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Development of methods to combine social network analysis and institutional logics applied to research projects in the urban water sector

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Master's thesis

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Summary [English]

Development of methods to combine social network analysis and institutional logics applied to research projects in the urban water sector.

Nowadays, a paradigm shift in the urban water sector is observable: while hierarchical governance structures were present in the past, many currently relevant challenges are characterized by a higher complexity, requiring novel approaches. Therefore, *network governance*, a term describing a coordination based on broad social participation instead of hierarchical orders, is gaining popularity. Similar to the change in governance structure, an altered approach is experienced in regard to *institutional logics*, a perspective describing the rationalities, values and actions of people. While the technically-oriented *hydraulic logic* has been dominating the urban water sector in the past, two alternative approaches are rising, namely the *water market* and *water sensitive logics*, being focused on the economic and the environmental aspects of water management, respectively. To understand how current and future challenges regarding climate change are being approached by researchers, different sociological concepts have to be united.

Founded on a literature-based enquiry, this thesis aims to develop methods in order to combine the two concepts of social network analysis and institutional logics. The developed methods are practically implemented in form of case study research, pursuing the goal to determine the extent of the paradigm change in two research networks. The application is focused on two cases: one research group based in Germany and another group from Norway, each working on current challenges in the urban water sector. Utilized methods include the assessment of project documentation and expert interviews. Moreover, a questionnaire is created and distributed in the research groups ‘Klima 2050’ (NOR) and ‘KURAS’ (GER). The collected network data is analyzed and visualized using UCINET, whereas statistical analysis is performed with SPSS.

The final comparison of both research projects reveals striking similarities concerning both, the network characteristics as well as the distribution of institutional logics. Additionally, differences between both projects are examined. Conclusively, the benefit of the developed methods is evaluated, limitations are addressed, and future perspectives are proposed, considering the methods to provide a basis for the scientific community to pursue various studies on topics that have not been analytically linked before.

Zusammenfassung [Deutsch]

Entwicklung von Methoden zur Verbindung von sozialer Netzwerkanalyse und institutioneller Logiken, angewandt auf den städtischen Wassersektor.

Im städtischen Wassersektor ist ein Paradigmenwechsel erkennbar: Während hierarchische Führungsstrukturen sich in der Vergangenheit etabliert haben, zeichnen sich viele aktuelle Herausforderungen durch eine höhere Komplexität aus und erfordern daher neuartige Lösungsansätze. Dementsprechend gewinnt die *Network Governance* zunehmend an Bedeutung, ein Begriff, der Koordination und Lenkung auf der Basis einer breiten Beteiligung anstatt von vertikalen Weisungsstrukturen, beschreibt. Ein vergleichbarer Wandel vollzieht sich hinsichtlich der *institutionellen Logiken*, einer Perspektive, welche die Denkweise, zugrundeliegende Werte und resultierende Handlungen von Menschen beschreibt. Historisch wurde der städtische Wassersektor von der technisch-orientierten *Hydraulic Logic* dominiert, jedoch zeichnen sich in Form von *Water Sensitive* und *Water Market Logic* zwei alternative Ansätze ab, welche sich auf die ökonomischen sowie ökologischen Aspekte des Wassermanagements fokussieren. Um zu erforschen, wie sich Forscher den heutigen und zukünftigen Herausforderungen angesichts des Klimawandels annehmen, müssen verschiedene soziologische Konzepte vereint werden.

Diese Masterarbeit beschäftigt sich mit einer auf Literaturrecherche basierenden Entwicklung von Methoden zur Verknüpfung zweier Konzepte: der sozialen Netzwerkanalyse sowie der institutionellen Logiken. Die entwickelten Methoden werden im Rahmen von Fallstudienforschung praktisch angewandt, mit dem Ziel, den aktuellen Stand des beschriebenen Paradigmenwechsels anhand von zwei Forschungsprojekten festzustellen. Hierbei werden zwei Fälle betrachtet, einer in Deutschland und einer in Norwegen. Beides sind Vereinigungen von Forschern, die an aktuellen Themen im Wassersektor arbeiten. Zu den verwendeten Methoden zählt die Auswertung von Projektdokumenten sowie Experteninterviews. Zusätzlich wird ein Fragenkatalog erstellt und innerhalb der Forschungsgruppen „Klima 2050“ (NOR) und „KURAS“ (GER) verteilt. Die auf diesem Wege gesammelten Daten werden genutzt um sowohl mittels UCINET das soziale Netzwerk zu visualisieren und zu analysieren, als auch mit Hilfe von SPSS statistische Analysen anzufertigen.

Schlussendlich offenbart der Vergleich beider Forschungsprojekte bemerkenswerte Ähnlichkeiten in Bezug auf Netzwerkcharakteristika sowie die Verteilung der institutionellen Logiken. Ebenfalls werden verschiedene Abweichungen zwischen beiden Projekten betrachtet. Abschließend werden die entwickelten Methoden hinsichtlich ihres Nutzens evaluiert, Einschränkungen der Studie werden adressiert und Zukunftsaussichten vorgeschlagen. In diesem Sinne werden die Methoden der wissenschaftlichen Gemeinschaft, als Grundlage für verschiedenartige Studien von bislang analytisch nicht verknüpften Themen, zur Verfügung gestellt.

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1 Introduction

Our society faces many challenges due to significant environmental changes of the last decades. In particular utility sectors, e.g. energy and water, have to counteract the impacts of global warming. Forecasts predicting severely increased water stress by 2050 call for workable approaches (Alcamo, Flörke, & Märker, 2007). While innovative technologies, new governance modes and changes in consumer behavior have been promoted to address imminent problems, the transformation is slower than assumed. Technologies do not spread effectively, governance changes are only implemented in theory and consumers do not behave as expected (Fuenfschilling & Truffer, 2014).

1.1 Relevance

Historically, engineers have been confronted with problems that were for the most part characterized by linear cause and effect relationships allowing for predictive models and best-practice solutions. Increasing efficiency was the primary goal, which was achieved through subdivision of problems into various elements, that could be optimized individually (Kurtz & Snowden, 2003). Roberts (2000) defines these problems as 'type 1 problems', which are characterized by a commonly known and generally accepted definition and solution of the problem. Many challenges, that society faces nowadays, differ from these experiences in the way that they are more intricate and the whole is not the sum of the parts. These 'type 2 problems' have a higher complexity and require a different approach. Every act changes the entire system, negating any optimization method that relies on optimizing the parts of the system. Instead, allowing elements to run sub-optimally is necessary to increase performance of the system as a whole. Such challenges are different from the known, since cause and effect patterns may not be predicted from the outset but only discovered during the course of action (Kurtz & Snowden, 2003). While stakeholders may accept the problem definition, there is no agreement on which solution should be implemented, which results in conflict. Beyond that, Roberts (2000) establishes the term 'type 3 problem', also known as *wicked problem*, which describes settings with a complete lack of agreement on the problem's definition. Interested parties perceive numerous aspects of the situation to constitute the main problem and consequently favor varying solutions. Time, resource and political constraints interfere with the problem solving process and are constantly changed because public officials and managers revise their priorities, miscommunicate or the whole stakeholder composition shifts (Conklin & Weil, 1997).

Applied to the *urban water services* (UWS), this development is reflected in the sense that water management tools, which have been successful in fulfilling water supply as well as wastewater and stormwater drainage functions for over one century, are doubted to be effective in addressing current issues regarding environmental, sustainability and livability objectives (Gleick, 2000; Larsen & Gujer, 1997). Simple problems in the past, specifically type 1 problems, could be solved with straightforward methods of resolution, however water managers are currently confronted with problems that are of a more complex nature and force them to face various challenges from growing societal expectations to climate change, declining water resources, decaying infrastructure, population growth and increased institutional complexity (Brown, Keath, & Wong, 2009). Water management strategies followed a rigid command and control approach based on the assumption that effects of management interventions are fully observable and can hence be optimized through calculations and reduction of the system into elements that are controlled separately (Pahl-Wostl, Jeffrey, Isendahl, & Brugnach, 2011). As long as systems are more or less stable, and events can be reliably predicted, these measures continue to perform effectively, but once systems develop unexpected behavior, traditional management tools are not flexible enough to handle changes that are not of a linear nature. More suitable to problems of type 2 and 3 is a looser management approach that focuses on setting a direction through rules and goals while appreciating more freedom in the fulfillment of tasks. Hence, this flexible concept is more capable of addressing complex matters compared to rigid plans relying upon extensive prediction and control mechanisms (Pahl-Wostl et al., 2011). Consequently, a paradigm shift is developing and while both paradigms have distinctive differences as depicted in Table 1, the current situation of the urban water sector is not explicitly associated with one of them. In fact the sector is argued to be in a transition between both paradigms, the actual transition stage being unclear, but theoretic research supposedly being far ahead of practical implementations (Pahl-Wostl et al., 2011).

The urban water sector encounters climate change effects that result in various challenges, such as frequent cloud bursts, urban flooding, water demand peaks and higher environmental requirements, which require a revised approach and increase transformation pressure on the sector. This transformation is represented in recent research literature, with two important constituents being the emerging concept of network governance (Provan & Kenis, 2008; Sørensen & Torfing, 2016) as well as evolvements towards increased sustainability demands (Fuenfschilling & Truffer, 2014; Markard, Raven, & Truffer, 2012; Van den Bergh, Truffer, & Kallis, 2011). Assumptions and characteristics of traditional water management are questioned due to new insights and changed perspectives in research literature (Pahl-Wostl et al., 2011). The role of governance gains more importance, as emphasized by the Organisation for Economic Cooperation and Development (OECD), that attributes the current crisis in the water sector primarily to governance issues and not to technological problems (OECD, 2011). To understand this, governance needs to be defined, but there are large disagreements between different scholars. Therefore, instead of using a general definition of governance, this thesis will rely upon a definition of governance in the urban water sector, as “collaborative social practices and their supporting and resulting social structures that allow individuals to organize for the provision of UWS” (Franco-Torres, 2018). Instead of narrowing attention on the government as the sole policy maker, water management topics have been enlarged by the idea of multi-level governance contributing to decision-making processes through various actors from diverse institutional settings (Mayntz, 2003).

1.2 Purpose

How does our society and particularly the academic branch approach these new challenges? To understand the extent of this transformation among the scientific community, this thesis will highlight both, social networks of researchers as well as paradigms and priorities prevalent among them. Social network analysis is applied in order to investigate how researchers cooperate and which actors occupy central roles in the network (Borgatti, Everett, & Johnson, 2013). To analyze how researchers perceive reality and according to which beliefs, norms and values they act, the perspective of institutional logics is implemented (Thornton & Ocasio, 2008).

Society can be classified to consist of three levels, which Thornton & Ocasio (2008: 104) describe as "individuals competing and negotiating, organizations in conflict and coordination and institutions in contradiction and interdependency". In this regard, institutions are understood as formal and informal rules that a society is based on (W. R. Scott, 2013). While organizations and institutions constitute opportunities and boundaries for individual behavior, institutions themselves are created by individuals and organizations (Berger & Luckmann, 1967). Therefore all three levels of society are influencing each other. Thornton & Ocasio (2008) criticize that previous research has mostly focused on either one of the mentioned levels while losing sight of the other two components. This thesis tries to address this concern through consideration of all three levels defining society: institutional logics (level three), the social network of a research organization (level two) as well as interconnected individuals, partaking in this network (level one).

Table 1: Two water management paradigms and their manifestation in characteristics of the water management regime (Pahl-Wostl, 2007b)

Dimension	Prediction, control paradigm	Integrated, adaptive paradigm
Governance style	Centralized, hierarchical. Narrow stakeholder participation	Polycentric, balance between bottom-up and top-down processes. Broad stakeholder participation
Infrastructure	Massive, centralized infrastructure. Single sources of design and power delivery	Combination of centralized and decentralized infrastructure. Diverse sources of design and power delivery
Finances and risk	Financial resources and risk are concentrated on structural protection	Financial resources and risk are diversified using a broad set of private and public financial instruments
Dealing with uncertainties	Uncertainties are perceived as undesirable signs of incomplete knowledge. Emphasis lies on reducing uncertainties. Influence of different perspectives is largely ignored.	Irreducible uncertainties are accepted. Emphasis lies on robust strategies to deal with uncertainties. Influence of different perspectives is explicitly acknowledged.

2 Background

To assess the progress of the aforementioned paradigm change, among research groups that are studying urgent challenges in the urban water sector, this thesis will investigate the research group's social network and combine the results with an analysis of present institutional logics. This approach aims to determine priorities and values prevalent in the group as a whole and among its individual members. The subsequent chapter will describe social network analysis as a tool, including an emphasis on its historical development. An introduction of institutional logics, the use of this meta-theory as an analytical method as well as its origin will be outlined afterwards.

2.1 Social network analysis

Social networks have been increasingly receiving attention over the past decades, producing popular results such as Travers and Milgram's small-world experiment, stating that any randomly selected pair of people in the United States trying to reach each other, are separated by only five to six people on average (Travers & Milgram, 1967). While the concept of social networks has become omnipresent in our society through social media and 'social networking' websites, the original idea of social networks in sociology is more extensive and much older. At first, social network analysis was developed to explore how "interweaving" social actions are organized in the "web" of social life, terms introduced by German theorists Simmel (1920), Vierkandt (1928) and Von Wiese (1933). Since the 1930s, researchers have started to systematically utilize mathematics in order to identify network parameters, such as density and connectedness. The modern techniques of social network analysis originate from work of the 1970s, when analytics became increasingly technically oriented and were merged with knowledge from previous writings of sociometric analysts, social anthropologists and psychologists. As depicted in Figure 1, there has been a rising trend to include social networks in social science literature since 1975, which increased even further since the mid-1990s. While these analysis concepts have been gradually improved over the years as well as applied to a wider range of fields, the highly mathematical and technical nature of social network analysis has also posed a challenge to many researchers interested to incorporate these techniques into their studies (J. Scott, 2017).

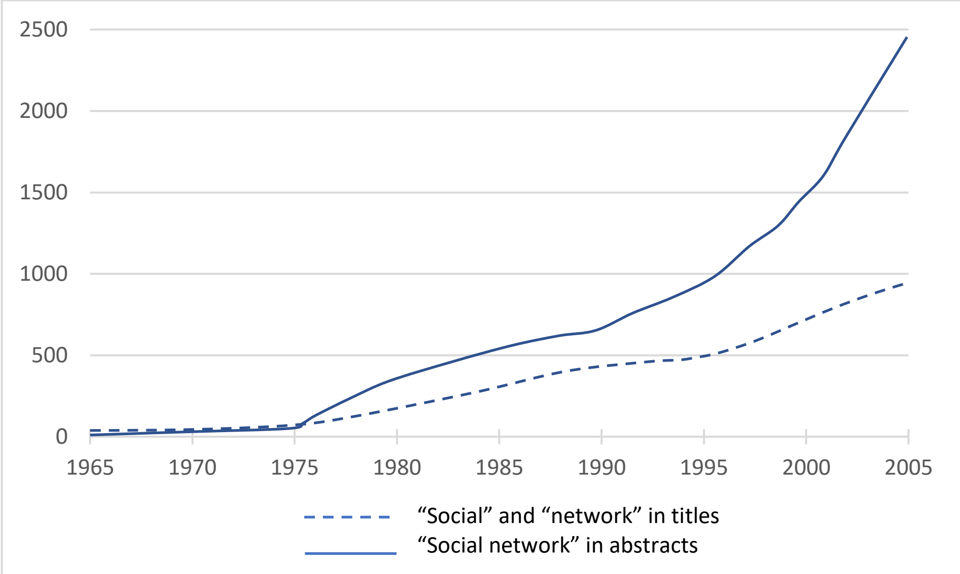

Figure 1: Growth of social networks as key concepts in social science literature (Knoke & Yang, 2008)

The study of social networks enables researchers to discover valuable correlations between network-related attributes, such as the centrality of an actor, and non-network attributes, for example an actor’s gender. One practical example is a study concerning public health innovation by Becker (1970), that showed which medical doctors adopted new drugs first. When a new drug was deemed relatively safe, central doctors, those that have many ties, are well-known and respected, would adopt the new pharmaceuticals first. A controversial drug on the other hand would be adopted substantially earlier by marginal doctors, who have far fewer ties and would not focus on protecting their professional reputation as much as central doctors, that were highly conforming to norms. Kerckhoff & Back (1965) conducted a different study with a similar conclusion. The workers of a textile plant in the USA were successively infected by a disease, that was allegedly transmitted by the bite of an insect. When most workers had become numb and weak, the factory was closed. Based on questions about each worker’s friends, a subsequent social network analysis showed that the first workers, who had reported their illness, were social isolates being rarely to never named by their colleagues. As the symptoms were unusual, most of the ‘first adopters’ were marginal actors, whereas central ones did not report their illness because of social pressures. Only when more and more workers became infected and the illness spread in the social network, actors of increasing centrality started to call in sick. Both studies show how controversial innovations are initially implemented by marginal actors, later to be spread among actors of a higher social integration (Granovetter, 1973).

Thus, one of the major reasons to study networks is the hypothesis that by setting constraints and opportunities, an actor’s position in a network partly determines his behavior and beliefs. Hereof, networks are regarded as social systems that concentrate on relationships between actors in the system. Depending on the study’s focus these actors – also called nodes – mostly represent individuals but can be collectivities e.g. teams and firms as well. Actors are characterized by attributes and form relationships with each other – also called ties. While social networks deal with relationships between individuals and organizations, they do not differ significantly from networks faced in other scientific fields in regard to their analysis. The common ground among networks from fields, such as computer science, physics, genetics or social science, is constituted by a mathematical foundation called graph theory. Beside matrices, graphs represent one of the most frequently used ways to conceptualize networks and consist of two sets: one set of nodes and one set of ties. If two nodes are connected by a tie, they are called adjacent. The more ties a specific node has, the higher is its *degree* in the network. A node with only one tie is named *pendant*, a node without any ties on the other hand is called *isolate*. If ties have a logical direction they are called directed and describe for instance who receives advice from whom, or who is the parent of whom, whereas undirected ties that depict e.g. friendships and acquaintanceships, because no logical direction is evident or every relation is reciprocated (Borgatti et al., 2013). A visual representation of nodes and ties, such as the depiction in

Figure 2, creates a web that is typically associated with social networks.

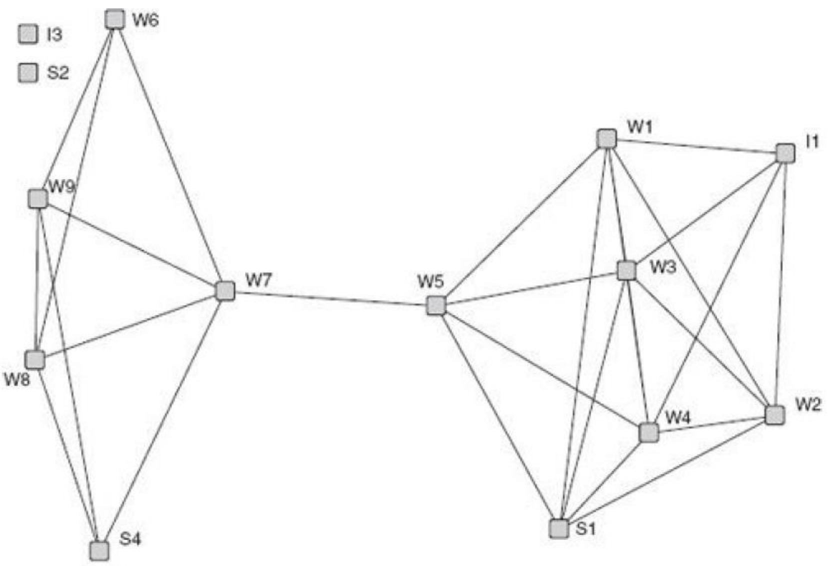

Figure 2: Network depicting a relation within a bank (Borgatti et al., 2013)

Two nodes that are not adjacent may still be able to communicate and pass information via other nodes. In Figure 2, nodes W6 and W1 are not adjacent, but information can pass from W6 to W7, afterwards to W5 and finally reach W1. A sequence of nodes is called a *walk*. In this case, every node is only visited once and hence, this special kind of walk is also called *path*. The sequence W6-W7-W8-S4-W8-W9 for example, is not a path, because W8 is visited twice. The length of a path is defined as the number of its edges. The shortest path between two nodes is called *geodesic*, conclusively the shortest distance between two nodes is called *geodesic distance* (Borgatti et al., 2013).

