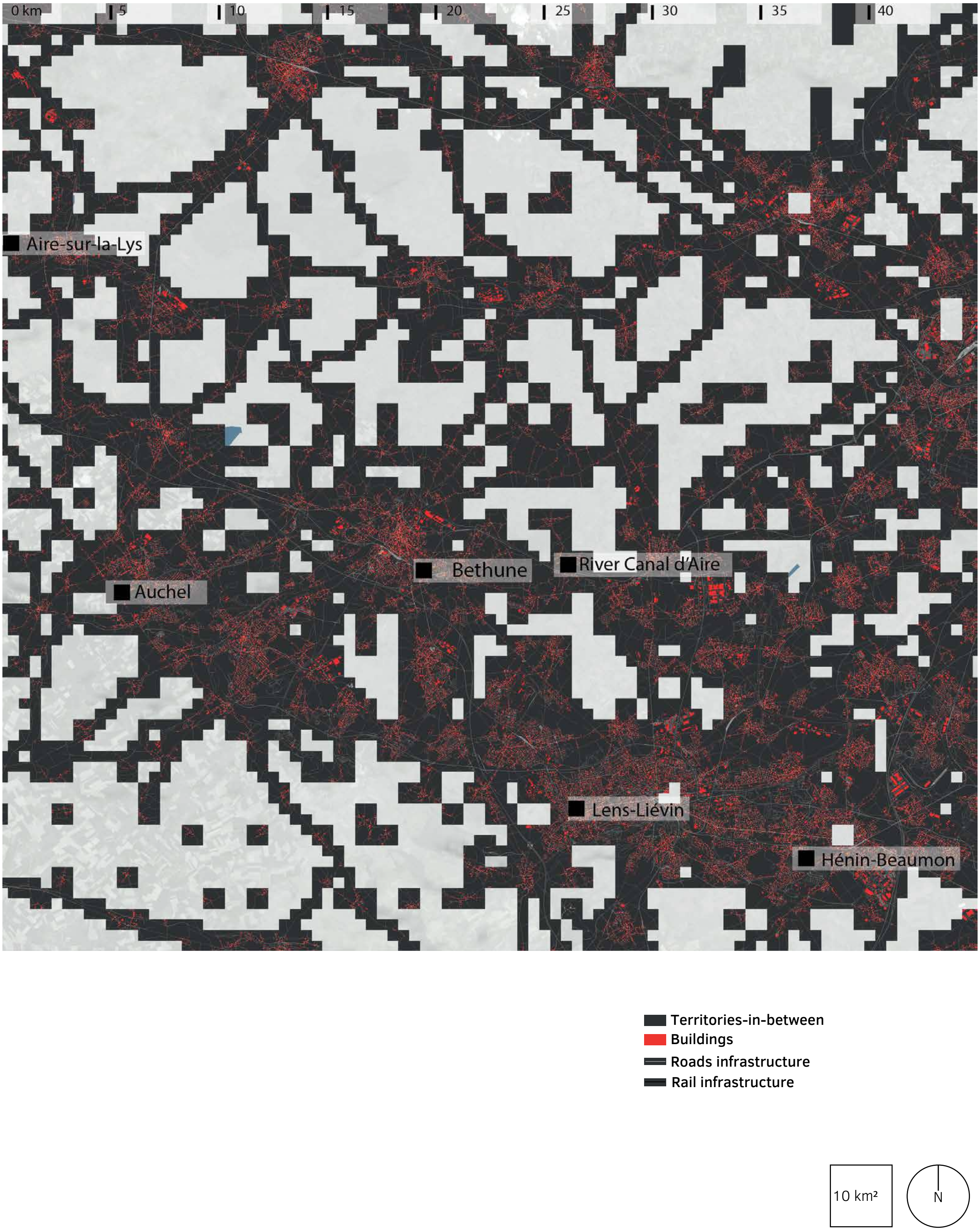

FIG. 8.27 In the case of Pas-de-Calais, the TiB type of networks of towns and cities is more dominant in the north. In the south, the field like TiB are present.

TYPOLOGY OF OPEN SPACES

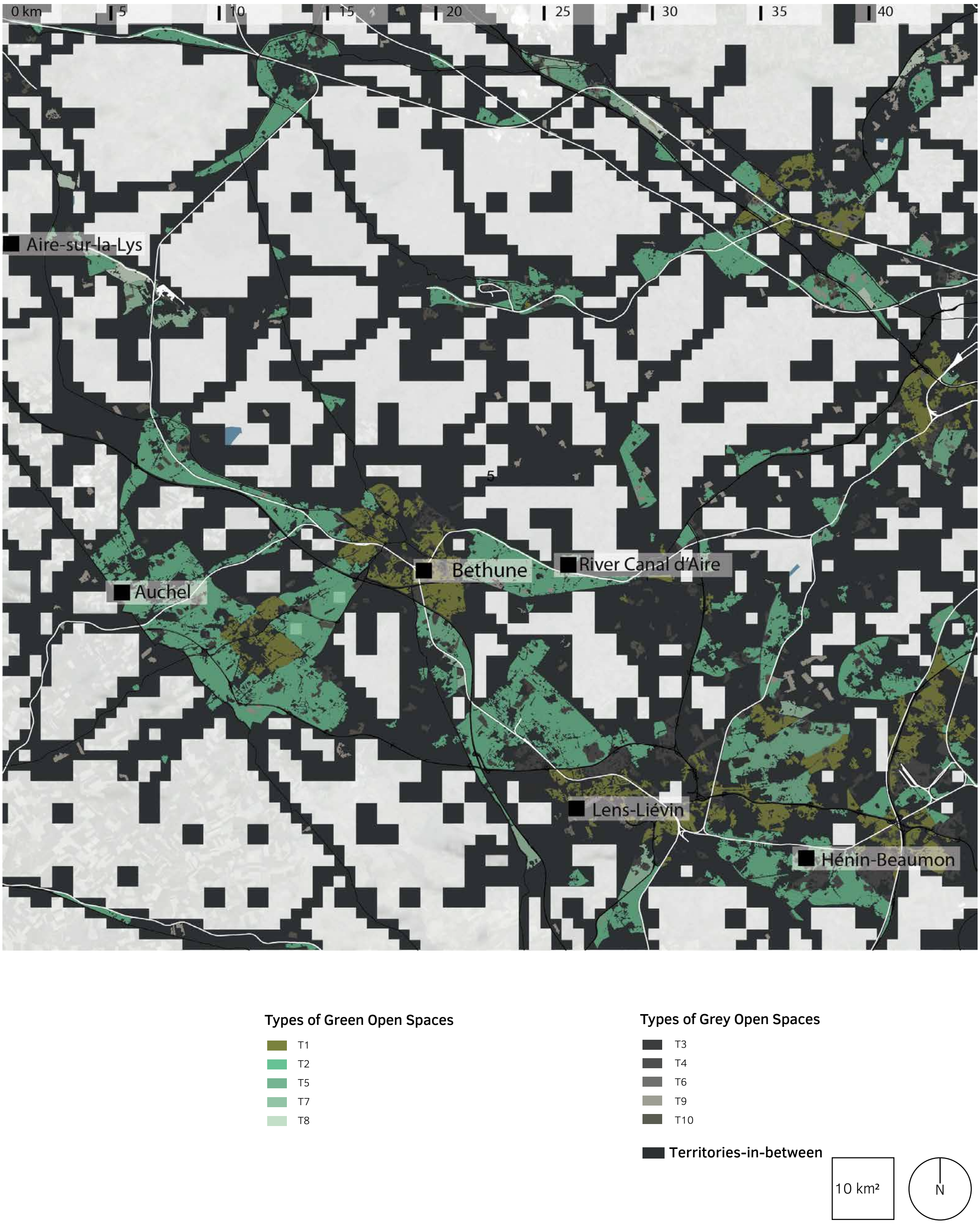

FIG. 8.28 The most common green space is type 2 and the most frequent grey open space is type 4. Both types are often in very central locations of the street network, with the highest potential of multifunctionality between operators of production and residential uses. They provide regulating as well as provisioning and cultural ecosystem services

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FIG. 8.29 (1) A park along a creek crosses a town and provides cultural and regulating ecosystem services. (2) A former mining facility transformed into a park providing cultural ecosystem services while strengthening the regional ecological system. (3) A parking lot close to the town centre is an example of a typical grey space.

NUMBER OF RESIDENTS WITH ACCESS TO GREEN SPACES

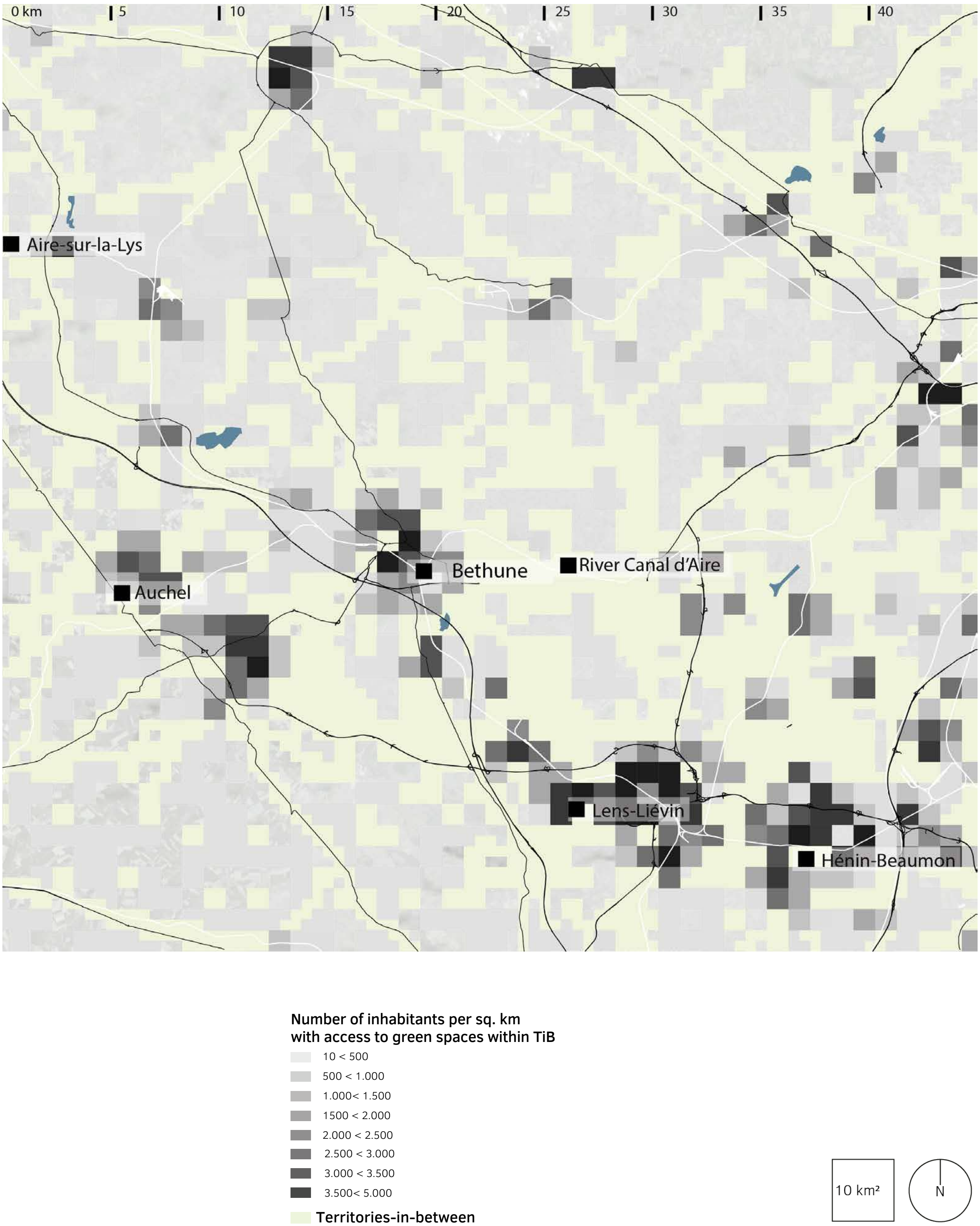

FIG. 8.30 Around 52 per cent of the inhabitants of the TiB in Pas-de-Calais have access to more than one size of green space.

NUMBER OF RESIDENTS WITH ACCESS TO GREEN SPACES

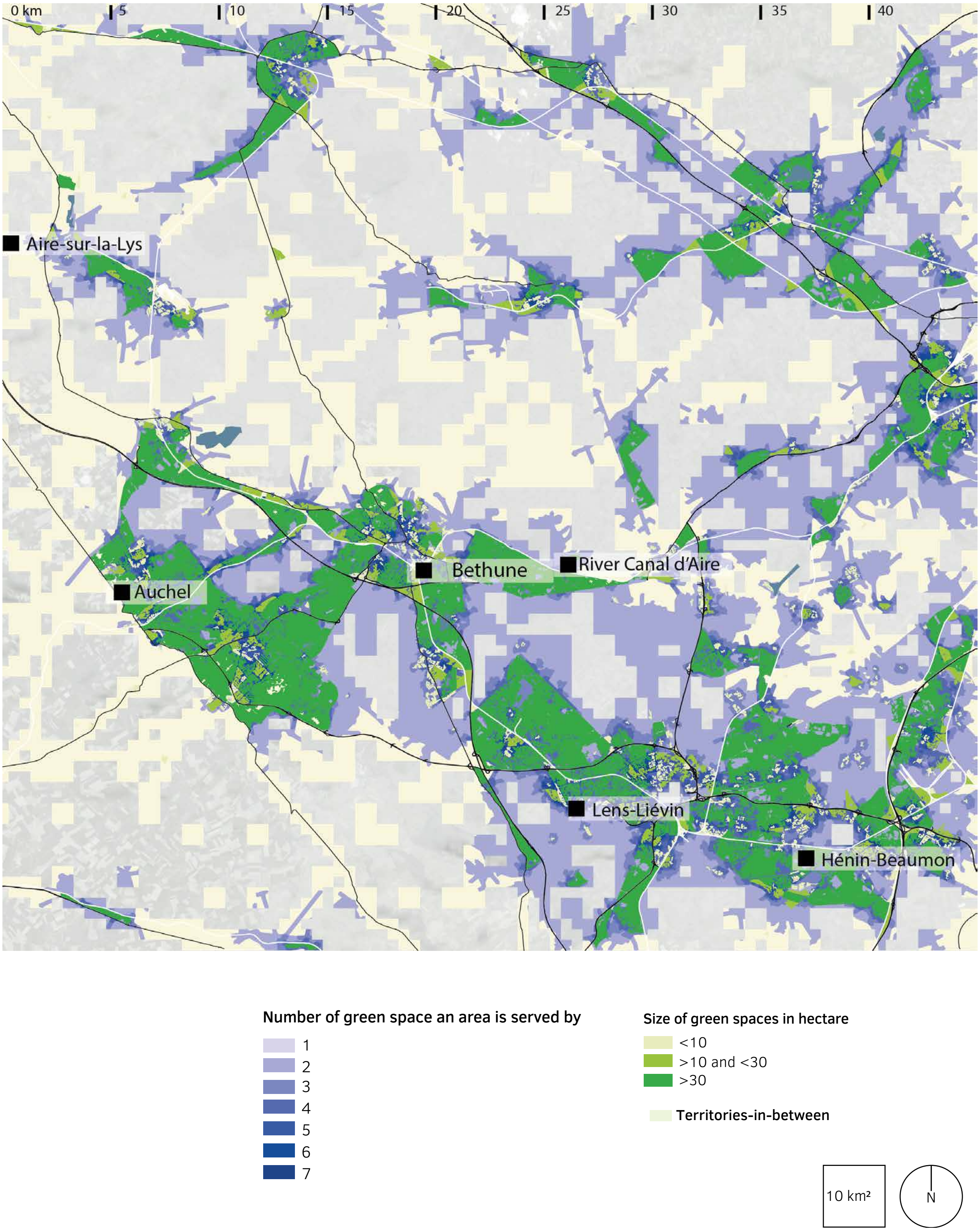

FIG. 8.31 The high intensity of access to green space is widespread.

8.5.5 South-Holland

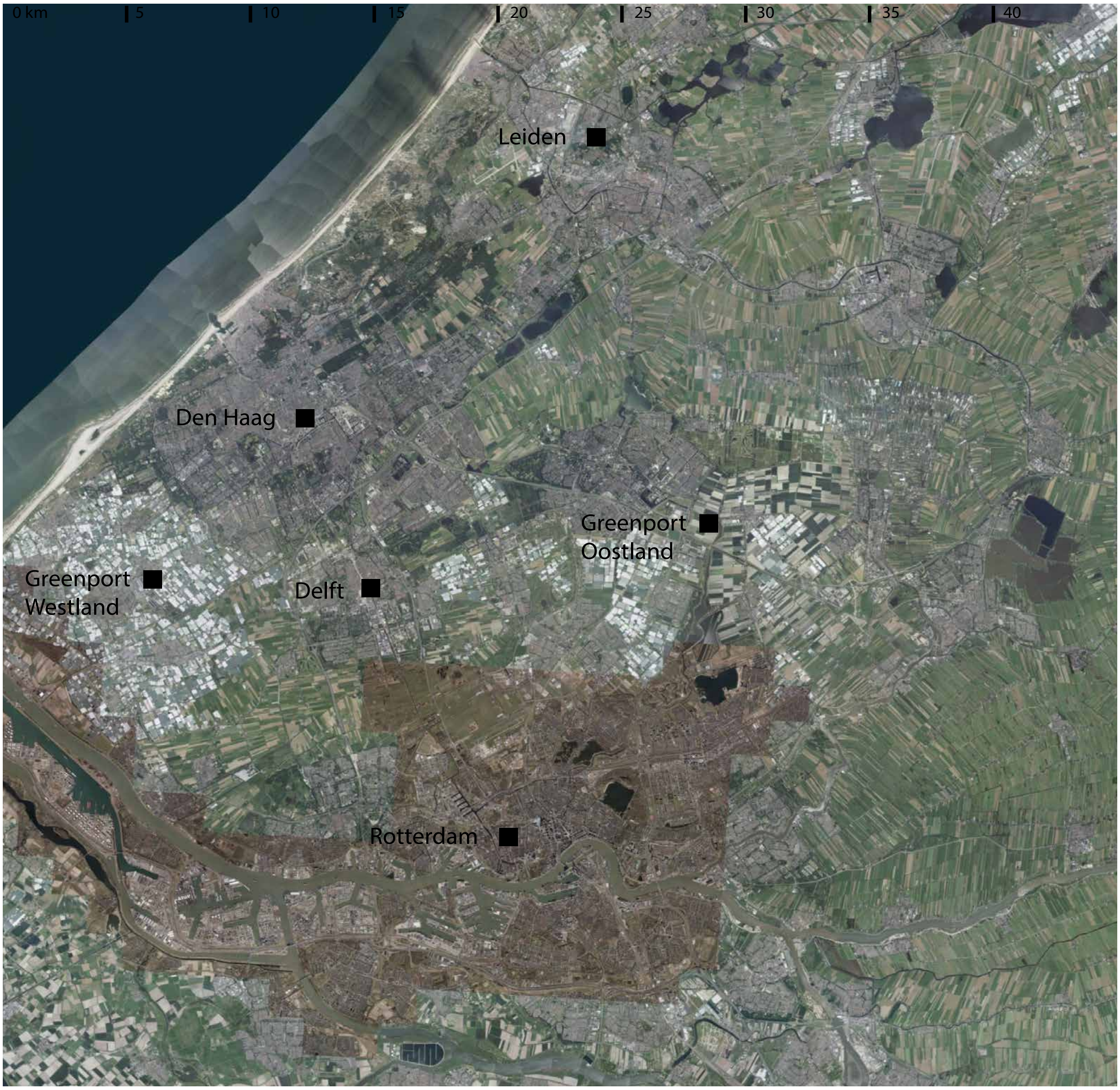

FIG. 8.32 The case study area in South-Holland, with the Maas delta in the south. The Den-Haag- Rotterdam metropolitan area as the south-wing of the Randstad and the edges of the green heart are main features of the area. Extended greenhouse areas of the so-called Greenport Westland and Oostland are also visible. Another prominent feature is the dunes along the coastline. Image Source: Google Earth.

