

# Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences



## Graduation Plan: All tracks

Submit your Graduation Plan to the Board of Examiners ([Examencommissie-BK@tudelft.nl](mailto:Examencommissie-BK@tudelft.nl)), Mentors and Delegate of the Board of Examiners one week before P2 at the latest.

The graduation plan consists of at least the following data/segments:

Personal information	
Name	Jens Berkien
Student number	4694856

Studio		
Name / Theme	Planning Complex Cities	
Main mentor	Dr. Verena Balz	Spatial Planning & Strategy (Urbanisms)
Second mentor	Dr. Kristel Aalbers	Environmental Technology & Design (Urbanism)
Argumentation of choice of the studio	<p>One of the major challenges of the current spatial practice is to be able to align all the various voices around the design table. As the urbanist begins to change into the role of a so-called 'bridge-maker', it becomes apparent that the urban conflicts surrounding the energy transition, migration, housing crises, nature loss, climate change adaptation, water management etc. call for the need to change current spatial planning practices to transdisciplinary relationships between all stakeholders involved. These current issues cannot be defined by what we so-call 'borders'. As we have seen in recent years, increasing fluctuations between floods and droughts in the Dutch river lands have created large conflicts within the agricultural, water management, economic, and biodiversity sectors. This has resulted in major impacts on farmers, inland shipping, nature reserves, economic services, regional infrastructures, and urban residents in not only Dutch but also German, Belgium, French, and Swiss cities.</p> <p>Within my thesis, I want to research the transboundary collaboration systems within the European context and use the case of the Room of the River program as an example of a new intersectoral European planning scheme for the Rhine Basin, but also research the need for new reconsiderations of the contents of the program in ever-changing sustainability and water management context. The new need for a reconsideration of one of the large-scale interdisciplinary programs in the Netherlands (Room of the River Program) creates a new opportunity to combine and integrate current agricultural, economic, residential, and social conflicts, trying to figure out a combination of an adaptive and inclusive</p>	

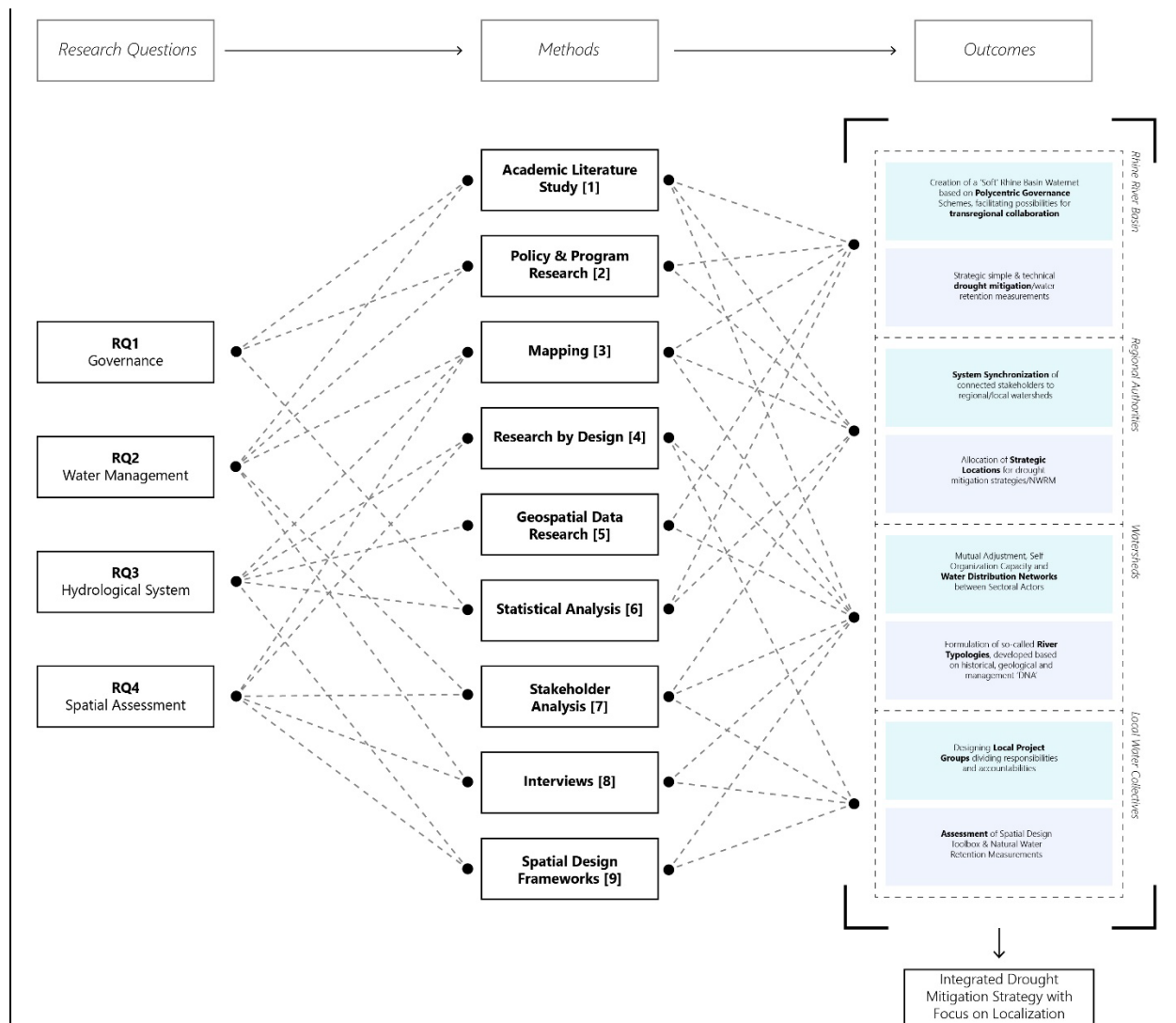
	<p>riverscape of the regions of the Rhine basin. As the Complex Cities research studio places the focus on the relation between spatial planning, design, and policies within socio-economic and urban conditions, it encompasses the conflict of the claims of space between various groups of farmers, municipalities, industries, nature, water management, civil society, etc. Currently, space in the Netherlands can be considered one of the scarcest resources the Netherlands has to offer. Increasing pressure from the European Union create new challenges for a well-known Dutch practice to use its knowledge of spatial planning to integrate and create new space for nature, residents, water, infrastructure, and urban and rural areas, but to also set the tone for new European collaboration of the protection and integration of the regions alongside the vital Rhine River.</p>
--	--