Beside the investigation of tie connections between actors, a second layer of analysis assesses the strength of interpersonal ties. Granovetter (1973:1361) divides ties into 'strong' and 'weak' ties and defines the strength of a tie as a "combination of the amount of time, the emotional intensity, the intimacy (mutual confiding), and the reciprocal services which characterize the tie", the individual parameters being independent, but intercorrelated. One popular assumption states that the overlap of two actors' networks correlates with the strength of their mutual tie. Furthermore, tie strength influences several aspects from the diffusion of information and the influence of nodes to social cohesion and community organization. A major impact of tie gradation lies in the concept of *bridges*, which describe ties that constitute the only path between two nodes A and B. Said bridges are key factors in networks, as they represent the only way along which information, influence or opinions may pass from any contact of A to any contact of B. The adjacent nodes W7 and W5 in Figure 2 are linked by a bridge, that establishes the only connection between the left and right network groups. Both nodes are called *cutpoints*, because if either of them would be eliminated, the network would be divided into two separate components. A *component* is defined as set containing all nodes that can reach each other by any path (Borgatti et al., 2013). On the basis of these properties of bridges, Granovetter (1973) asserts that every bridge must be a weak tie and concludes one of his most noted findings, that connections within small and well-defined groups are mostly founded on strong ties while links between groups are usually weak. Hence weak ties are essential to enable social mobility and therefore create a sense of community whereas local cohesion arises from strong ties, which lead to overall fragmentation. How personal experiences of individuals are integrated into and dependent upon the context of social structure is thus crucially supported by the strength of ties (Granovetter, 1973).

Social networks can be quantified on three levels: dyad, node and network. This thesis will emphasize the last two. At the dyad-level, pairs of actors are examined, following questions like "do actors with business ties tend to develop friendship ties?". At the network-level, popular questions include "do networks with more ties tend to diffuse ideas faster?". A question at the node-level could be: "Do actors with more friends tend to be happier?" (Borgatti et al., 2013). The key measure on the node-level is the centrality of nodes, which is usually measured through aggregated dyad-level measurements, such as the sum of ties a given node has. In this respect, centrality indicates how well connected a single node is. Inquiries in regard to the whole network on the other hand, require the determination of the network's cohesion, a value specifying how tightly-knit a network is. Of the various cohesion measures, the simplest is the total tie strength, which is the sum of all ties in the network. Both, centrality and cohesion, are essential measures used in social network analysis to compare either nodes or entire networks, respectively. Below, various ways of calculating node- and network-level measures are introduced.

2.1.1 Node-level measures

The centrality of a node shows how well connected it is to other nodes. A highly central node can represent a person that is socially integrated, has many contacts and receives as well as distributes much information. Furthermore, the behavior of a node and various non-network characteristics, such as the influence on others or the possibility of acquiring power, may depend on its centrality. There are different ways of identifying a node's centrality. Subsequently several centrality measures are presented.

Degree centrality is the most basic form of centrality measures, describing the number of ties that a given node has. The degree centrality d_i of actor i is defined as

$$d_i = \sum_j x_{ij} \tag{2.1}$$

where x_{ij} is the (i, j) entry of the adjacency matrix, representing a possible tie between actors i and j. Degree centrality is interpretable in various kinds of networks, high degree centrality of a node tends to be considered as a sign of high importance. Nodes with high degree in organizational networks are usually listed as important people in the group. In a gossip network, a given actor's degree is highly correlated with the chance of receiving information. A major disadvantage of degree centrality is the fact that it does not take into account all network data, but only the ties a given node has. As such, a node with ties to four nodes that do not have any other links has the same degree centrality as a node that has ties to four nodes, who themselves are well connected with other actors (Borgatti et al., 2013).

Eigenvector centrality addresses the last concern by not only counting how many nodes are connected to a given node, but also taking into account their centrality (Bonacich, 1972). The eigenvector centrality e of node i is defined as

$$e_i = \lambda \sum_j x_{ij} e_j \tag{2.2}$$

where λ is a proportionality constant called eigenvalue and x_{ij} is the (i, j) entry of the adjacency matrix. According to eigenvector centrality every node's centrality is proportional to the sum of its adjacent nodes' centralities. Thus, a node A with lower degree could have a higher eigenvector centrality than a node B with higher degree, if its neighbors themselves have a higher eigenvector score than B's neighbors. A downside to Eigenvector centrality becomes visible in disconnected networks, as all nodes in smaller components will be assigned zeros (Borgatti et al., 2013).

Beta centrality merges both previously mentioned measures (Bonacich, 1987)**.** Represented as convergent infinite sum, beta centrality c is

$$c = \sum_{k=1}^{\infty} \beta^{k-1} A^k 1 = \alpha(A1 + \beta A^2 1 + \beta^2 A^3 1 + \cdots) \tag{2.3}$$

where β is a chosen parameter that is multiplied with powers of the adjacency matrix. For that matter it should be noted that the (i, j) cell of the adjacency matrix to the power of k resembles the number of all walks between i and j that are of length k – that is, the final sum provides the number of walks of all possible lengths between every pair of nodes, weighted by β^{k-1}. Correspondingly by choosing different values of β the researcher can vary to what extend longer walks will be taken into account. When β is zero the result of beta centrality will be degree centrality. Whereas β being infinitely close to $1/\lambda$ the result will be equal to eigenvector centrality. Any value between zero and $1/\lambda$ will provide different weight to longer walks. For example, β of 0.5 will proceed to weigh walks of length 2 with 0.5, walks of length 3 with $0.5^2 = 0.25$ and so on, therefore a walk of length 10 will be weighted with 0.000977, which would have little influence on the result. Hence beta centrality is a useful measure that can be adjusted when only short walks matter or when progressively longer walks are of importance in the network (Borgatti et al., 2013).

Betweenness centrality measures how often a given node is located on the geodesic (shortest) path between two nodes (Freeman 1979). The betweenness centrality b of node i is defined as

$$b_i = \sum_{j<k} \frac{g_{jik}}{g_{jk}} \tag{2.4}$$

where g_{jik} is the number of geodesic paths between nodes j and k that go through node i and g_{jk} represents the geodesic paths connecting every pair of nodes in the network. Actors with high betweenness score tend to have influence on information flow and are able to filter or manipulate it, as they fulfill a gatekeeping role in the network. Practically betweenness scores usually feature a high variance, allowing to distinguish effectively between nodes (Borgatti et al., 2013).

Closeness centrality is the sum of all geodesic distances between a given node and every other node in the network. To normalize the result, usually $n-1$ is divided by the calculated distance, where $n-1$ is the score of a node that has a direct connection to all other $n-1$ nodes in the network. This way the maximum possible closeness centrality is 100 %. The formula is as follows

$$\frac{n-1}{\sum_j d_{ij}} \tag{2.5}$$

where n is the number of nodes and d_{ij} is the length of the geodesic distance between nodes i and j. Having high closeness centrality means that the distance to every other node is rather short. Hence information can reach the given node relatively quickly and usually less distorted than by following a longer path. In disconnected networks closeness becomes difficult to calculate as some paths do not exist, which is adjusted e.g. through replacement with a large constant. This as well as other compensation methods tends to produce closeness scores that suffer from little variance and are therefore hardly applicable to correlation analysis (Borgatti et al. 2013).

There are some differences in valued networks regarding centrality calculation. Degree is adjusted by summing up tie strengths, while eigenvector and beta centrality do not have to be modified. Betweenness and closeness on the other hand utilize optimal paths that are easily identified as the paths with the fewest ties in unvalued networks. With weighted ties a number of decisions have to be made including whether short paths consisting of weak ties are ranked higher or lower than long paths of strong ties. To avoid making several judgmental decisions most researchers simplify their valued network data through binarization and application of the traditional measures presented earlier (Borgatti et al. 2013).

2.1.2 Network-level measures

On the network-level a key measurement is cohesion. There are different variants, which will be introduced below, all having in common, that one measure characterizes the entire network. The cohesion of a network reflects how tightly linked its nodes are and can be interpreted as a measure of how stable it is and how fast information can flow through the network. Moreover, cohesion is a key value in comparing different networks.

A basic measure on the level of the whole network is the **total tie strength**, which simply counts the number of all ties. Total tie strength on the network-level mirrors degree on the node-level, as ties between all nodes are accumulated.

Density of a network is defined as the proportion between the number of ties in a graph and the maximum number of possible ties (J. Scott, 2017). In an undirected non-reflexive graph density is represented mathematically as

$$\frac{l}{n\frac{(n-1)}{2}} \tag{2.6}$$

where l is the number of present ties and n is the number of nodes. As density automatically adjusts for the number of nodes in a network, it has an advantage over the simple number of ties and is more meaningful in most cases. Then again densities tend to be considerably different depending on group size. While it is perfectly plausible that every actor in a group of 20 people has contact with all other actors, it is very doubtful that this is still the case in a group of 1000 people. Hence larger networks are likely to have lower density than smaller networks (Borgatti et al., 2013).

Average degree of a network is a measurement that is easier to interpret than density, as it simply describes the average amount of ties each node has. In an undirected, non-reflexive graph, the average degree $\bar{d}$ is related to the network density by

$$\bar{d} = \frac{2l}{n} = density \cdot (n-1) \tag{2.7}$$

where l is the number of present ties and n is the number of nodes. Unlike density average degree does not suffer from generally decreasing measurements with increasing network size. Still just as the other described measures it only characterizes the network in regard to the number of ties ignoring their distribution (Borgatti et al., 2013).

Average geodesic distance is defined as

$$\frac{\sum_{i \neq j} d_{ij}}{n(n-1)} \tag{2.8}$$

where d_{ij} is the geodesic distance between nodes i and j. Average geodesic distance as a measure has the benefit that it can be understood as reference to the expected time something requires to pass from one randomly chosen node to another. If on average all nodes in a network can be reached rapidly, high network cohesion is indicated. Unfortunately average geodesic distance suffers from an inability to measure disconnected graphs, as nodes from different components cannot be reached by any path (Borgatti et al., 2013).

Connectedness measures the proportion among pairs of nodes that can reach each other by any possible path, i.e. the proportion of nodes located in the same component (Krackhardt, 1994). Connectedness is defined as

$$\frac{\sum_{i \neq j} r_{ij}}{n(n-1)} \tag{2.9}$$

where r_{ij} is 1 if nodes i and j can reach each other and 0 if not. Connectedness can also be altered to fragmentation, which is 1 minus connectedness (Borgatti, 2006). Connectedness or fragmentation are typically used to assess how a network is affected by change. If for instance, the police are trying to disrupt a criminal organization, these measures can indicate which actors to arrest first. An algorithm would examine all possible combinations and determine the optimal set of actors, whose absence would maximally increase the fragmentation of the criminal network (Borgatti et al., 2013).

Compactness is a modification of connectedness where $1/d_{ij}$ takes the place of r_{ij}. It is defined as

$$\frac{\sum_{i \neq j} \frac{1}{d_{ij}}}{n(n-1)} \tag{2.10}$$

where d_{ij} is the geodesic distance between nodes i and j and $1/d_{ij}$ is defined to be zero when no paths connect i and j. In contrast to the average geodesic distance compactness is applicable to disconnected networks, rendering it a preferred measure in said cases (Borgatti et al., 2013).

An alternative to cohesion measurements is the concept of robustness, which evaluates how many ties or nodes have to be removed from a network in order to disconnect it. When many ties or nodes have to be eliminated to increase the number of components, a network is robust, which in turn indicates a high cohesion (Borgatti et al., 2013).

2.2 Institutional logics

The institutional logics perspective is a theory that explains how behavior and cognition of actors are influenced by a set of cultural elements or rationalities. These rationalities are reflected on social institutions, which can be understood as a construct of formal and informal rules. The findings are based on the suggestion that different institutional sectors exist in various parts of society, where every sector encompasses its own rationality and resulting practices. An institution's rationality is embodied by the institutional logic that demonstrates the "deep-structural rules that coordinate and guide actor's perceptions and actions" (Geels, 2012:3). Institutions enable behavior and change, at the same time providing rules, that guide and limit agency – the capacity of individuals to act independently (Fuenfschilling & Truffer, 2014). However, to understand institutional logics, one must first arrange them in their context as one approach that emerged from institutional theory (Thornton & Ocasio, 2008).

Institutional theory itself has a major influence on contemporary organization science, but institutions have already been studied in organizational analysis since the 1940s (Selznick, 1948, 1949, 1957). A new approach to institutional analysis followed in the 1970s when Meyer & Rowan (1977) and Zucker (1977) focused on culture and cognition in institutional analysis, studying institutions on different levels of analysis. Zucker (1977) pointed out the role of the institutionalization process in regard to cultural persistence. Institutionalization is the embedding of conceptions, such as beliefs and values, within a system, for example an organization or a society, in form of rules, for instance laws, guidelines and traditions (Fuenfschilling & Truffer, 2014). Zucker's (1977) main result stated, that the uniformity, maintenance and resistance to change of cultural understandings depends highly on the degree of institutionalization. Instead of examining the process of institutionalization, Meyer & Rowan (1977) studied structures related to institutions, examining them on the societal level. A key observation was the rationalization of taken-for-granted rules, that lead to isomorphism in the formal structures of organizations. In this sense, isomorphism means, that the structures of different organizations became more similar because of external factors, such as the adaptation of external assessment criteria. One example is the accounting convention to allocate value to units of the organization, based on their contribution to the products, that are created by the company. For many units however, this method is hardly applicable, because e.g. the exact contribution of an administrative department to the company's product remains unclear. In these cases, accountants calculate their value, by using external prices of these units, that are present in the market. Thus, organizations assign a value to departments such as advertisement, by using external factors, in order to measure efficiency or profitability (J. W. Meyer & Rowan, 1977). During the 1980s "the new institutionalism" was termed by DiMaggio & Powell (1983), who expanded the theories of Meyer and Rowan by analyzing institutions on the level of organizational fields – communities that are held together by common values, beliefs and associated practices. Their research explained many phenomena with mimetic isomorphism. This type of isomorphism describes how organizations imitate the structure of other organizations, that are perceived as successful and legitimate. Companies, that in principle are trying to be different from their competitors, steadily become more similar, because so called ‘best-practices’ are adopted. This trend is enhanced by the growing influence of management consulting firms, acting as diffusors of imitation mechanisms (DiMaggio & Powell, 1983). Organizational structure was interpreted as being based on legitimacy instead of rationality and efficiency (Tolbert & Zucker, 1983).

Institutional logics emerged as a new approach to institutional analysis and were mentioned first by Alford & Friedland (1985). This approach was partly similar to prior research as both have the impact of cultural rules and cognitive structures on organizational structures in common. The institutional logics approach however, highlights the effects of logics on individuals and organizations. Instead of focusing on isomorphism and homogeneity like prior studies, contending logics are viewed as the main sources of influence in every societal sector (Thornton & Ocasio, 2008). In turn, individual actors as well as organizations are affecting and changing institutional logics (Thornton, 2004). By linking institutions and action, institutional logics embody a bridge between Meyer & Rowan's (1977) and DiMaggio & Powell's (1983) perspective on structures and Zucker's (1977) perspective on processes.

With the help of institutional logics Alford & Friedland (1985) addressed contradictory practices and beliefs in institutions of modern societies, the institutions being the capitalist market, the bureaucratic state, the nuclear family (two parents and their children), democracy and religion, each with a certain logic guiding the behavior of individuals (Friedland & Alford, 1991). This distinction was developed further by Thornton (2004) who differentiated six institutional orders: market, corporation, profession, state, family and religion with community further being added as the seventh order (Thornton, Ocasio, & Lounsbury, 2012). By way of example, a straightforward activity such as chopping firewood can be based on the pursuit of different goals, all depending upon the institutional order the woodchopper is embracing. One plausible explanation for the activity, is the woodchopper’s intention of selling the firewood. This is a typical instance, where work is based on the market order. However, the woodchopper may instead require timber, to heat up his or her home, where the children are sleeping. In this case, the woodchopping is derived from the family order. Also, the wood may be needed for a ceremonial bonfire, to celebrate a religious occasion and hence, religion would be the decisive order. Therefore, all institutional orders rest upon certain institutional logics, that specify which goals are prioritized and what means of pursuing these goals are accepted (Fuenfschilling & Truffer, 2014). To examine these logics, a sociological construct called ideal type is used. An ideal type is an analytic tool, constructed in order to approximately resemble reality. Thus, ideal types are based on intentional exaggeration as well as simplification of certain characteristics, that were observed in reality. Generalizing a complex reality into several abstract ideal types allows to study conflict and consensus of different logics in the society, organizations and individuals. The key aspect of this approach is therefore to highlight how actors adopt socially constructed rules, norms, values, beliefs and taken for granted practices and what effect these have on actor’s decision-making and behavior (DiMaggio & Powell, 1983, 1991; J. W. Meyer & Rowan, 1977; P. Scott, 1995). In other words “an institutional logic is the way a particular social world works” (Jackall, 1988).

Structure created by institutional logics both constrains and enables agency of individual and organizational actors (Giddens, 1984; Sewell Jr, 1992). Interests, values, identities and assumptions of actors are embedded within the respective institutional logic (Thornton & Ocasio, 2008). In this assumption, called embedded agency, lies the main difference compared to perspectives on institutions that presume rational choice and individualistic interests (Ingram & Clay, 2000; North, 1990). According to the institutional logics perspective, it is not a mere rational decision, which problems will be tackled and which solutions will be incorporated, but it is heavily influenced by laws and conventions of underlying logics (March, Olsen, Christensen, & Cohen, 1976). Thus, mental models used to initially frame observed phenomena are heavily influenced by the respective disciplinary background and experience of every actor. An engineer’s analysis of a water stress situation will probably identify technical problems like inefficient design while a social scientist might determine the perception of individuals, such as inadequate concerns about declining water resources, to constitute the main problem (Pahl-Wostl et al., 2011).

Institutional logics vary between different organizational fields – communities that are held together by common values, beliefs and associated practices (W. R. Scott, 2013). Every organizational field is characterized by certain organizing rules and principles that guide the behavior of actors (Friedland & Alford, 1991). These rules are commonly accepted and “refer to the belief systems and related practices that predominate in an organizational field” (W. R. Scott, 2001: 139). Institutional logics as a theoretical concept are used for understanding organizational fields, as they link institutions with actions of individuals (Friedland & Alford, 1991; W. R. Scott, Ruef, Mendel, & Caronna, 2000; Thornton & Ocasio, 2008). Typically, every organizational field is characterized by a combination of various logics, which result in a specific field logic. Since institutional logics illuminate connections that imply unity and a common goal within an organizational field (Reay & Hinings, 2009), the latter is mostly dominated by one field logic although several others can coexist and eventually assume the prevalent role through institutional change (Thornton & Ocasio, 1999). To model institutional change within a field the institutional logics concept is essential because the rearrangement of the dominant logic constitutes the basis of understanding change (Reay & Hinings, 2009). Even if different logics are present, the dominant logic shapes the behavior of most actors, driving their attention toward problems and solutions that are coherent with this logic instead of the others (Thornton, 2004). There are situations in which equally established competing logics have existed in parallel for longer time periods (Marquis & Lounsbury, 2007; Reay & Hinings, 2005), however competing logics are associated with conflicting parameters of power and result in rivalry (Thornton, 2004). New logics entering a field, becoming dominant and providing new direction to actors have been studied by various researchers (Hensmans, 2003; Kitchener, 2002; W. R. Scott et al., 2000).

Fuenfschilling & Truffer (2014) have identified three different ideal types of field logics in the urban water sector – the historically dominant *hydraulic logic* (HL) as well as the emerging *water market logic* (WML) and *water sensitive logic* (WSL). These ideal types are not representing actual conditions of the urban water sector, instead they are analytic constructs simplifying reality to describe the characteristics of structures influencing water sectors worldwide (Fuenfschilling & Truffer, 2014). As a shift between field logics results in changed priorities in regard to pursued problems and preferred solutions (Thornton & Ocasio, 2008), many studies implicitly assume that typically one logic dominates every organizational field and over time may be replaced by a different logic (Fuenfschilling & Truffer, 2014). Thornton & Ocasio (1999) for example analyzed how the United States' publishing sector experienced a shift from a profession-based logic to a logic that was dominated by market principles. This led to increased resource competition and financial pursuit, a change from organic organizational growth towards growth through acquisitions and consequently a rising size of organizations. Nevertheless there are also cases where several logics compete in the same organizational field, because supporting actors of neither one can get the upper hand. Ruef & Scott (1998) discussed how the Californian health care sector is divided into two parts, medical tasks being dominated by a profession logic and administrative tasks that are supported by a market logic. While both logics contradict each other, their collective influence forms the organizational field (Fuenfschilling & Truffer, 2014).

Worldwide, all industrialized countries are characterized by very similar water sectors in terms of formal organization, utilized technologies, central actors, funding sources and belief systems (Fuenfschilling & Truffer, 2014). These are based on an institutional logic that was omnipresent in the water management of virtually every industrialized country and was focused on water supply as well as wastewater and stormwater drainage (Espeland, 1998; Evers & Benedikter, 2009; Gottlieb, 1988; Molle, Mollinga, & Wester, 2009). Fuenfschilling & Truffer (2014) label this ideal-typical logic the hydraulic logic and distinguish it primarily as a combination of profession (mainly engineering) and state logics. Efficient technology and social welfare provided the main guidance of actors in the field, which resulted in an acceptance of natural exploitation for the good of national wealth and wellbeing. Key decision-makers were government and public water utilities while utility engineers were responsible for technical execution concerning the security of drinking water, sanitation, irrigation and electricity. Therefore, conventional organizations were hierarchical and vertically integrated whereas respected expertise and dominant mindsets derived mainly from engineering perspectives. This field logic became highly institutionalized over the centuries. The common assumptions and solutions of this hydraulic approach have been taken for granted and shape the water sector to this day. However since society's expectations began to change and drastic effects of global warming on the water sector became evident, the dominant logic was questioned and the focus started to shift towards economic and environmental aspects (Fuenfschilling & Truffer, 2014).