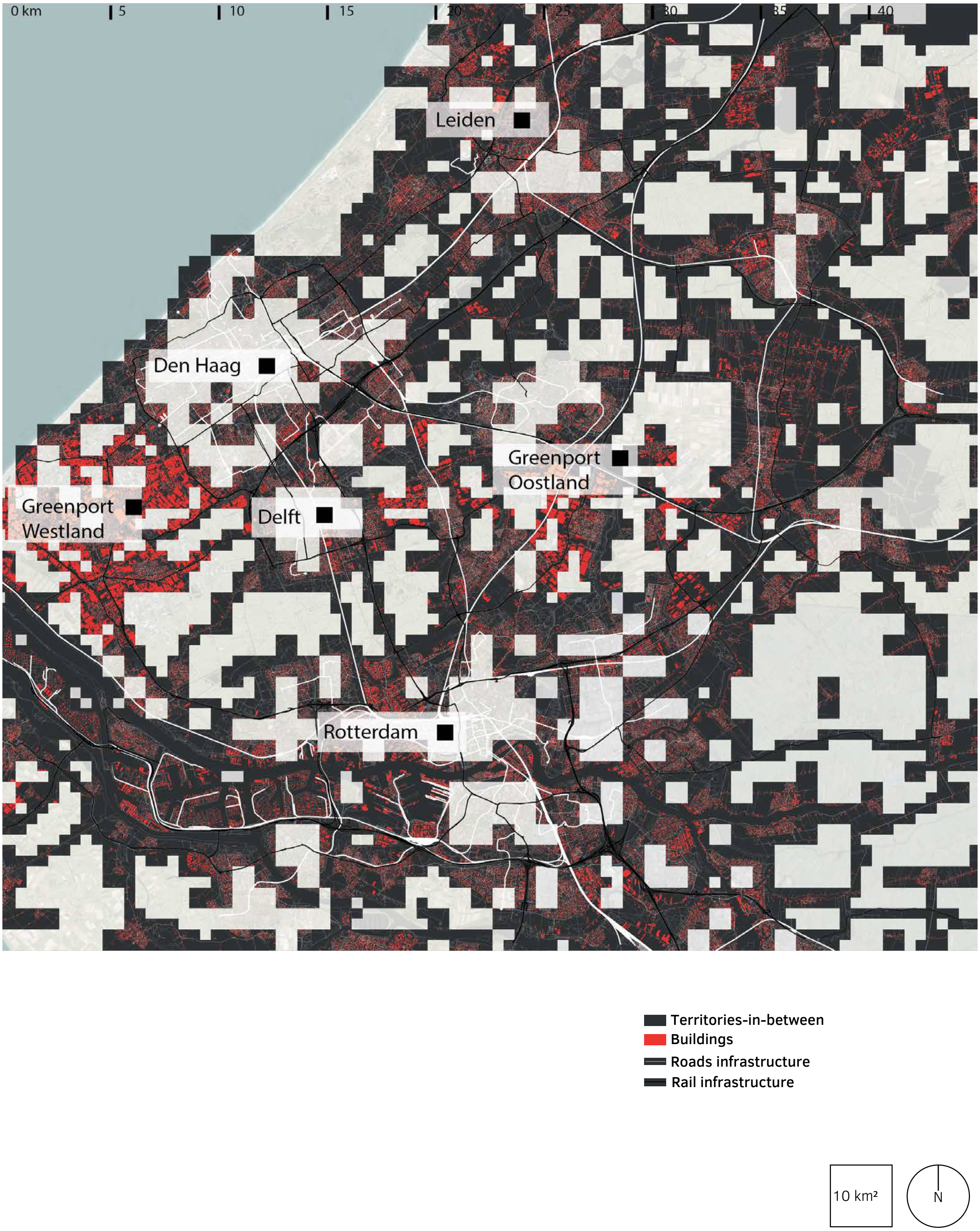

FIG. 8.33 The TiB in South-Holland are predominantly a field like type in the south between and around Rotterdam and The Hague. The network of cities and town type is more prominent in the northern part of the case study area.

TYPOLOGY OF OPEN SPACES

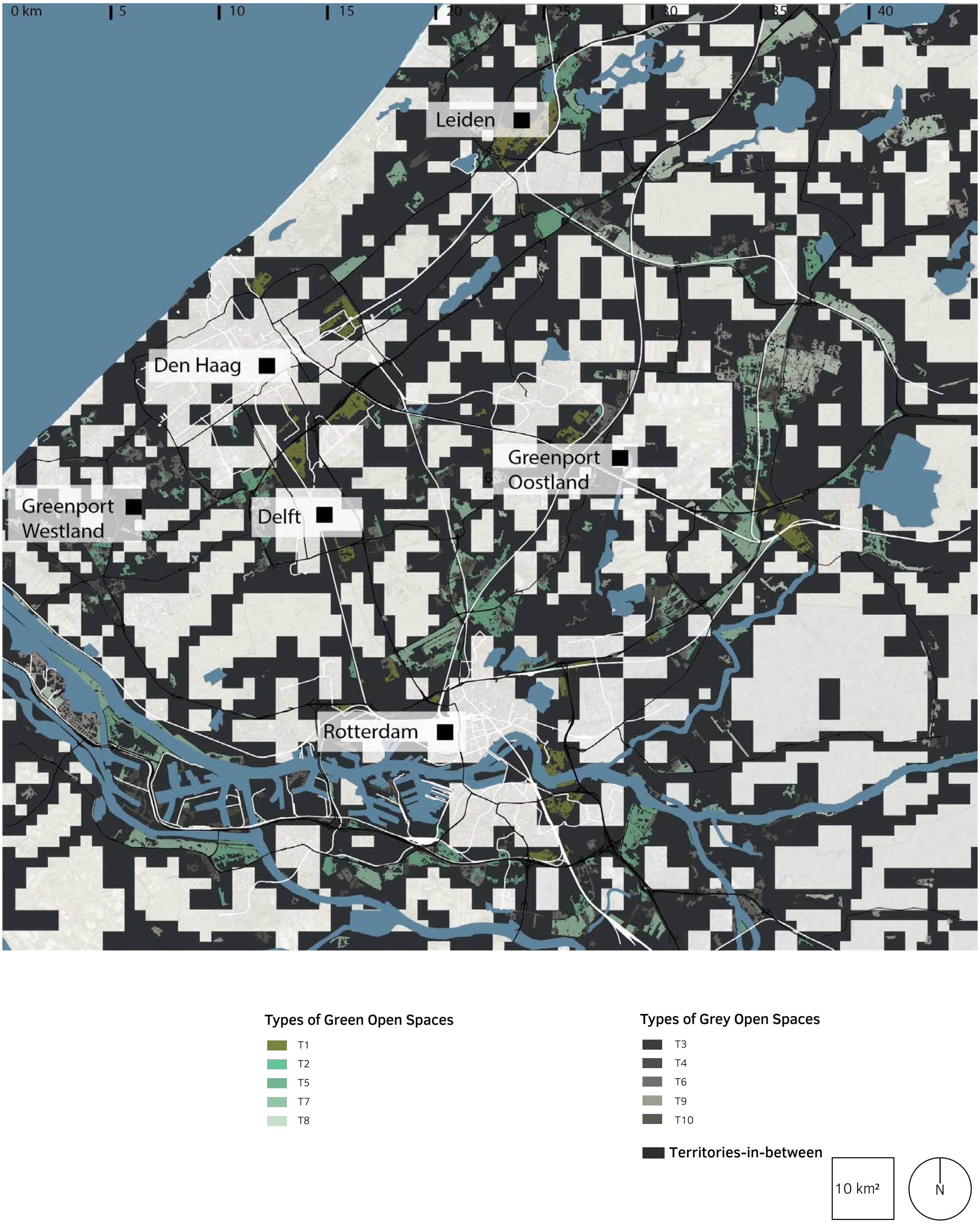

FIG. 8.34 The most frequent type of green space is Typ 7. Type 7 can be best described as the backyards of settlements with a rather high potential of multifunctionality between residential use with green infrastructure. These spaces have a key role as buffer areas between housing areas and intensive agricultural areas, but also as ecological corridors connecting the backbone of the regional green infrastructure with the urban green network. Open space type 6 are crucial areas in establishing an ecological network that connects rural and suburban ecosystems.

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FIG. 8.35 (1) A green space in the Westland that provides provisional and cultural ecosystem services. (2) Green and grey open spaces with accompanying public transit infrastructure, providing regulating ecosystem services. (3) A typical grey space is a parking lot at a sports facility in the green heart.

NUMBER OF RESIDENTS WITH ACCESS TO GREEN SPACES

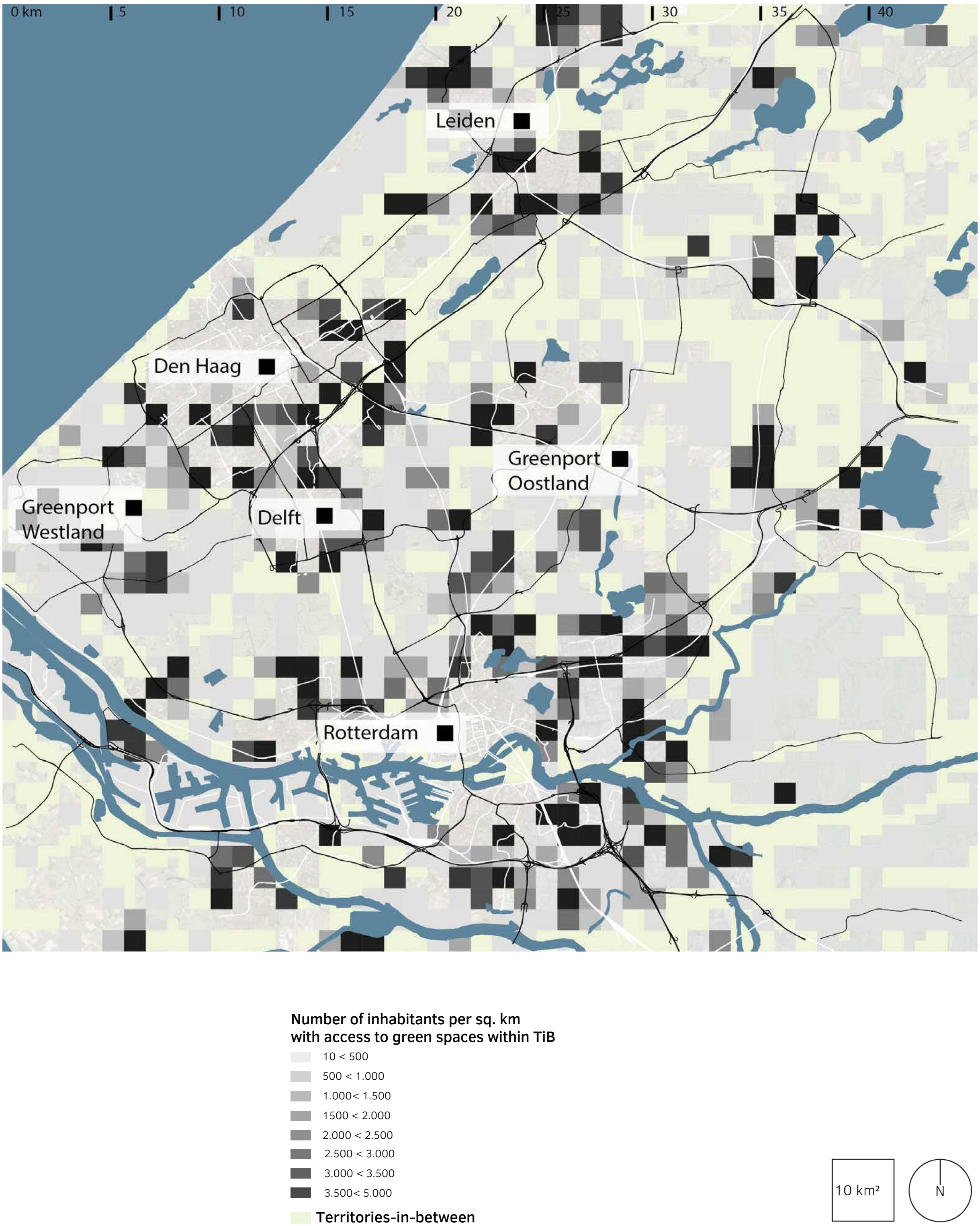

FIG. 8.36 Around 40 per cent of the inhabitants in the TiB in South-Holland have access to more than one size of green space.

NUMBER OF RESIDENTS WITH ACCESS TO GREEN SPACES

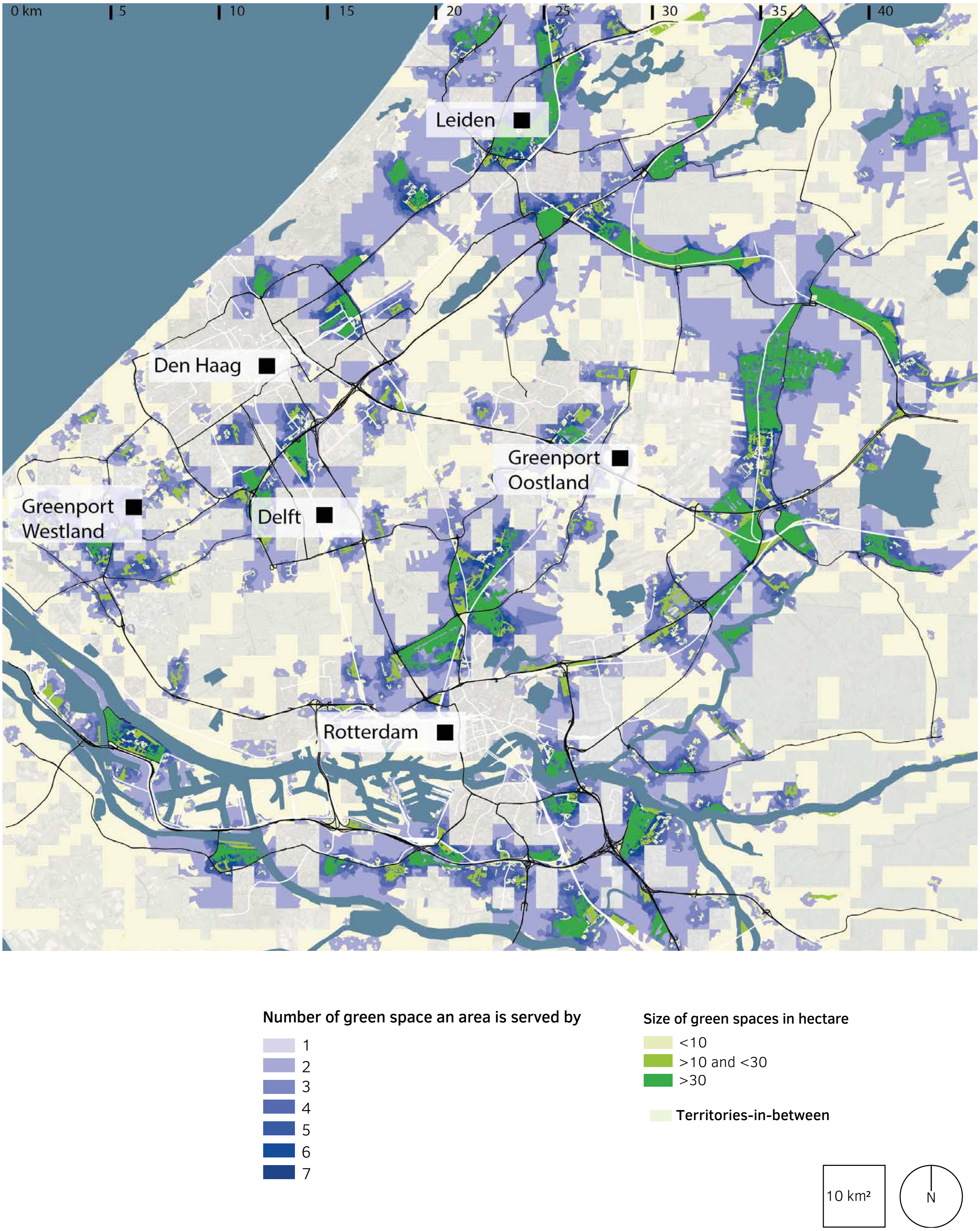

FIG. 8.37 The high intensity of access to green space is widespread.

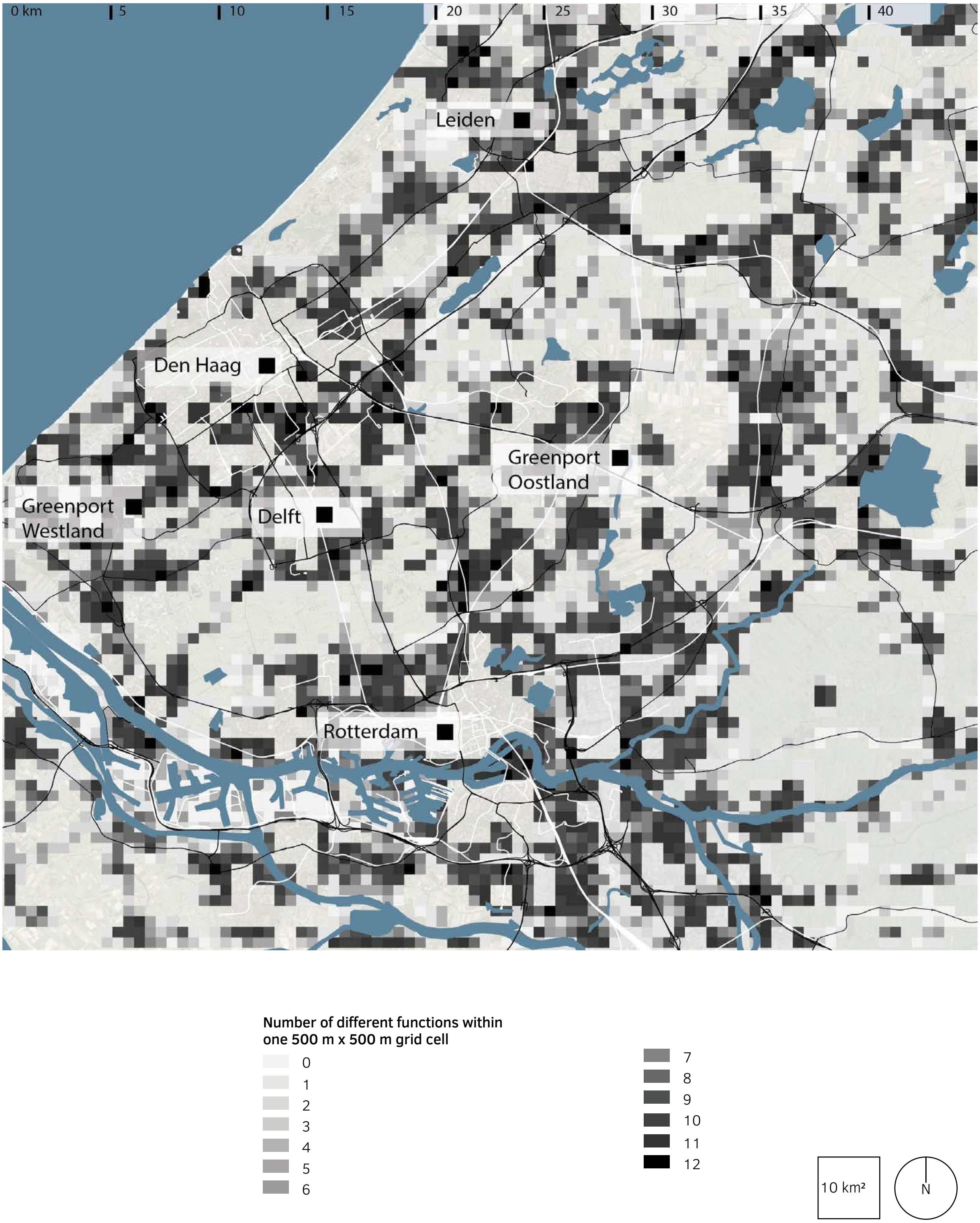

FIG. 8.38 Approximately 75 per cent of the inhabited grid cells hosts more than three functions. The highest mix of function is located in all cities and towns.

SETTLEMENT STRUCTURE

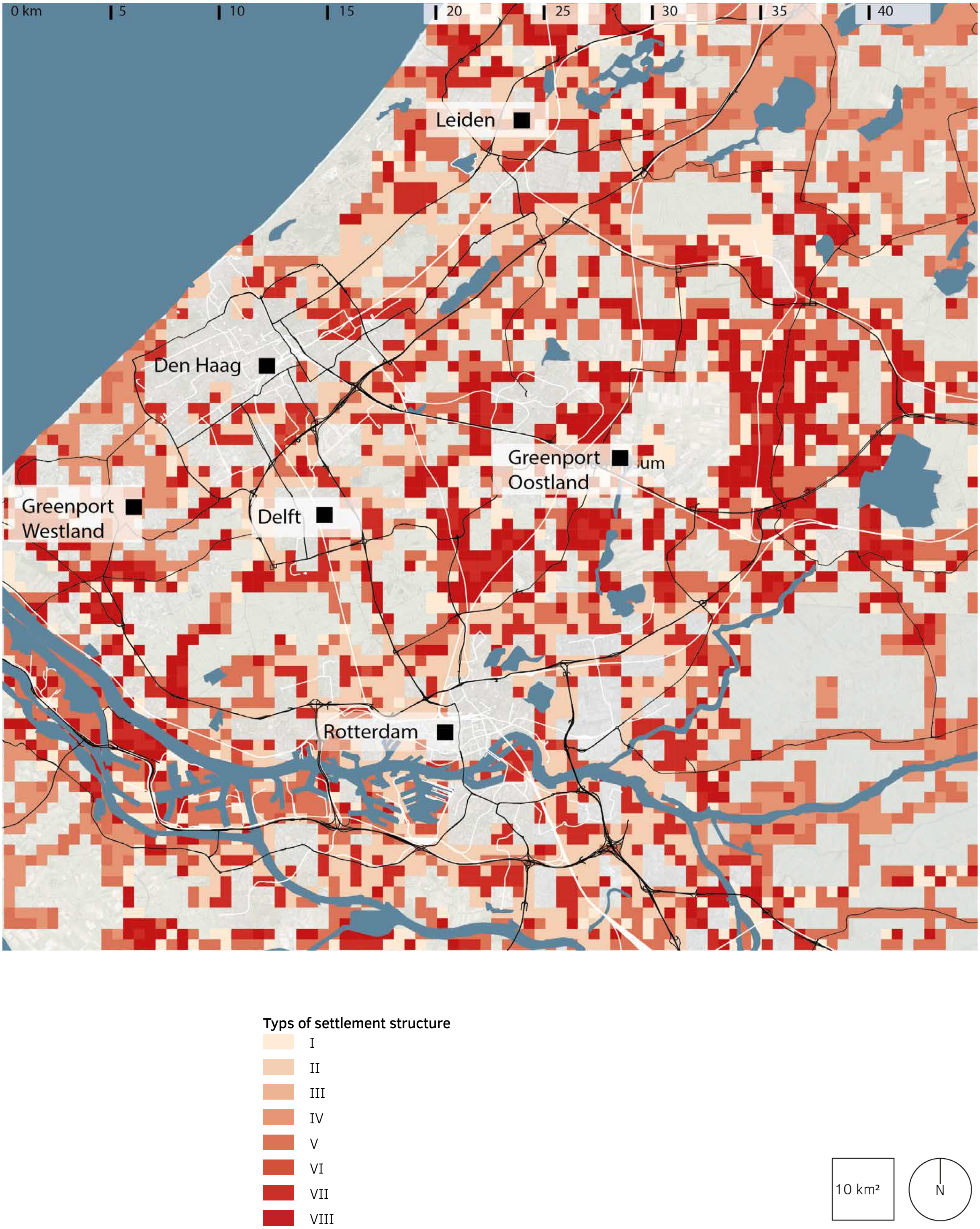

FIG. 8.39 Type V is the most frequent (29 per cent) settlement type, which is predominantly monofunctional. In all other settlement types, more than 90 per cent of the cells hosts more than three different functions. See table 6.6 for details.