Graduation project	
Title of the graduation project	Finding Common Water – Localizing water management for an adaptive Rhine River Basin
Goal	
Location:	Rhine River Basin (Netherlands, Belgium, Germany, Luxembourg, France, Switzerland, Liechtenstein, Austria) + Case Study Room of the River Program (Netherlands).
The posed problem,	<p><b><i>Problem Statement</i></b></p> <p>The Rhine River provides drinking water for 60 million Europeans, the large industrial sites of Germany and France, and the 2nd largest agricultural producer in the world. The Rhine River is facilitated by the biggest freshwater reserves in the Alps, but its natural conditions are under threat due to the increasing effects of climate change putting the current water-stable Rhine under pressure. Besides endangering the basin with periods of extremely high water, the most dangerous are the periods of extremely low water leading to intense periods of drought. These droughts not only have the potential to disrupt existing economic and financial infrastructures but also cause major implications on the quantity and quality of surface and groundwater levels for residential and ecological use (UNESCO, 2009; European Environmental Agency, 2018).</p> <p>Furthermore creates increasing uncertainties of discharge flows within the water systems, problems with soil, ecology, and hydrologic subsystems even potentially further extending the effects of climate change. The conflict between the increasing demand for water from all sectors, industrial, agricultural, and energy for production (Water Europe, 2018), and ever-shrinking water</p>

	<p>resources demands a governance framework that facilitates the fair distribution of the burdens and benefits for the use and storage of water resources. The issue arrives from power interests within European and national governance, looking for joint gains to retain existing resource-depleting economies (Van Berge, et al., 2022). In the anthropogenic age of resource depletion, the natural river systems are overlooked and exploited (European Commission, 2019). The need for a representative voice of the river as a natural system seems necessary to rebalance the water distribution of the human and natural systems (Wilk et al., 2019). As the impact and importance of climate change are well-known in European, national, regional, and municipal level governments with the implementation of the EU Green Deal to multiple cross-border and transboundary collaboration programs, implementation of European (water) Legislation in the local context still lacks translation (Moodie, et. al, 2022; Van Rijswijk, 2015). Therefore the need arises for a change in existing water governance arrangements (Teisman &amp; Edelenbos, 2011; Rietveld, et al., 2013; Akamani, 2016). The current Rhine River Basin consists of 8 nations of which 2 are non-EU members, with a combined total of 15 transboundary programs, 3 International commissions of river authorities, and other authorities directed at the hydrological, transportation, and navigation sectors. However, the institutional thickness of European and transboundary policies and the lack of coordination between governments facilitates the growing sense of EU fragmentation within the local context of the European mainland (Nadin et al., 2021; Moodie et al., 2022).</p> <p>As the governance surrounding water systems is boundless to administrative borders (Teisman &amp; Edelenbos, 2011) the need for European authority is necessary to facilitate the interface for national and regional-wide cooperation. As the gap between EU decision-making and local implementation remains a factor for EU fragmentation among societal groups, the concept surrounding active subsidiarity has been researched in recent years to facilitate new stepping stones for the integration of citizen participation measurements in EU spatial planning (Moodie et al., 2021; Moodie et al., 2022). The need for active subsidiarity however lacks the connection with integrated water management although it could be related to Dutch multi-level governance structures in various water management programs. Therefore the relationship between local implementation to EU-based programs should be facilitated from within local conditions and sub-national governance cooperation structures (Akamani, 2016; Carlise &amp; Gruby, 2019; Moodie, et al., 2022).</p>
Research questions	<p><b>Main Research Question:</b></p> <p>How can Active Subsidiarity lead to Adaptive Water Governance mitigating Drought in Rhine River Basin whilst empowering Local and Regional Governances in new programmatic and spatial Water Management arrangements?</p>

	<p><b>RQ1:</b> What does Active Subsidiarity entail in conceptual terms and how can it be implemented in Governance Arrangements?</p> <p><b>RQ2:</b> How is Active Subsidiarity reflected in water management arrangements and how are citizens incorporated into decision-making processes of water governance?</p> <p><b>RQ3:</b> What are the current environmental conditions of the Rhine River Basin considering the increasing danger around future periods of droughts?</p> <p><b>RQ4:</b> What are the spatial implications of drought mitigation strategies as facilitated in localized water management arrangements?</p>
design assignment in which these results.	<p><i><b>Hypothesis</b></i></p> <p>As is explained in the problem statement the conflict over the interest and coordination of water resources and the conflict over the implementation and cooperation of multi-level governance arrangements, do not facilitate the needs necessary for a fair distribution of water resources among its stakeholders. To overcome these conflicts over the interest and collaboration surrounding water resources, the decreasing availability of water resources and the lack of regional and local empowerment has to be tackled. Currently, the power relations between human and natural systems, and between national agendas and local integrations, pose a threat to the fair distribution of water.</p> <p>By recognizing the revitalization of the natural systems and their ability to store water in times of need, and localizing decision-making in water management towards localized water cycles, a more sustainable and fair relationship can be established between the various claims on the use of water resources. As the local relationship with the water can be traced back in history (Boelens, 2016), the underlying cultural aspects of the water and humans should be shared among the various stakeholders.</p> <p>The Dutch Room of the River program will act as a case study on which localized water management was established (Edelenbos, et al., 2016).</p> <p><i><b>Research Aim</b></i></p> <p>This thesis aims to design an adaptive and robust waternet between the locally and regionally newly organized water cycles of the Rhine river basin. Therefore, the programmatic approach of the Dutch Room of the River is investigated and translated into a spatial strategy for local water management arrangements in the Rhine basin. To integrate these newly created local water cycles and management arrangements into real-life scenarios, the investigations of the current management cultures of the Rhine nations, the regional and local water dependencies between stakeholders, and the understanding of the current</p>