Market and corporation - two institutional logics that have been gaining influence in various sectors since the 1970s are highly compatible and strengthen each other (Thornton, Jones, & Kury, 2005). While the market logic encompasses aspects of efficient transactions, share prices and self-interest, the corporation logic is focused on growth of firms, M-form organizations and managerial capitalism. The water sector was no exception as public utilities were corporatized or privatized, pricing was adapted, consultancies and multinational corporations became essential for many water projects and funding was transferred from government to consumers. In summary this emphasis on economic efficiency and rationalization is captured by the term water market logic (Fuenfschilling & Truffer, 2014).

A third ideal-typical logic incorporates the idea of water not being a consumption good, but a vital driver of livability and thereof human wellbeing. Environmental movements based on the notions of conservation and anti-growth (Hajer, 1995) influenced this belief system as much as publications demonstrating effects of climate change or think tanks such as the Club of Rome releasing its influential report 'The Limits to Growth' (Meadows, Meadows, Randers, & Behrens, 1972). Environmental sustainability became a political agenda with water conservation being one part of it. Consequently, new regulations were issued in regard to water allocation, water reclamation or recycling. The fundamentals of the developments belonging to this water sensitive logic are the two logics of community and profession (mainly environmental science and ecology) with decentralized organization of water systems and community-based arrangements being favored approaches to contemporary problems (Fuenfschilling & Truffer, 2014).

Although the hydraulic logic has gained competition in form of new field logics, it still remains dominant. water market logic and water sensitive logic do not only contradict the old paradigm but are also in conflict with each other, because of opposed background principles. While the emerging field logics have not yet gained as much consistency as the historically dominant one, they already affect actors in the UWS. The water sector has been identified to have a very stable socio-technical regime in every industrialized country and is defined by a combination of the three field logics (Fuenfschilling & Truffer, 2014). However, these logics have a variable degree of institutionalization, i.e. influence on consumer behavior, preferred technology, arranged financial investments as well as implemented policy and regulation. Recent research of Fuenfschilling and Truffer (2016) has emphasized the importance of actors mediating between institutions and technologies. Actors are campaigning in the pursuit of a logic's realization in the form of policies and investments. While they are actively increasing the institutionalization of their preferred regime structures, actors are simultaneously trying to deinstitutionalize the opposing logic's structures, i.e. to weaken their influence. One example is the building of several large-scale desalination plants in Australia as a result of successful lobbying, which in turn prevented significant investments into recycling or storm water harvesting. In this regard, the mediating efforts of certain actors, come to fruition in the form of technologies, that meet the criteria of a logic. Academic literature exhibits more criticism regarding long-term sustainability of traditional practices in this sector (Daigger, 2007). Yet, the stable configuration of highly institutionalized structures produces rigid and path dependent belief systems that impede transitions to more sustainable structures (Fuenfschilling & Truffer, 2014).

3 Specific Aim

Worldwide, researchers in the urban water sector are confronted with the consequences of climate change, thus facing new challenges and increasingly complex problems that require a new approach and innovative solutions. Over the years, a paradigm shift has been observed in the scientific community from a linear focus on technical issues to a more comprehensive conviction that additionally encompasses economic aspects as well as environmental sustainability. Furthermore, research literature and discourses are more progressively dealing with governance than ever before. Although a trend towards network governance in organizations and rising awareness of water as a finite resource and livability factor among engineers has been observed, it remains unclear how extensive this shift has developed in practice. Currently no research has been conducted to analyze how social networks and belief systems of actors influence each other. Specifically, no single study was conducted, analyzing all three levels of society: institutions, organizations and individuals.

To address this need, I will develop a method combining the institutional logics perspective with social network analysis using a mixed-methods-research approach in order to gather evidence from various sources and triangulate the results. The dichotomous method will be tested through application to existing collaborative research projects in two different cases. The feasibility of this method is supported by established research on the phenomena that every actor's behavior and decisions are significantly influenced by his social position in the network and prevailing institutional logics in a social group (see examples in chapter 2.1). Belief-systems and taken-for-granted practices, determine which values and norms are adapted by actors, that identify with said group. Thus, a consideration of the social network in regard to institutional logics is expected to indicate why our society and researchers in particular approach current challenges in the water sector the way they do.

By means of a 'two-case' case study, I will observe research projects in Germany and Norway that are studying the effects of current developments on the water sector, aiming to provide long-term solutions for urgent challenges. This allows to investigate three objectives. Objective 1 will study if said research groups experience differing social network structure and dominant logics, thus indicating whether a paradigm change in the urban water sector develops differently in research groups with similar challenges, but different cultural and historical backgrounds. Objective 2 will investigate whether network position and individual belief-systems are interrelated, determining the relationship between an actor's centrality in the social network and his dominant logic. Objective 3 will examine demographic aspects regarding prevailing institutional logics. Through investigation of an actor's age and his experience in the field it will be revealed whether these factors affect the logic a certain actor adapts.

The study will establish a new method to comprehensively investigate and provide greater insight into the relationship between institutions, social networks and individuals. Therefore, the method will provide a basis for the scientific community to pursue various studies on subjects that have not been analytically linked before.

4 Material and Methods

In this thesis, two research projects in the urban water sector are studied through a combination of different research methods encompassed in case study research. Below, case study research is introduced, the utilized methods concerning data collection and analysis are presented and evaluated in regard to validity and reliability.

4.1 Case study research

The case study as a research method is an empirical inquiry that observes a contemporary event in its immediate context. Thus details of events and processes are observed and analyzed inside their real world context, "especially when the boundaries between phenomenon and context may not be clearly evident" (Yin, 2014:16). Whilst experimental research is based on isolation of variables in the artificial laboratory environment, thus offering potential for manipulation, researchers have no possibility to systematically manipulate or control behavior in case studies.

Among widespread quantitative and qualitative research strategies, the case study has been gaining attention in the past three decades (Yin, 1989). Traditionally, case study research was prevalent in organizational studies, which are based in social sciences (J. Hartley, 2004). The main advantage of case studies compared to other approaches is the opportunity to view an event or process holistically as various utilized tools allow detailed observation within its real environment (Gummesson, 2000). A key difference to other qualitative methods like ethnography or grounded theory (Corbin & Strauss, 1990; Gioia & Chittipeddi, 1991; Glaser & Strauss, 1967) is the fact that case studies are flexible to use different theories and conceptual categories for data collection and analysis purposes, whereas latter methods presuppose that theoretical perspectives emerge from previously collected, rigid firsthand data (C. B. Meyer, 2001). In the past, case study research was regarded as a qualitative approach that aimed to provide information, which may be difficult or impossible to gain with quantitative methods (Sykes, 1990). However, modern research allocates more attention on blending quantitative and qualitative data to use both types as part of one case study (Yin, 2014).

Whether case study research is an appropriate method choice depends on the underlying research question. Case study research is not advantageous when the question focuses on incidence or prevalence of certain phenomena. Yin (1989) characterizes these as 'what' questions, which typically favor surveys, polls, epidemiologic analysis and archival records as data sources. In contrast to said methods, case studies are a favorable choice given descriptive or explanatory research questions – or simply depicted as 'how' and 'why' questions (Leonard-Barton, 1990). A second method that deals with these questions is historical research with the difference lying in the considered time frame. While both methods include document analysis and archival records as data sources, case studies rely on a variety of evidence such as interviews, surveys and observations that are not available to the historical method as they require contemporary events (Yin, 2014).

Case study research will constitute the central method used in the thesis at hand. To examine how climate-change related challenges in the urban water sector are currently approached by our society and particularly by the academic branch, the thesis has to focus on contemporary phenomena in their real-life context, instead of investigations in experimental environments. To understand, how researchers cooperate, which actors occupy central roles, why certain rationalities are dominant and whether they are correlated with network centrality, the analysis of institutional logics is utilized in combination with social network analysis. Unlike methods like grounded theory, case study research allows for a composition of various data collection strategies and analysis methods such as surveys, document analysis and interviews. Quantitative and qualitative data can be utilized simultaneously to support eventual findings. Thus, case study research allows a consideration of the social network in regard to institutional logics, which is expected to indicate why researchers address current challenges in the water sector the way they do.

Most data used in social science can be distinguished as attribute data and relational data (Berkowitz & Heil, 1980; Wellman & Berkowitz, 1988). *Attribute data* constitute properties, qualities or characteristics of actors and may refer to actor's opinions or behavior (J. Scott, 2017). These types of data are suited for common statistical analysis such as variable analysis, as depicted in Figure 3. *Relational data* however describe connections between actors or groups and can be viewed as properties of a relational system consisting of a pair of connected actors. Suited procedures of analysis are network analysis methods (J. Scott, 2017). Relational data are essential for investigation of social structures, because these are made up of relations between actors (J. Scott, 2017). Social network analysis relies on mathematical techniques in general and graph theory in particular, which are exceptionally beneficial in analyzing relational data. In addition, a third type of data, directly describing meanings, motives and typifications that influence actions, resembles the social underpinning of both other data types – *ideational data*. Although it consists of many aspects that are central for the understanding of social science, ideational data has been discussed less than the other two data types. Accordingly methods to analyze ideational data are not as well established (J. Scott, 2017). This thesis aims to address this need by including the institutional logics perspective in a social network analysis.

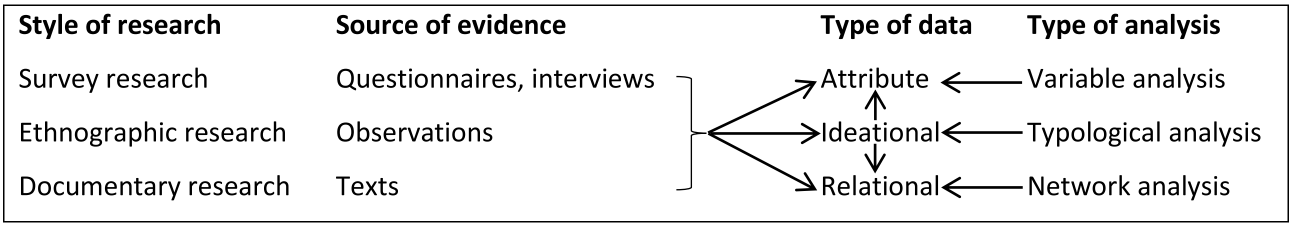

Figure 3: Types of Data and Analysis (J. Scott, 2017)

The basis of social science data are cultural values and symbols, clearly distinguishing it from physical data gathered in natural sciences. Social science data has its roots in meanings, motives and typifications. Therefore data collection procedures embedded in a sociological case study – from survey as well as documentary research – necessarily involve the process of interpretation (J. Scott, 2017).

Case studies are distinguished by their research designs as depicted in Figure 4. On the one hand the study can include a single case or multiple cases. Single-case studies are limited in generalizability and are often afflicted with information-processing biases (Eisenhardt, 1989). These problems can be mitigated if multiple cases are included in the same study (Leonard-Barton, 1990). Evidence gathered from multiple cases tends to be more compelling and the study is often regarded as more robust (Herriott & Firestone, 1983). When similar or contrasting cases are observed, single-case findings can be grounded through specification of how, where and why events happened as they did (Miles & Huberman, 1994). Therefore multi-case based case studies add confidence to findings, increase external validity and minimize the influence of observer bias (C. B. Meyer, 2001). Nevertheless, multiple-case research also has a major drawback, as studying several cases requires more time and resources (Yin, 1989).

On the other hand a case study may incorporate a single unit of analysis or multiple units of analysis, also called holistic or embedded design (Yin, 1989). In contrast to differing between several cases this involves differentiating within cases and analyzing subunits in each case (J. Hartley, 2004). Having more than one unit of analysis is one way to address researchers' bias (Yin, 2014).

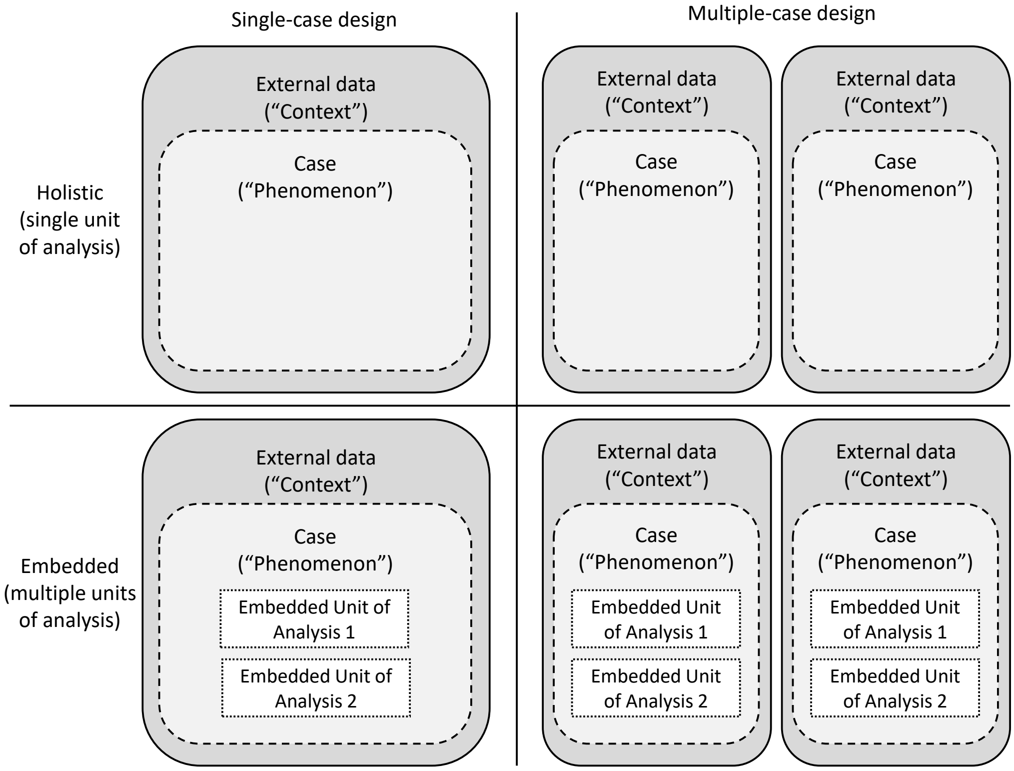

Figure 4: Basic types of case study designs (Yin, 2014: 85)

4.1.1 Design decisions

As stated earlier, case study research in itself is a diversified method that can include various optional steps and does not follow any specific requirements. This circumstance has the benefit that procedures can be adapted to the research question, in this case how current challenges on the water sector are approached by our society and academia in particular. For this purpose, several design choices have to be made prior to the administration of the study. Consecutively, I highlight important choices made regarding the case study of research networks, ranging from case selection to data collection procedures.

Single or multiple cases

As specified in chapter 4.1, consideration of multiple cases in the case study has several advantages. Although several rationales for single-case designs usually cannot be fulfilled by multiple cases, e.g. observation of an extreme case, critical case or unusual case, this is not relevant for the thesis at hand (Yin, 1989). Therefore, a multiple-case design will be favored. Nevertheless the main advantages of case study research require an in-depth and pluralist perspective in the examination of case details, which significantly limits the number of considered cases (C. B. Meyer, 2001). Even though the addition of a second case may not considerably alter the generalizability of the study, a 'two-case' case study design has analytical benefits compared to single-case research (Yin, 1989). Hence this thesis will focus on two cases in order to benefit from cross-case comparisons while maintaining the capability to observe each case in detail.

Sampling cases

Case studies utilize theoretical sampling, which is based on a radically different logic than statistical sampling and aims at choosing cases that are either likely to replicate and broaden findings or to provide contrasting examples (Eisenhardt, 1989). Thus theoretical sampling relies on selecting cases purposefully instead of randomly (Miller & Crabtree, 1992).

To achieve representativeness, qualitative sampling concerns itself with information richness (C. B. Meyer, 2001). The choice of cases was aimed at finding research projects that responded to the effects of climate change on the water sector, experienced various similar challenges, but nonetheless were characterized by different circumstances. To match these requirements, I chose cases from Norway and Germany that were generally both working on current and future problems in the urban water sector yet were embedded into different country-specific contexts. This allowed an evaluation of KURAS, a research project in Germany, and Klima 2050, a research association in Norway, following the direct replication logic.

Unit of analysis

Modification of the unit of analysis represents a further way of differentiating case studies. Embedded designs address researchers' bias by investigating subunits of the case whereas a holistic design attends the case only (Yin, 2014). Choosing an embedded design allows to observe differences between the cases as well as within each case (J. Hartley, 2004).

I chose an embedded design by implementing individual researchers as subunits, which are integrated into the case – namely the network. Thus, the prevailing institutional logic was investigated for every researcher in both cases. However, the main unit of analysis was composed of the social network in regard to its dominant institutional logic. Consequently, this study uses an embedded multiple-case design, as previously shown in Figure 4: In both cases the research network (case) is examined as well as the participants (embedded subunits).

Bounding the case

To bound a case study, time period and social group are determined. In my case the participants of the respective research associations constitute the topic of the case study and provide subject data regarding the analyzed phenomenon. External data is supplied by the context of the case study, which includes people who have not participated in the research. Typical for case study research, boundaries between case and context are not perfectly clear, as some participating companies have relied upon various employees to fulfill tasks at different times, who in turn may have not been part of the communication to other researchers (see 4.2.2 Survey). The observed time period includes the entire project lifecycles up until the date of analysis.

Selection of data collection procedures

Preferred data collection procedures depend on the research question that guides the entire case study (C. B. Meyer, 2001). One of the main strengths of case study research are converging lines of inquiry based on a mixture of several collection methods, ranging from archives, interviews and questionnaires to field observations (Yin, 2014). (Yin, 2014). Instead of conducting several separate studies, each having individual conclusions, this thesis relies on converging evidence from multiple sources, as depicted in Figure 5. This combination of sources supplies data, that can be triangulated to augment the substantiation of findings and hypotheses. Nevertheless decisions regarding data selection methods are limited not only by the research question but also time, resource and access constraints (C. B. Meyer, 2001).

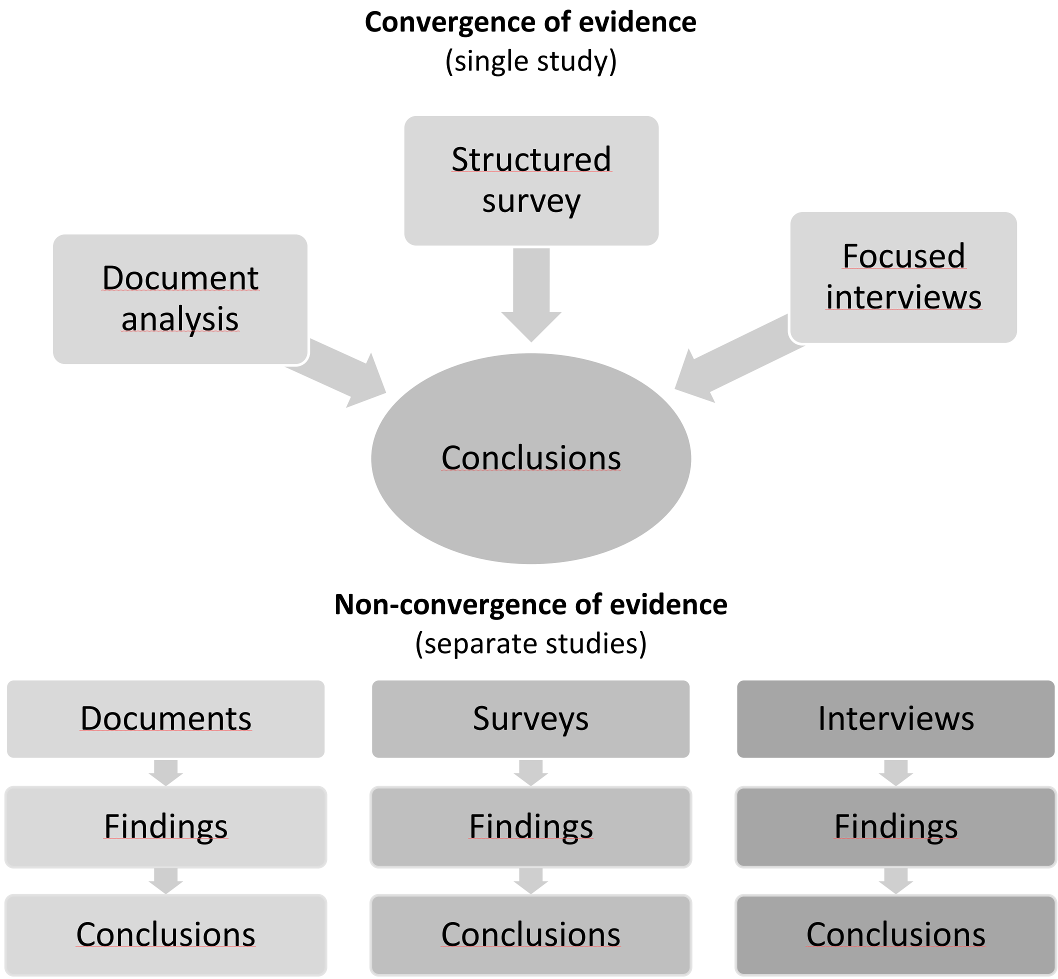

Figure 5: Convergence and non-convergence of multiple sources of evidence (Yin, 2014)

In many case studies, researchers assume their findings to represent a single reality. Therefore, data triangulation usually serves the purpose of ensuring accurate results. This case study on the other hand focuses on the perspective of individuals and acknowledges the possibility of multiple realities. In spite of this relativist orientation, data triangulation is equally important in order to improve the confidence in obtaining accurate results regarding the actor's perspectives (Yin, 2014). Accordingly, this study utilizes data triangulation based on three sources: documents are analyzed, a survey is conducted, and semi-structured interviews are performed. Document analysis and interviews are tools that are frequently used in case study research, whereas surveys typically constitute a rival research method. Nonetheless, it is designed as part of the embedded case study and supplies quantitative data to the usually qualitative case study evidence. Standard sampling procedures and instruments from survey research are applied, but in contrast to conventional survey research, the evidence is only one part of the assessment conducted in the overall study (Yin, 2014). To discover, which researchers cooperate with each other and what institutional logics prevail among the individuals, data is gathered via survey. While this data on the social network as well as institutional logics of every individual, document analysis and interviews allow conclusions on the dominant logic overall and in-depth insights into central actors respectively (see chapters 4.2 and 4.3). Direct observations were not appropriate on account of the research question's nature. Interviews were focused on key figures, to determine how experts understand the observed phenomena.