8.5.6 Gelderland

GELDERLAND

FIG. 8.40 The case study area includes the two cities of Arnhem and Nijmegen as well as the river planes of the river Waal, Rhine and Ijssel and a ribbon of towns and villages in the otherwise agriculturally used plain. The north of the area is dominated by the De Hoge Veluwe National park a landscape consisting of heathlands, dunes, and woodlands. In the south are forests between Nijmegen and Groesbeek.

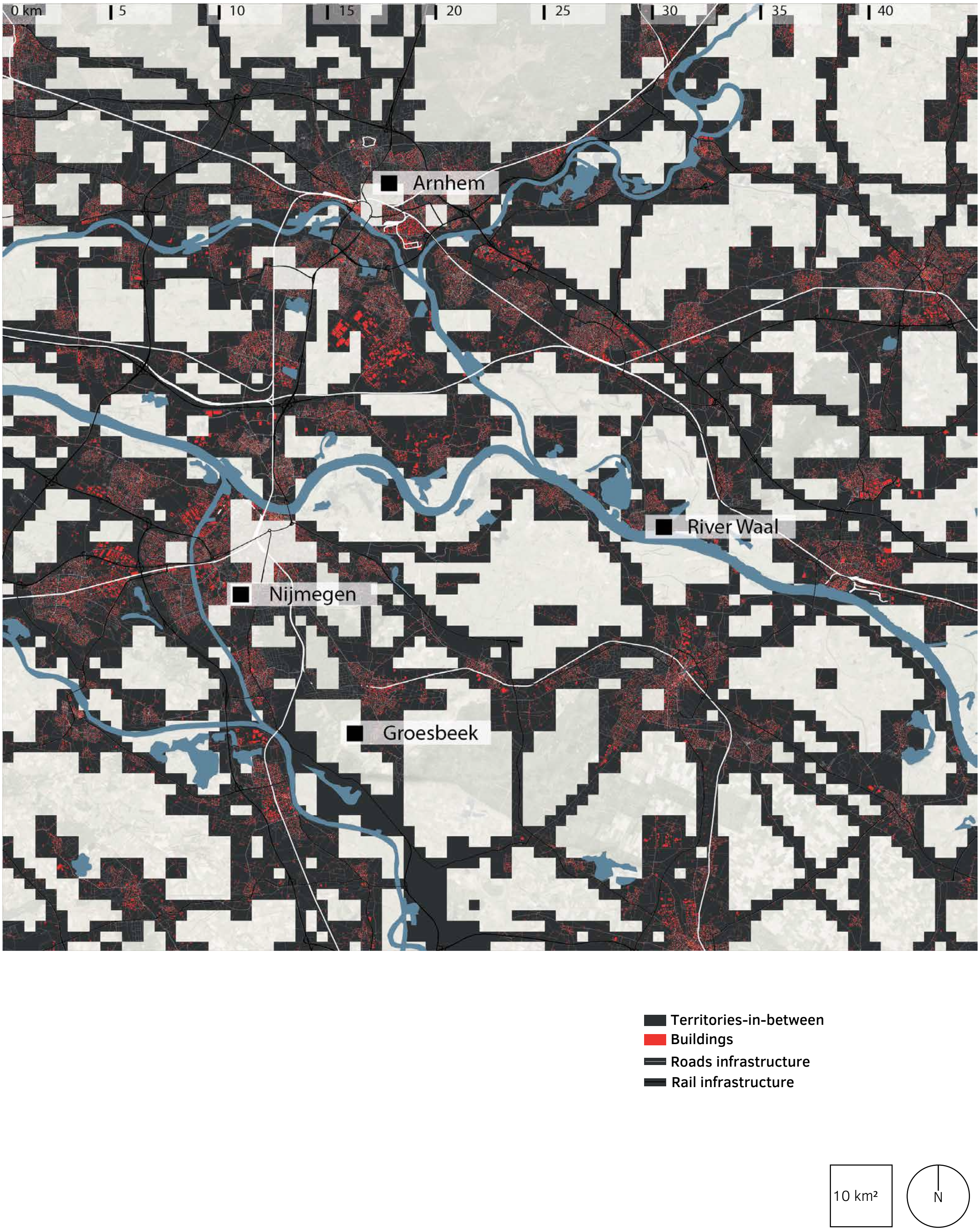

FIG. 8.41 Two different forms of TiB can be observed, one more field like between Arnhem and Nijmegen, and the network of towns and cities in the rest of the case study area.

TYPOLOGY OF OPEN SPACES

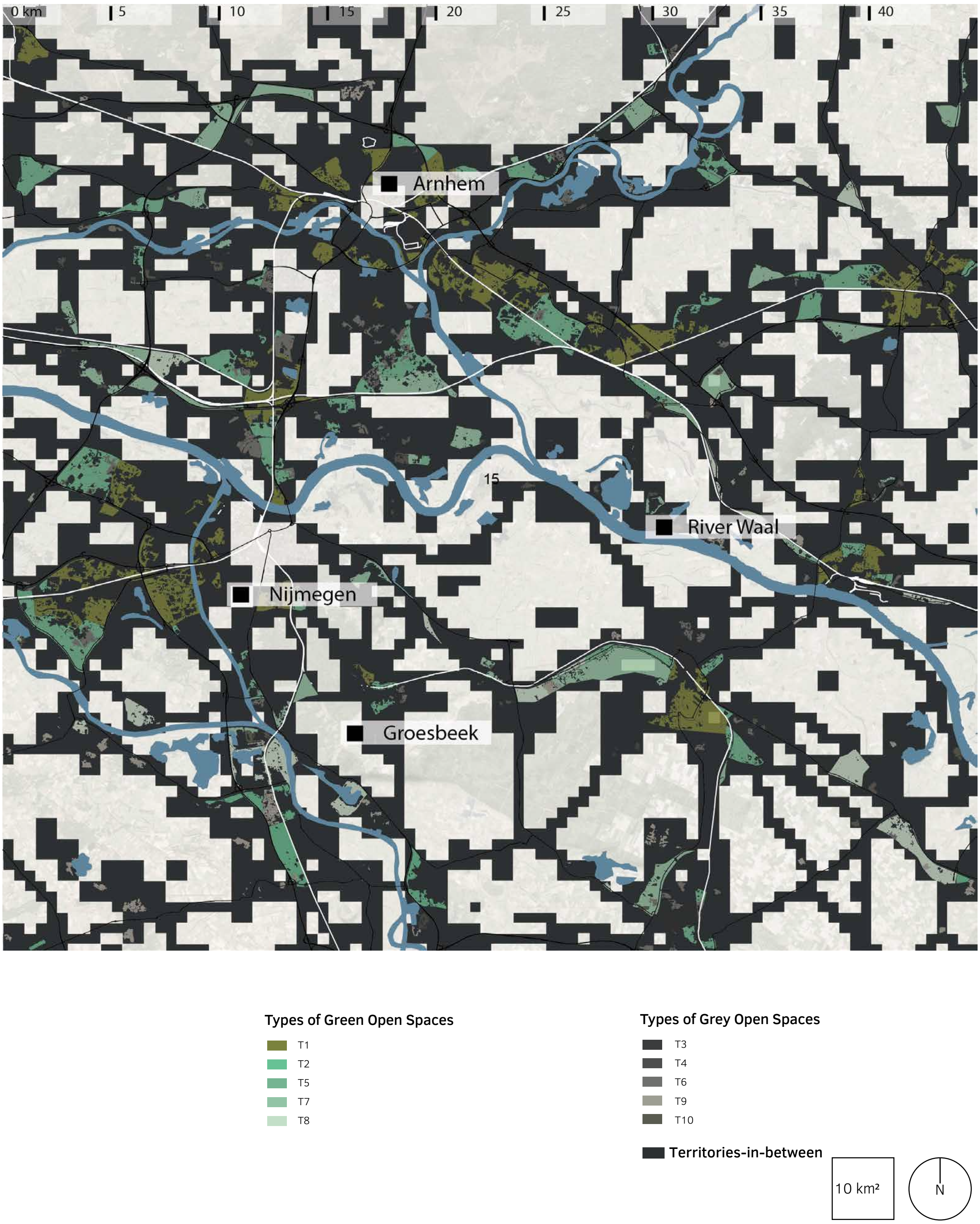

FIG. 8.42 Type 1 is the most common green space and type 3 is the most common grey space. Both are often located within the fringe zone of towns cities, and they have a high potential for multifunctionality, specifically concerning regulating and cultural ecosystem services. These open spaces are under the highest urbanisation pressure and plays a crucial to facilitate social interaction.

FIG. 8.43 (1) A green-blue open space that provides regulating and cultural ecosystem services to its direct surroundings. (2) A residual green space used as a playground. (3) The market street is an example of a multifunctional grey space.

NUMBER OF RESIDENTS WITH ACCESS TO GREEN SPACES

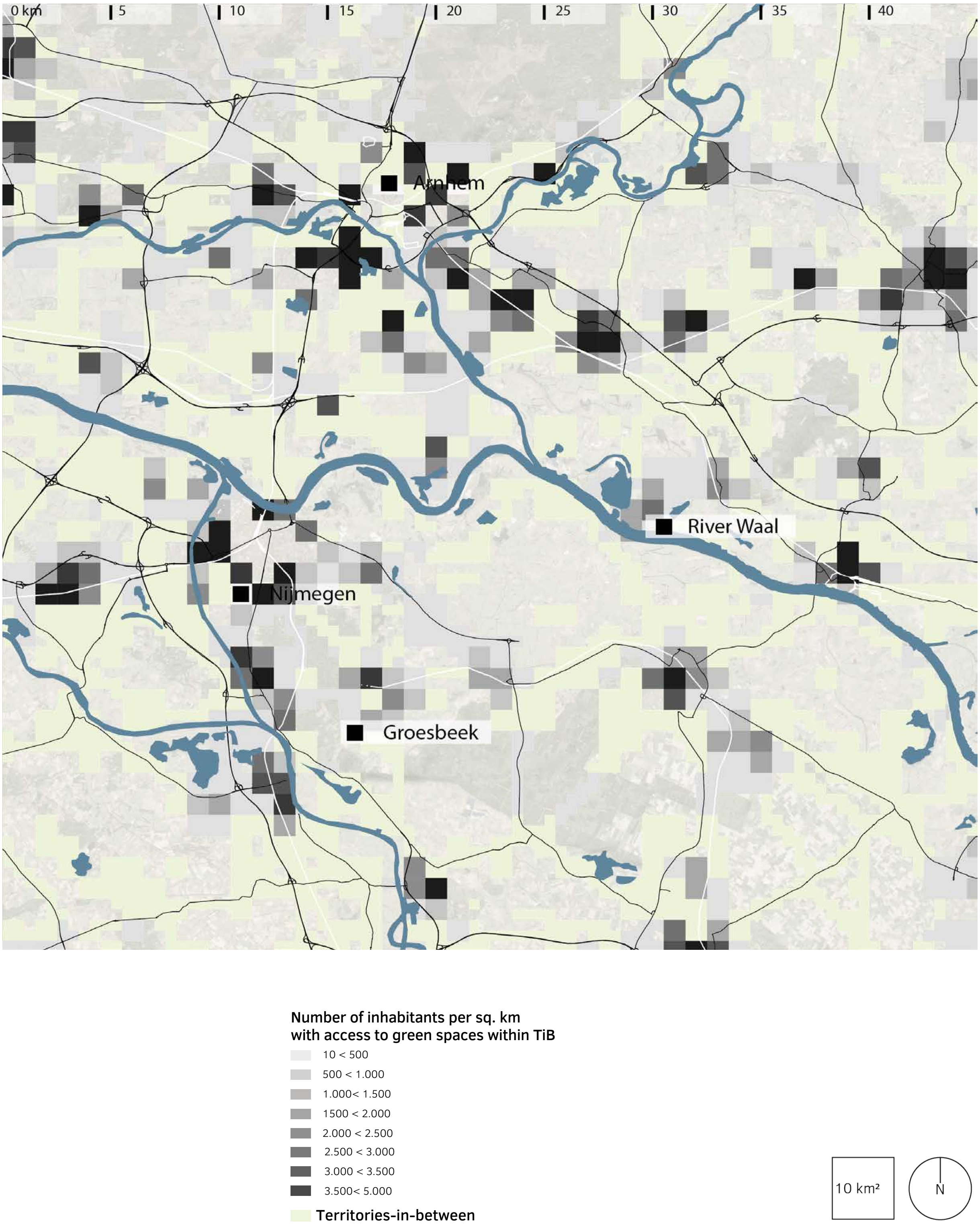

FIG. 8.44 Around 60 per cent of the inhabitants in the TiB in Gelderland have access to more than one size of green space.

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NUMBER OF RESIDENTS WITH ACCESS TO GREEN SPACES

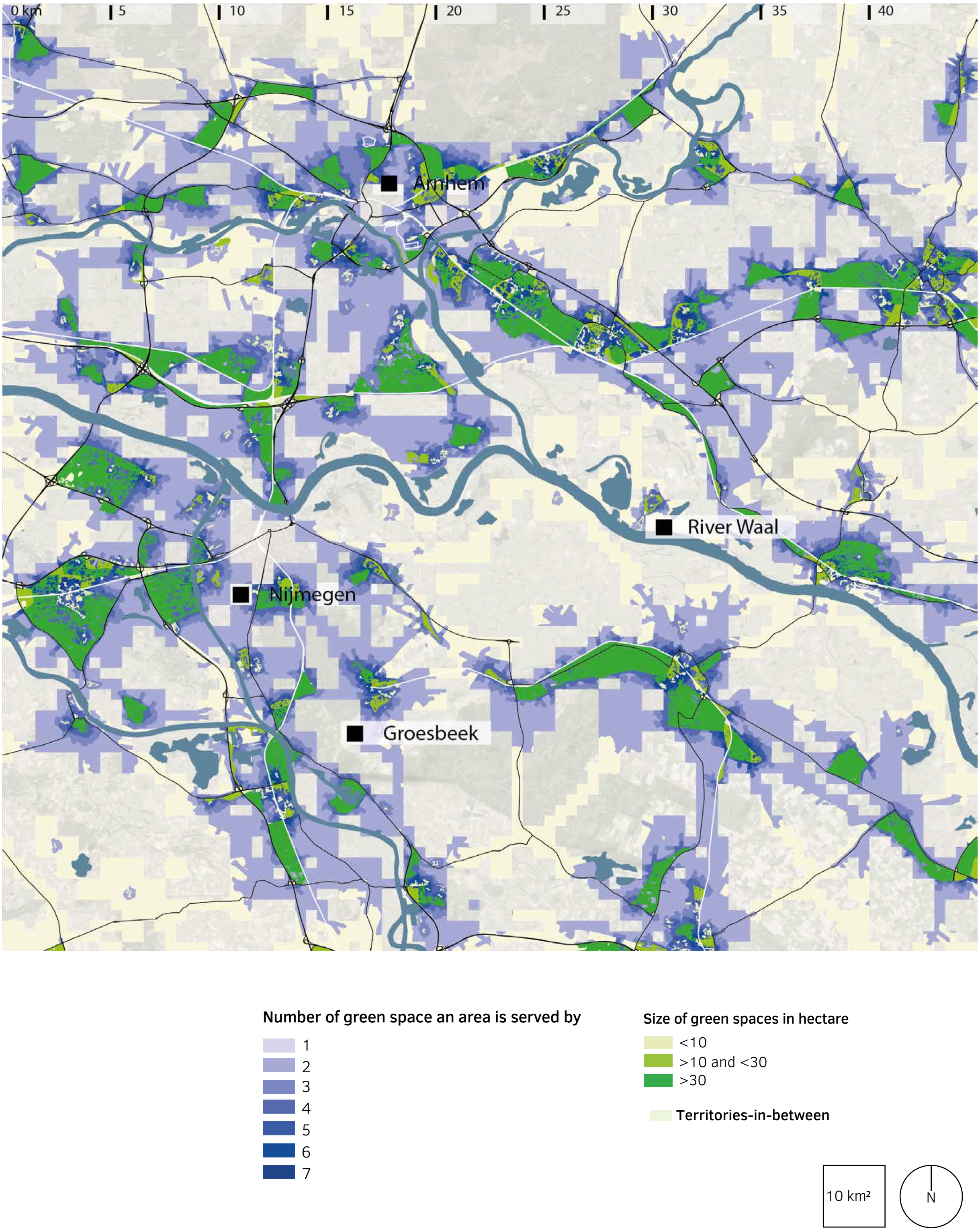

FIG. 8.45 The high intensity of access to green space is widespread.

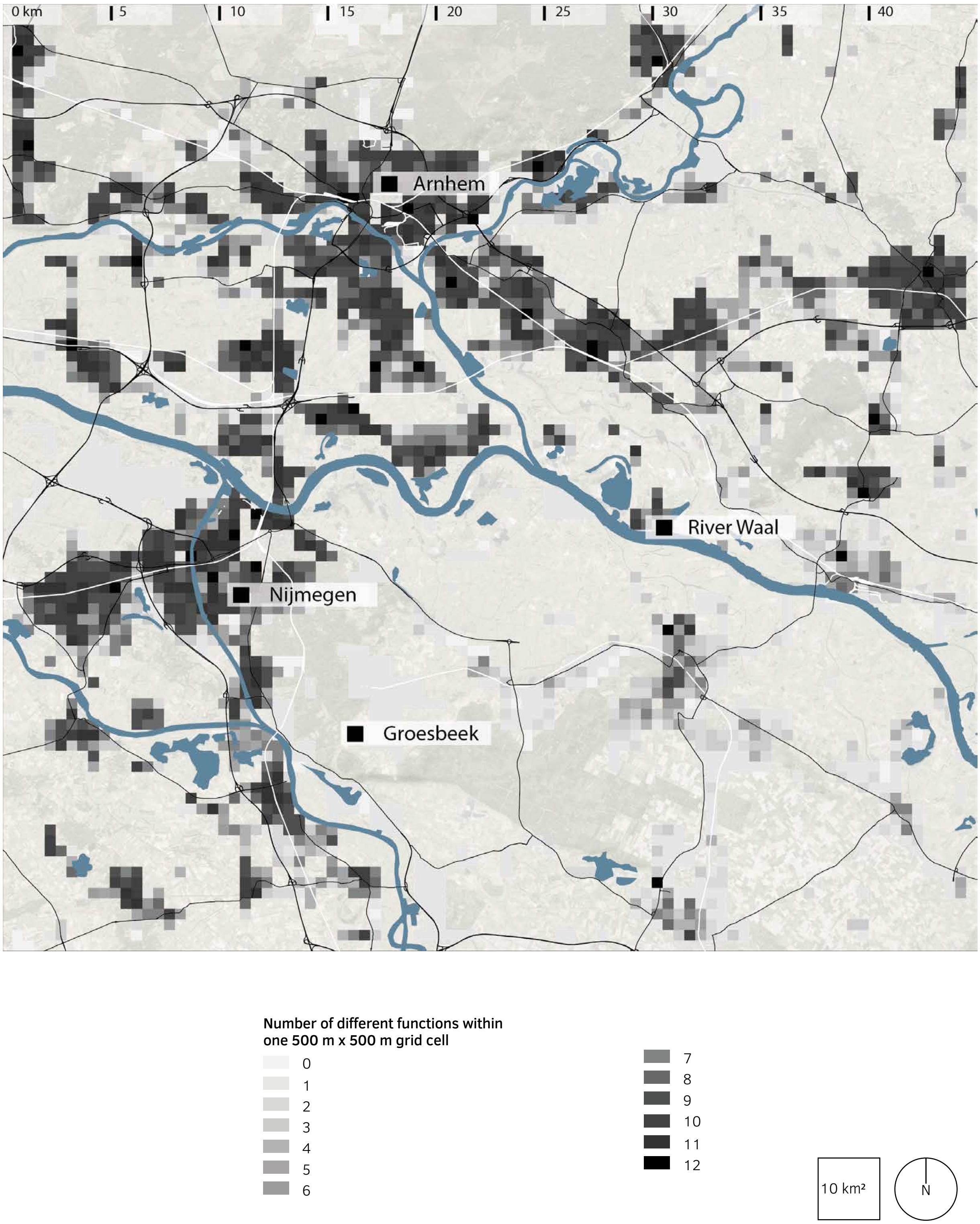

FIG. 8.46 Around 70 per cent of the inhabited grid cells hosts more than three functions. The highest mix of function is located in all cities and towns. A bid less mixed-use can be found in the south-east of the case study area.