	hydrological water systems in the age of the Anthropocene are vital for the formulation of a robust technical system, whilst leaving implementation over the local context.
Process	
Method description	
<p><b>Methodology</b></p> <p>As the proposed research focuses on governance and spatial constructions related to the exploration of drought mitigation in the Rhine river Basin, the methods used in answering the sub-research questions can be considered different from one another. As part of the investigation towards the understanding of the relations to the environmental conditions of the Rhine River Basin, within increasing periods of drought, the need for academic research into the understanding of the underlying geomorphological systems arises. Not only for the creation of a knowledge base for the understanding of the river system but also the potential zoomed-in test locations further up the road. Subsequently, will the methods related to statistical analysis and mapping of these geomorphological systems help to understand the grounded impacts and data of water-related issues. This research will lead toward the understanding of the environmental conditions in the Rhine river basin. Integrated qualitative research concerning specialist interviews would give acknowledging and new insight into the underlying natural but also governance constructions of the existing policies and programs related to the Rhine river basin.</p> <p>Furthermore, will the evaluation of existing EU, national and regional policies and spatial planning practices related to multi-level governance arrangements and citizen participation tools facilitate the underlying gaps in the EU trajectory towards Active Subsidiarity. As the concept of Active Subsidiarity is still not fully understood within the applications of spatial strategies, the need for a spatial definition is vital in further research on the implementation of Active Subsidiarity in water-related spatial planning approaches. Therefore it is vital to understand the existence and current programs of stakeholders related to water management within the Rhine river basin. On the next page, the methods used in this graduation program are more elaborated (Figure 1).</p>	



(Figure 1: Research Methods, Author, 2023)

## Methods

For this project, a mix of quantitative and qualitative research methods will be used. Since the project location of the Rhine is made up of multiple European nation-states, large amounts of quantitative data have been provided to allow for the socio-spatial analysis of climate change threats, natural conditions, water use, distribution, and human systems. Besides that, will the availability of water management policies, programs, and documents, be vital in providing insight into existing ambitions, goals, and responsibilities.

### Academic Literature Study [1]

This method is used especially to understand the current constructs of the European spatial planning sector and its trends towards new forms of governance (active subsidiarity, polycentric governance & territorial governance). Non-site-specific theories about adaptive planning systems, adaptive water governance, and water as a common resource are explored with these methods and will contribute to finalizing the means necessary for the implementation of localized water management.

### Policy and Program Document Research [2]

The use of secondary literature is essential as major transregional projects, organizations, and water management ambitions of (inter)national and regional authorities formulate the current state of water

management in the Rhine basin. These policies and programs surrounding the distribution, use, and management of water as a common resource are vital in understanding current power relations, stakeholder ambitions, and management goals for the sustainable management of water resources.

### **Mapping [3]**

The availability of open-source European datasets provided by the EEA, Eurostat, BGR, CHR, IKSR, and other organizations, stimulates the integration of quantitative research by mapping current spatial configurations of the Rhine River Basin. The method of mapping can bring to light, potential locations for water storage, water distribution bottlenecks, major water use claims, and drought threats. Besides mapping the more quantitative data, historical and cultural analysis of the Rhine river can be visualized in a series of maps, showing the development of the basin. These are vital in understanding the spatial relations of the site and its people.

### **Research by design [4]**

This method is used for the development of drought mitigation strategies on the local, watershed, and regional scales, and later for the development of a programmatic Rhine river basin. It allows for exploratory design research in applying drought mitigation strategies to real-life spatial configurations and assesses the implications it will have for its surroundings.

### **Geospatial Data Research [5]**

Available open-resource datasets provided by the EEA, Eurostat, GRDC (Global Runoff Data Centre), Deltares, IKSR, Landsat, and other organizations, allow for the usage of quantitative data concerning water use, water distribution, river widths, river discharges, and other hydrological systems. Also, the use of quantitative analysis when researching stakeholders and management structures can help provide additional knowledge for the establishment of power relations between stakeholders.

### **Statistical Analysis [6]**

The use of statistical analysis can help provide knowledge on the numbers of water this research is considering applying within localized water management arrangements. As the Rhine river is considered one of the most monitored rivers in the world, the abandonment of water statistics would be a huge loss.

### **Stakeholder Analysis [7]**

As this report aims to localize water management cycles, the understanding of the need, use, and ability to delegate among stakeholders is key. Per watershed level, in the allocated focus regions a list of stakeholders can be established corresponding scale and sector. As the water is shared by these stakeholders, the power relations between stakeholders are also to be analyzed using the Complex Adaptive System (CAS) method of Meyer, et al., 2014.

### **Interviews [8]**

This method is used to investigate the future of the water claims of stakeholders that are dependent on the provision of water of the Rhine. Also, potential environmental adaptation possibilities used by local stakeholders are included in the interviews. As this research depends on the lessons learned from existing integrated water management arrangements, in-depth interviews with professionals regarding hydrological systems, water



management systems, and civil engineers could provide additional information for later created spatial interventions and assessments.