4.1.2 Case description

Two research associations from Norway and Germany were chosen as cases in order to test the developed method of combining social network analysis with an institutional logics approach. The urban water sector of both countries is comparable with respect to the level of technologic advancements, formal organizations, influential actors and funding sources as well as in terms of traditional belief systems being based on the hydraulic logic. Many challenges associated with global warming, such as increased frequency of cloudbursts, are observed in both countries, therefore utility engineers face various similar problems (Mijødirektorate, 2015; Pfahl & Wernli, 2012). Both associations are funded partly by the respective government while the participants come from equal sectors.

However cultural distinctions, diverse historical developments and differences in climate and geography limit similarities. Hence, both research associations value the importance of varying topics differently. Klima 2050 emphasizes the danger of landslides, which does not constitute a major risk in Berlin, the exemplary application area of the German project. KURAS on the other hand studies the effects of droughts and resulting low-flow conditions in pipes, a topic that Norwegian researchers do no attach great importance to. Moreover Klima 2050 has explicitly included a working package on decision-making processes and impact as one major research field, while there is no equal focus exhibited in KURAS. In turn, research interests in KURAS are not limited to effects of stormwater but do encompass current challenges in wastewater systems as well.

Klima 2050 was created in 2015 and provides research-based innovation as reaction to gradual climate changes and extreme weather conditions experienced in Norway. Financing by the Research Council of Norway and the consortium partners – from public and private sector as well as research and education – enables long-term studies with the goal of increasing Norwegian innovation abilities and competitiveness in regard to climate adaptation. Klima 2050 aims to reduce societal risks associated with climate change and in particular with enhanced precipitation and flood water exposure within the built environment. Emphasized topics include stormwater management, blue-green solutions, development of moisture resilient buildings, prevention of water-triggered landslides, socio-economic incentives and decision-making processes. The association is also affiliated with training and education as graduate students and PhD students are part of the projects. The research organizations SINTEF (Norwegian acronym for: Stiftelsen for industriell og teknisk forskning, Engl.: The Foundation for Scientific and Industrial Research), Norwegian University of Science and Technology (NTNU), Norwegian Geotechnical Institute (NGI) and BI Norwegian Business School share the role of leadership.

The KURAS project (Ger.: Konzepte für urbane Regenwasserbewirtschaftung und Abwassersysteme, Engl.: Concepts for urban stormwater management and wastewater systems) is a research association with focus on linked stormwater and wastewater management addressing current issues in German urban water systems, in particular the effects of climate change and extreme weather events. It was established in 2013 and concluded at the beginning of 2017. The main purpose was to demonstrate how stormwater and wastewater infrastructure can be adapted to present and future challenges. Partners from research as well as public and private sector joined the cooperation that was coordinated by the Technical University of Berlin (TU Berlin) and the Kompetenzzentrum Wasser Berlin (abbr.: KWB, Engl.: Berlin Centre of Competence for Water). KURAS was financed by the Federal Ministry of Education and Research and was aimed at improving the quality of waterbodies, urban climate and quality of life in cities. Attended challenges include cloudbursts, demand peaks, increased environmental requirements, changed wastewater composition and reduced water consumption. Selected areas in Berlin were used as exemplary demonstrations of sustainable stormwater and wastewater management. Main goals constituted the development of decentral measures to improve stormwater management in regard to its effects on the community, environment and economics as well as the examination of adaptation measures to improve wastewater infrastructure facing the effects of climate change.

4.2 Data collection

Data collection of attribute, relational or ideational data does not necessarily differ and may derive from a single source or a combination of sources, as depicted in Figure 3. If collected via survey, although the specific questions for each data type will be distinct from one another, normal rules of survey construction and analysis will be applied. The data set of this thesis contains project documents, survey and interview data. As this study aims at linking social network properties (e.g. centrality, cohesion) and individual characteristics of actors (e.g. age, field of study) with institutional logics, both relational and attribute data as well as the underlying ideational data are part of the same investigation and will therefore be generated through the same survey. Differentiation between these data types will not commence before data analysis. Nevertheless, the survey will only constitute a part of the mixed-method-research approach that is the foundation of this study. The combination of qualitative and quantitative methods as a systematic strategy has gained attention in recent years (Creswell & Clark, 2007; Hollstein & Dominguez, 2012) and through triangulation it allows more objective and comprehensive data handling (J. Scott, 2017). Analysis of the dominant institutional logic of the project will be predicated on document analysis regarding project documents. In contrast, the conduction of interviews will provide information on prevailing institutional logics, focused on central actors in the network.

4.2.1 Documentary data

One method used in this thesis is the analysis of documents compiled in both research projects. Reports and presentations are the written results of every project and serve as an image of predominant priorities and values among project teams. Therefore, the thesis will derive which principal logic guides the entire research association by interpreting final documents.

The key presumption is that every actor's language represents an important indicator for his perception of reality (Berger & Luckmann, 1967). Actors express their beliefs and values in the form of written texts by describing their view of major problems and preferred solutions (Fuenfschilling & Truffer, 2014). Discourses signify how institutions evolve and which logics prevail at a specific moment, in the way how language changes over time (Phillips, Lawrence, & Hardy, 2004). For the actual analysis procedures see explanations in chapter 4.3.1.

4.2.2 Survey data

A survey will constitute the main data source in either case, providing both relational and attribute data as well as ideational data. As described earlier, data collection does not necessarily differ between these data types, instead questions addressing various inquiry aspects are included in one survey. While relational data will serve as basis for the subsequent social network analysis, attribute data will be analyzed statistically and provide a means of explanation for observed phenomena whereas ideational data will be subject to interpretation in order to indicate which institutional logic prevails among individual actors.

As depicted in Table 2, every survey type, including electronic surveys, benefits from several advantages while suffering losses in other regards. Self-administered network surveys, including mail-out and online surveys, do not rely on personal communication between researcher and interviewee and minimize the degree of self-consciousness on the part of respondents, hence resulting in low issues of sensitivity and interviewer response effects, making this survey type very convenient for the researcher. While being administered at little to no cost, data handling is carried out electronically minimizing interface losses that frequently occur when data are migrated from one medium to another. On the other hand, electronic surveys are mostly unable to elicit extended information on promising answers due to the lack of dialogue. A further substantial downside to self-administered surveys that are not hand-delivered are typically much lower response rates (Borgatti et al., 2013). A recommendation for reducing non-response is to build rapport with potential respondents prior to survey distribution (Johnson, 1990). However, this proves to be notably difficult with mail-out and online surveys, as chances to establish personal contact are typically low (Borgatti et al., 2013).

Table 2: Features of different survey types (Borgatti et al., 2013: 65)

Type of data collection	Face-to-face	Self-administered	Mail-out	Electronic	Phone	Group setting
Issues of sensitivity	High	Low	Low	Low	Moderate	High
Interviewer response effects	High	Low	Low	Low	Moderate	Moderate
Data handling errors	Moderate	Moderate	Moderate	Low	Moderate	Moderate
Cost of administering	High	Moderate	Low	Low	Moderate	High
Ability to establish rapport	High	Low	Low	Low	Moderate	Moderate
Ability to maximize elicitation	High	Low	Low	Low	Moderate	Moderate

In the present case the electronic format was chosen, because time constraints did not allow for a face-to-face survey, which would have provided a high chance to increase participation rates, as the ability to build a relationship with every participant would enable a mutual understanding, willingness to invest time into the questions and a higher likelihood to receive deeper insights into the thoughts and believes of every respondent. Unfortunately, this option was excluded, since both networks consisted of more than 50 people each and the social network analysis relied on a data set, that is as complete as possible, rendering a face-to-face survey with every participant a time-consuming activity. Therefore, an electronic survey was created, which had multiple benefits in addition to its lower resource costs. Since no personal contact was established to the participants and anonymity of their answers was guaranteed, there were significantly lower sensitivity issues than in personal interviews. Neither could the researcher's presence affect any responses. Most importantly, all responses were managed in Microsoft Excel from the beginning, minimizing data handling errors, which can cause serious concerns in personal surveys. In order to raise the participation rate in Klima 2050, the survey was presented to a group of researchers, working on decision-making challenges, prior to its distribution. After their feedback was considered, two main project coordinators were selected and contacted. Both were willing to support the study by sending out the survey to their fellow researchers. Likewise, the main project coordinator of KURAS supported the distribution within the German network. Moreover, a preliminary list of possible participants was established in both research projects. This allowed sending the survey to each one personally, aiming at a higher response rate.

The survey was partitioned into four parts: introduction, general questions, institutional logics and network (for survey questions see Appendix A, Table A1). The introduction included explanatory statements about the purpose of the study, data handling and the voluntary participation. Subsequent general questions asked for every participants name, age, educational background, occupation and work experience. The following section inquired which phenomenon a participant is studying in regard to his work at the respective research network and which challenges in the water sector he or she is addressing with his work. To gather data, which enable the interpretation of institutional logics, eight consecutive questions were implemented in the survey. Each question aimed at a certain topic, that provides characteristic differences for each of the logics.

Correspondingly three answers were available for every question, with the option to grade each one from 1st to 3rd preference. The questions were designed partly on the basis of Fuenfschilling & Truffer's (2014) illustration of research policy as depicted in Figure 6.

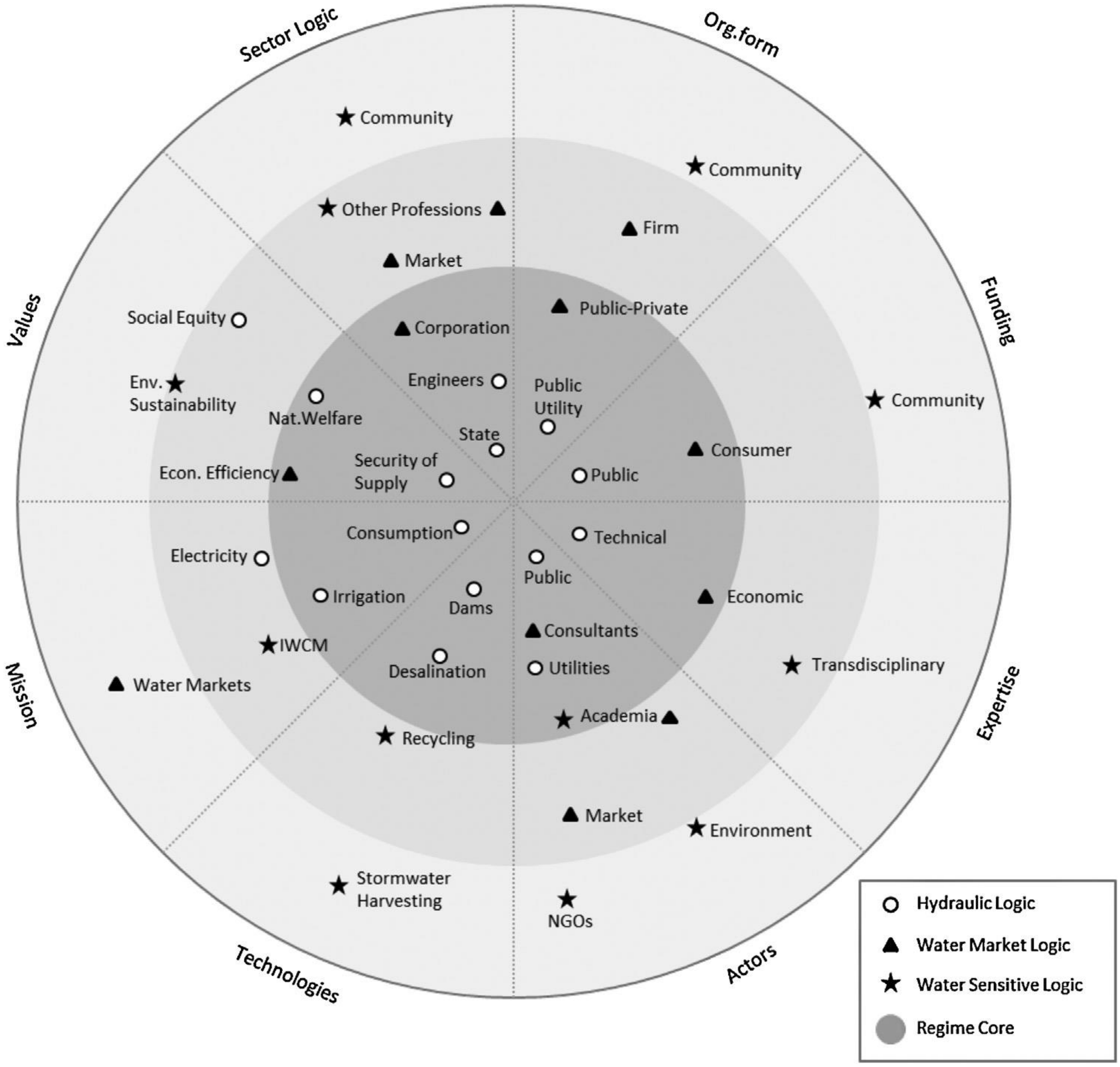

Figure 6: Institutionalization of specific logic elements in the Australian water sector based on a qualitative analysis in 2010 (Fuenfschilling & Truffer, 2014).

The last segment of the survey consisted mainly of one comprehensive question. A matrix contained a listing of known researchers from each project group, with one name in every row, facing the frequency of contact divided into four columns: from 'weekly' to 'never'. Thus, every participant would choose whether he ever had contact with every listed individual and if he did, how often this contact occurred. This design was chosen although it is harder to implement than an open-ended question asking to list every person one had contact with. This is due to the fact that electronic mail-out surveys feature a significant disadvantage in regard to recall error, when relying upon open-ended network questions (Borgatti et al., 2013). When asked to list their contacts, people often cannot remember every person no matter how well they know each other. Johnson, Boster, & Palinkas (2003) studied the crews of a polar research station over the course of three years. Each year one crew consisting of 22 to 28 people spend 8,5 months together, isolated from the outside world. Every crew member knew his colleagues to a great degree and could give detailed answers to every personal question about them. When asked to list their crew members however, people forgot up to 25 % of their team. A face-to-face survey provides the investigator with the possibility to probe for missing names and encourage the respondent to rethink whether his list is complete. As this is not possible in mail-out questions, the presented survey was constructed around a closed-ended format in order to reduce the risk of recall error (Borgatti et al., 2013). Nevertheless, just as the open-ended questionnaire, this format does have significant drawbacks. In contrast to an open-ended survey, the mere size that a list of potential contacts can reach, raises the response burden immensely (Rolstad, Adler, & Rydén, 2011). If a list becomes too large, it can intimidate a respondent and at worst cause him to abandon the survey. More importantly, the researcher must know which nodes will be included in the study before it is distributed. This requires an in-depth knowledge of the studied network. Whereas an open-ended question may be distributed without knowing the size of a network or its members, closed-ended questions require research to be done ahead of the actual study (Borgatti et al., 2013).

Ultimately, the survey was distributed to a set of 55 people respectively, that were identified as the main sample in both research networks. This amount of people would not unnecessarily raise the response burden and is well suited the closed-ended format. In the KURAS project, these 55 actors constituted the entire research team. Klima 2050 however, is a research project with blurred borders. Various people act as advisors, external partners or exchange researchers and are hard to pin down. Furthermore, every participating company can assign flexibly which employees work on the research projects at what time. There was no final and exhaustive list of Klima 2050 researchers available at the time. 55 actors were selected according to information on the Klima 2050 homepage and advice given from key personnel. Still, this list was at risk of being incomplete. Thus, a second stage of addressing potential network members was introduced. One open-ended question was implemented in addition to the main network inquiry. In the style of snowball-sampling, this respondent-driven stage asked every participant to name additional members of the research network, that were not already included in the list, as well as to rate the frequency of contact to these researchers. As a third stage, the survey, containing 55 names, was not only distributed to these 55 people, but also published in the Klima 2050 newsletter, which was send periodically to everyone who had participated in Klima 2050 in any way. As these are considerably more people than in the defined target sample of researchers working with stormwater or decision-making processes, readers were asked only to participate, if they would consider themselves to be part of this particular group. Combined, these three stages constituted a solid method to include as many relevant actors as possible in the study.

4.2.3 Interview data

This thesis includes the conduction of two interviews, which seek to gather additional information in regard to the results of the study's further analysis procedures. The nature of this inquiry presupposes subjective data in form of expert opinions, that are collected as the result of qualitative interviews. There are three types of qualitative interviews: structured, semi-structured and unstructured interviews (DiCicco-Bloom & Crabtree, 2006). The chosen format is the semi-structured interview, a type that blends different properties of its structured and unstructured counterparts. The semi-structured interview is not a questionnaire, that is composed of firmly structured standardized questions with restricted options to answer, neither is it an entirely informal and undirected conversation (Kvale, 2008). To conduct semi-structured interviews, the researcher has to decide in advance, which general structure and topic to follow. Therefore, several open-ended key questions are prepared in order to guide the interview. Nevertheless, the interview is supposed to evolve into a meaningful dialogue. In this sense, the detailed structure is not predefined, but develops during the interview, as the interviewee can choose in what detail to answer questions, how to phrase the answers and what information to leave out. This degree of freedom is inadequate for most studies that require a large number of participants and quantifiable answers. Instead, the semi-structured interview, as a highly flexible method, is suitable for small-scale research, such as case studies (Drever, 1995).

Among different categories of semi-structured interviews, the in-depth interview was selected, because it provides the means to acquire information from different perspectives on a certain topic. The decision to conduct semi-structured interviews derives from their purpose as an auxiliary method in this particular study. Interviewing central actors of the two networks is the final part of a series of procedures. When the main analysis, consisting of documentary, statistical and social network analysis, is completed, two interviews are supposed to resolve contradictions, explain observations, expand findings and hence, confirm or disprove theories. The interview purpose is thus partly explanatory and partly hypothesis-testing. Where explanatory interviews typically favor a less structured approach in favor of the potential to follow-up on answers and uncover previously unknown information, hypothesis-testing interviews require a more structured concept, especially when comparing two groups (Kvale, 2008). As this study includes the comparison of two research networks, the topic and sequence of the main questions asked in the first interview, mostly matched those of the second (for transcriptions of main questions and associated answers see Appendix B).

Semi-structured in-depth interviews belong to the most used formats in qualitative research and are subdivided into individual and group interviews. Group interviews seek to accumulate a wide range of perspectives and experiences whereas individual interviews enable the interviewer to delve into the perspectives of single participants, acquiring more detailed knowledge (DiCicco-Bloom & Crabtree, 2006). As the objective of examining a wide selection of network members was already covered by the surveys, the interviews were focused on determining context and meaning for previous results. Therefore, semi-structured individual in-depth interviews were the chosen in order to enhance the quality of the study's data and consequent conclusions.

In this case, one central actor of each research network was interviewed in order to determine his or her personal opinion on the findings as well as plausible explanations. The selection of interviewees is based on purposeful sampling, that aims for rich and deep data in the interviews (Kuzel, 1992). Thus, in order to compare the results, an appropriately homogenous sample was ensured (McCracken, 1988), by selecting interviewees that shared critical similarities in regard to their network characteristics and function in the research project.