SETTLEMENT STRUCTURE

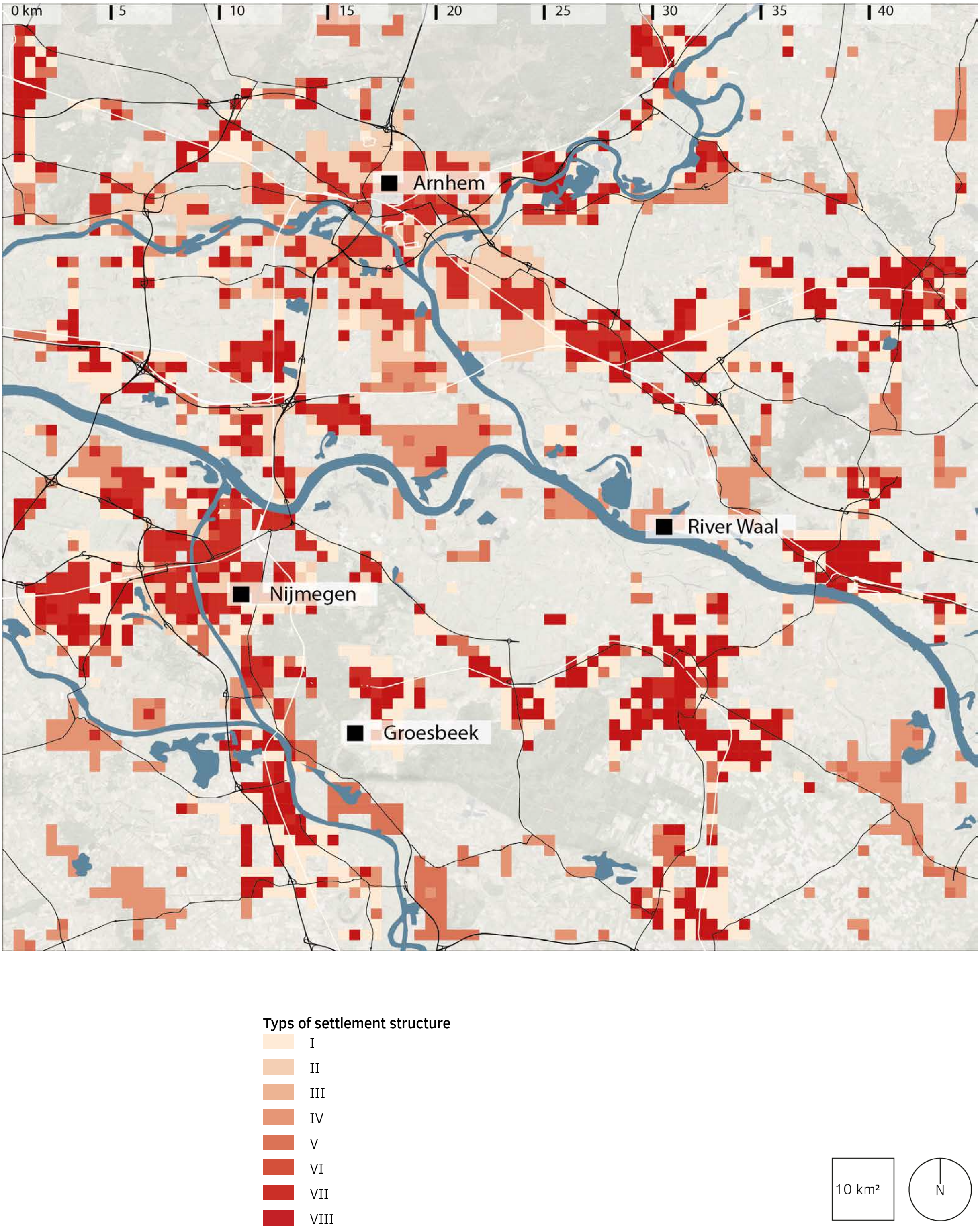

FIG. 8.47 The most frequent (22 per cent) settlement type is type I, which has around 43 per cent of mono-functional cells but also 46 per cent of cells with more than three but less than ten different functions, as well as ten per cent of cells with ten or more functions. Type VIIIaccounts for roughly 22 per cent and has more than 70 per cent of cells which host 3 or more functions. See table 6.6 for details.

8.5.7 Bergamo-Brescia

FIG. 8.48 The case study area in Bergamo-Brescia can be divided into three parts: the alps in the north and the riverplain in the south and an intensive zone full of infrastructures, like motorways, rail lines and an airport with accompanying urbanisation at the foods of the Alps between Bergamo and Brescia.

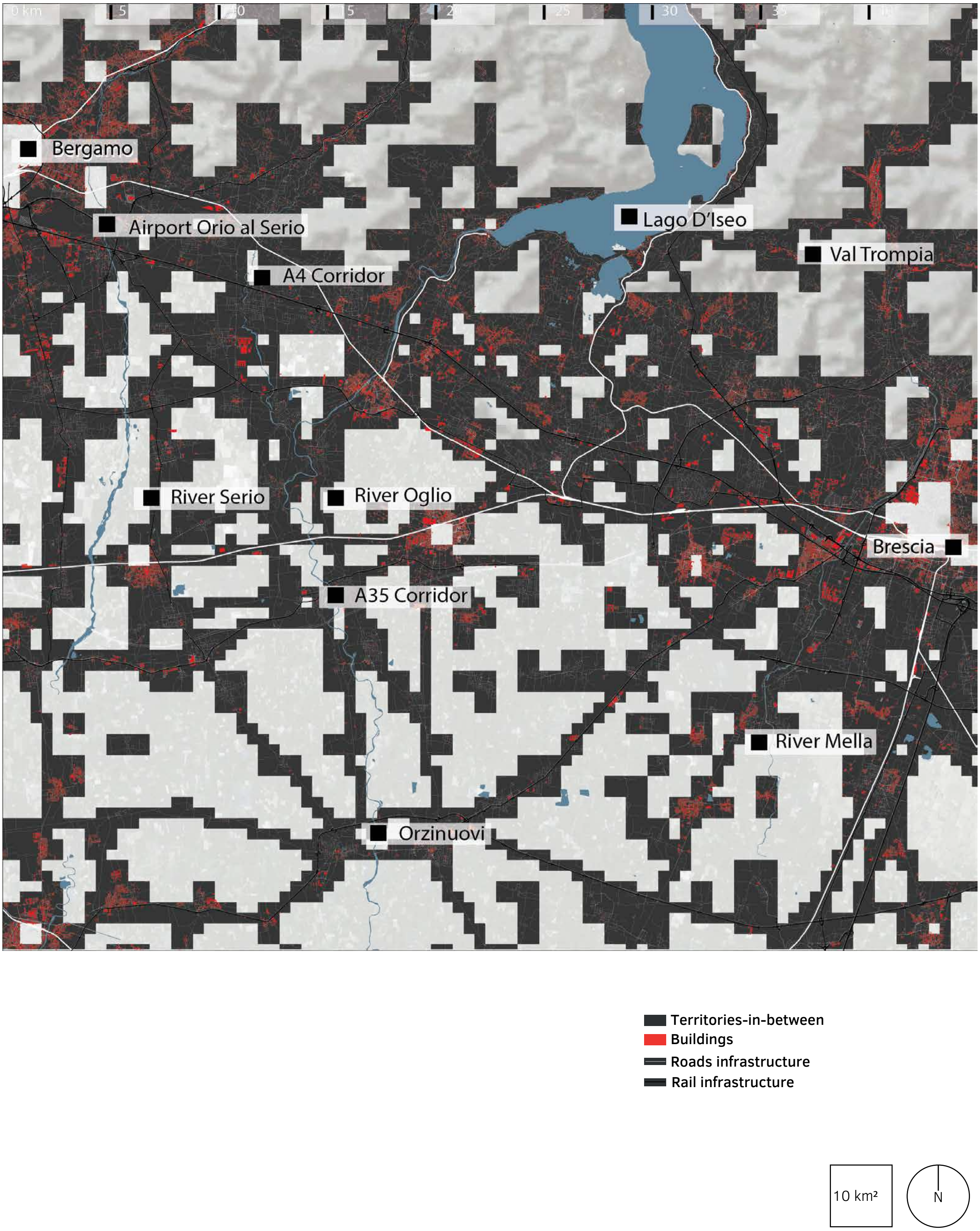

FIG. 8.49 The infrastructure corridor type between Bergamo-Brescia dominates the case study area. The valley type is present in the north and the network of cities and towns type in the south.

TYPOLOGY OF OPEN SPACES

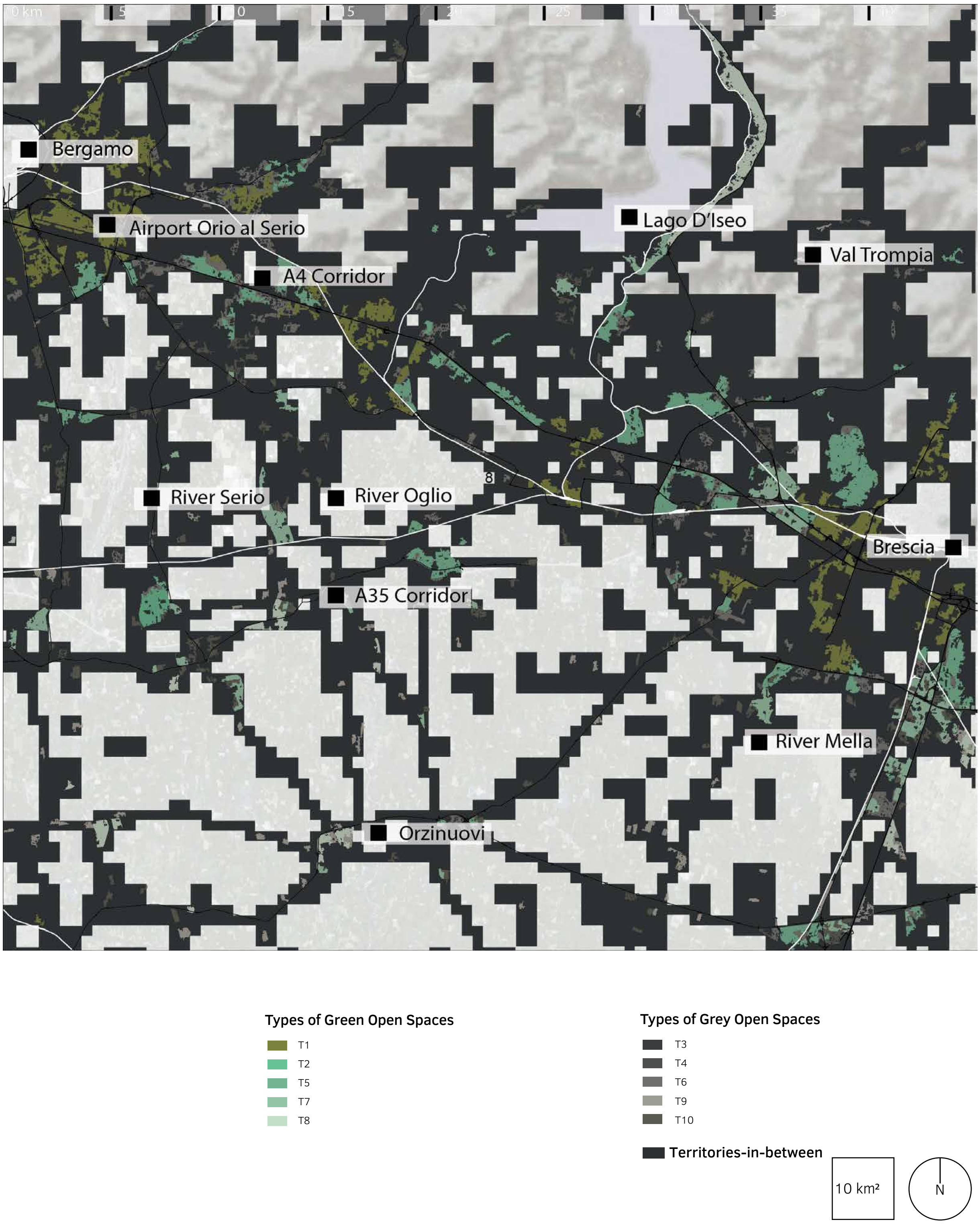

FIG. 8.50 Type 1 is the most common green space and type 6 is the most common grey space. Open spaces of type 1 are often located within the fringe zone of towns cities. They have a high potential for multifunctionality, specifically concerning regulating and cultural ecosystem services. These open spaces are under the highest urbanisation pressure and play a crucial role in facilitating social interaction. Type 10 open spaces are often located at the edges and within smaller settlements or in industrial areas as well as along big technical infrastructures, like highways and airports. They play a key role in the provision of regulating and cultural ecosystem services.

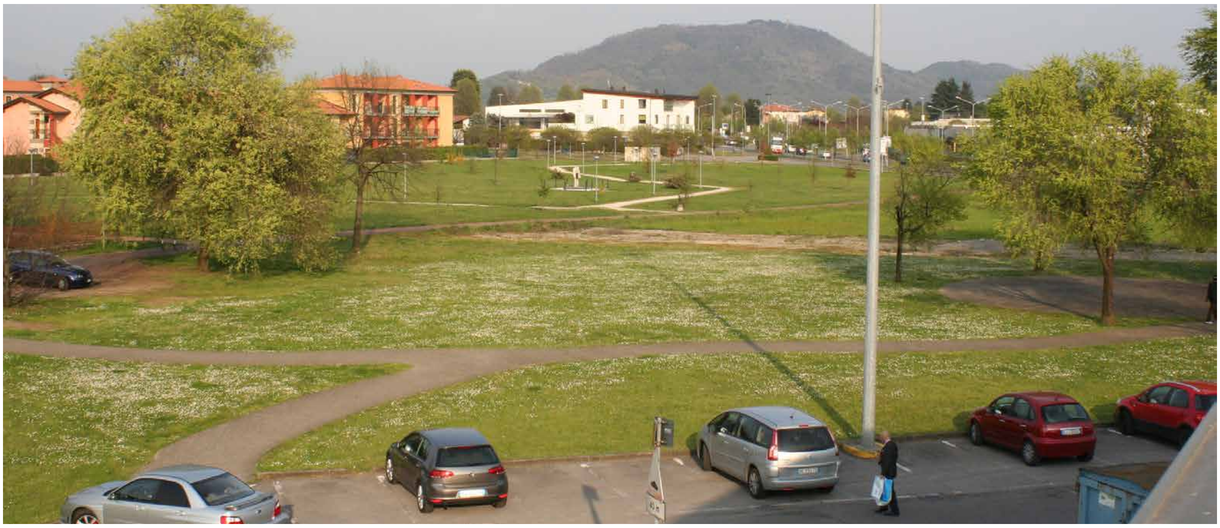

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FIG. 8.51 (1) An example of green open space at the edge of a settlement. (2) An extreme example of a grey open space, the parking lot at the roof of a shopping mall. (3) A widespread grey space, in this case, the parking lots in industrial and business parks.

NUMBER OF RESIDENTS WITH ACCESS TO GREEN SPACES

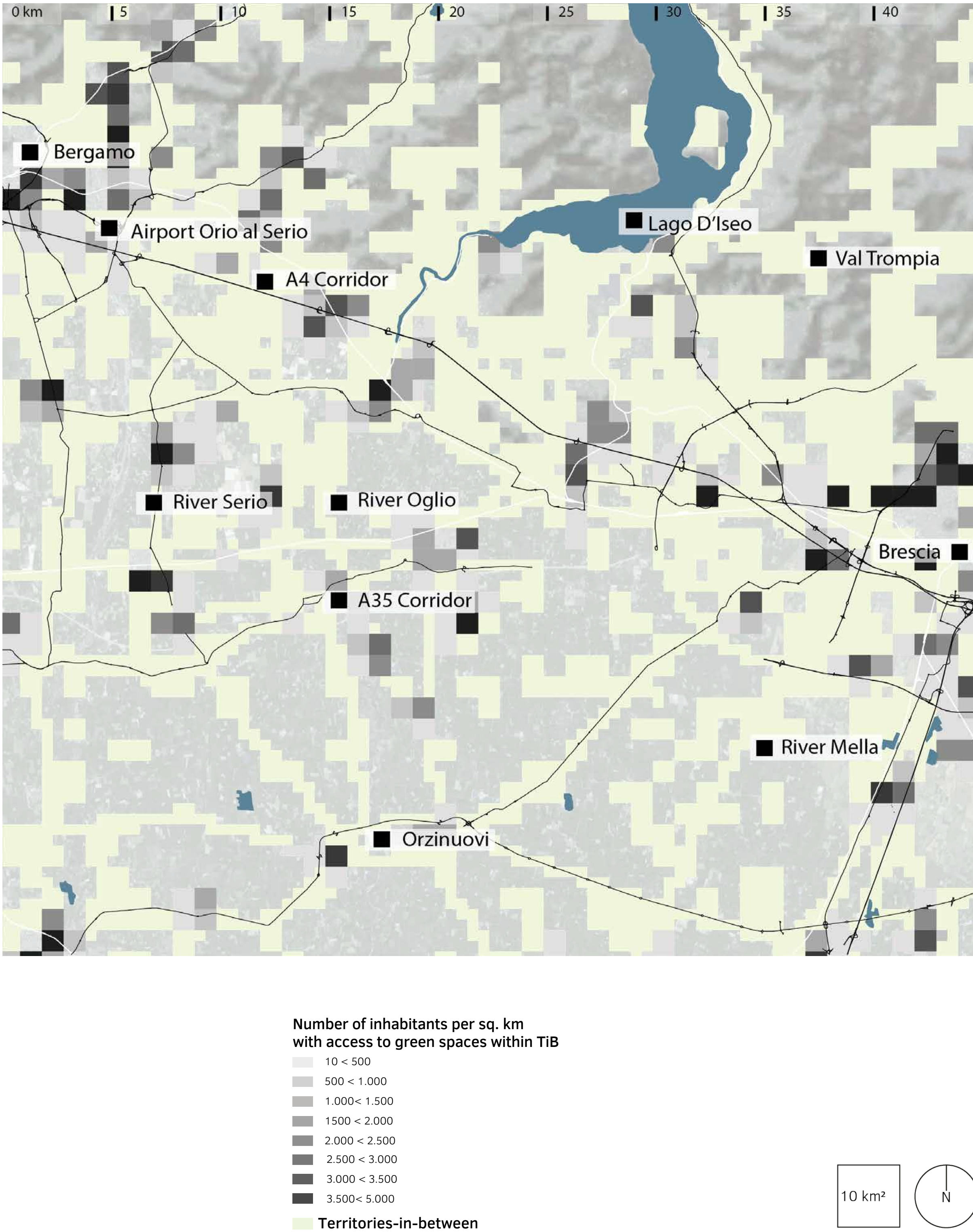

FIG. 8.52 Only around 25 per cent of the inhabitants in TiB in Bergamo-Brescia have access to more than one size of green space.

NUMBER OF RESIDENTS WITH ACCESS TO GREEN SPACES

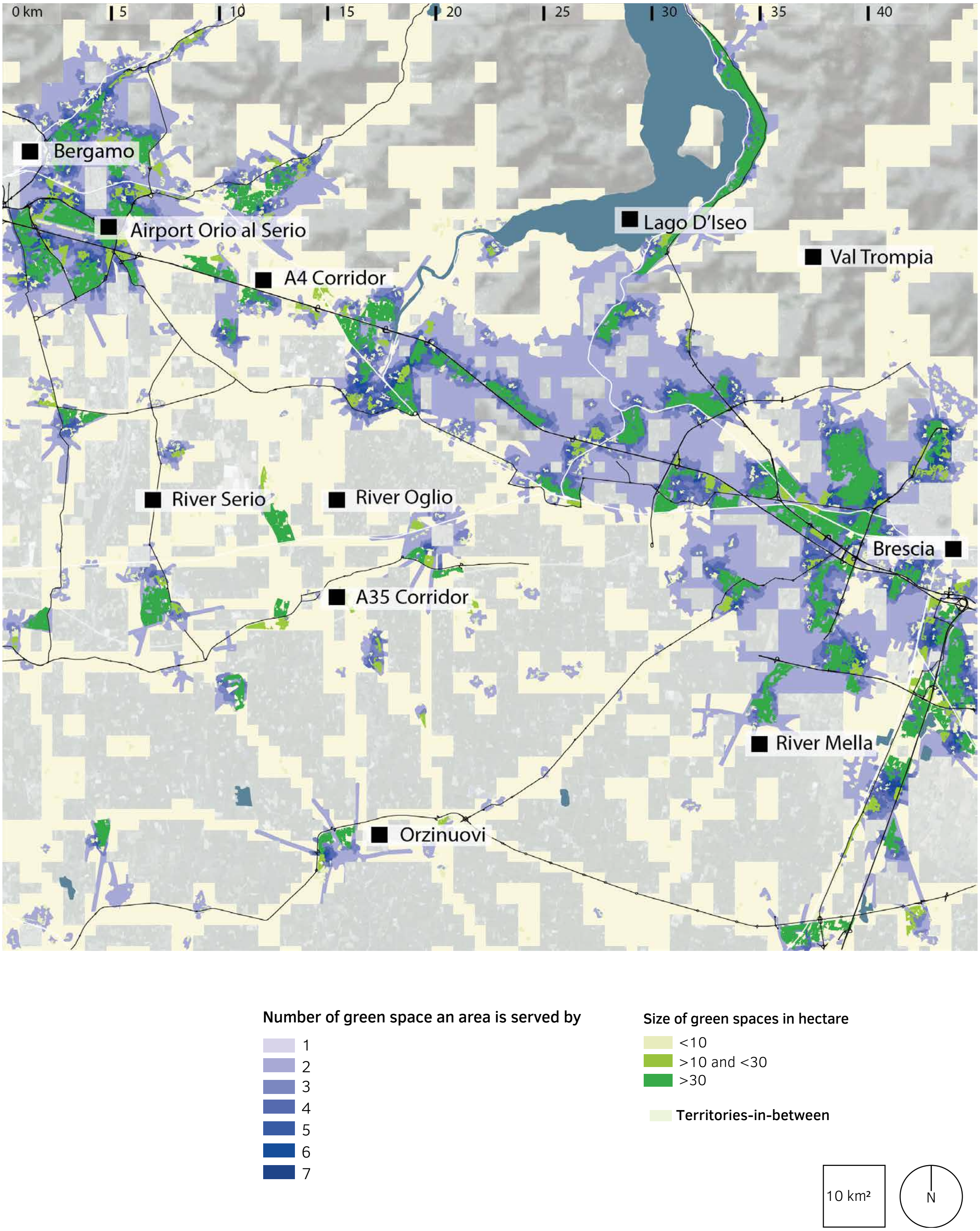

FIG. 8.53 The intensity of access to green space is highest along the A4 corridor.