### **Spatial Design Frameworks [9]**

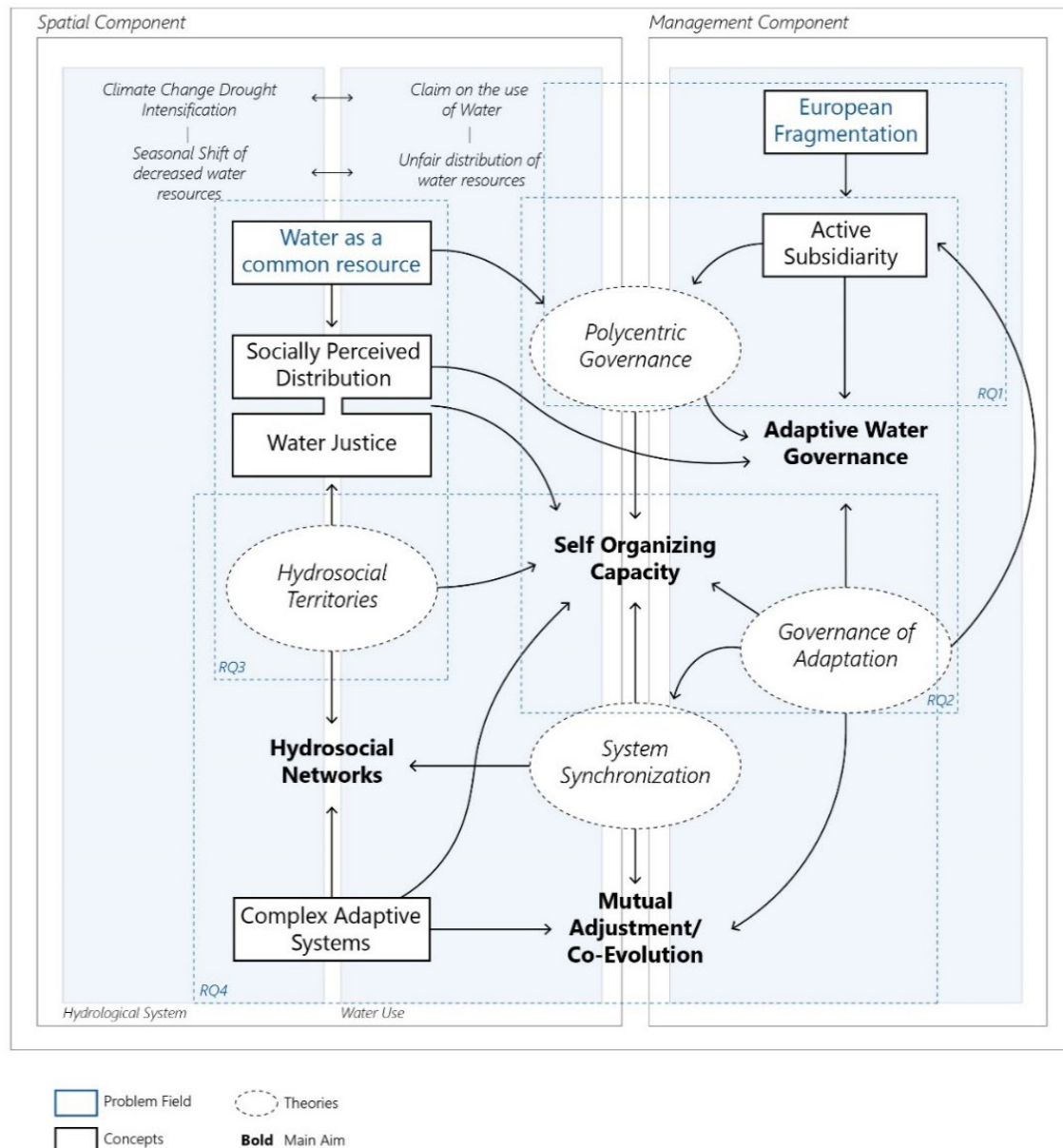
This method is used for the development of a spatial framework of river typologies that can be distinguished from the hydrological and historical contexts. It allows for the formulation of a set of spatial typologies that can be placed around the Rhine river basin. It could also be used for research considering other river basins.

### **Expected Outcomes**

The eventual outcomes will be divided according to four different scales: The EU/National scale will cover the whole Rhine basin, the (trans)regional scale will cover the allocated administrative region(s) toward system synchronization, the regional scale will cover the watersheds that are present within these administrative regions and lastly the local scale where the drought mitigation strategy will be implemented and assessed.

The eventual outcome of this thesis plan is to be able to formulate a Rhine River waternet with localized drought mitigation strategies around the Rhine river through a polycentric and intersectoral governance framework build around the central principle of active subsidiarity. The conceptual framework of the created concept used theories and main aims can be found on the next page (Figure 2). As part of the implementation of active subsidiarity within spatial planning practices between the Rhine nations and their respective multi-level governance collaborations, a policy framework is created to help restructure decision-making processes in water management incorporating both bottom-up approaches from self-organizing decision-making centers of society and top-down guiding principles regarding the distribution of water resources and drought mitigation strategies. This is where the management structure of the Room of the River program will be used as an example.

These frameworks will be tested on specific site locations, chosen by the evaluation of the underlying environmental conditions concerning drought risks in the future. These drought risks are created by analyzing water use, distribution, storage, and stress variables. For the testing of the frameworks on the specific locations, spatial typologies are created concerning specific spatial, often technical, design interventions. The following sections show in more detail the results created from analytical research based on management and governance analysis on the one side [M] and hydrological and system analysis on the other side [W] per created scale level.



(Figure 2: Conceptual Framework. Author, 2023)

#### Rhine river basin [B] (EU/National scale)

[M] On the scale of the Rhine basin, a set of principles from the literature of 'Active Subsidiarity' and 'Adaptive Water Governance' will be created according to academic literature, that can later assess existing policies and programs concerning water management. Analysis of the spatial planning trends and cultures of the Rhine nations is intended to formulate an understanding for later assessment of the applicability of the strategies proposed in this research.