According to Kvale (2008) there are several ways of recording an interview, including audiotape recording, videotape recording, note-taking and remembering. In the implementation of two telephone interviews, this study relied on a combination of the two latter methods and thereby eliminated the potential for technical errors during recording. On the one hand, there are obvious limitations in regard to an interviewer's memory and on the other hand, the extensive taking of notes may disrupt a conversation. Thus, both techniques are able to compensate for their respective disadvantages. The active listening and recollection of statements matches the characteristics of a selective filter. This provides not merely a biased collection procedure, but rather the capability to screen and preserve essential information, that is most relevant in regard to the purpose of the interview. Taking notes during the conversation provides assistance in transcription, when the main aspects of the interview are written down (Kvale, 2008).

The final transcriptions were sent to the interviewees to be checked for misunderstandings. After their approval, they were annexed (see Appendix B).

4.3 Data analysis

Collected data undergoes analysis depending on source and addressed research question. While collected relational data is processed in a social network analysis, attribute data will be analyzed statistically and provide explanations to observations, whereas ideational data will be interpreted in order to indicate dominant institutional logics.

4.3.1 Document analysis

A document analysis constitutes the first component of the analytical section and is partitioned into two interweaved parts. Both research projects have released countless documents such as reports, presentations, press releases, handbooks, technical journals and scientific publications. These written results of a project resemble dominant institutional logics of the authors and of the network as a whole, since values and belief-systems inherent to an institutional logic, determine which problems researchers focus on and which solutions are considered or ignored. At first, several key documents were analyzed qualitatively for every project, followed up by a quantitative examination of a wide range of documents in the second part.

The second section of the discourse analysis sacrifices the inspection of context in favor of measurability. All available documents were scrutinized in order to quantify the frequency of every comprised word. Since the length of text varies highly between different kinds of documents, every word's frequency was divided by the document's number of pages to ensure relative measures. Subsequently, the frequency of every specified term was consolidated within all documents. Given that a report of one page may exhibit the same if not higher significance compared to a 60-page thesis, this was conducted irrespective of page numbers. Instead, every document was calculated having the same share as all others. Hence, as depicted in Figure 7, the result may be interpreted as a probability measure p_i of encountering a specific word i among all k available documents – each having equal weight – rather than the absolute density of a word among all pages of text. Therefore, the probability p_i is

$$p_i = \frac{\sum_{j=1}^{k} \frac{q_{ij}}{n_j}}{k} \tag{2.11}$$

where q_{ij} is the quantity of term i in a document j and n_j is the number of pages of said document.

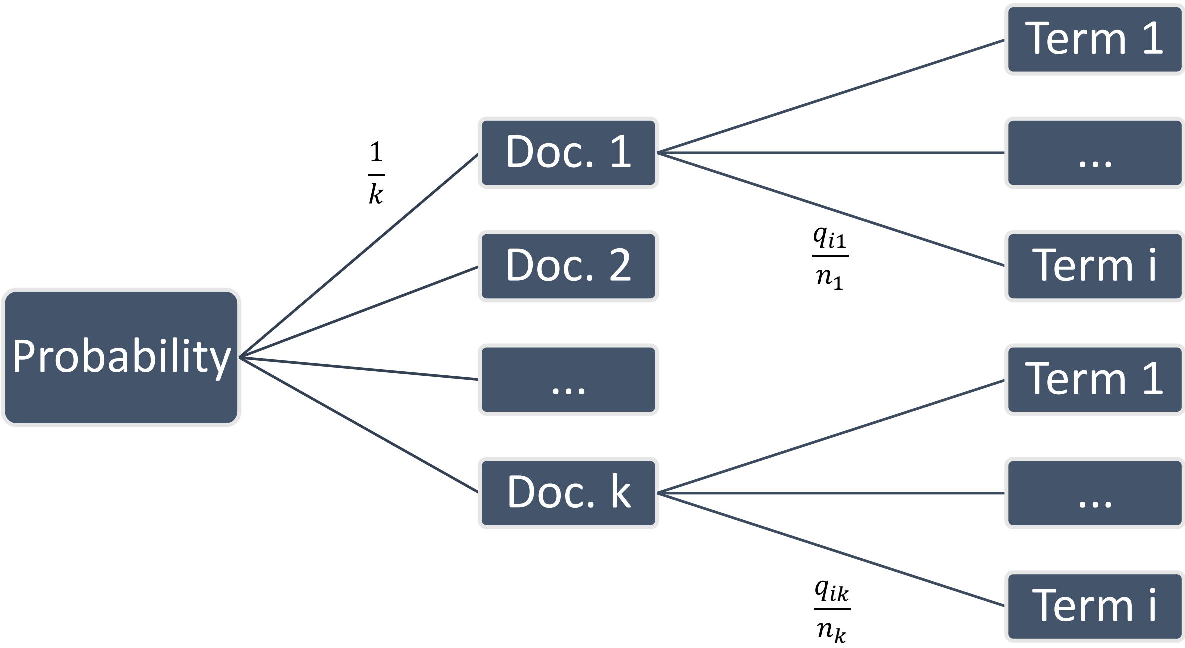

Figure 7: Probability tree of encountering term i in k available documents

Only terms exhibiting a probability higher than 10 % were examined. As these terms occur at least once every ten pages on average, they feature the highest chance to represent prevailing institutional logics. All others were deemed less significant and were disregarded for the sake of simplification. Within the chosen group, every word was considered that could be associated with one of the three institutional logics. Thus, different words were filtered out for various reasons. Terms such as 'for' and 'not' dropped out as they do not convey any logic, whereas 'urban' and 'water' are ignored, because they can be connected to every logic.

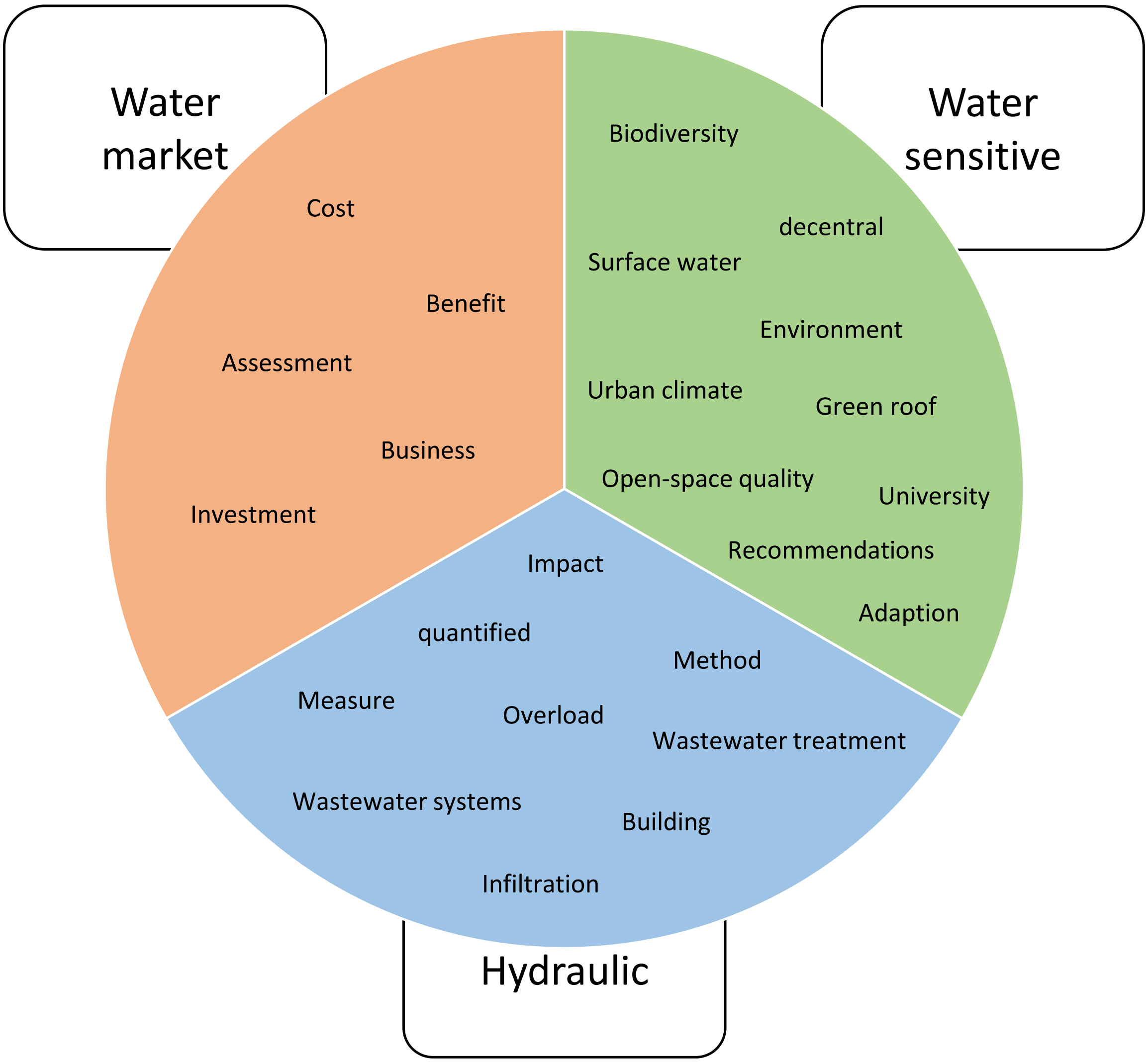

Figure 8: Terms divided by institutional logic

At the end of the categorization process a list emerged, containing decisive terms that characterize values and priorities of their respective institutional logics. Figure 8 illustrates selected examples of the aforementioned terms, identified in Klima 2050 documents. It becomes evident that these terms are not evenly spread among all three logics (see 4.3.1 Document analysis). Besides, this categorization does not qualify as an objective tool, because various terms such as ‘environment’ can be used in different contexts. In these cases, the classification of the particular term was based on assessing, which logic it fits best.

4.3.2 Statistical analysis

Parts of the data that was gathered in the survey, was either quantitative such as age, or quantifiable such as the number of actors working as coordinators. This information was used as the basis for statistical comparisons between Klima 2050 and KURAS.

Furthermore, the dominant institutional logic of each participant was determined based on the answers to eight consecutive questions in the third segment of the survey. Every question dealt with a topic that is characterized by a conclusive distinction between the three institutional logics. As the three logics provide different rationalities and belief-systems, they can be distinguished by a varying prioritization of issues such as financing, expertise, organizational form, decision-making foundation and central values. In addition to the six questions addressing these topics, two more were included, asking for the most critical challenges in the water sector today and for preferred mechanisms of adapting to climate change. A participant had to choose between three options in every question, grading them according to his 1^{st}, 2^{nd} and 3^{rd} priority. The data was analyzed statistically, by allocating different figures to the priorities. The first priority was assigned three points and the third priority was assigned one. For every logic, the points from all eight questions were accumulated in order to determine the most dominant logic of every participant. Despite using the results from this evaluation as attributes in the social network analysis, they were also utilized to compare both research projects directly in regard to percentages of members following different institutional logics.

Finally, statistical analysis was performed using IBM SPSS Statistics Version 22.0 (IBM Corp., 2013) in order to assess correlations between dominant institutional logics, age, employment level, work experience, working hours, the role in the project and various centrality characteristics (see chapter 5.2) of the two research projects. A Pearson correlation was calculated using a two-sided 0.05 level of significance.

4.3.3 Social network analysis

For every listed individual, a participant would choose whether there was any contact and if there was, how frequent this contact was. Moreover, those participants who listed additional names, would also include the frequency of contact. A higher frequency was interpreted as a stronger tie. As a result, an adjacency matrix was created, that included which nodes were connected by a tie as well as the strength of every tie. The final Klima 2050 network consists of 76 nodes, of which 55 were originally chosen and listed in the questionnaire. Additional 16 actors responded to the stage two participation request, that was distributed in the entire research network. Five more actors were listed by participants in the 'snowballing' question of the survey. All in all, out of all 76 illustrated nodes, 48 have submitted answers to the survey. Every actor is characterized by various attributes, although only the 48 active participants feature non-network attributes. On the other hand, quantitative network-derived attributes such as degree, eigenvector and betweenness were calculated for every actor via UCINET Version 6.647 (Borgatti, Everett, & Freeman, 2002) in order to evaluate how central actors are and whether there is a correlation between centrality and institutional logics. Non-network attributes derive from the survey and are mostly categorical. Age, being the only quantitative attribute, was divided into three age brackets and therefore converted into a categorical attribute.

Depending on the goal, various ways of visualizing a network were utilized, the main ones being: attribute-based scatter plotting, ordination and graph-theoretic layout algorithms. All of them have in common, that every node is represented by a point and all ties are represented by lines, which connect these points. To create an attribute-based scatter plot, all points are positioned depending on a selected attribute. This visualizes how connections between nodes can be affected by attributes. (Borgatti et al., 2013)

In ordination, points are positioned based on statistical techniques, the most important one being multidimensional scaling (MDS). MDS creates a layout where all points are positioned in a way that the distance between two points is directly correlated to the strength of the ties between the two corresponding nodes. Two nodes which are visually close to each other, will be connected by strong ties. One major advantage of this layout is the possibility to spot clusters – groups of nodes that are closer to each other than to other nodes. (Borgatti et al., 2013)

Furthermore, the layout of a social network may be altered by different algorithms, which do not display point distances as directly correlated to their node's proximities but are instead based on several criteria. One graph-theoretic layout used in this thesis relies upon three criteria. The first is the same one as in MDS: correspondence of the visual distance between two points and the actual distance of the path between two nodes. This constitutes the basis for the second criterion: node repulsion. If two nodes are too close to each other, because e.g. they have the same distance to all other nodes, they are artificially separated, to avoid one hiding the other. The third and last criterion is the equal length of edges. This results in a layout, where most ties are of comparable length, assuring a clean layout that tends to be aesthetically pleasing and easier to read (Borgatti et al., 2013). A major drawback on the other hand is the lack of information within node distances and locations. Since these are altered for aesthetic reasons, they do not represent any meanings anymore and every node can be individually dragged to any place without distorting the diagram.

Attributes of nodes and ties are typically integrated into the network by adding visual properties to the depicted points and lines. The size of a point may demonstrate the node's centrality, while the size of a line conveys the strength of the corresponding tie. Colors and geometrical shapes add further customization options, e.g. to display characteristics like an actor's employer and dominant institutional logic.

For additional analysis, ties may be dichotomized, meaning that valued ties are converted to unvalued ties. Different tie strengths may be selected as cutoff value: if only the strongest tier of ties is considered for instance, all weaker ties will be suppressed after the network is dichotomized. Moreover, groups of nodes may be merged, if for example every actor belongs to the same company. This allows the examination of connections between companies. To explore the influence of specific nodes on the network cohesion, they can be filtered, thus revealing possible fragmentation or different components of the network.

4.3.4 Interview evaluation

The analysis of qualitative interviews should be conducted simultaneously with the data collection (DiCicco-Bloom & Crabtree, 2006). Ideally, analysis techniques, such as clarification queries, are already used during the interview situation. There are several aspects to consider in the course of an interview. Participants share their perception of reality by describing their experiences, feelings and actions in regard to a topic. Moreover, interviewees might also themselves discover new realizations to their experiences while describing them. For example, an employee might recount a standard operating procedure in the company and uncover a flaw or inefficiency that never attracted his or her attention, while performing this exact procedure. The entire time, it is the interviewer's responsibility to capture the respondent's narrative, to interpret its meaning and to cross-check interpretations by condensing their quintessence and passing it on to the interviewee. That way, the respondent is able to confirm or to clarify what he or she meant. In this form of a 'self-correcting' interview, the interviewer continues consistently to decipher the meaning of the descriptions and to receive feedback approving or amending these interpretations. Thus, a major part of the analysis is already concluded during the interview, creating a solid foundation for and decreasing the needed effort of, later analysis proceedings. Afterwards, the researcher is able to examine the transcription in order to determine the participant's opinions entirely, to associate them with additional findings and to add own perspectives (Kvale, 2008).

4.3.5 Validity and reliability

Many qualitative researchers work alone and tend to present results instead of demonstrating how they obtained their findings, which can lead to questionable validity (Miles & Huberman, 1994). Validity criteria introduced to assess qualitative studies, suffer from little consistency, because every author proposes a new selection of criteria (C. B. Meyer, 2001). Instead, there is the option of applying the same criteria that are used in quantitative studies. Therefore, inspired by C. B. Meyer's *Case in Case Study Methodology* (2001), this thesis will be evaluated in regard to construct validity, internal validity, external validity, reliability as well as objectivity and intersubjectivity.

Construct validity

The essence of construct validity, is the identification of operational measures for the concepts that are being studied. The theoretical paradigm is supposed to correspond to the study's observations (Kirk & Miller, 1986). The aim of this study is to determine how our society and particularly the academic branch approaches the new challenges in the UWS. In this regard, I am studying the current advancement of a paradigm change on the basis of two research projects the water sector, by analyzing the dominant institutional logic of both networks as well as of their individual members. To assess the construct validity, I have to determine whether the theoretical concept – the institutional logics – is legitimately applicable to the observed facts – the data collected from documents, surveys and interviews. A common way to establish the justified application of a theory to one's observations is the citation of published studies that match this approach (Yin, 2014). However, by combining social network analysis with institutional logics, this thesis seeks to develop new methods, which shall be applied to research projects in the water sector in order to test their effectiveness. By virtue of the thesis aim, there are no published studies using the same procedures. Therefore, the construct validity has to be demonstrated on the basis of the actual implementation of the developed methods. Ways of increasing construct validity include longitudinal studies, a multi-case approach, triangulation and the use of feedback loops (C. B. Meyer, 2001). The thesis at hand is based on a cross-sectional study and thus, cannot benefit from the advantages of longitudinal designs. However, including more than one case is a possibility to validate the stability of constructs regardless of the study type. By analyzing two different cases – one in Norway and one in Germany – the construct validity of this thesis is improved. Since two cases constitute the minimum requirement for multi-case scenarios, there are limitations to this benefit. Nonetheless, these are overcome, because not only each network is studied, but also the individual researchers and hence, several units of analysis are examined. One additional way of strengthening construct validity is the implementation of multiple sources of evidence. These can involve multiple viewpoints within as well as across data sources (C. B. Meyer, 2001). Furthermore, the thesis at hand is based upon the concept of data triangulation, building a chain of evidence based upon multiple data sources, which are examined parallelly, in order to validate the results. Multiple viewpoints are also used within the data sources, as a survey involving all known network members is conducted in both research projects, while interviews with different experts are supposed to clarify findings and expand conclusions. In addition to a triangulation of evidence, the parallel analysis of two different cases and the implementation of more than one unit of analysis in each case, the construct validity was enhanced, because the case study draft was reviewed and commented on by key informants – a tactic recommended by Yin (2014). Finally, a feedback loop was implemented, which involves discussing the developing interpretations and theory with interviewees as well as looking for contradictions in the data (C. B. Meyer, 2001). This step was conducted in the form of expert interviews with the coordinators of each project, after all other data collection and analysis procedures were completed. In the course of the interviews, both, expected results and surprising contradictions were reviewed.

Internal validity

Internal validity refers to the legitimacy of hypothesized relationships within the study. There are concerns in regard to qualitative studies, that a researcher can always state plausible explanations and edit the data to secure a coherence (Sykes, 1990). This has led to calls for better documentation of data collection procedures, the data itself and interpretations of the researcher (C. B. Meyer, 2001). The data collection and data analysis methods as well as the type of primary data utilized in the thesis, were described after being assessed by the Data Protection Official for Research of the Norwegian Centre for Research Data (NSD) (see chapters 4.2 and 4.3). Moreover, several advantages of case studies are used as well (see chapter 4.1). First off, case study research is highly flexible to different data sources and theories. In contrast, qualitative studies such as ethnography and grounded theory presuppose findings on theoretical perspectives that emerge from rigid first-hand data. Secondly, case studies enable the combination of qualitative and quantitative methods, all of which can be used to triangulate results. The present thesis involves documents, surveys and interviews as data collection sources. Various data analysis procedures are used in addition to the social network analysis, which constitutes the core of this study. Thus, findings can be compared and validated, while being expanded by supplementary information, whereas institutional theory forms the basis for interpreting results. Effectively, the study's internal validity is ensured by a selection of strategies that aim at eliminating ambivalence and discrepancy by providing strong links between data and conclusions (C. B. Meyer, 2001).

External validity

In regard to external validity, there is a contrast between generalizing from a case study and generalizing from empirical data. Statistical generalization is a more commonly recognized way and makes inferences about a population based on empirical data that is collected from a sample. Nonetheless, one case does not represent one unit of a sample, instead one case can be considered as being similar to one experiment. Hence, statistical generalization is not applicable to a case study. The generalization process does not rely on population-based statistical inference, but rather theoretical propositions based on features of the case study (J. F. Hartley, 1994). The 'two-case' design of this thesis is therefore not a study, which is based on a sample of two units but rather a study that resembles two experiments. Therefore, a cross-case analysis aims at analytic generalizations instead of statistical generalization and hence, the goal is to conclude and expand theories and not to extrapolate probabilities (Yin, 2014).