MIXED-USE

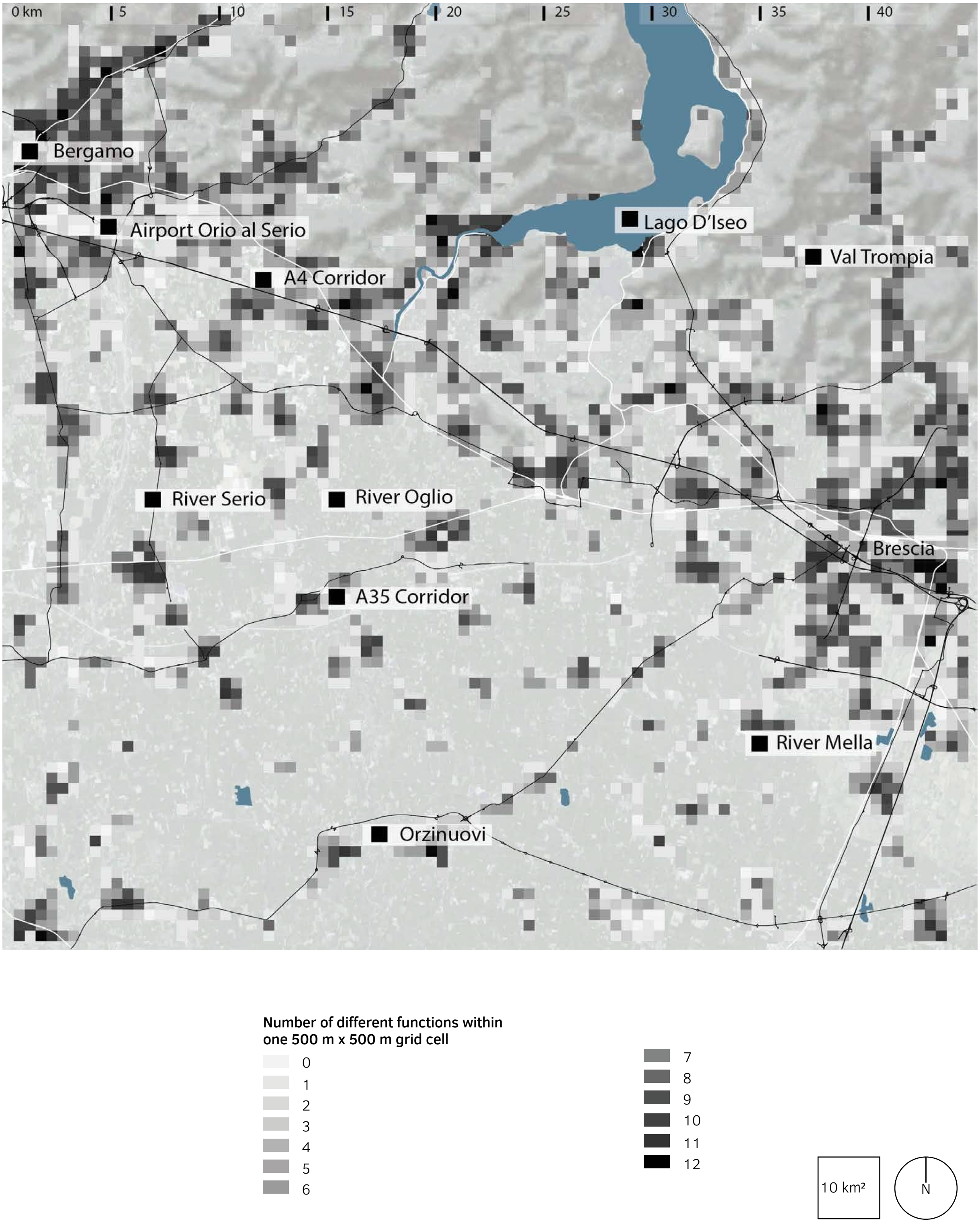

FIG. 8.54 Around 70 per cent of the inhabited grid cells hosts threeor more functions. The highest mix of function is widespread.

SETTLEMENT STRUCTURE

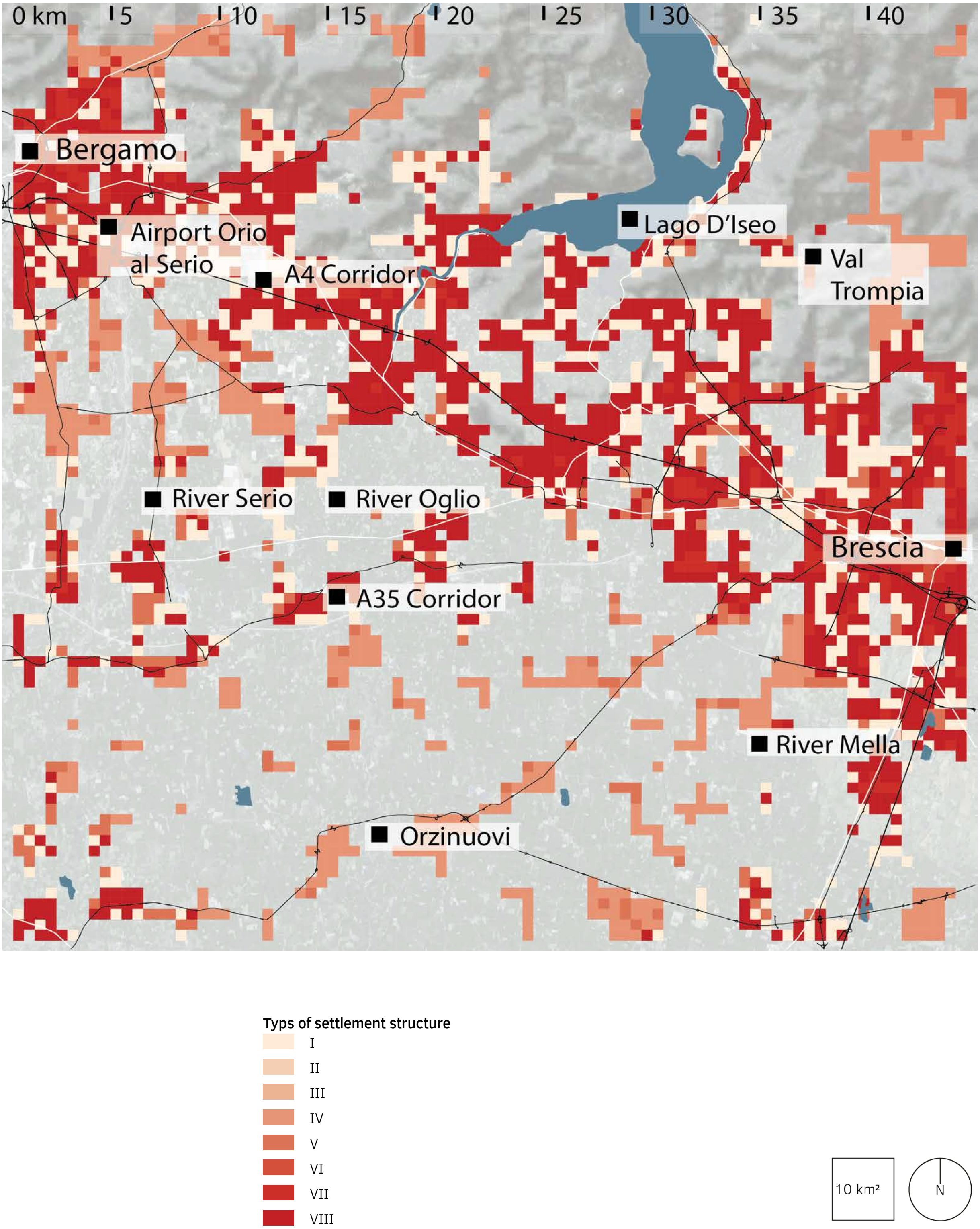

FIG. 8.55 The most frequent (42 per cent) settlement type is type VIII, which has around 20 per cent of mono-functional cells, but also 70 per cent of cells with more than three but less than ten different functions, as well as ten per cent of cells with ten or more functions. Type I, accounts for roughly 24 per cent of all cells, has more than 55 per cent of cells which host 3 or more functions. See table 6.6 for details

8.5.8 Veneto

VENETO

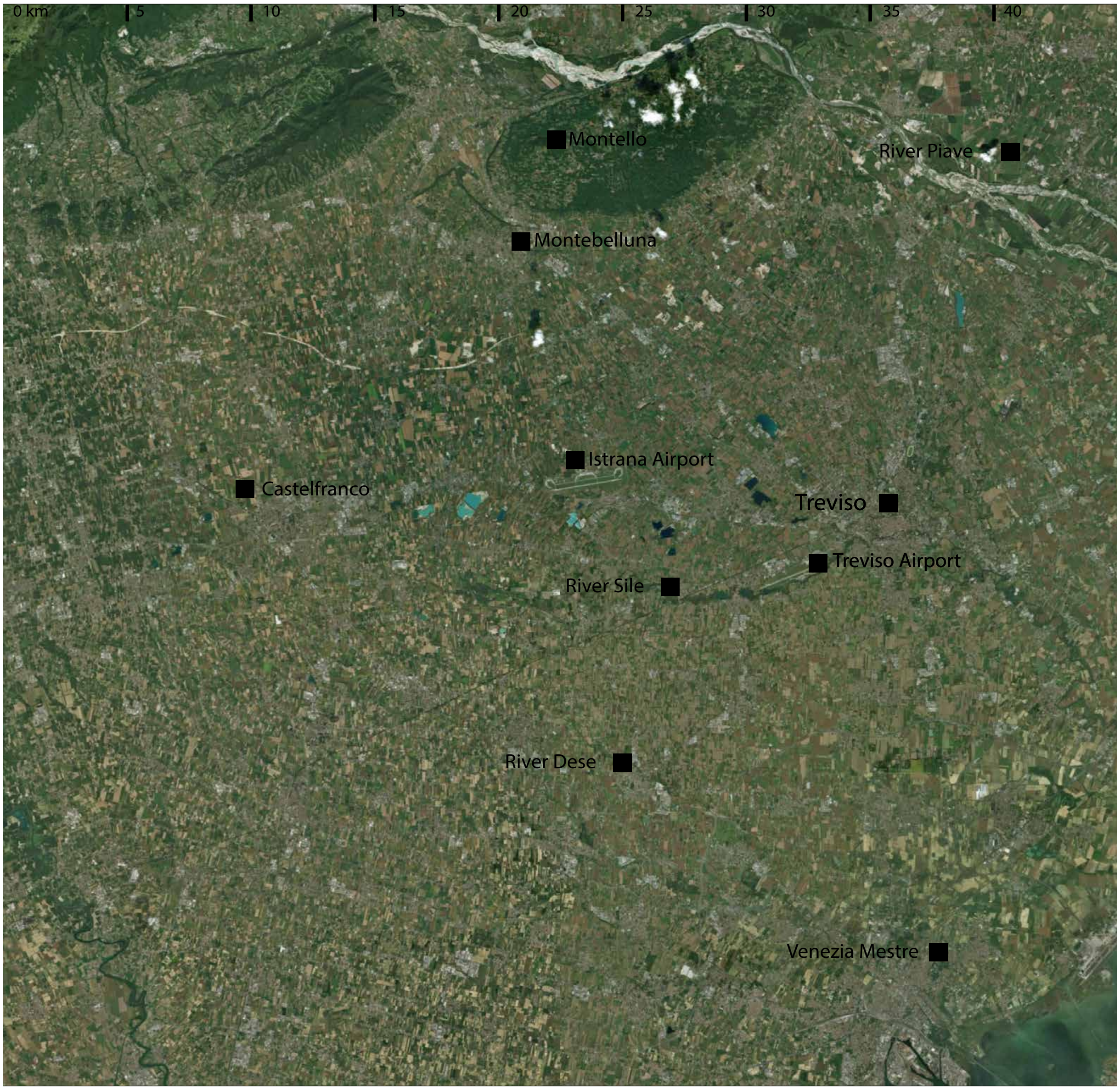

FIG. 8.56 The case study area in Veneto spans from the pre-Alpine hills via the lower plain towards the coastal zone. The city of Mestre is situated in the most south-eastern corner. The river Piave is a visible landscape feature in the north-east in the case study area. The biggest cites in the central area of the cases study area is Treviso. A large part of the case study is occupied by a settlement pattern identified as città diffusa by Indovina..

TOC

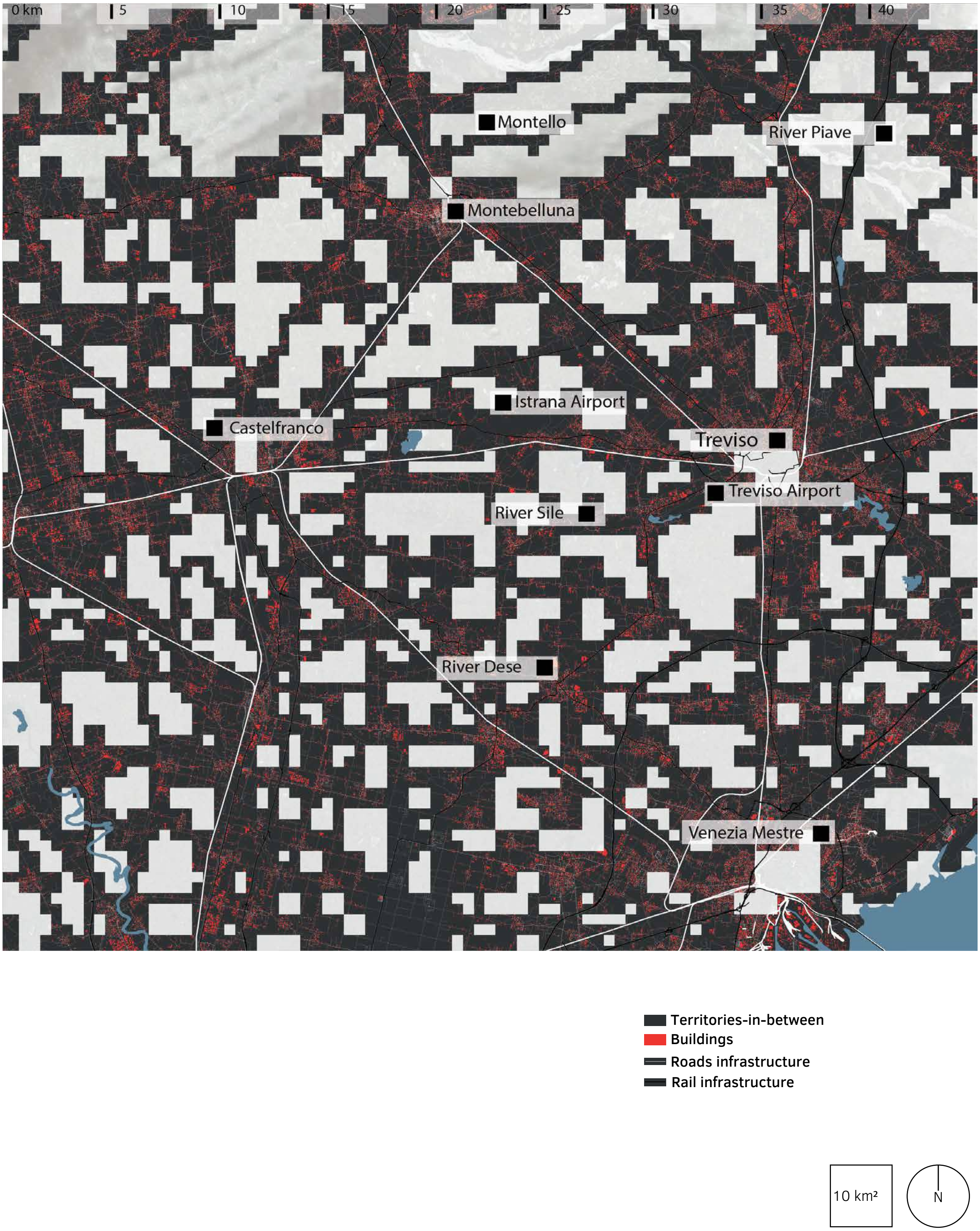

FIG. 8.57 Two differernt forms of TiB can be observes, one more field like around Cardiff and alond the sea, and a the typical valley type.

TYPOLOGY OF OPEN SPACES

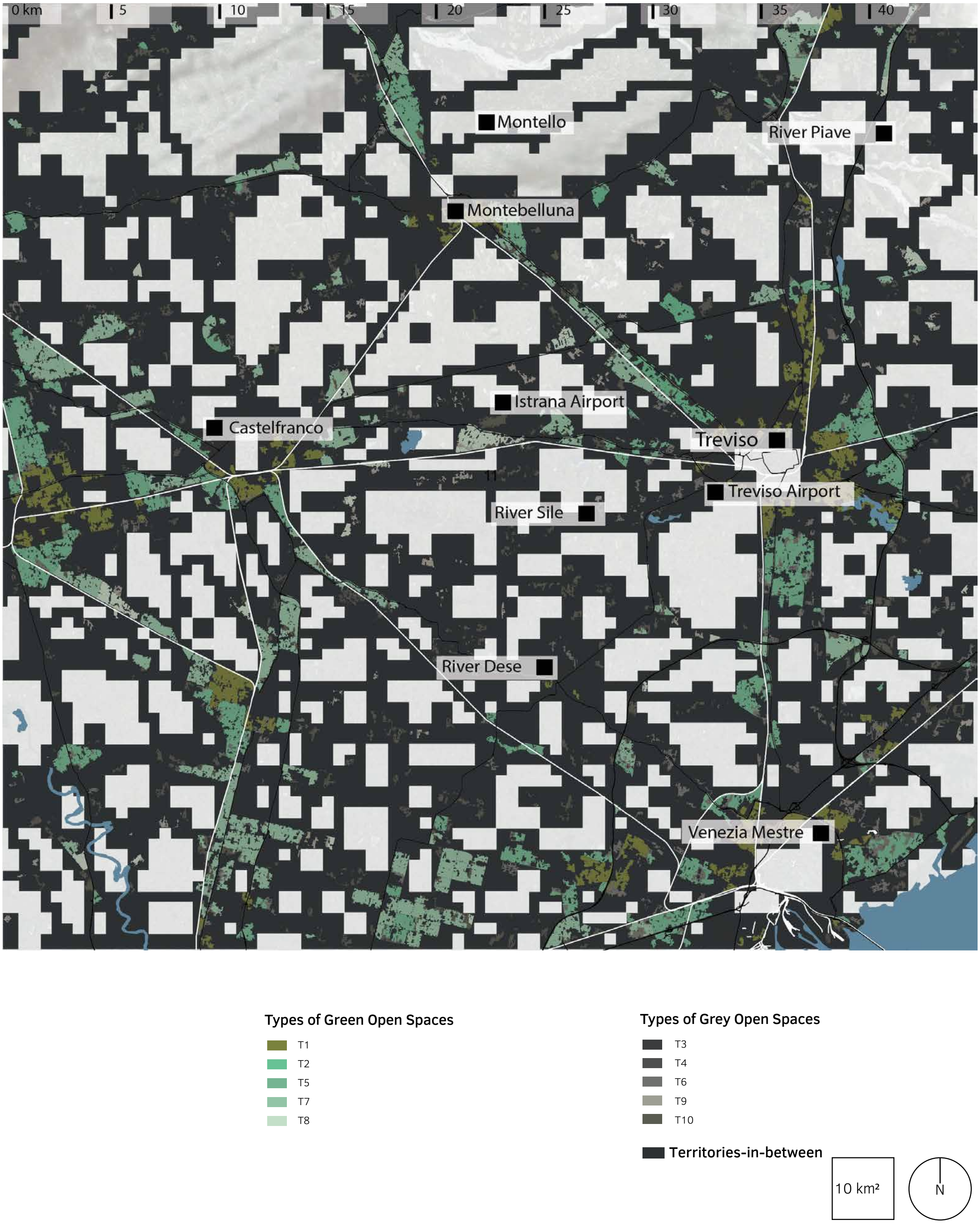

FIG. 8.58 The most frequent type of green space is Typ 7 and type 10 is the most frequent grey space. Type 7 can be best described as the backyards of settlements, with a rather high potential of multifunctionality between residential use with the green infrastructure. These spaces have a key role as buffer areas between housing areas and intensive agricultural areas, but also as ecological corridors connecting the backbone of the regional green infrastructure with the urban green network. Open spaces of type 10 are very often located at the edges and within smaller settlements or in industrial areas as well as along big technical infrastructures, like highways and airports. Those grey spaces play a crucial role in the provision of relation to regulating and cultural ecosystem services.

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FIG. 8.59 1) A green-blue open space providing regulating ecosystem services to its direct surroundings. (2) A widespread grey space, in this case, the parking lots in industrial and business parks. (3) A multifunctional grey space on a market day.