[W] On the scale of the Rhine basin, a set of locations for drought mitigation strategies will be created regarding water stress locations, water distribution nodes, and water storage locations. These locations result from the hydrological analysis of the Rhine river basin. Based on the allocation of these locations, water management

regions will be chosen for further research. Besides that, based on the Room of the River program and the Natural Water Retention Measurements, guiding principles will be created as drought mitigation strategies.

#### **Regional Administration [R] ((trans)regional scale)**

[M] The intended outcome of this section is to show the current relations and management structures of regional water management, their relation to transregional programs, and their involvement in the stimulation of active subsidiarity and adaptive water governance principles. This will be shown in management structures and hierarchies based on the CAS method of stakeholder analysis and power relations.

[W] Again based on the CAS systems this research is intended to analyze the current power relations between sectoral subsystems and their claim on the use and distribution of water, which will be shown in maps. Additional mapping on the historical background of the relation between the water and CAS subsystems will underline the historical timeline factor needed for the potential interaction of system synchronization.

#### **Intermezzo: Room of the River**

[M] The intended outcome of the analysis of the management structures of the Room of the River program will act as a case study for the Rhine river. The management arrangements, local project groups, roles, and responsibilities of stakeholders will facilitate lessons for the like-wise programs of the regional territories of the Rhine river.

[W] Besides the management arrangements acts the strategic framework of the Room of the River is an example of the like-wise overall Rhine river programmatic framework. Strategies taken will be used to formulate simple drought mitigation strategies that are implemented on earlier allocation stress or potential locations.

#### **Watershed [W] (regional scale)**

[M] The intended outcome of the analysis of the management system surrounding the watershed is to create an understanding of the power-interest relations of the localized subsystem stakeholders present. Their relations, water needs, self-organizing capacities, and mutual adjustments are researched through mapping, stakeholder analysis, historical analysis, quantitative research, and stakeholder interviews.

[W] The intended outcome of the hydrological component of this research scale is the creation of a spatial toolbox based on the hydrological and historical characteristics that can formulate 'Hydrosocial territories'. Scalar differences between rivers in the watershed further underline power relations between stakeholders. The intended outcome will create an overview of different river typologies scattered around the watershed. As there are multiple watersheds per administrative regional area, multiple watersheds will be analyzed through the same method. Based according to these river typologies the assessment of the Natural Water Retention Measurements will facilitate an impact assessment of the relationship between river typology and drought strategy.

#### **Local Water Collectives [L]**

[M+W] The intended outcome of the local project groups is to zoom into a drought mitigation strategy and determine the roles and responsibilities of the created design groups, consisted out of residents, citizen

organizations sectoral organizations, researchers, experts, and public authorities. The idea is to create a sustainable self-organized water cycle between the parties involved in the project groups.

*Zooming out:*

**Watershed [W] (regional scale)**

Based on previous outcomes a watershed-based water cycle can be created, where responsibilities, strategies, and water distribution and use will facilitate mutual adjustment between stakeholders. In this story, the drought strategies form the links in the water cycle.

**Regional Administration [R] ((trans)regional scale)**

Reflection of watershed-based water cycles on the regional scales. The same CAS method will be used to show the differences before and after. Assessment will be given on system synchronization and the relations and impacts created by the separate watershed cycles on each other.

**Rhine river basin [B] (EU/National scale)**

To go one scale further, the new system interactions of the regional scales will be allocated in a new management structure based on active subsidiarity and adaptive water governance principles to stimulate coordination and the transmission of knowledge between regions on a horizontal line and towards a polycentric vertical governance system.

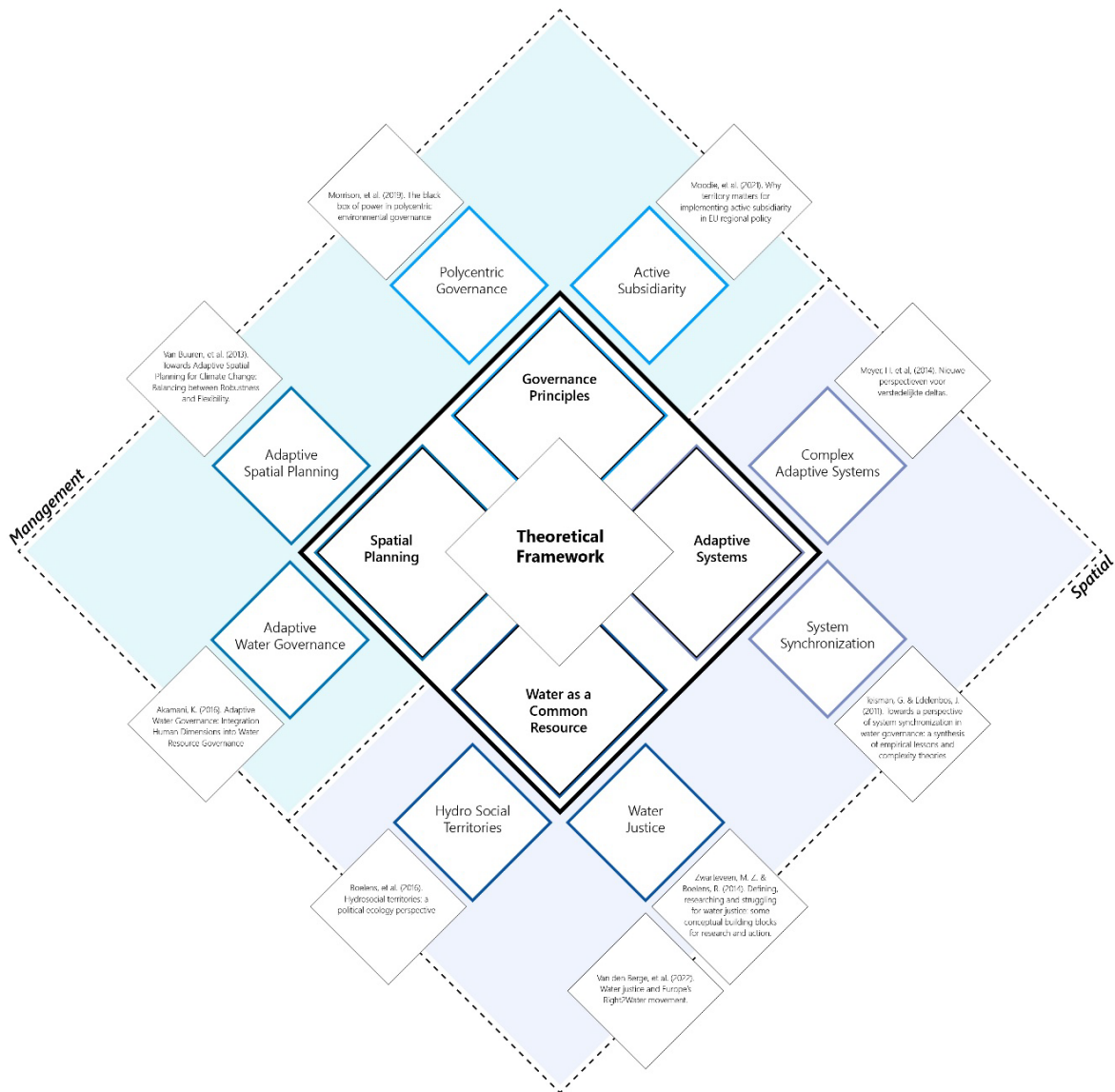
On the next page, the total research framework is shown (Figure 4).