Conclusively, the external validity or generalizability of a case study does not rely on a high amount of observed cases. On the contrary, it depends mostly on the persuasive power of the theoretical reasoning (C. B. Meyer, 2001). One classic example is the case of *Street Corner Society* by W. F. Whyte (2012). First published in 1943, this book reveals details about the lives of lower income youth. Distinguishing between small groups of 'corner boys' and 'college boys', Whyte presents the formation of local gangs as well as the career advancements of adolescents moving up the social ladder. The study demonstrates how the lives of people start revolving around certain corners of their neighborhood or in contrast, how others are able to break neighborhood ties. Although the results originate from a single case – a small group of people living in one neighborhood – that was studied more than 70 years ago, *Street Corner Society* remains highly relevant, ironically, because of its generalizability. Researchers studying the social structure of other neighborhoods in various time periods, have consistently found parallels to Whyte's work (Yin, 2014). Therefore, a multi-case approach is not a requirement for adequate external validity. However, a replication logic similar to the one used in multiple experiments can be applied to a case study, if it includes multiple cases (Yin, 2011). Thus, successful replication, meaning that two or more cases support the same theory, results in an enhanced external validity (C. B. Meyer, 2001).

Reliability

A study's reliability measures whether a different investigator conducting the same procedures, as used in the original study, would arrive at the same results and conclusions. This means that the subsequent researcher examines the exact *same* case again, not that he tries to replicate the results by doing a different case study. There are practical limitations to repeating the case study, as this would require the researcher to gather primary data. While the studied documents should remain accessible, and the survey can be copied to contain identical questions, receiving the same answers is highly implausible, even if the same respondents participate again. The semi-structured interviews were designed to create a dialogue, which is unlikely to be exactly repeated by a different interviewer. However, a creation of a case study database, as proposed by

Yin (2014), is inadmissible on account of the primary data's nature. As personal data, it has to be anonymized or deleted at the end of the study and may not be distributed to other researchers. Moreover, the processing of social science data requires interpretation, as the data has its roots in meanings, motives and typifications (J. Scott, 2017). Consequently, deviations between studies conducted by different researchers are to be expected (C. B. Meyer, 2001). Nonetheless, the researcher has a responsibility to provide information to the public about the study's preparation as well as data collection and analysis procedures (Kirk & Miller, 1986). To address this issue, a description of the case study's design decisions, chosen cases, data sources as well as collection and analysis procedures was included in the form of chapter 4 Material and Methods, while additional information such as a list of evaluated documents as well as questions from both surveys and interviews were annexed (see Appendices).

Objectivity and intersubjectivity

One important issue to address is objectivity, or relative neutrality and reasonable lack of unacknowledged research bias (Miles & Huberman, 1994). Researchers risk shifting roles from observer to advocate (Leonard-Barton, 1990), if objectivity is lost, which can happen through involvement with the organization especially in longitudinal studies (C. B. Meyer, 2001). Although researchers should not aim at being fully objective in qualitative studies, as sensitivity to subjective aspects of the relationship between interviewer and interviewee constitute part of the research process (King, Cassell, & Symon, 1994), research bias should still be addressed in order to avoid results that are only the product of the researcher's prejudice (C. B. Meyer, 2001). Therefore every researcher should try to consciously resign his presuppositions in the analysis (Gummesson, 2000) and consider rival conclusions (Miles & Huberman, 1994).

To minimize effects of unacknowledged bias during this study, research questions were defined as precise as possible and methods were developed in detail. Thus, the actual implementation was constantly guided during data collection and analysis. An electronic survey, as the essential data collection procedure in this study, suggests low interviewer response effects, as it does not involve a meeting and even less a personal connection between interviewer and interviewee (see chapter 4.2.1). Hence a relatively low risk of researcher bias was asserted in the main part of the study. Nonetheless, I tried to be receptive to new data and unforeseen results. Besides, interviewing central actors helped to search for negative evidence by asking problem-oriented questions.

Another crucial part to be considered is intersubjectivity – whether other researchers can follow the interpretations made in the case study. Miles & Huberman (1994) provide advice in form of four aspects: a) describing the study's methods and procedures in detail, b) presenting the sequence of data collection, processing and analysis, c) linking conclusions with exhibits of displayed data and d) retaining and making the primary data available to others.

With reference to these suggestions, I have presented the methods of data collection and analysis individually and demonstrated how they string together in order to provide final data that was displayed in the results, which in turn were related to the conclusions. Because the study examines personal data, it was subject to notification by the Data Protection Official for Research of the NSD. Personal data was treated confidentially and was anonymized at the end of the study, hence beside the processed data that was released in the final thesis, no data was made available to others.

5 Results

This thesis relies on a combination of qualitative and quantitative data for the triangulation of findings. The subsequent presentation of the elaborated results is subdivided into their respective analysis stages.

5.1 Document Analysis

Klima 2050 (NOR) aims at adapting buildings and infrastructure to the effects of climate change, particularly enhanced precipitation and flood water. The research activities are divided into four main areas: stormwater management, moisture-resilient buildings, landslides and decision-making processes (Time, 2016). Essentially, the central vision of the research project lies in reducing risk within the built environment, through the development of solutions applicable to challenges associated with the effects of climate change on stormwater (Time, 2015). This incorporates three out of four working packages, whereas the fourth one is structured around socio-economic incentives and decision-making processes.

Of Klima 2050's four work packages, this study focuses on package 2, which is centered around the management of stormwater. This corresponds highly to the hydraulic logic, that relies on values of security and safety. Diminishing societal risks of climate change corresponds well to the hydraulic priority on national welfare. Nonetheless many applied methods such as nature-based solutions or blue-grey implementations are driven not only by the need to drain stormwater effectively, but also by the intention to promote sustainability (Ugarelli, Martínez, Ahmadi, & Raspati, 2017). Moreover, one entire working package, staffed with researchers from various transdisciplinary fields, is dedicated to social processes, by focusing on decisions made in the community, further strengthening the water sensitive logic. Comparably little intention is paid to various aspects related to the water market logic, given that the cost-effectiveness of some methods is mentioned, but rarely carved out in detail. Although consortium partners of several industries, ranging from finance and insurance to consulting, are deemed to be interested in economic benefits, these goals do not seem to constitute the central guideline of the research project. The aim to find technical solutions, hence reducing risk, damages and consequently costs might be seen as an adequate solution guaranteeing economic efficiencies in the long-run.

Regarding the quantitative analysis of Klima 2050 I refer to a cooperation with Manuel Franco Torres. As a PhD candidate working in the Norwegian water sector, he helped to categorize both Norwegian and English terms. Unlike KURAS, a project that has been finished in early 2017, Klima 2050 is still ongoing. Therefore, there are no final results and discussions to inspect, instead annual reports are examined as key documents. However, an archive containing a large number of documents is publicly available on the homepage. All documents from the two categories 'Kunnskapspredning' (Engl.: dissemination of knowledge) and 'Temasamlinger' (Engl.: collection of subjects) were chosen to be analyzed, as these promised a high explanatory power in regard to the rationalities behind Klima 2050's results (see Appendix C, Table C1). The 45 examined documents of Klima 2050 provided 329 words that occurred at least once every ten pages on average (see Appendix D, Table D1). Of this set, 106 categorized terms were assigned to suitable institutional logics, accounting for approximately 25 terms per page (for examples see chapter 4.3.1). With 14.62 terms per page almost 60 % of these correspond to the hydraulic logic. The water sensitive logic is slightly less represented with almost 8,8 terms per page. Approximately 7 % of overall categorized words are allotted to the water market logic. Compared to the dominant HL, its frequency is 12 %. As expected from the qualitative analysis the hydraulic logic emerges as the dominant driver in front of the water sensitive logic. Above all the water market logic has barely any direct influence on the examined writings, as mentioned in the prior analysis.

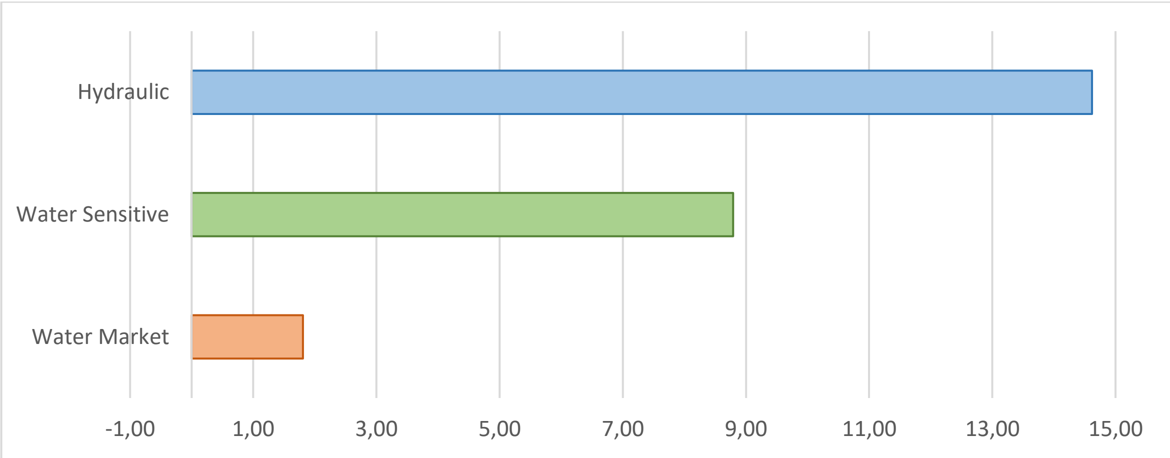

Figure 9: Institutional logics in documents of Klima 2050 [average terms per page]

The project KURAS (GER) evaluates various methods of stormwater and wastewater management, that are capable of being integrated into the planning of new construction undertakings. Three final documents were inspected, one guideline for wastewater systems, one guideline for stormwater management and one discussion paper. The results of the research project are condensed in both guidelines and further recommendations are included in the discussion paper, making these documents an ideal source of spotting how priorities were determined, and which solutions were preferred. Regarding wastewater, five goals were set: to reduce urban flooding, combined sewer overflows, deposition of solids in pipes, clogging pumps and the non-compliance with environmental requirements in wastewater treatment plants (Matzinger, A., Riechel, M., Remy, C., Schwarzmüller, H., Rouault, P., Schmidt, M., Offermann, M., Strehl, Nickel, D., Sieker, H., Pallasch, M., Köhler, M., Kaiser, D., Möller, C., Büter, B., Leßmann, D., von Tils, Säumel, I., Pille, L., Winkler, A., Bartel, H., Heise, S., Heinzmann, B., Joswig, K., Rehfeld-Klein, & Reichmann, 2017). Regarding stormwater, one of the main results of the examination is the high potential of several methods to reduce hydraulic stress and material pollution on urban waterbodies, not only decreasing infiltration speed and consequently reducing the amount and extent of combined sewer overflows, but also filtering out substances such as phosphorus and ammonium. While drainage of stormwater is seen as an essential goal, several other effects are mentioned to be benefitting the livability as well as the environment. These include the quality of open spaces that may be improved by infiltration swales or artificial ponds, the reduction of urban heat islands through increased evaporation and shading, or the gain in biodiversity resulted from added blue-green elements and their function in linking existent grassed areas (Thamsen & Matzinger, 2016). Finally, economic factors are considered in detail since every method is evaluated in a cost-benefit-analysis. Investment costs as well as maintenance are compared to water savings and energy-related efficiencies.

An initial analysis of this documentation conveys the impression that the priority consisted of goals related to the hydraulic logic. Optimization of the wastewater system in terms of pumps and pipes as well as the drainage of stormwater to reduce the risk of flooding are vital aspects in the face of climate change. Costs of potential damage are high, therefore benefits of safety and security measures are appreciated. Nevertheless, countless advantages of these measures are not of hydraulic nature, but serve the environment or the human livability instead, accordingly they represent the water sensitive logic. Negative effects of combined sewer overflows on fish populations are addressed just as environmental requirements on wastewater treatment plants or the biodiversity in urban areas. Livability factors such as the quality of open spaces and the reduction of heat islands are emphasized although calculations of tangible effects are complicated and therefore rough. The water market logic, though least pronounced, establishes itself periodically as evaluations of every suggested measure are not limited to quantified effects but include costs and potential efficiencies as well.

The basis for investigating the KURAS project quantitatively were all 12 documents, that were published on the homepage and mainly consisted of final reports and guidelines displaying results and conclusions, as well as interim presentations and discussion papers (see Appendix C, Table C2). These 12 documents included 169 words, that featured at least a 10 % probability of being encountered (see Appendix D, Table D2). In absolute terms, this is a significantly smaller number compared to Klima 2050, leading to fewer categorized terms. All in all, 46 distinctive words were assigned to a fitting institutional logic, resulting in 10,12 categorized words per page. With 4,9 almost half of those are associated with the hydraulic logic. The water sensitive logic on the other hand presents around 3,91 categorized words per page, leaving the water market logic on third place composing 1,31 words per page, an amount which equates to 27 % compared with the hydraulic logic. This distribution confirms the impression of the qualitative document analysis, due to the fact that the hydraulic logic arises dominantly, followed closely by the water sensitive logic. Moreover, the water market logic remains as the least powerful one, though with around 13 % still containing a significant share of utilized terms per page.

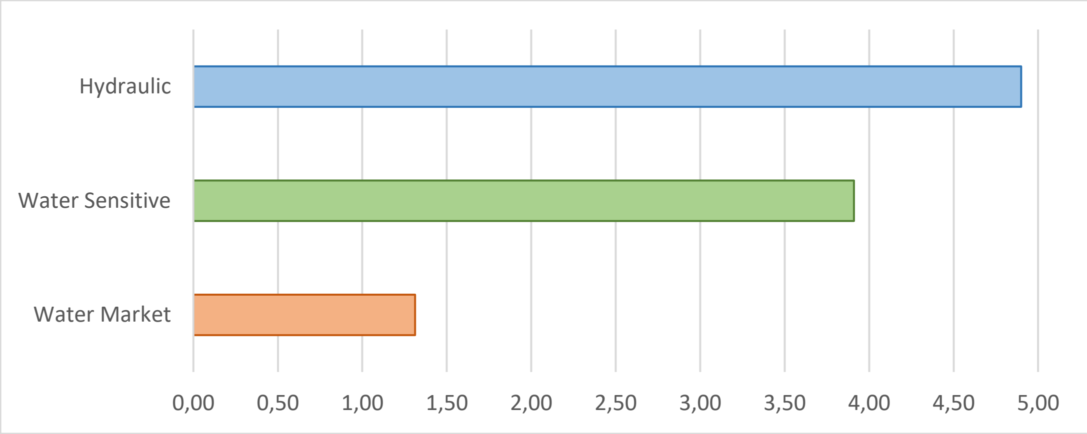

Figure 10: Institutional logics in documents of KURAS [average terms per page]

5.2 Social network analysis

To assess differences between both groups, a two-sided 0.05 level of significance was used. A correlation and a regression analysis were performed, resulting in no statistical differences between both groups considering age or dominating logic. As presented in Table 3, both networks offer similar parameters, allowing for a better comparability while excluding bias caused by age or dominant logic.

Table 3: Subject characteristics of Klima 2050 and KURAS

	Group		P-Value
	Klima 2050	KURAS	
n	48 / 76	21 / 55	
Response rate	63,16 %	38,18 %	
Age in years	44,69 ± 10,896	42,19 ± 10,898	0,384
Institutional logics			0,637
Hydraulic	54%	48%	
Water sensitive	38%	43%	
Water market	8%	10%	

Depending on the answers to 8 consecutive questions of the survey, a score was calculated, resembling the dominant institutional logic of every participant. For the sake of simplification, we assume that every actor follows his or her determined dominant logic. Successively, various formulations like 'actor follows logic X', 'actor is categorized as X' etcetera are used synonymously, meaning that X is this actor's dominant logic. Moreover, the network questions provided the basis for the creation of an adjacency matrix, that was symmetrized by creating a new data set in which all ties are reciprocated and undirected. The adjacency matrix was symmetrized using the OR rule, also known as union rule, meaning that a tie is created if either actor mentioned a connection to the other. Alternatively, the AND, or intersection, rule may have been used if the data sets were complete. This would have resulted in ties being created, only when both actors have stated a connection to each other. The tie strength is equal to the highest strength specified by either of the two actors. This way, unintended asymmetry that results when actors do not respond to the survey or respondents forget some contacts, is corrected.

5.2.1 Klima 2050

Figure 11 illustrates the distribution of institutional logics within the network. The size of every node depends on its degree. Nodes are allocated according to a graph theoretic layout to ensure higher readability. As this results in distances being meaningless, the strength of ties between two nodes is shown in the thickness of the respective lines, graded in three stages. Dominant institutional logics are color-coded to be easily distinguishable and are assigned shapes, which will be used in further visualizations. The hydraulic logic is presented as a blue square, the market logic as an orange triangle and the water sensitive logic as a green circle. Every actor that has not participated in the survey is pictured as a white diamond. Of the 48 actors, that submitted answers to the survey and could hence be categorized according to their dominant institutional logic, 26 follow the hydraulic logic, which equates to more than 54 %. While the water sensitive logic is still very influential with 18 respondents, only 4 researchers or 8,33 % of the sample followed the water market logic. The entire network forms one component and contains no isolates although more than 20 people did not respond to the survey. There are only four pendants (nodes that have only one tie), all of whom were exclusively named in the open-ended question of the survey, that was asking for further contacts beside the ones already listed.

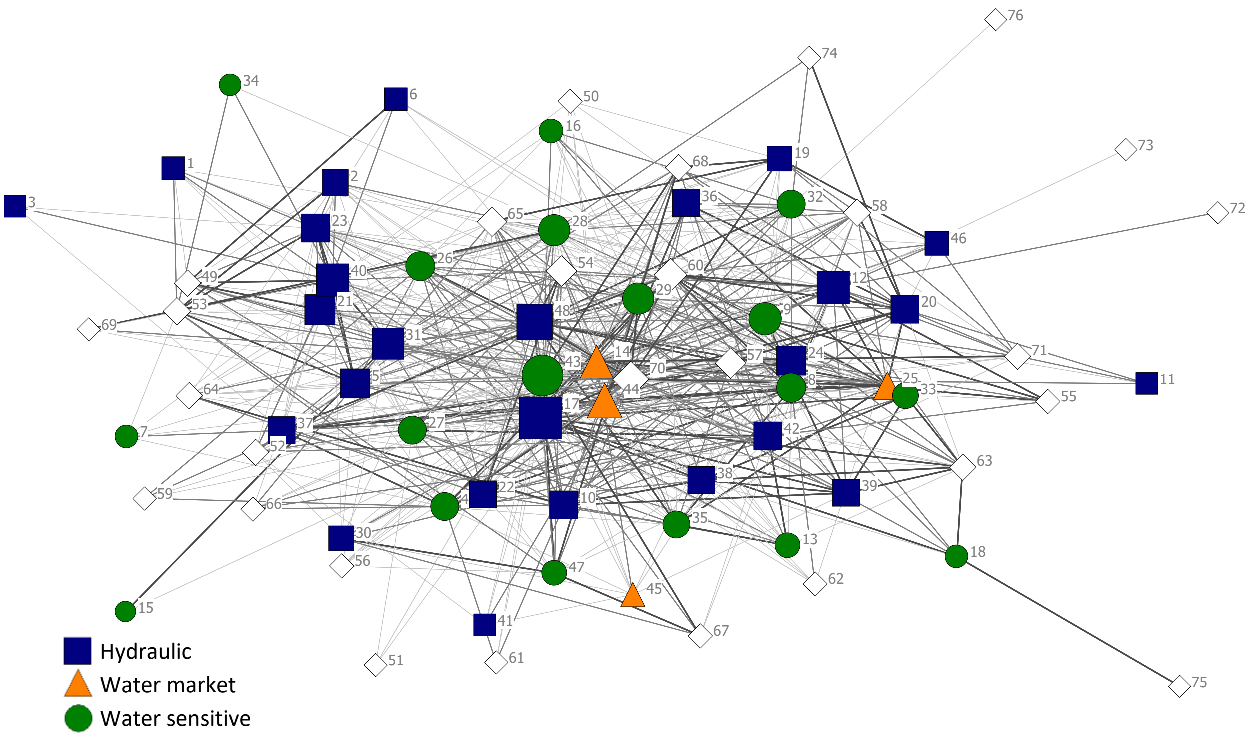

Figure 11: Klima 2050 network, specifying dominant institutional logics

Researchers of Klima 2050 were divided into three age groups, the first containing everyone up until an age of 35 (blue), the second group including everyone between 36 and 50 (orange) and the third group consisting of every researcher over the age of 50 (green). Depicted in Figure 12 is the Klima 2050 network, where the size of node symbols is proportional to every node's centrality, age is color-coded, and institutional logic is represented by the node symbol's shape. The four most central actors derive from the second age group. Two of these four researchers are categorized as hydraulic, while the other pair follows the water market and the water sensitive logic respectively. This accumulation of actors following the hydraulic logic is noticeable in the entire network, as already observed in Figure 11. Prevailing as most frequent logic is the hydraulic one, whereas the water sensitive logic follows closely. With only four nodes, the water market logic is barely represented. The share of every logic is similar across all age groups. Slightly more researchers are categorized as hydraulic as well as water sensitive among the oldest age group, because only one actor follows the water market logic. In contrast, slightly more researchers follow the water market logic among the second age group. The percentages among the youngest researchers are in between those of the other two groups.