NUMBER OF RESIDENTS WITH ACCESS TO GREEN SPACES

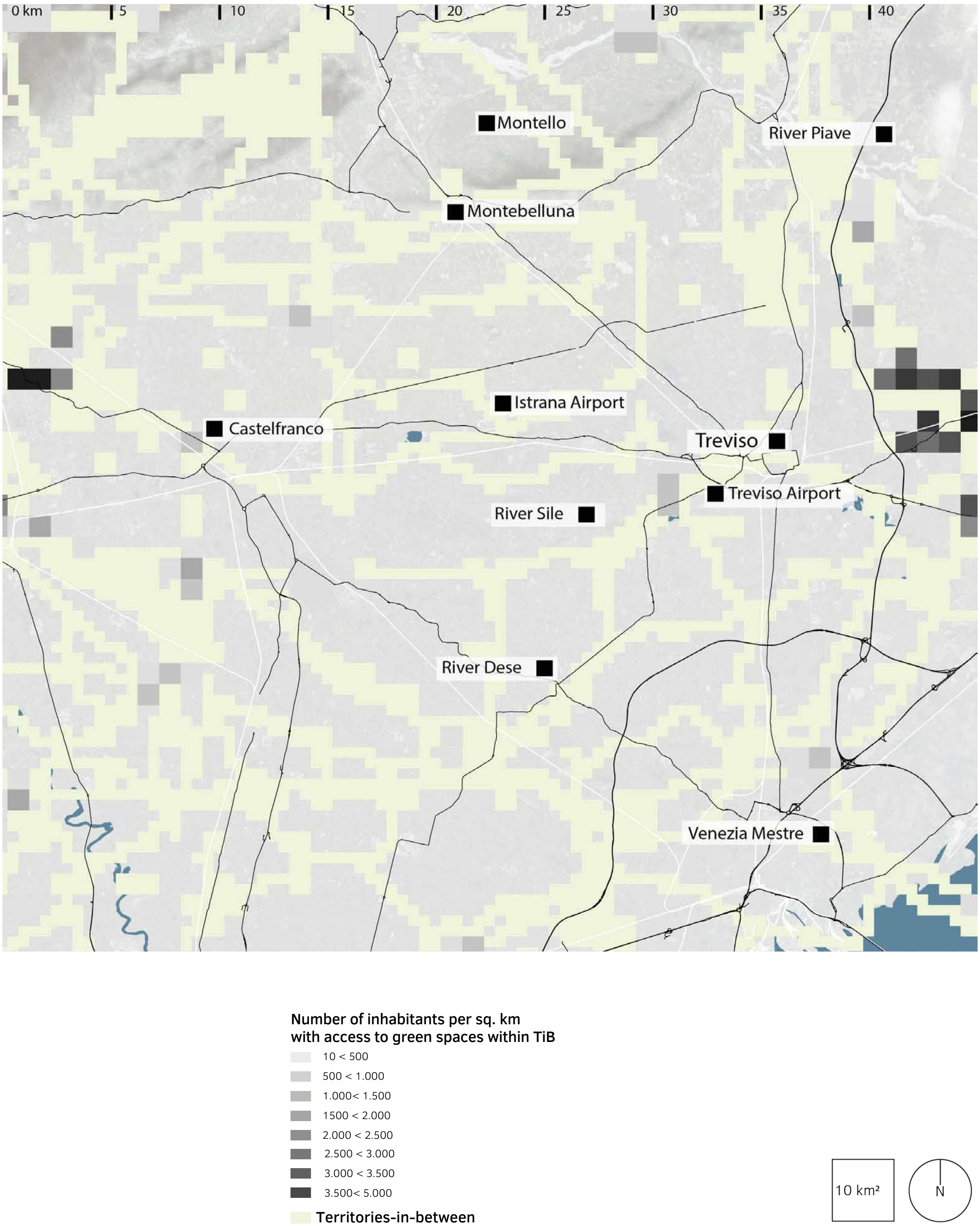

FIG. 8.60 Around 30 per cent of the inhabitants in the TiB in Bergamo-Brescia have access to more than one size of green space.

NUMBER OF RESIDENTS WITH ACCESS TO GREEN SPACES

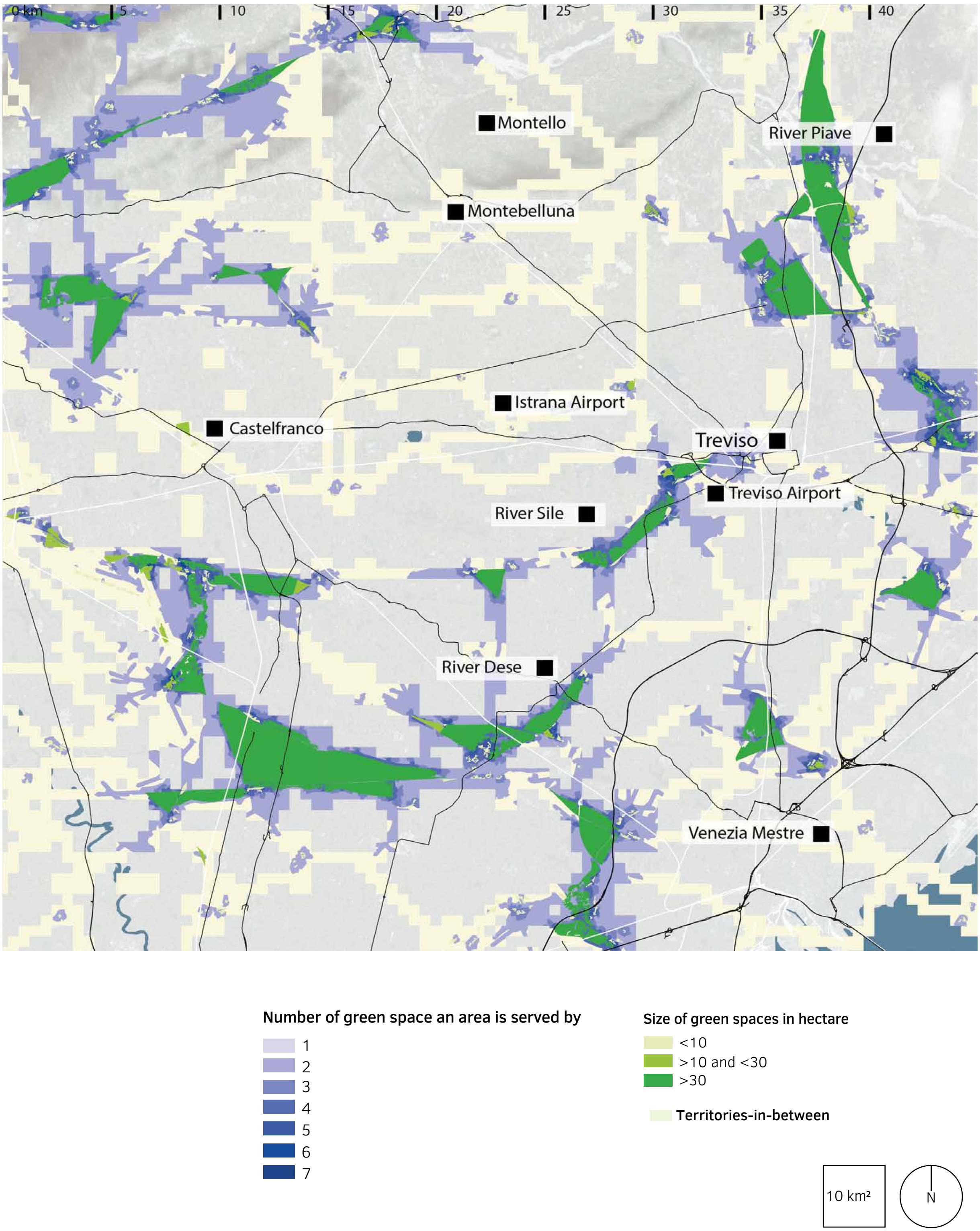

FIG. 8.61 The intensity of access to green space is highest in and around the towns and smaller cities.

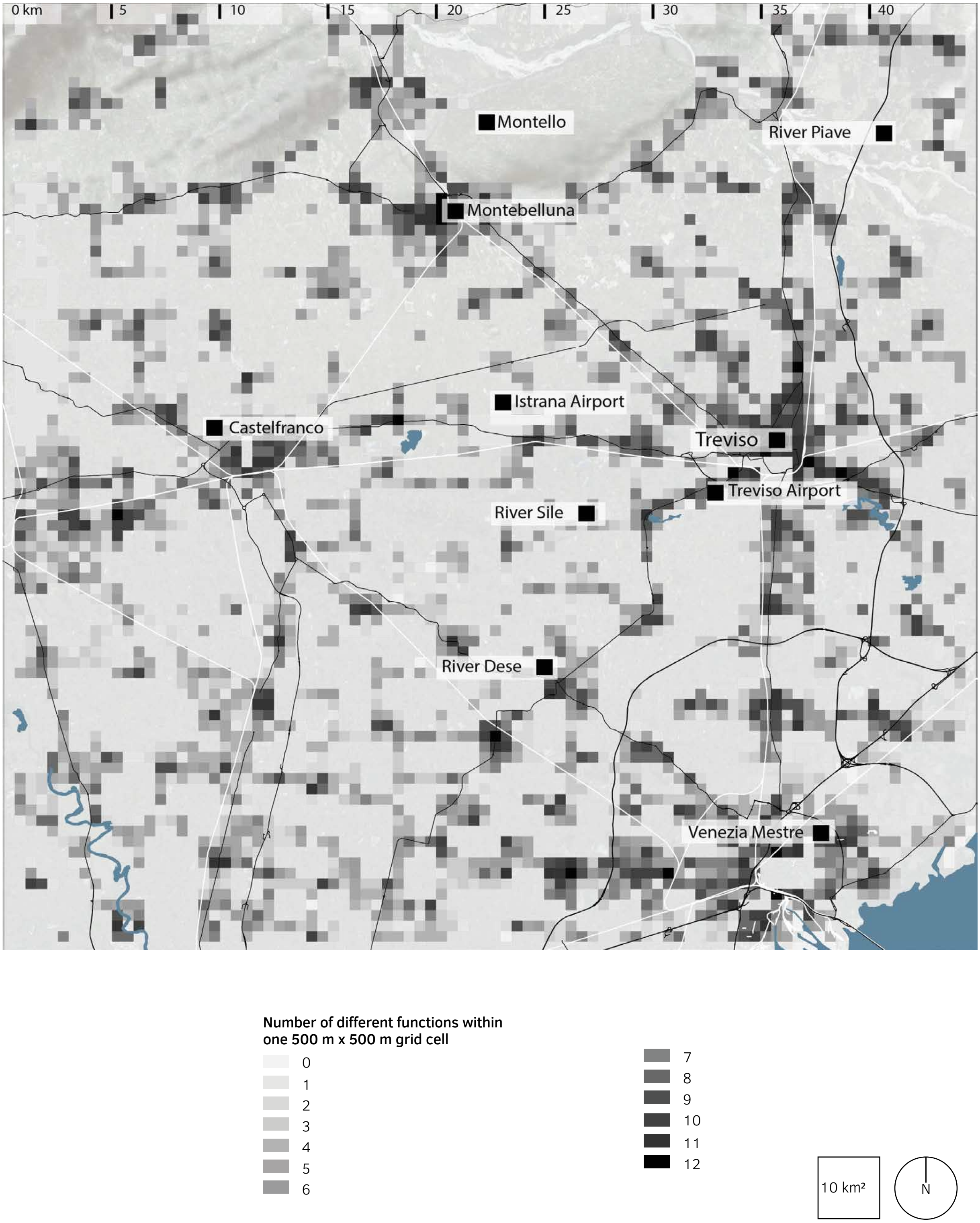

FIG. 8.62 Around 75 per cent of the inhabited grid cells host three or more functions. The highest mix of function is concentrated in cities and towns.

SETTLEMENT STRUCTURE

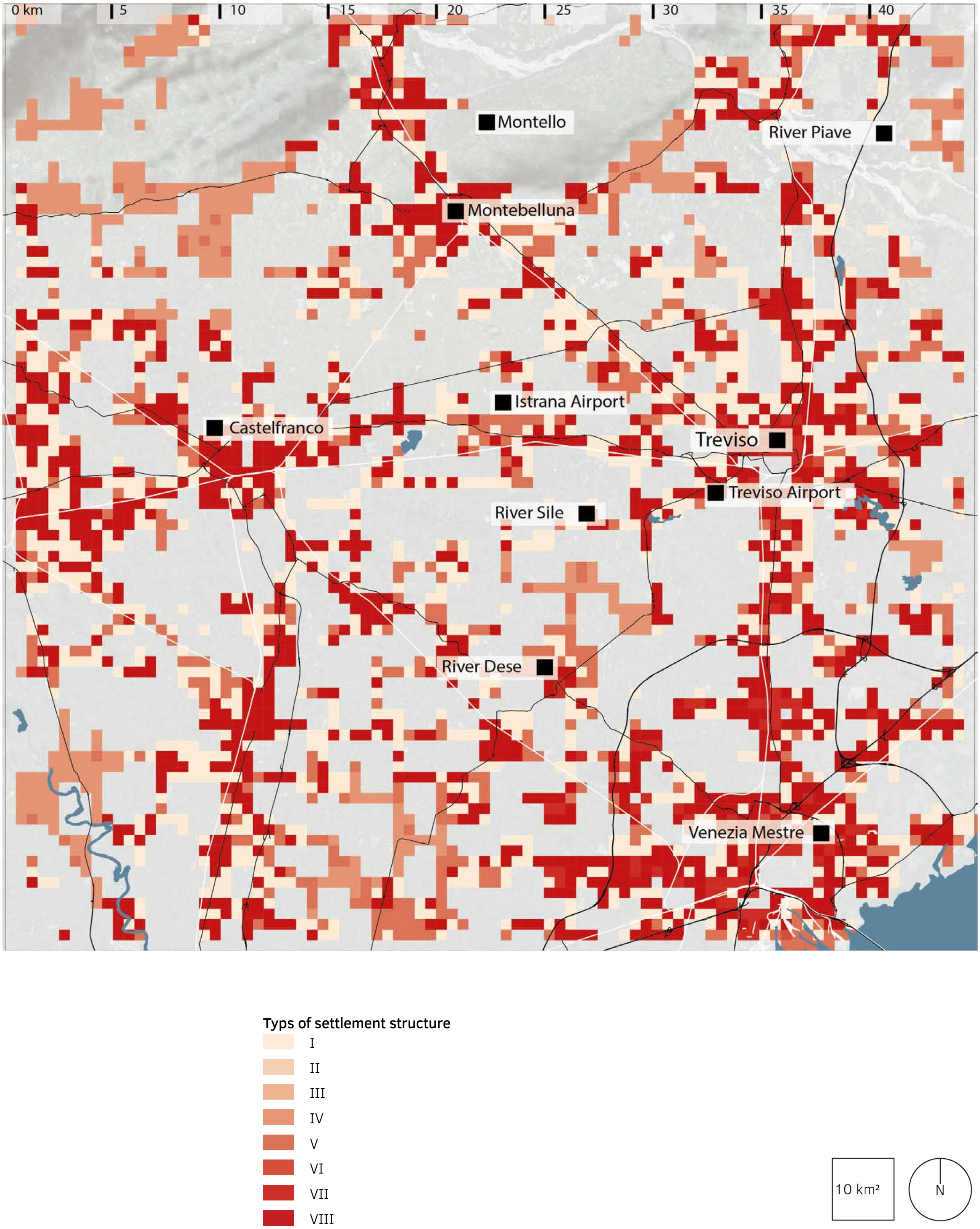

FIG. 8.63 The most frequent (37 per cent) settlement type is type VIII, which has around 17 per cent of mono-functional cells, but also 72 per cent of cells with more than three but less than ten different functions, as well as eleven per cent of cells with ten or more functions. Type I, which accounts for roughly 33 per cent, has more than 70 per cent of cells which host 3 or more functions. See table 6.6 for details.

8.5.9 The Tyrol

FIG. 8.64 The case study area in the Tyrol with the Inn valley in the centre and the Alps as the most dominant feature. The two valleys leading to the south are the Stubaital in the west, one of the most prominent winter tourism areas in the area and the Wipptaal to the east, which leads to the Brenner pass one of most important passes of the Eastern Alpine range which has the lowest altitude among passes in the eastern Alps.

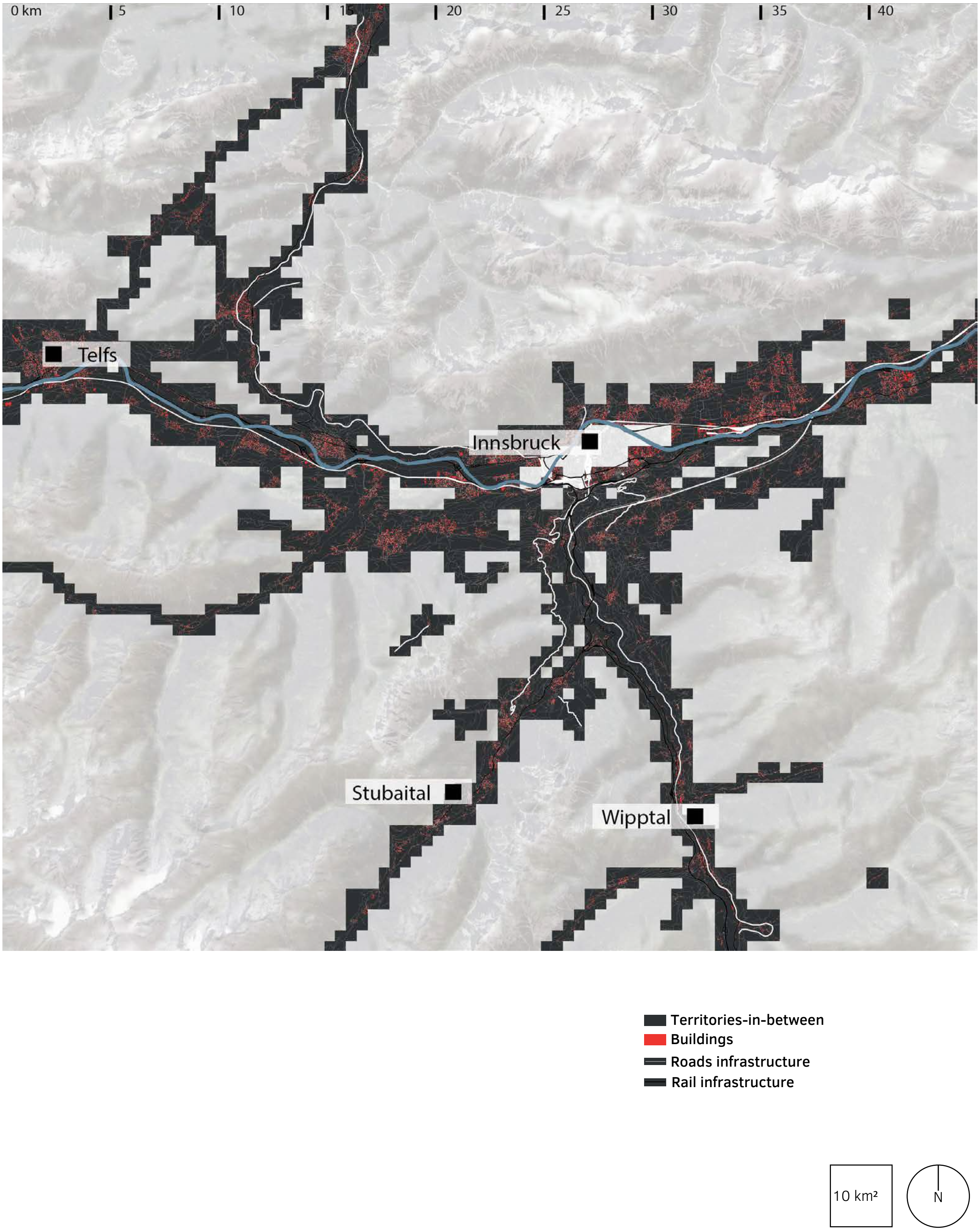

FIG. 8.65 The valley type of TiB is dominant.

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TYPOLOGY OF OPEN SPACES

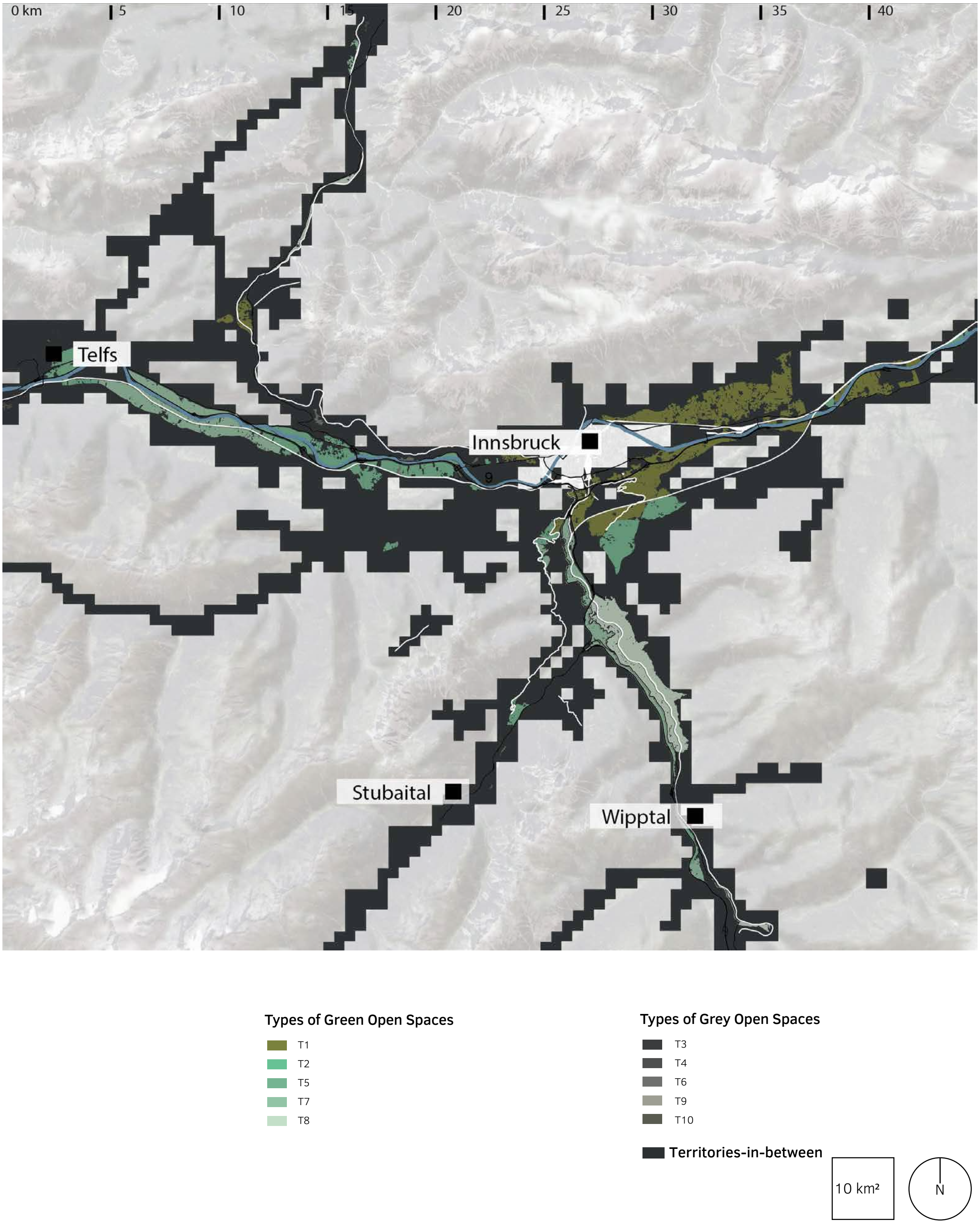

FIG. 8.66 The most frequent type of green space is type 1 and type 3 is the most frequent grey space. Both are often located within the fringe zone of towns cities, they have a high potential for multifunctionality, and regulating and cultural ecosystem services. These open spaces are under the highest urbanisation pressure and play a crucial to facilitate social interaction.