## Literature and general practical preference

### Theoretical Framework

The following theories and concepts are used as a guiding theme for this thesis project and strive towards the fair allocation and distribution of water resources among the various levels of governance (Figure 3).



(Figure 3: Theoretical Framework. Author, 2023)

### Literature

#### *Governance Principles*

Carlisle, K. & Gruby, R.L. (2019), Polycentric Systems of Governance: A Theoretical Model for the Commons. *Policy Stud J*, 47: 927-952. <https://doi.org/10.1111/psj.12212>

Moodie, J. R., Salenius, V. & Wøien Meijer, M. (2022) Why territory matters for implementing active subsidiarity in EU regional policy, *Regional Studies*, 56:5, 866-878, DOI: 10.1080/00343404.2021.1966404

Morrison T.H., Adger W.N., Brown K., Lemos M.C., Huitema D., Phelps J., Evans L., Cohen P., Song A.M., Turner R., Quinn T. & Hughes, T.P. (2019). The black box of power in polycentric environmental governance, *Global Environmental Change*, Volume 57, 2019, 101934, ISSN 0959-3780, <https://doi.org/10.1016/j.gloenvcha.2019.101934>

Purkharthofer, E., Sielker, F. & Stead, D. (2022) Soft planning in macro-regions and megaregions: creating toothless spatial imaginaries or new forces for change? *International Planning Studies*, 27:2, 120-138, DOI: 10.1080/13563475.2021.1972796

### *Spatial Planning*

Akamani, K. (2016), Adaptive Water Governance: Integrating the Human Dimensions into Water Resource Governance. *Journal of Contemporary Water Research & Education*, 158: 2-18. <https://doi.org/10.1111/j.1936-704X.2016.03215.x>

Gupta, J., Termeer, C., Klostermann, J., Meijerink, S., van den Brink, M., Jong, P., Nooteboom, S. & Bergsma, E. (2010). The Adaptive Capacity Wheel: a method to assess the inherent characteristics of institutions to enable the adaptive capacity of society, *Environmental Science & Policy*, Volume 13, Issue 6, 2010, Pages 459-471, ISSN 1462-9011, <https://doi.org/10.1016/j.envsci.2010.05.006>

Rietveld, P., Van Buuren, A., Teisman, G., Salet, W., Driessen, P.P.J., Rijswijk, H.F.M.W. & Spit, T.J.M. (2013). Towards Adaptive Spatial Planning for Climate Change: Balancing Between Robustness and Flexibility. *Journal for European Environmental & Planning Law*. 10. 29-53. 10.1163/18760104-01001003.

### *Adaptive Systems*

Meyer, V. J., Bregt, A. K., Dammers, E., & Edelenbos, J. (2014). Nieuwe perspectieven voor een verstedelijkte delta: naar een methode van planvorming en ontwerp. MUST Publishers.

Teisman, G. R., & Edelenbos, J. (2011). Towards a perspective of system synchronization in water governance: A synthesis of empirical lessons and complexity theories. *International Review of Administrative Sciences*, 77(1), 101-118. <https://doi.org/10.1177/0020852310390121>

### *Water as a Common Resource*

van den Berge, J., Vos, J., & Boelens, R. (2022). Water justice and Europe's Right2Water movement. *International Journal of Water Resources Development*, 38(1), 173-191. <https://doi.org/10.1080/07900627.2021.1898347>

Boelens, R., Hoogesteger, J., Swyngedouw, E., Vos, J., & Wester, P. (2016). Hydrosocial territories: a political ecology perspective. *Water International*, 41(1), 1-14. <https://doi.org/10.1080/02508060.2016.1134898>

Zwarteveen, M. Z., & Boelens, R. (2014). Defining, researching and struggling for water justice: some conceptual building blocks for research and action. *Water International*, 39(2), 143-158. <https://doi.org/10.1080/02508060.2014.891168>

### *Definition of Drought*

Dracup, J. A., Lee, K. S. & Paulson, Jr., E. G. (1980). On the Definition of Droughts. *Water Resources Research*, Vol. 16, No. 2, pages 297-302, 1980. School of Engineering and Applied Sciences, University of California, Los Angeles, United States.