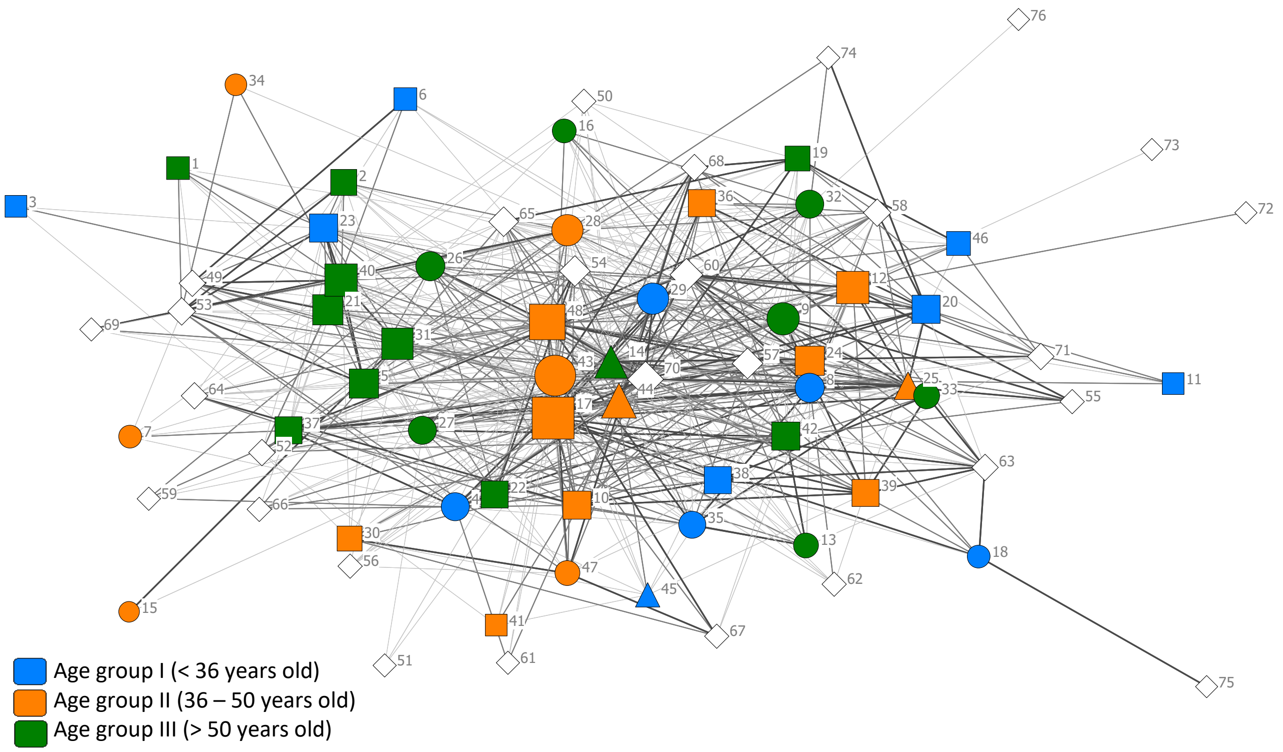

Figure 12: Klima 2050 network displaying institutional logics and age (graph theoretic layout)

The multidimensional scaling (MDS) utilized in Figure 13 visualizes distances between nodes more clearly. Every node's size correlated to its eigenvector centrality. The four central nodes form a tight cluster. The oldest actors are scattered circularly around this central cluster, whereas the youngest actors are distributed evenly throughout the network, a few being quite central while others are highly peripheral. Several older actors are grouped together, the younger actors on the other hand appear to be relatively separated from one another.

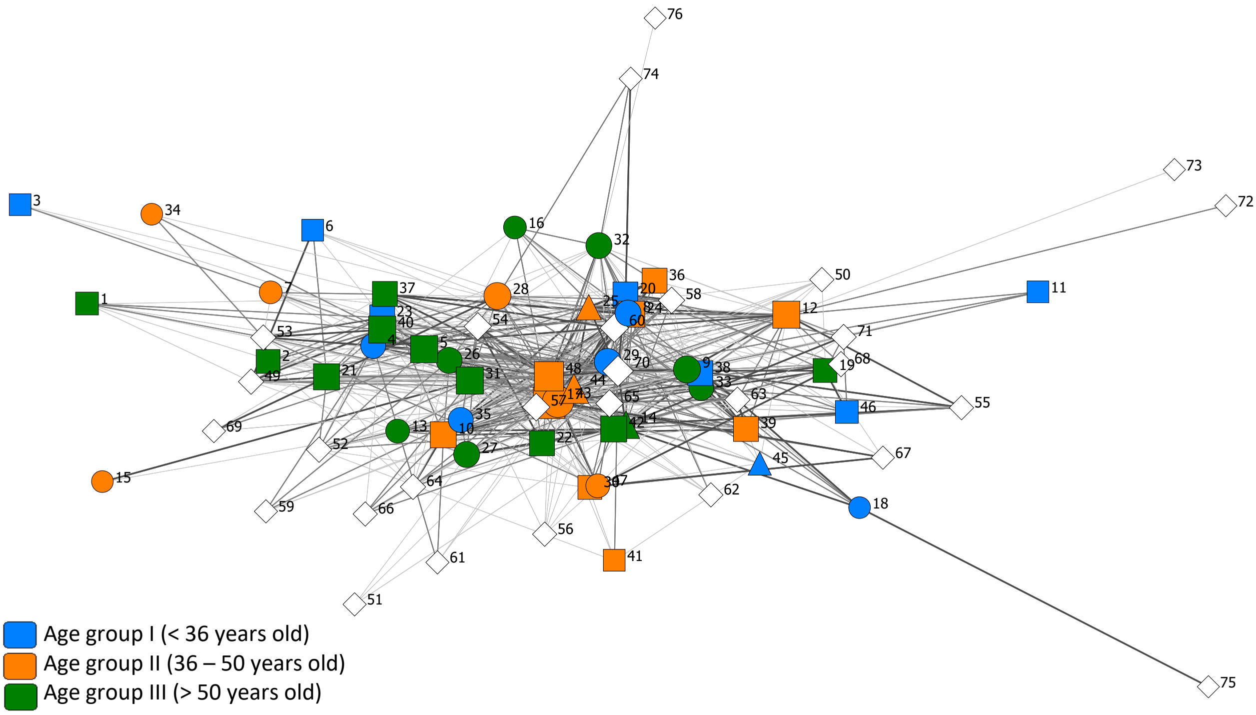

Figure 13: Klima 2050 network displaying institutional logics and age (MDS layout)

The same MDS layout is depicted in Figure 14, showing every actor's employer. A majority of nodes in the central cluster work at SINTEF (blue), the leading research organization. Node 43 is characterized by high centrality measures and is a part of this cluster but belongs to Statsbygg (dark grey). In comparison, both its colleagues have far lower centrality and are located closer to the fringe of the network. NVE - The Norwegian Water Resources and Energy Directorate forms another cluster with eight nodes, of which some are relatively central and strongly linked to the network's core while others are more peripheral. Four nodes related to Statens vegvesen (dark green) are arranged not far from this cluster, indicating forms of collaboration between these organizations. A third cluster consists of six NTNU actors (red), although three more are located close to the above-mentioned clusters. Three actors working at Trondheim Kommune (bordeaux) are located close to the core of NTNU, reflecting the actual proximity of both employers residing in Trondheim. Nodes from several private companies are located to the right of the network, including Skanska, Isola, Mersterhus, Skjæveland and Saint-Gobain Byggevarer. The four nodes from Saint-Gobain Byggevarer are relatively scattered across this part of the network, which reflects the fact that Saint-Gobain is a group, consisting of several companies, such as Leca Norge and Weber Norge.

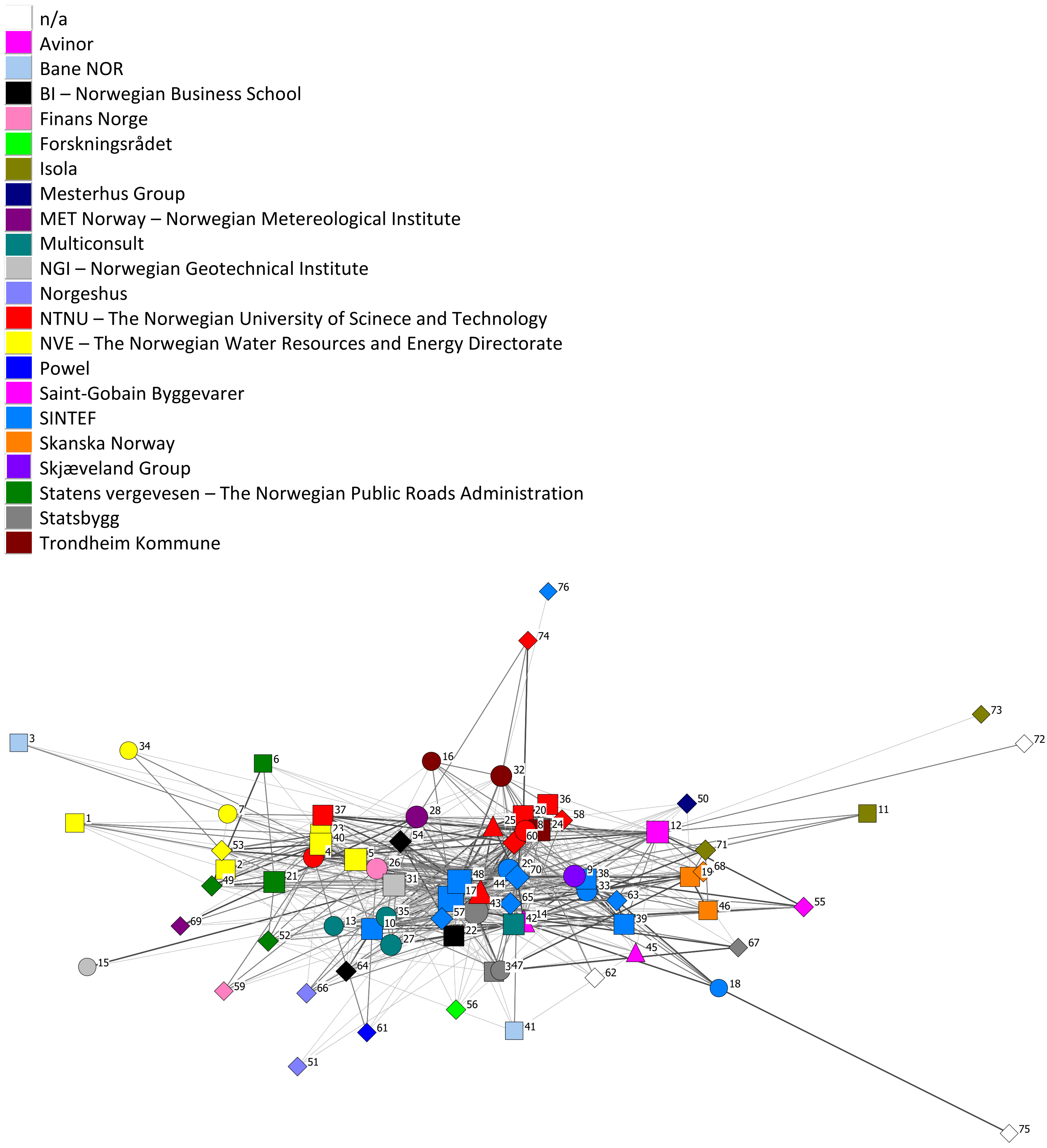

Figure 14: Klima 2050 network displaying institutional logics and employers

Utilizing an attribute-based scatter plot, the nodes are rearranged according to respective institutional logics and are sized according to their closeness centrality. A striking accumulation of companies becomes apparent. Both researchers from Skanska Norway (orange) are located in the hydraulic corner. Likewise, most SINTEF actors (blue) are associated with the hydraulic logic. A majority of NVE employees (yellow) are not only considered to be hydraulic, but also feature far larger centrality measures than their few water sensitive colleagues. Equally, both researchers from Statens vegvesen (dark green) follow the hydraulic logic. On the other hand, three out of four actors from Multiconsult (turquoise) are water sensitive and reside in the lower left corner of the network. While three nodes of NTNU (red) are hydraulic, the logics among the university's employees are unusually wide spread and almost evenly distributed. 50 % of the WML group are composed of two researchers from NTNU. Another two NTNU actors are water sensitive, as are two actors from Trondheim Kommune.

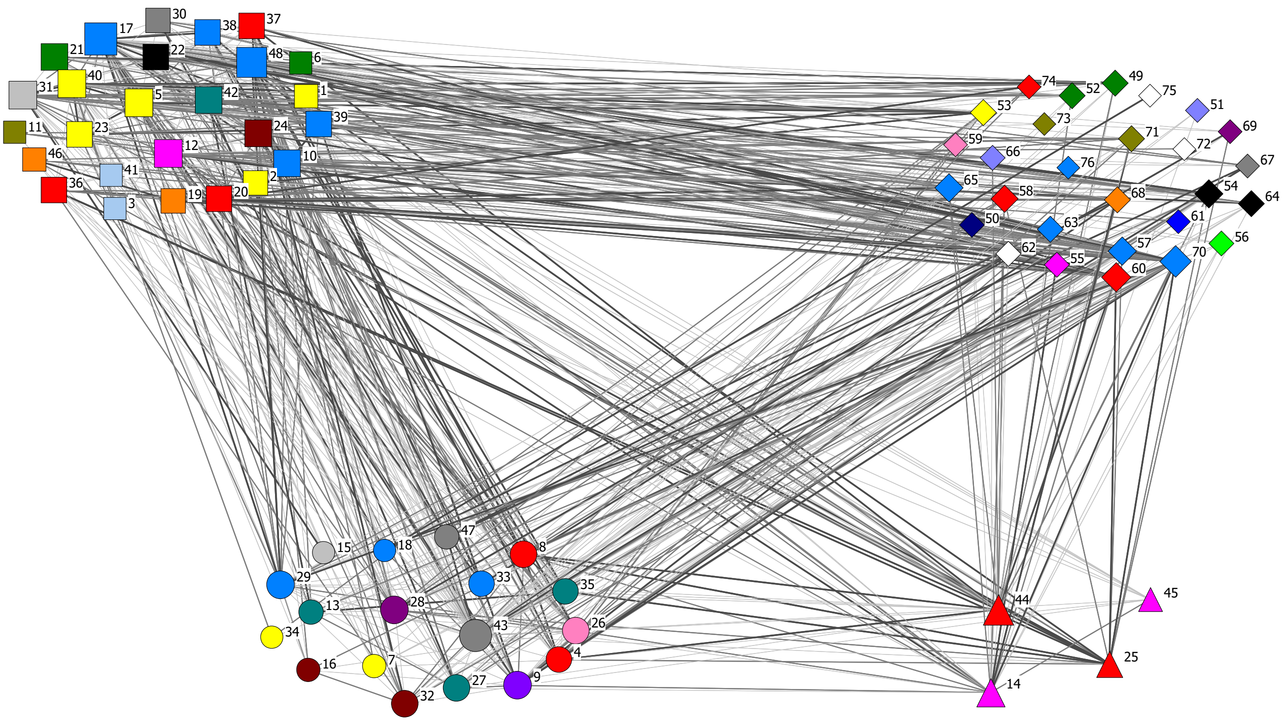

Figure 15: Klima 2050 network grouped by institutional logic
(colors according to employer, shapes according to dominant institutional logic)

As the weakest possible tie represents communication between two people that was less frequent than three months, there is a high potential for ties between various nodes, culminating in a network that consists of only one component. To receive a more comprehensive understanding of the subgroups included in this network, Figure 16 shows ties exclusively portraying weekly communication between nodes. The resulting network consists of three components, that vary greatly in size, as well as 19 insolates, a majority of which are actors that did not participate in the survey. The smallest component is a single dyad between two nodes, both working at the Norwegian Meteorological Institute (purple) and hence, explaining their frequent contact. The second-largest component, located in the lower middle of the graph, consists of three organizations that have their head offices in Oslo. Half of the component's members are NVE employees (yellow), the most central of which (node 40) adopts the role of a cutpoint that connects the entire group to three actors from Statens vegvesen (dark green) and two from NGI – The Norwegian Geotechnical Institute (light grey). Without these two inter-organizational bridges, the entire component would dissolve into three components, each encompassing several employees of one specific company. Finally, the largest component includes several subgroups, the numerically biggest being the entire groups of SINTEF, NTNU and Multiconsult. Node 70, a project coordinator from SINTEF, serves as a cutpoint linking the main part of the component to actors from Skanska, who in turn provide connections to Statsbygg. Furthermore, the entire group of Multiconsult is composed of bridges linking one node to another, the final node 35 being a cutpoint that connects the group to SINTEF and NTNU. All in all, the graph reveals that organizations headquartered in Trondheim appear to be very close to each other, as being noticeable with NTNU, SINTEF and Trondheim Kommune. SINTEF and NTNU constitute the main part of the biggest component and have connections to other research organizations, such as BI Norwegian Business School, as well as to private companies, such as Skanska, and to public entities, such as Avinor.

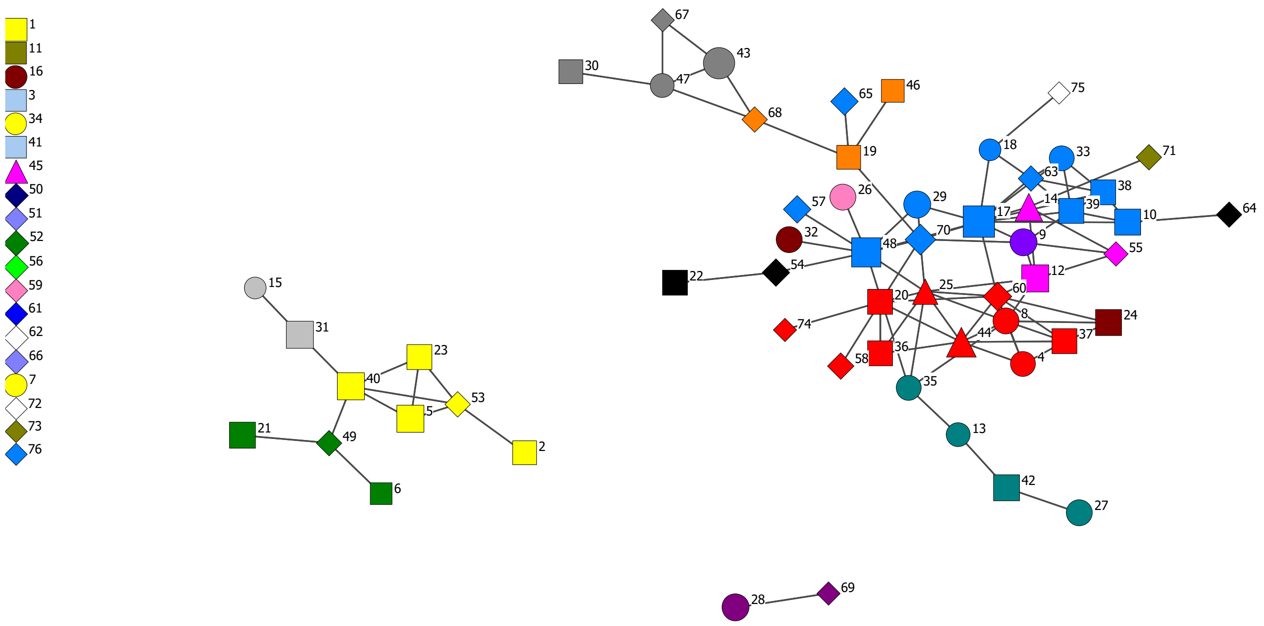

Figure 16: Klima 2050 network displaying strong ties
(colors according to employer, shapes according to dominant institutional logic)