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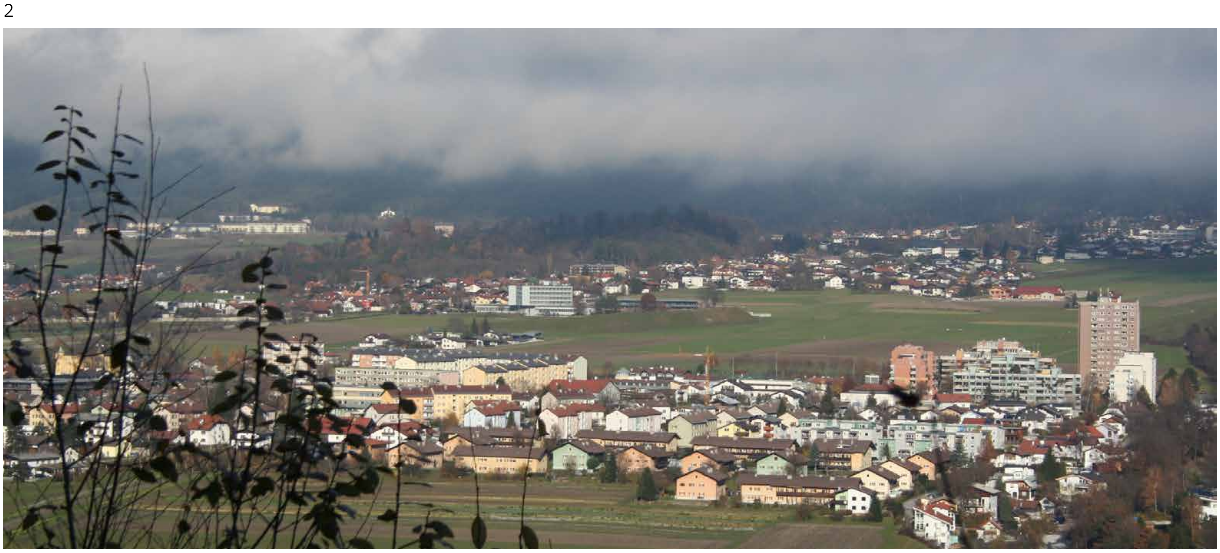

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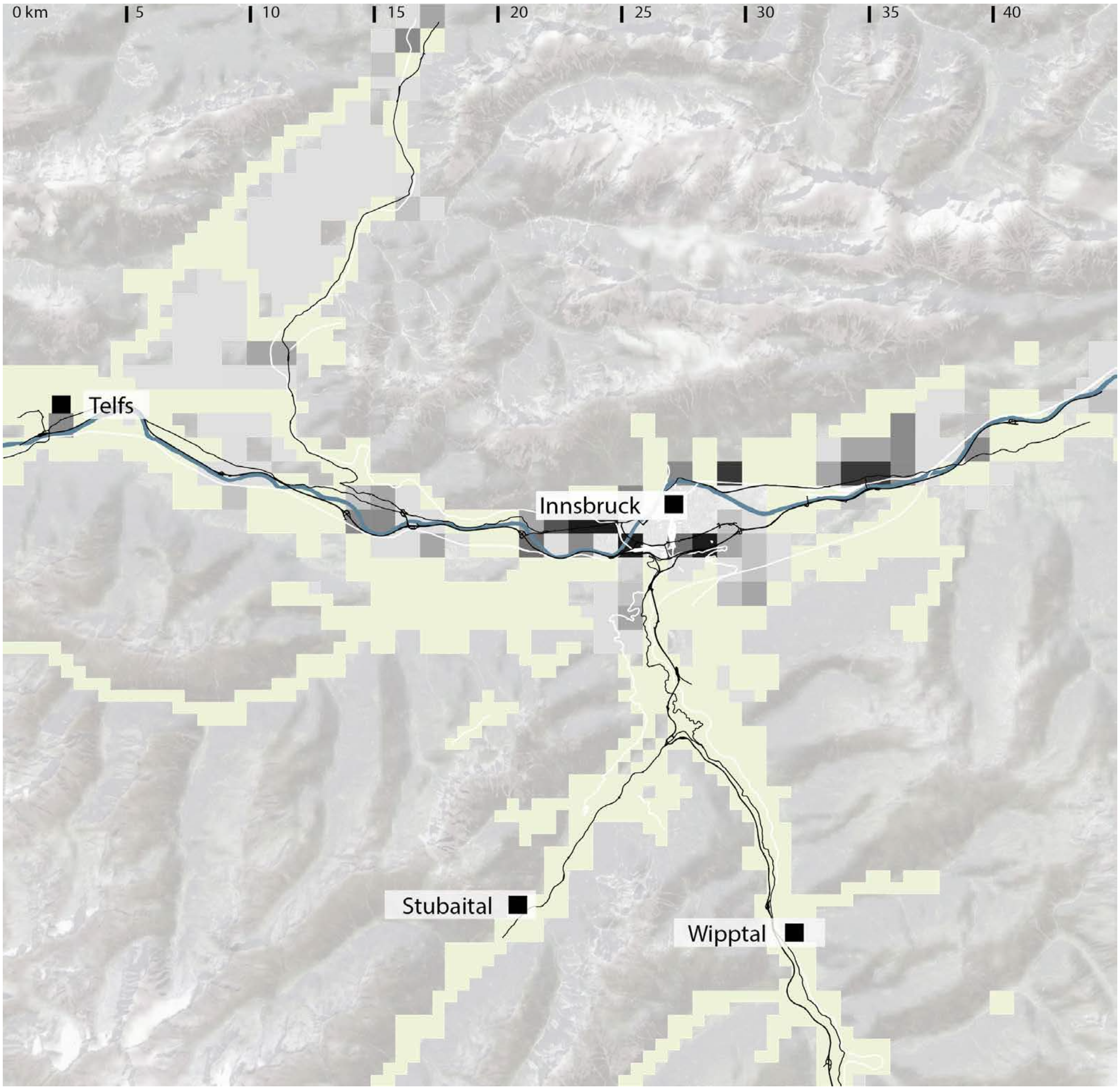
FIG. 8.67 (1) And ecoduct as an example of green infrastructure. (2) The parking lot at a skiing resort is a common grey space. (3) The intermingling of agricultural use areas and the settlement in the Inn valley.

NUMBER OF RESIDENTS WITH ACCESS TO GREEN SPACES



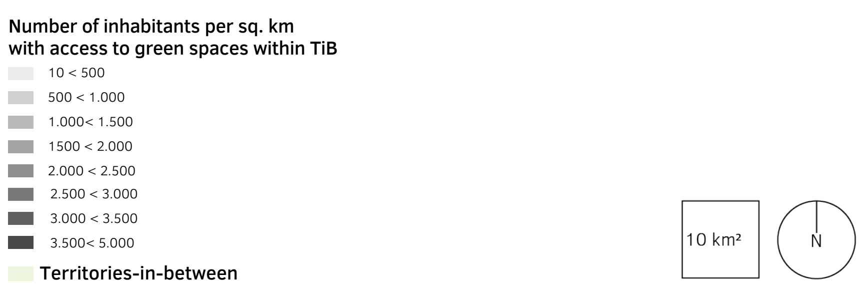


FIG. 8.68 Around 55 per cent of the inhabitants in the TiB in the Tyrol have access to more than one size of green space.

NUMBER OF RESIDENTS WITH ACCESS TO GREEN SPACES

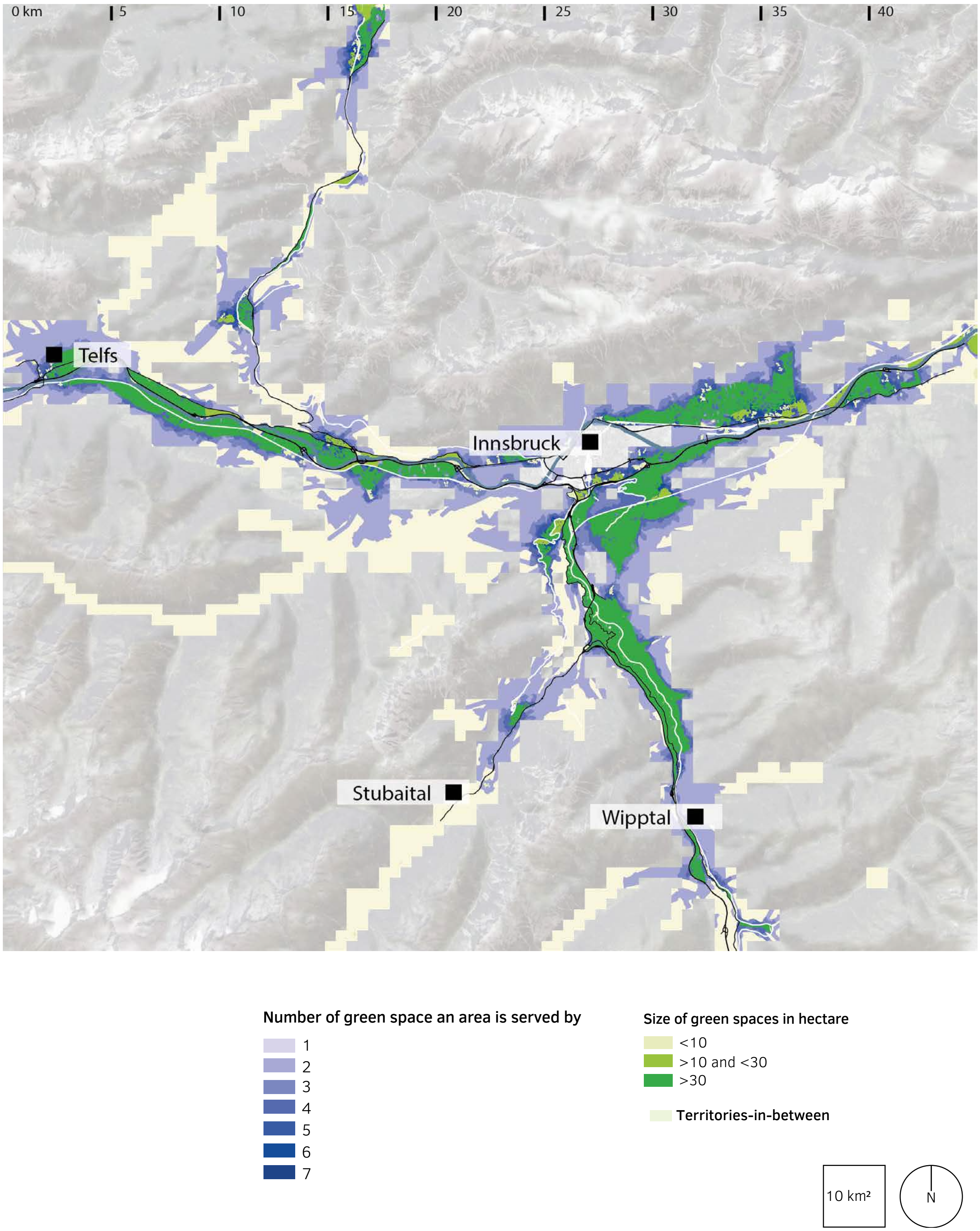


FIG. 8.69 The intensity of access to green space is highest in the Inn valley and the Mittelgebirge.

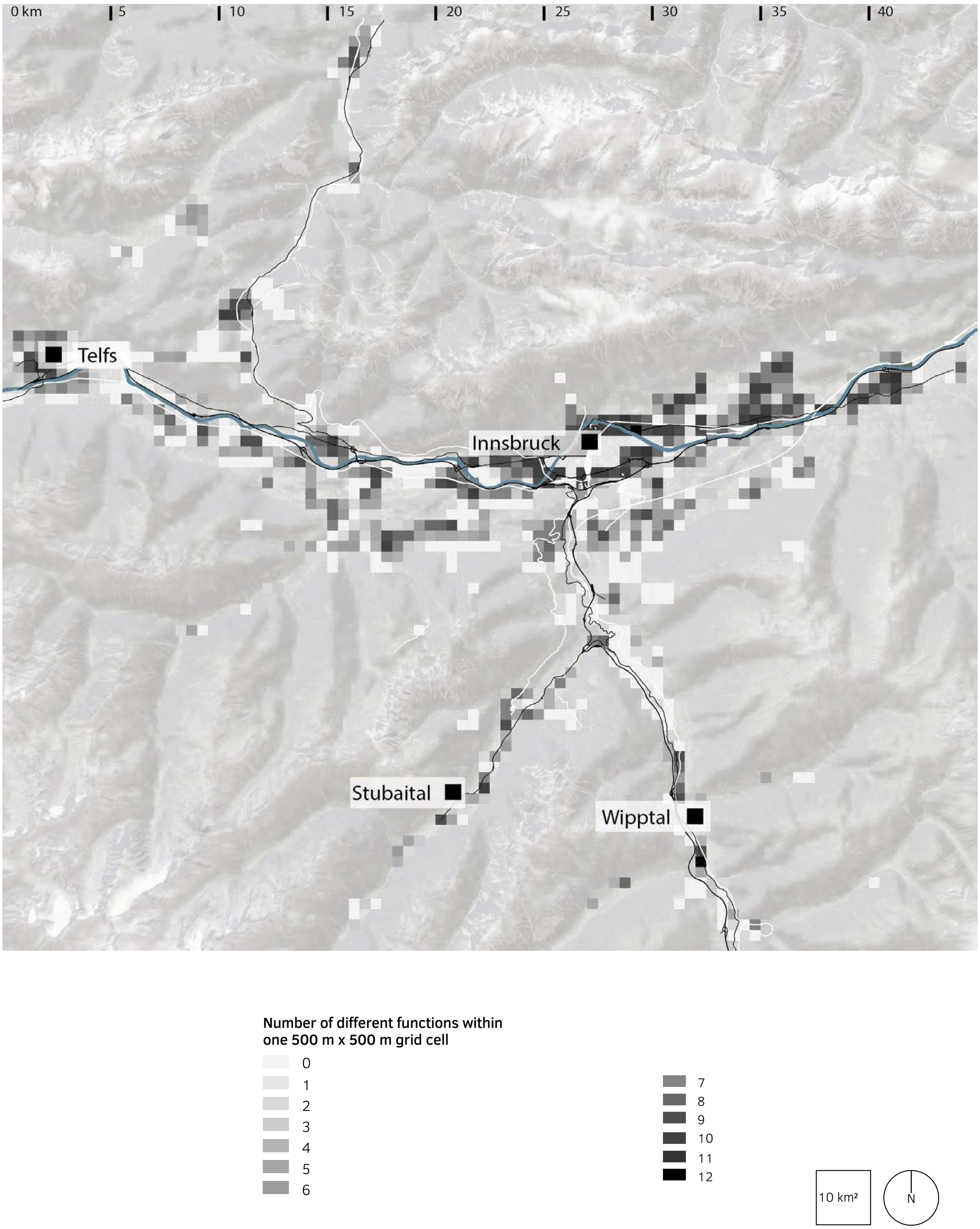


FIG. 8.70 Around 80 per cent of the inhabited grid cells host three or more functions. The highest mix of function is concentrated in the Inn valley and the larger villages.

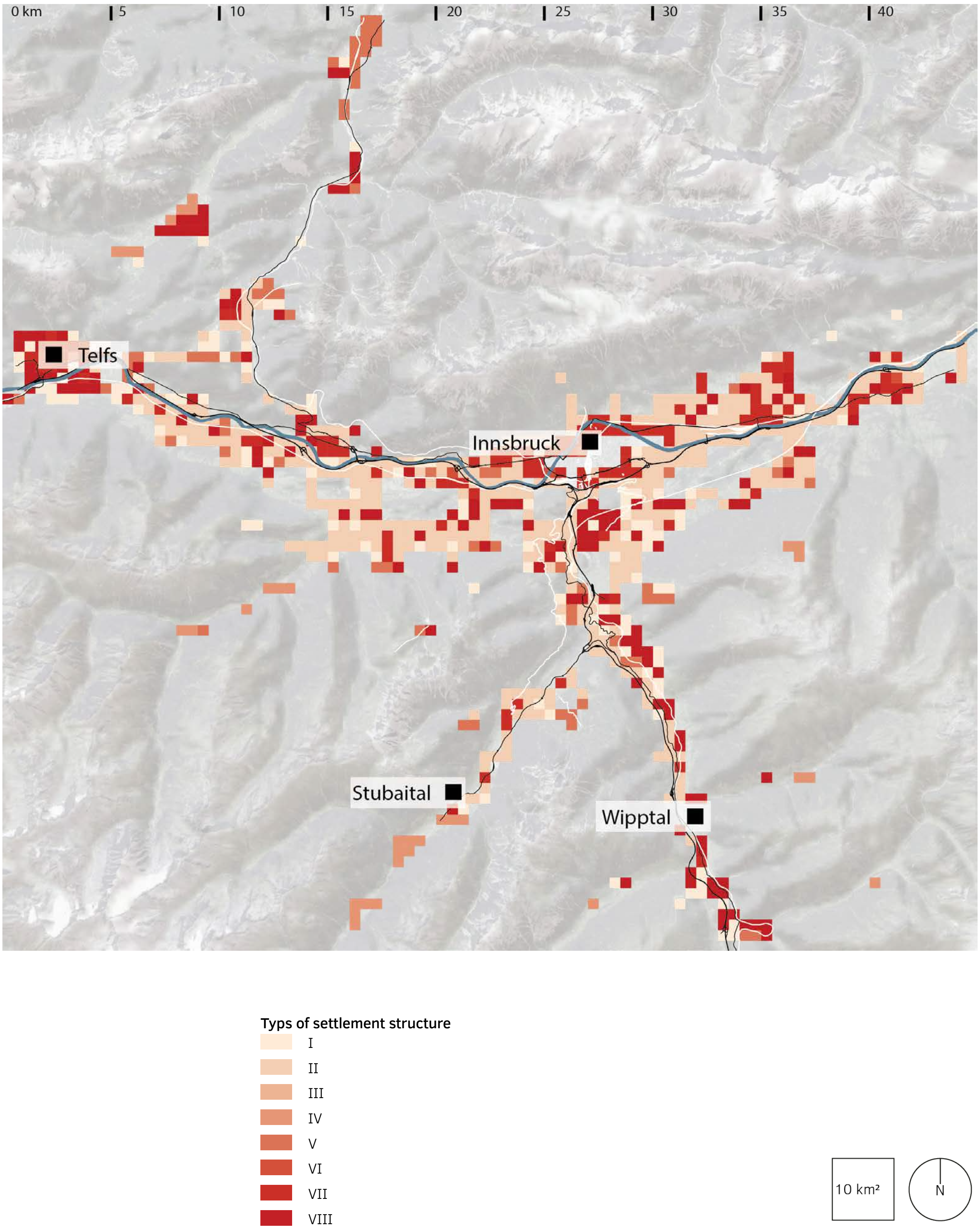


FIG. 8.71 The most frequent (37 per cent) settlement type is type II, which has around 33 per cent of mono-functional cells, but also 64 per cent of cells with more than three but less than ten different functions, as well as three per cent of cells with ten or more functions. Type IV, which accounts for roughly 40 per cent, has around 40 per cent of cells which host 3 or more functions. See table 6.6 for details.

8.5.10 Vienna-Bratislava

FIG. 8.72 The case study area in Vienna-Bratislava, along with the outskirts of Vienna in the west and Bratislava in the east and the river Danube wetlands, a national park between the two cities. The majority of the case study area is part of the Vienna Basin, north of the Danube is the Marchfeld, one of the most fertile regions of central Europe. The mountain ridges that cross the area from south-west to northeast are the Leitha Gebirge and the Carpaths, which separates the Vienna Basin from the Pannonia Basin. There is a notable difference in the plot size of the agricultural areas in the Austrian part of the case study compared to the Slovak areas, a result of different agricultural systems during the cold war, as the Morava river has been part of the iron curtain.