Tate, E.L., Gustard, A. (2000). Drought Definition: A Hydrological Perspective. In: Vogt, J.V., Somma, F. (eds) *Drought and Drought Mitigation in Europe*. *Advances in Natural and Technological Hazards Research*, vol 14. Springer, Dordrecht. [https://doi.org/10.1007/978-94-015-9472-1\\_3](https://doi.org/10.1007/978-94-015-9472-1_3)

### **Analytical Documents:**

#### **European Governance**

European Commission. (2018a). The principles of subsidiarity and proportionality: Strengthening their role in the EU's policymaking (COM (2018) 703 final). <https://ec.europa.eu/info/publications/communication-principles-subsidiarity-and-proportionality-strengthening-their-role-eu-policymaking>



European Commission. (2018b). Active subsidiarity: A new way of working. Report of the Task Force on Subsidiarity, Proportionality, and Doing Less More Efficiently. [https://ec.europa.eu/info/sites/default/files/report-task-force-subsidiarityproportionality-and-doing-less-more-efficiently\\_en.pdf](https://ec.europa.eu/info/sites/default/files/report-task-force-subsidiarityproportionality-and-doing-less-more-efficiently_en.pdf)

Nadin, V., Stead, D., Dąbrowski, M., & Fernandez-Maldonado, A. M. (2021). Integrated, adaptive and participatory spatial planning: trends across Europe. *Regional Studies*, 55(5), 791–803. <https://doi.org/10.1080/00343404.2020.1817363>

### **Water Management & Policies**

Delacámara, G., Gomez, C. M. & Maestu, J. (2015). Water Trading Opportunities and Challenges in Europe. Routledge Handbook of Water Economics and Institutions (p. 279-293) Chapter: 17, Publisher: Routledge.

European Environmental Agency. (2018). European waters. Assessment of status and pressures 2018. EEA Report, No 7/2018. ISSN 1977-8449

European Environmental Agency. (2021). Water resources across Europe – confronting water stress: an updated assessment. European Environmental Agency, 2021. Publications Office of the European Union, Luxembourg. ISBN 978-92-9480-391-7. doi: 10.2800/320975

European Environmental Agency. (2022). Europe's groundwater – a key resource under pressure. European Environmental Agency. TH-AM-22-003-EN-N - ISBN: 978-92-9480-459-4 - ISSN: 2467-3196 - Doi: 10.2800/50592

IKSR. (2020). Rhine 2040. The Rhine and its Catchment: Sustainably Managed and Climate-resilient. 16<sup>th</sup> Ministerial Conference, February 13<sup>th</sup>, 2020, Amsterdam, Netherlands.

IKSR. (2021). International flood risk management plan for the International River Basin District "Rhine" (Part A) (catchment areas > 2.500 km<sup>2</sup>). Second cycle of the FD (period 2022-2027). Final version: December 2021. International Commission for the Protection of the Rhine, Koblenz, Germany.

OECD. (2015). OECD Principles on Water Governance. Adopted by the OECD Regional Development Policy Committee on 11 May 2015. Centre for Entrepreneurship, SME's, Regions and Cities.

Panten, K., van Heel, B. F., Fliervoet, J. M., & van den Born, R. J. G. (2018). Cross-Border Collaboration in River Management: Views on Participation in a Dutch-German Case Study. *Water Resources Management*, 32(12), 4063–4078. <https://doi.org/10.1007/s11269-018-2039-9>

UNESCO. (2009). Atlas of Transboundary Aquifers. Global maps, regional cooperation and local inventories. UNESCO-IHP ISARM Programme.

Water Europe – The European Technology Platform for Water. (2018). The Value of Water. Water Sheikhs & Dam Builders, 65–82. <https://doi.org/10.4324/9781351321525-6>

### ***Room of the River***

De Bruijn, H., De Bruijne, M., & Ten Heuvelhof, E. (2015). The politics of resilience in the Dutch 'Room for the River'-project. *Procedia Computer Science*, 44(C), 659–668. <https://doi.org/10.1016/j.procs.2015.03.070>

Klijn, F., Asselman, N., & Wagenaar, D. (2018). Room for rivers: Risk reduction by enhancing the flood conveyance capacity of The Netherlands' large rivers. *Geosciences (Switzerland)*, 8(6). <https://doi.org/10.3390/geosciences8060224>

Rijke, J., Van Herk, S., Zevenbergen, C., & Ashley, R. (2012). Room for the River: Delivering integrated river basin management in the Netherlands. *International Journal of River Basin Management*, 10(4), 369-382. doi:10.1080/15715124.2012.739173



## Hydrological & Rhine Systems

Bettina Wilk, Dries L. T. Hegger <https://orcid.org/0000-0003-2721-3527>, Carel Dieperink <https://orcid.org/0000-0002-1926-4642>, Rakhyun E. Kim <https://orcid.org/0000-0002-1308-6849> & Peter P. J. Driessen <https://orcid.org/0000-0002-0724-6666> (2019) The potential limitations on its basin decision-making processes of granting self-defence rights to Father Rhine, *Water International*, 44:6-7, 684-700, DOI: 10.1080/02508060.2019.1651965

Frings, R.M, Hildebrand, G., Gehres, N. & Banhold, K. (2019). From source to mouth: Basin-scale morphodynamics of the Rhine River. *Earth-Science Reviews*. 196. 10.1016/j.earscirev.2019.04.002.