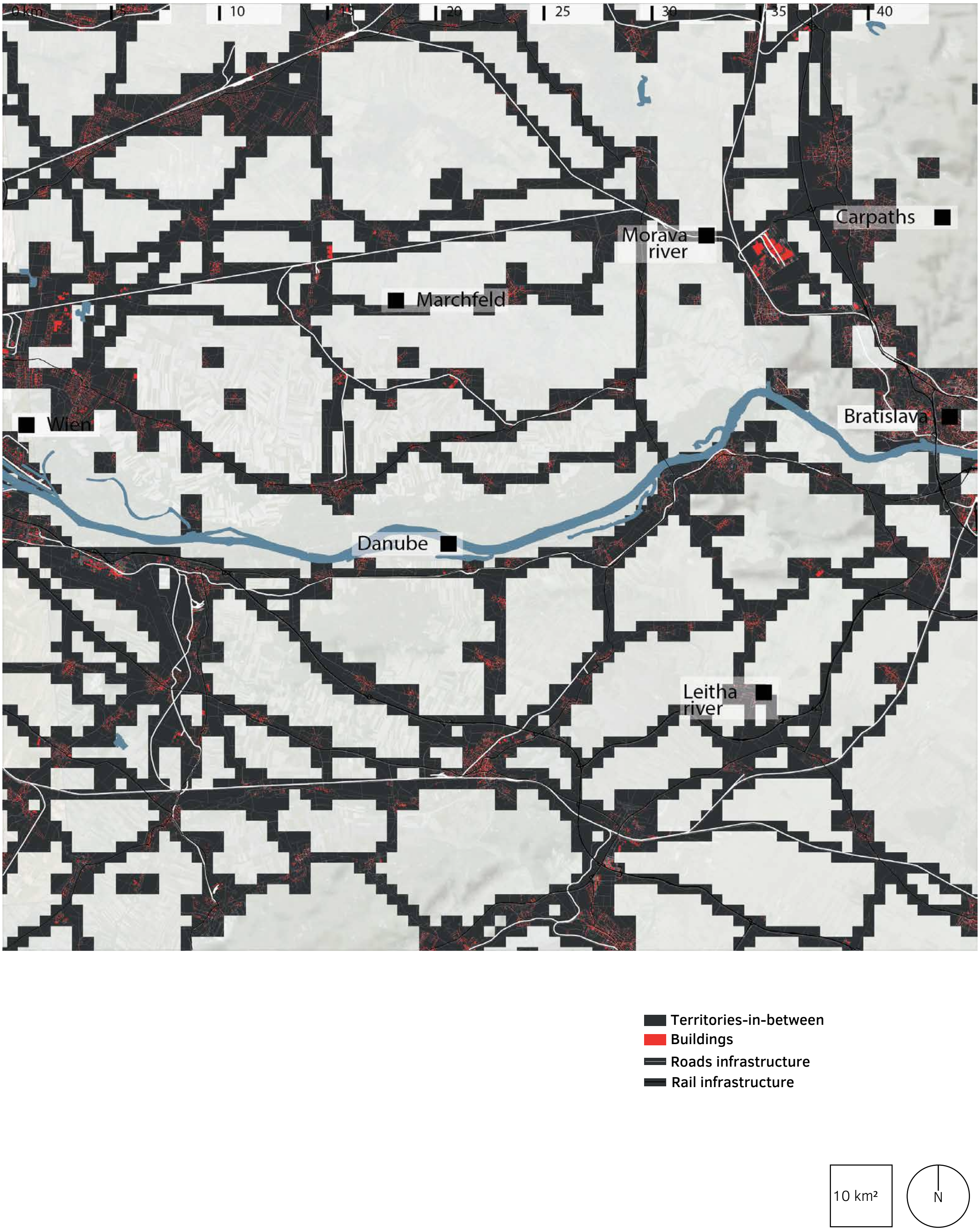


FIG. 8.73 The case study area is dominated by the network of cities and towns type of TiB. Only north of Bratislava and to the east of Vienna, small areas can be considered as being the field like type of TiB.

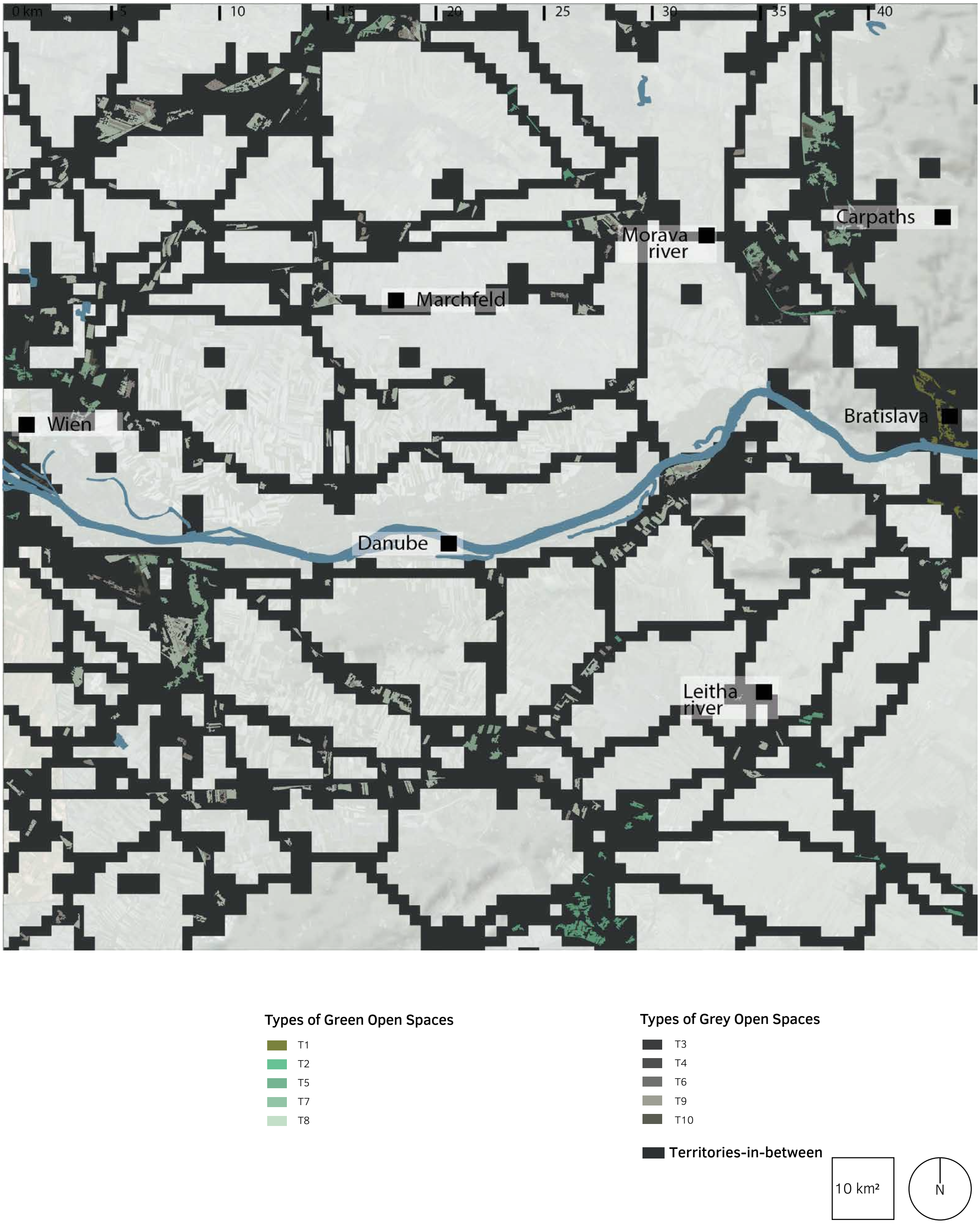


FIG. 8.74 The most frequent type of green space is the type 8, which plays a key role as buffer areas between industrial areas and intensive agricultural areas, but also as ecological corridors connecting the backbone of the existing green infrastructure with the urban green network. They are relevant for regulating and provisional ecosystem services. The most frequent type of grey open space is type 9, which is the grey open space with the lowest potential of multi-functionality. They are very often located in smaller settlements or industrial areas with automated functions like ports. They are crucial open spaces for the provision of regulating and cultural ecosystem services.

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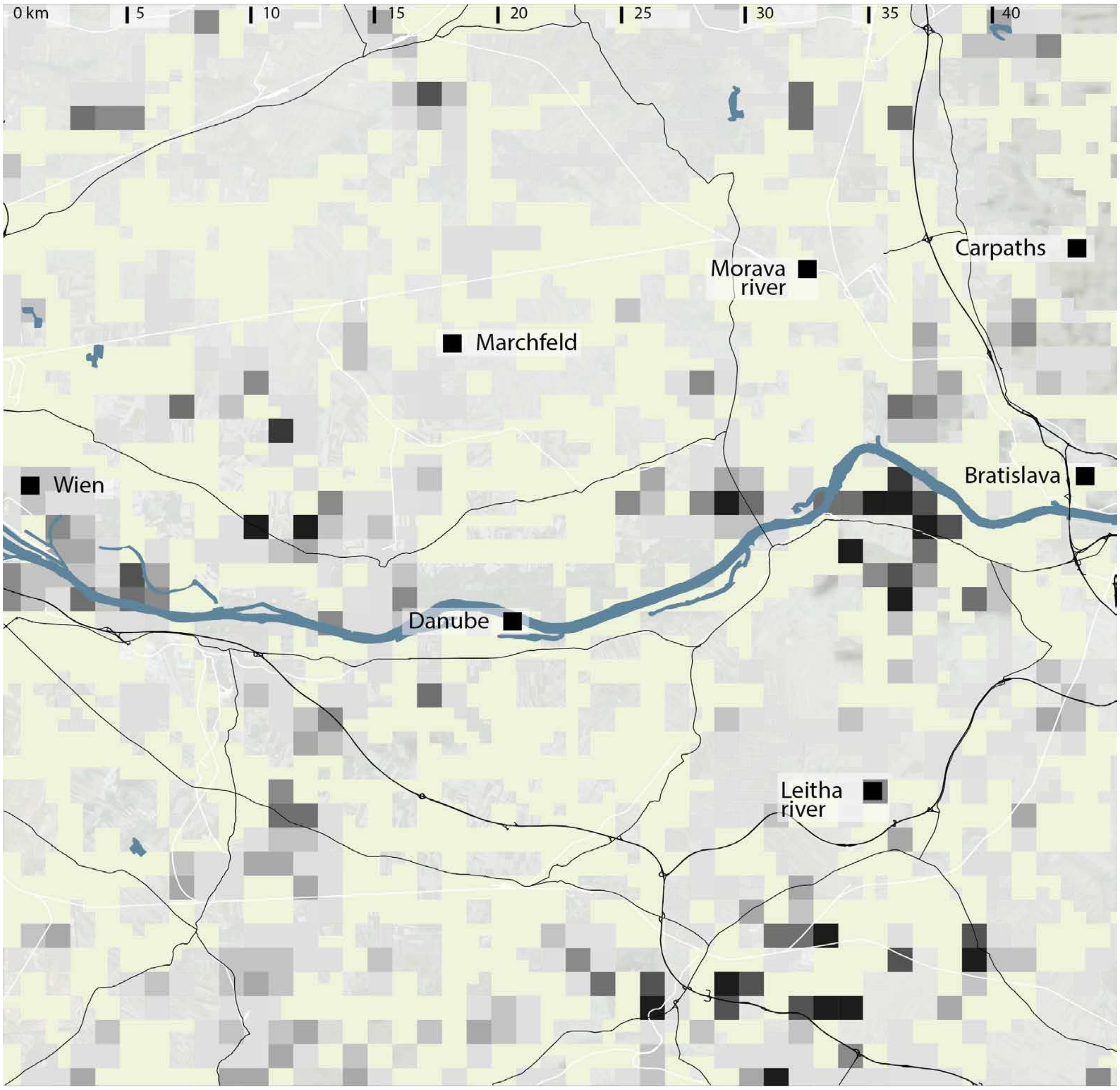
FIG. 8.75 (1) A multifunctional green space includes a playground and infrastructure in the buffer zone between settlements and a national park. (2) One of the remaining acres at the fringe of Vienna. (3) A typical grey space is a parking lot in a shopping park at the edge of a smaller town.

NUMBER OF RESIDENTS WITH ACCESS TO GREEN SPACES



Number of inhabitants per sq. km with access to green spaces within TiB

- 10 < 500
- 500 < 1.000
- 1.000< 1.500
- 1500 < 2.000
- 2.000 < 2.500
- 2.500 < 3.000
- 3.000 < 3.500
- 3.500< 5.000

Territories-in-between

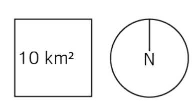


FIG. 8.76 Around 30 per cent of the inhabitants of the TiB in the Tyrol have access to more than one size of green spaces.

NUMBER OF RESIDENTS WITH ACCESS TO GREEN SPACES

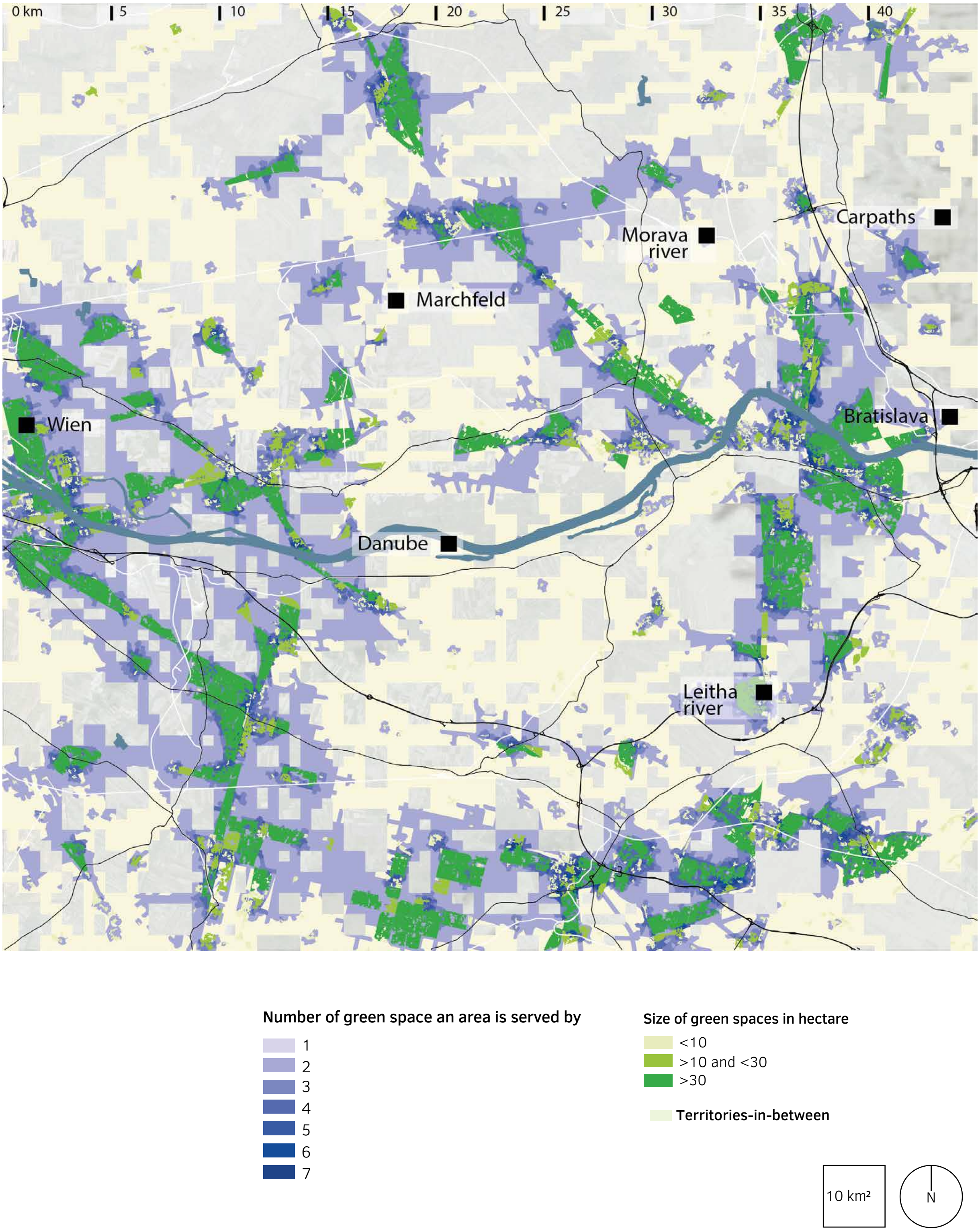


FIG. 8.77 The intensity of access to green space is highest around Bratislava and in the towns in the south as well as the north.

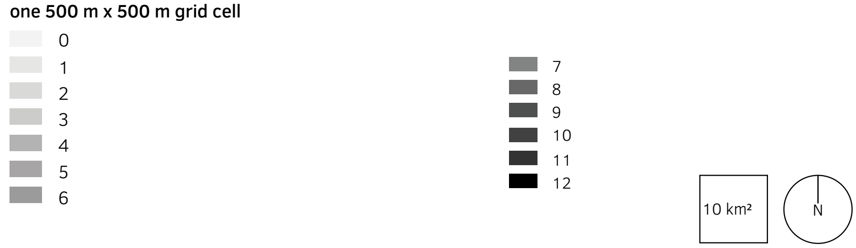


FIG. 8.78 Around 70 per cent of the inhabited grid cells host three or more functions. The highest mix of function is concentrated around Bratislava and the smaller cities and towns.

SETTLEMENT STRUCTURE

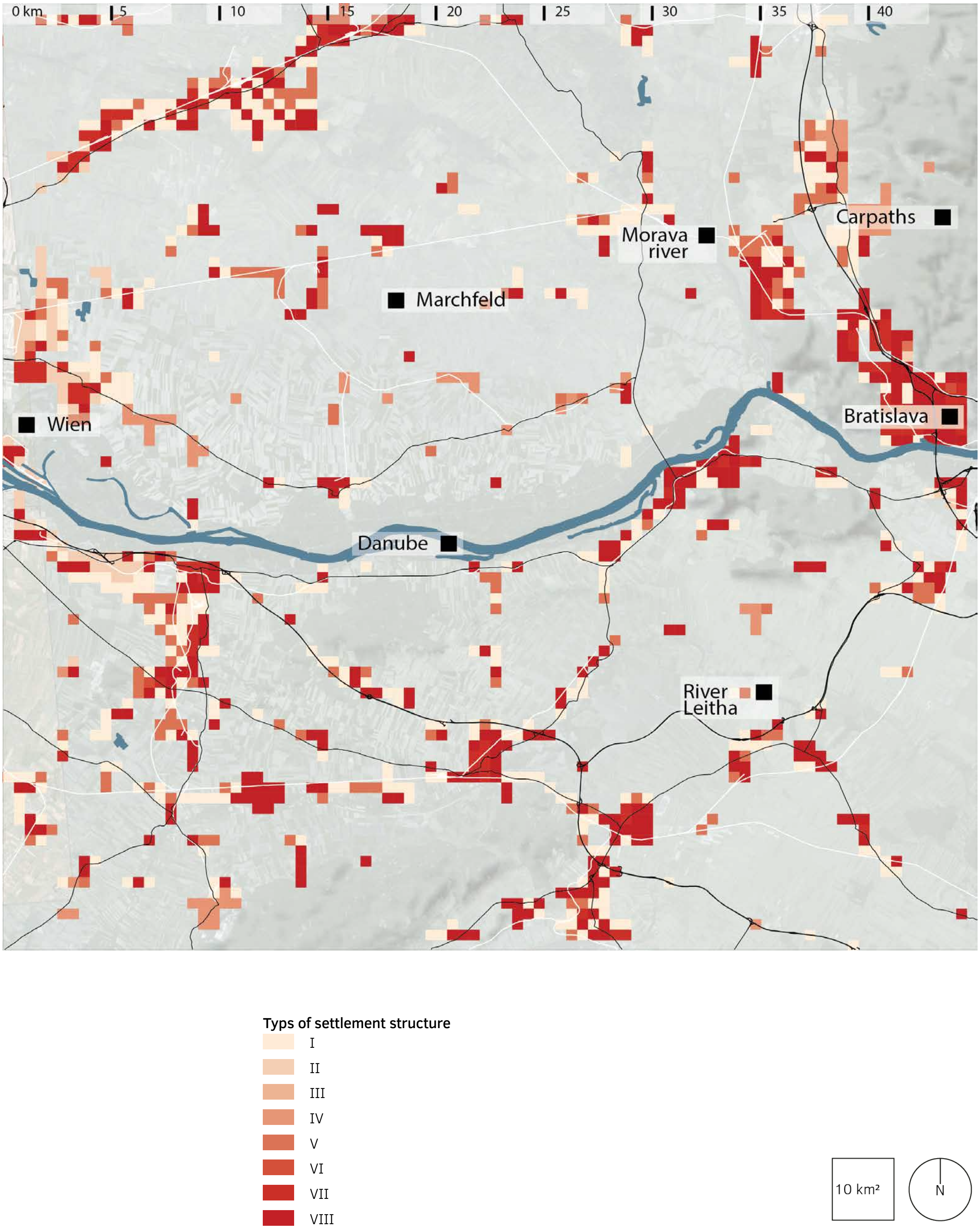


FIG. 8.79 The most frequent (40 per cent) settlement type is type VIII, which has around 19 per cent of mono-functional cells, but also 71 per cent of cells with more than three but less than ten different functions, as well as ten per cent of cells with ten or more functions. Type I, which accounts for roughly 32 per cent, has around 55 per cent of cells which host 3 or more functions. See table 6.6 for details.

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Curriculum Vitae

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20#02

Territories-in-between

A Cross-case Comparison of Dispersed Urban Development in Europe

Alexander Wandl

An increasing body of literature suggests that the conventional idea of a gradual transition in spatial structure from urban to rural does not reflect contemporary patterns of urban development and their potential for sustainable development. The research introduces the concept of territories-in-between (TiB) to address the issues surrounding the sustainability of dispersed urban development. A cross-case comparison research design was chosen to develop methods and principles that can be transferred to other geographical contexts. Ten cases in five countries were studied with the aim to answer the following questions:

– What spatial structures characterise dispersed urban areas in Europe?

– Which morphological and functional structures of dispersed urban areas offer the potential for more sustainable development? If so, how can this potential be mapped and measured to inform regional planning and design?

– Are there similarities and dissimilarities concerning potentials of dispersed urban areas in different locations, planning cultures, topographies and histories?

Do dispersed urban areas have distinct characteristics? In sum, the findings show that dispersed urban areas in Europe are quite distinct from urban and rural areas and that they share characteristics from one place to another. The research investigated three aspects of sustainable spatial development, the potential of multi-functionality, the provision of ecosystem services and the presence and potential for mixed-use.

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