Klijn, F., Asselman, N., Mosselman, E., & Sperna Weiland, F. (2019). Klimaatadaptatie in het rivierengebied: Een geo-ecologisch perspectief. *Landschap: tijdschrift voor landschapsecologie en milieukunde*, 36(2),

Mosselman, E. (2022). The Dutch Rhine branches in the Anthropocene – Importance of events and seizing of opportunities. *Geomorphology*, 410, 108289. <https://doi.org/10.1016/j.geomorph.2022.108289>

Preusser, F. (2007). Characterisation and evolution of the Rhine River system. *Netherlands Journal of Geosciences – Geologie en Mijnbouw*, 87-1, 7-19, 2009. Published online by Cambridge University Press  
<https://doi.org/10.1017/S0016774600024008>

Redeker, C. (2018). Rhine Cities – Urban Flood Integration (UFI). German and Dutch Adaptation and Mitigation Strategies

Wantzen, K. M., Leuven, R.S.E.W. & Arndt, H. (2009). The Rhine River Basin. First publ. in: *Rivers of Europe* / Klement Tockner u.a. - London: Acad. Pr., 2009, pp. 199-245 - ISBN 978-0-12-369449-2. 10.1016/B978-0-12-369449-2.00006-0.

## Water Data

Bergsma, T., Querner, E.P. & van Lanen, H.A.J. (2010). Studying the Rhine basin with SIMGRO. Impact of climate and land use changes on discharge and hydrological droughts. Alterra-report 2082, Alterra Wageningen, UR, Wageningen, Netherlands. Commissioned by the Dutch Ministry of Agriculture, Nature and Food Quality. ISSN 1566-7197

IKSR. (2011). Study of Scenarios for the Discharge Regime of the Rhine. International Commission for the Protection of the Rhine, Koblenz, Germany. ISBN 3-935324-70-7

Rottler, E., Bronsert, A., Bürger, G. & Rakovec, O. (2021). Projected changes in Rhine River flood seasonality under global warming. *Hydrology and Earth System Sciences*. 25. 2353-2371. 10.5194/hess-25-2353-2021.

Vandecasteele, I., Rivero, I., Baranzelli, C., Becker, W., Dreoni, I., Lavalle, C. & Batelaan, O. (2018). The Water Retention Index: Using land use planning to manage water resources in Europe. *Sustainable Development*. 26. 122-131. 10.1002/sd.1723.

Van der Kogt, W., Passchier, R. & Hegnauer, M. (2021). RIBASIM River basin simulation model of the Rhine – Volume 1 Main Report. Published by Deltares, Delft, Netherlands. Commissioned by the International Commission for the Hydrology of the Rhine basin (CHR). 11205564-000-ZWS-0002

## River Typologies

Lemm, J. Venohr, M., Globevnik, L., Stefanidis, K., Panagopoulos, Y., Gils, J., Posthuma, L., Kristensen, P., Feld, C., Mahnkopf, J., Hering, D. & Birk, S. (2020). Multiple stressors determine river ecological status at the European scale: Towards an integrated understanding of river status deterioration. *Global Change Biology*. 27. 10.1111/gcb.15504.

Rinaldi, M., Bussetini, M., Surian, N., Comiti, F. & Gurnell, A.M. (2016). Guidebook for the evaluation of stream morphological conditions by the Morphological Quality Index (MQI).

## Reflection

1. What is the relation between your graduation (project) topic, the studio topic (if applicable), your master track (A,U,BT,LA,MBE), and your master programme (MSc AUBS)?

This graduation project aims to coordinate existing water management cultures of the Rhine nations towards creating an adaptive and robust Rhine river waternet. Therefore resolution needs to be found within the underlying claims public, private and civil authorities have on the usage of water as a common resource. For the creation of this waternet, a large focus is put on understanding of one side the natural systems of the hydrological network of the Rhine and the water management sector from European governance arrangements to local collective water practices. Therefore this graduation project aims to move through the various spatial scales, to test and evaluate the viability of the outcomes. As the master track of Urbanism specifically focuses on different research methods that move towards a spatially just future, the question surrounding the fair distribution of water resources among its users will, in a time of uncertain availability of resources, need more attention.

2. What is the relevance of your graduation work in the larger social, professional and scientific framework.

### *Scientific Relevance*

There has been a lot of research related to the impact of climate change on current river systems in the world and also on the integration of EU policies within citizen engagement and participation strategies. As large climate adaptation strategies surrounding large multi-level governance structures in the Netherlands have been implemented with the Room of the River program and now with the Delta and HWBP programs of the future, the question remains of the implication potentials of like-wise governance structures within a European and therefore also within a water governmental context. The new concept of active subsidiarity in EU decision-making and citizen participation strategies still needs spatial planning implementations in the local contexts as the concept is still not visible in a locally grounded context. These spatial implementations to eventually mitigate drought risks on the increasingly uncertain available water resources will have an impact on the local context where the risk is deemed to be most apparent. As impact assessment of flooding impacts on local context can be widely implemented in 'western' practices but the rebalancing of the human and natural systems under the umbrella of drought mitigation is still unknown. As flood and drought mitigation is largely overlapping concepts, the impacts are different. Therefore results on drought mitigation might need new spatial recognition in the field of integrated water management.

### *Social Relevance*

The increasing occurrence of major droughts in the future of the Rhine River basin connects to the ethics of a fair distribution of water resources in the upcoming conflicts of water distribution among subsystems. The 'Right to Water' is a human right in EU policies but also facilitates global economic and transportation systems. The need for responsibility for the conservation, consumption, and protection of stressed surface and groundwater basins across administrative borders call for an equal voice from human and particularly the ecological and geological systems of the rivers.

But most important is the combination of both concerning the cultural identity of the water systems over the world bringing to the table the debates on EU citizen involvement and climate change adaptation that impact the local scales of society through macro-regional strategies surrounding the river basins as the administrative boundaries.