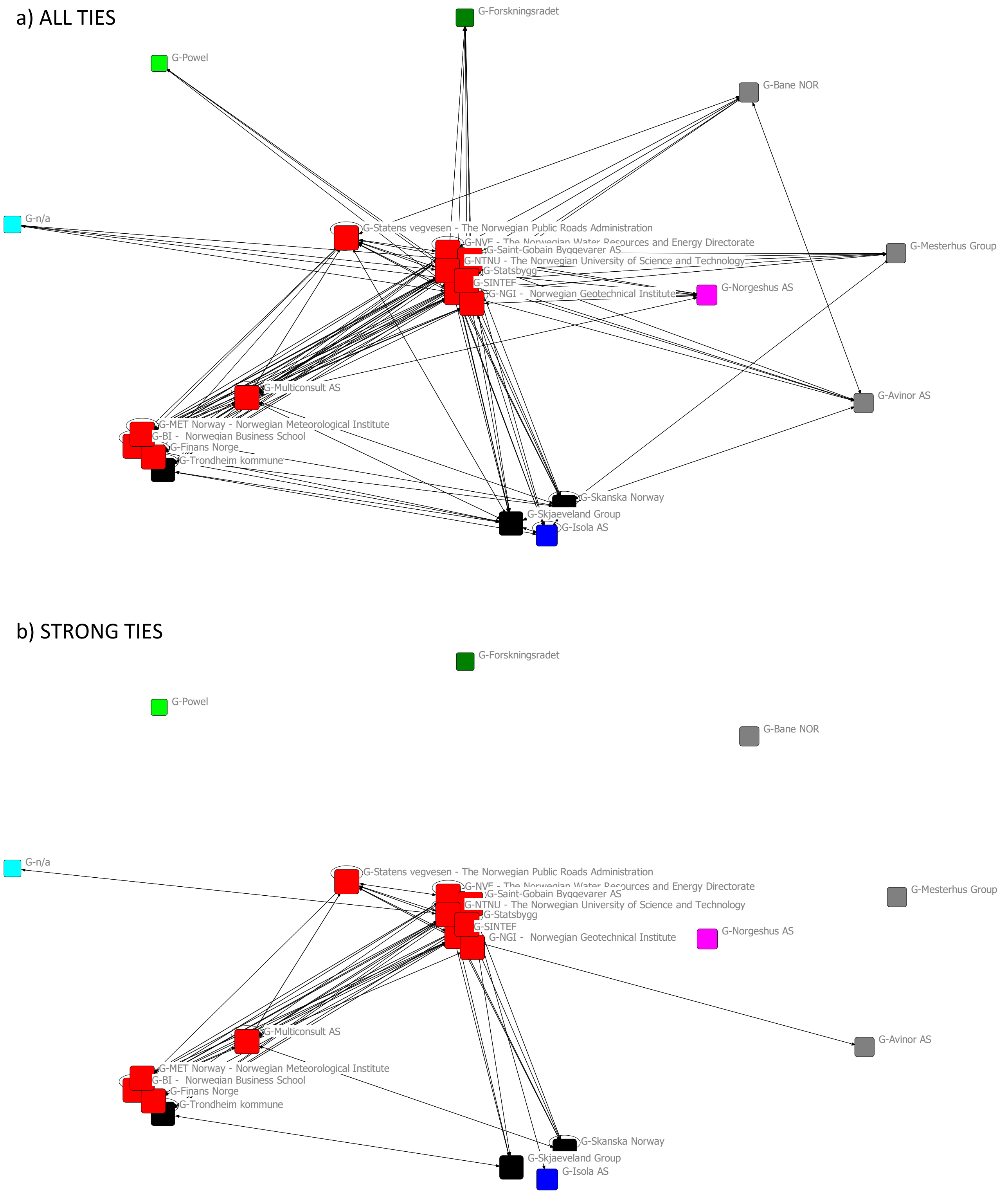

Figure 17: Klima 2050 actors collapsed by organization, a) all ties, b) strong ties

To show more clearly how the participating organizations are linked with each other, nodes were collapsed according to their respective employer in Figure 17. The resulting MDS layout shows a new set of nodes representing organizations instead of individuals. K-cores – subgraphs in which every actor’s degree is k or higher – were analyzed in order to render the color and size of each point in correlation to its k-core. The nodes with the highest k-core of 11 are represented by a red color, whereas black (10), blue (8), pink (7), grey (6), dark green (5), light turquoise (4) and light green (3) indicate incrementally smaller k-cores. The graph visualizes which nodes are connected and positions highly linked organizations closer to each other. While this graph is not meant to show central nodes, it does visualize which organizations appear closer to each other, such as NTNU and SINTEF or BI and Finans Norge, as well as how the cooperation between organizations changes if only strong ties are observed. If all except for strong ties are eliminated, the five nodes with the lowest k-core values are cut off from the remaining component. Since several network members have not participated in the survey, it can be assumed that this visualization would look different if network data for every participant would be available.

Furthermore, an ego-network for the actor with the highest centrality measures was created – that is a network containing all nodes that are linked to said ego. When that ego is removed from its network, it is possible to see fragmentation or the development of new clusters. In this case however, none of that happened, as the high density of ties requires the elimination of a significant number of nodes, before the network splits apart (see Appendix E, Figure E1). In other words, the network is very robust, indicating high cohesiveness.

5.2.2 KURAS

A similar network analysis was conducted in the KURAS project.

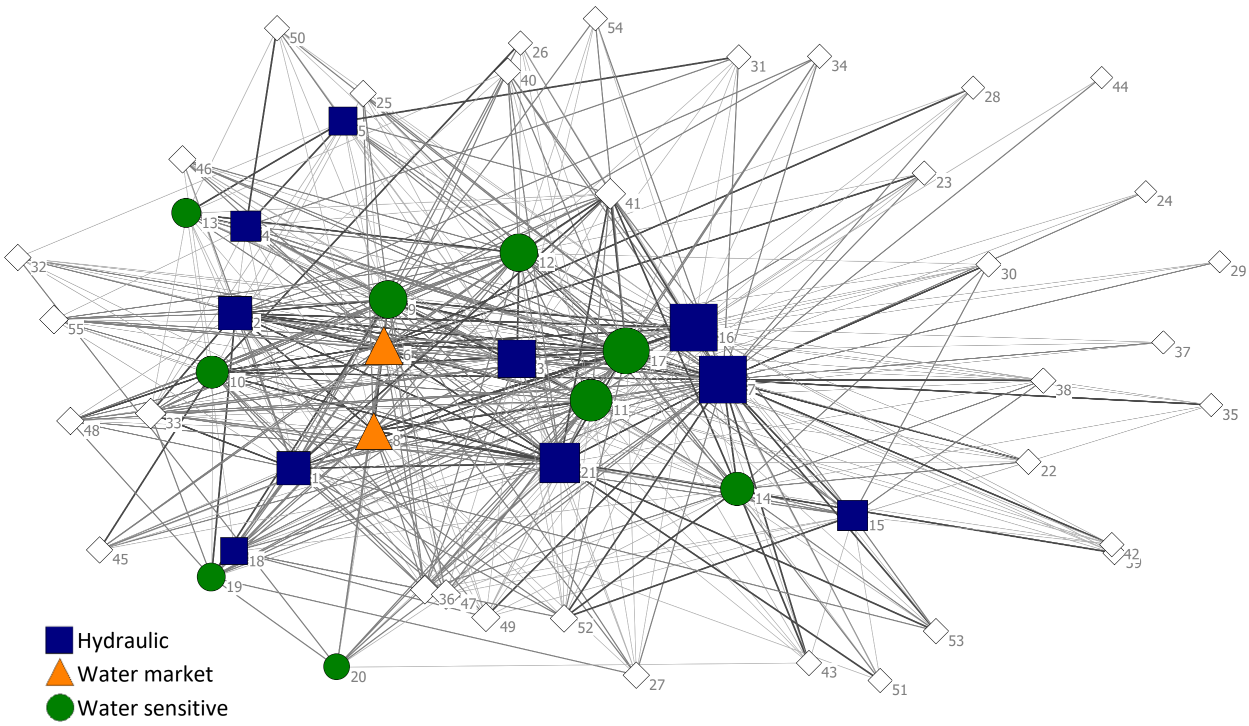

Figure 18: KURAS network specifying dominant institutional logics

Figure 18 shows a graph theoretic layout of the KURAS network – every node being sized according to its degree – and illustrates the dominant institutional logic of each actor: hydraulic (blue square), water market (orange triangle) and water sensitive (green circle). Disregarding actors who have not answered any questions (white diamond), the hydraulic logic prevails, but leads only with one actor ahead of the water sensitive logic. Although there are fewer actors following the water market logic than in Klima 2050, their share is higher with over 9,5 %. The shapes used to visualize each actor’s institutional logic stay identical in the following figures.

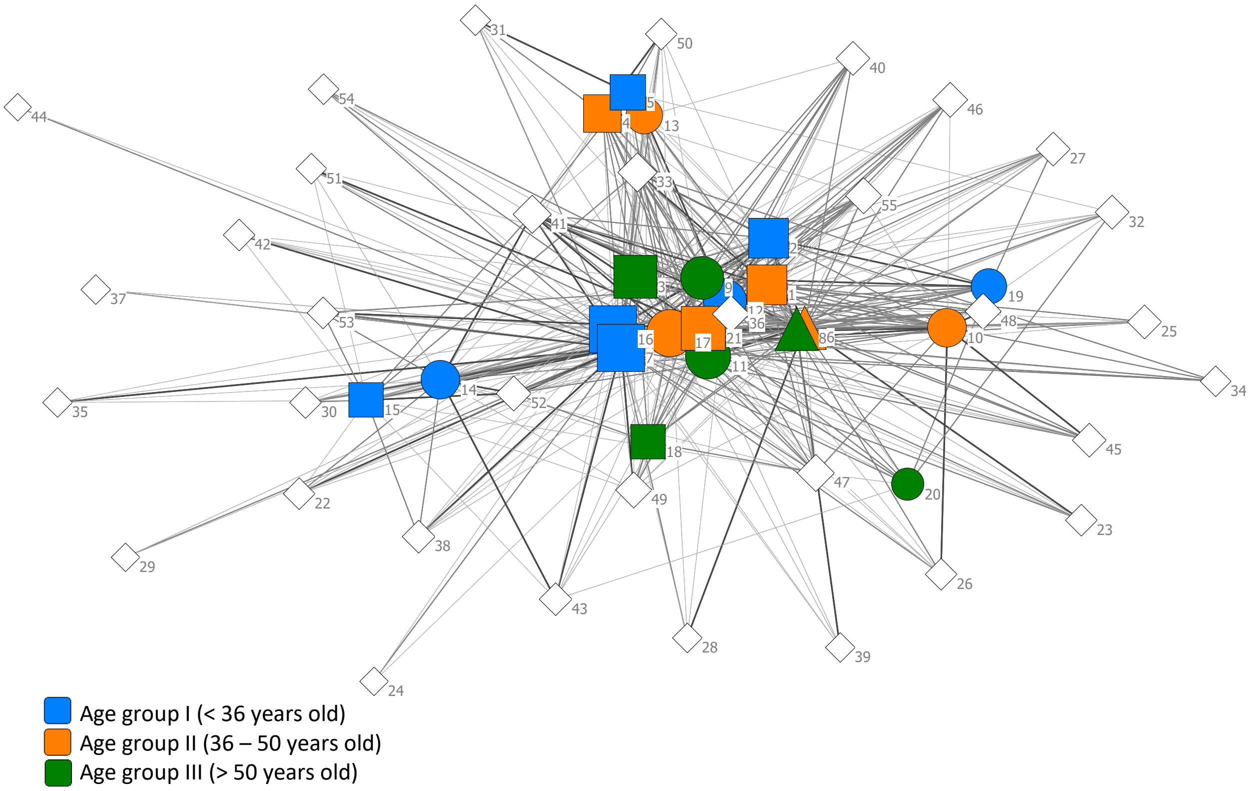

Figure 19: KURAS network displaying institutional logics and age

A further dimension of analysis is the actors’ age, as seen in Figure 19. Of the four most central nodes (7, 11, 16 and 17) two belong to age groups I and II, each. Although young researchers are fairly represented in this central cluster, they also account for the major part of the most peripheral nodes. On the other hand, actors of age 51 and older are underrepresented in the central cluster but are generally located in close proximity of it. Surprisingly, the share of hydraulic actors is highest in the youngest subgroup and declines consistently in both older age groups. In contrast, the share of water sensitive researchers increases between the youngest and the oldest subgroup. Only in age groups II and III one node each follows the water market logic.

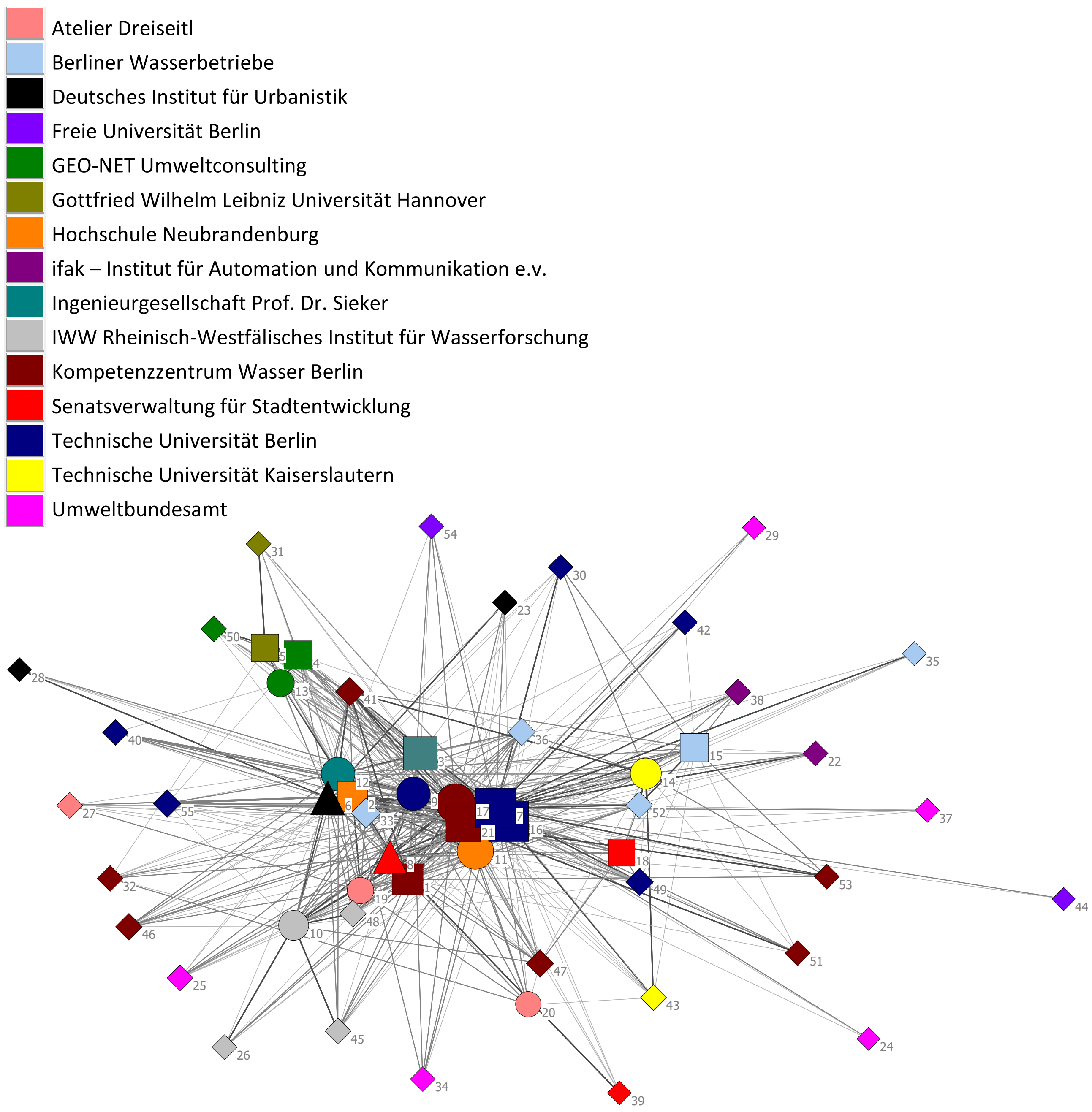

Figure 20: KURAS network displaying institutional logics and employers

A similar multidimensional scaling layout shows which organization each node belongs to in Figure 20. Of the five most central nodes, two are from the Technical University of Berlin (navy blue), two from Kompetenzzentrum Wasser Berlin (bordeaux) and one from Hochschule Neubrandenburg (orange). The high centrality of both, TU Berlin and KWB, demonstrates their function as coordinating partners of KURAS. Therefore, the central cluster is significantly influenced by academia. Far to the upper-left, there are three nodes from GEO-NET Umweltconsulting (green) and close to them two from Gottfried Wilhelm Leibniz Universität (olive green). The close proximity between these five nodes as well as the distant location from core clusters is an accurate representation of the fact, that both organizations are located in the city of Hannover, whereas the main cluster is composed of actors close to or in Berlin, which is approximately 280 km farther away. Similarly, the peripheral locations of nodes 10, 26, 45 and 48 (light grey) from

IWW Rheinisch-Westfälisches Institut für Wasserforschung (IWW), nodes 14 and 43 from the Technical University of Kaiserslautern (yellow) and nodes 19 and 20 from Atelier Dreiseitl (rose) can be explained by them being located in far-off cities. By contrast, node 15 is one of the outermost actors despite its location in Berlin. This is due to the role of its organization – Berliner Wasserbetriebe (light blue) – performing advisory functions rather than tasks of active project members.

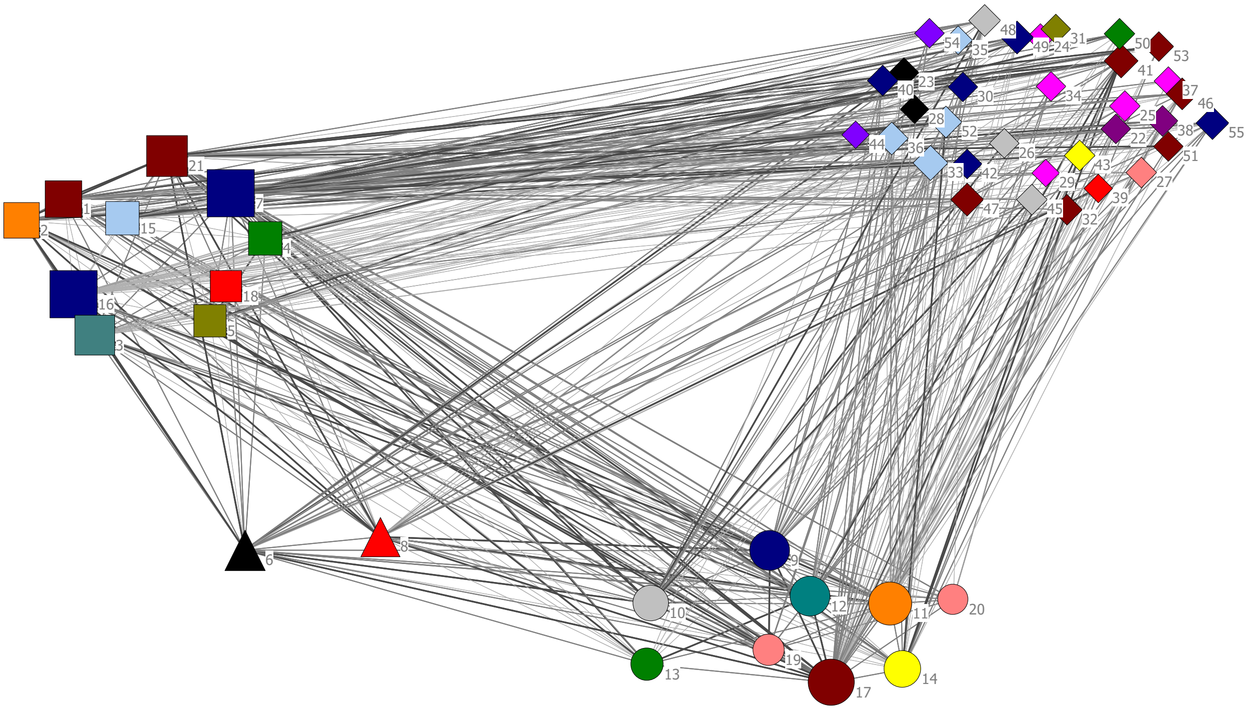

Figure 21: KURAS network grouped by institutional logic
(colors according to employer, shapes according to dominant institutional logic)

If the nodes are grouped using an attribute-based scatter plot, one can identify how institutional logics and organization are correlated (see Figure 21). Contrary to the phenomenon observed in Klima 2050, the allocation of organizations to specific institutional logics is less clear. The nodes of Hochschule Neubrandenburg (orange), Geo-Net (green) and Ingenieurgesellschaft Prof. Dr. Sieker (turqouise) are evenly distributed between the hydraulic and the water sensitive logic. Only the TU Berlin (navy blue) and KWB (bordeaux) have one more actor that is hydraulic rather than water sensitive. However, both respondents from Atelier Dreiseitl (rose) appear to be water sensitive, making it the only organization with more than one actor, that is exclusively in one corner of the graph. The sole node from the University of Hannover (olive green) is hydraulic, whereas the single researchers from TU Kaiserslautern (yellow) and IWW (light grey) are water sensitive.

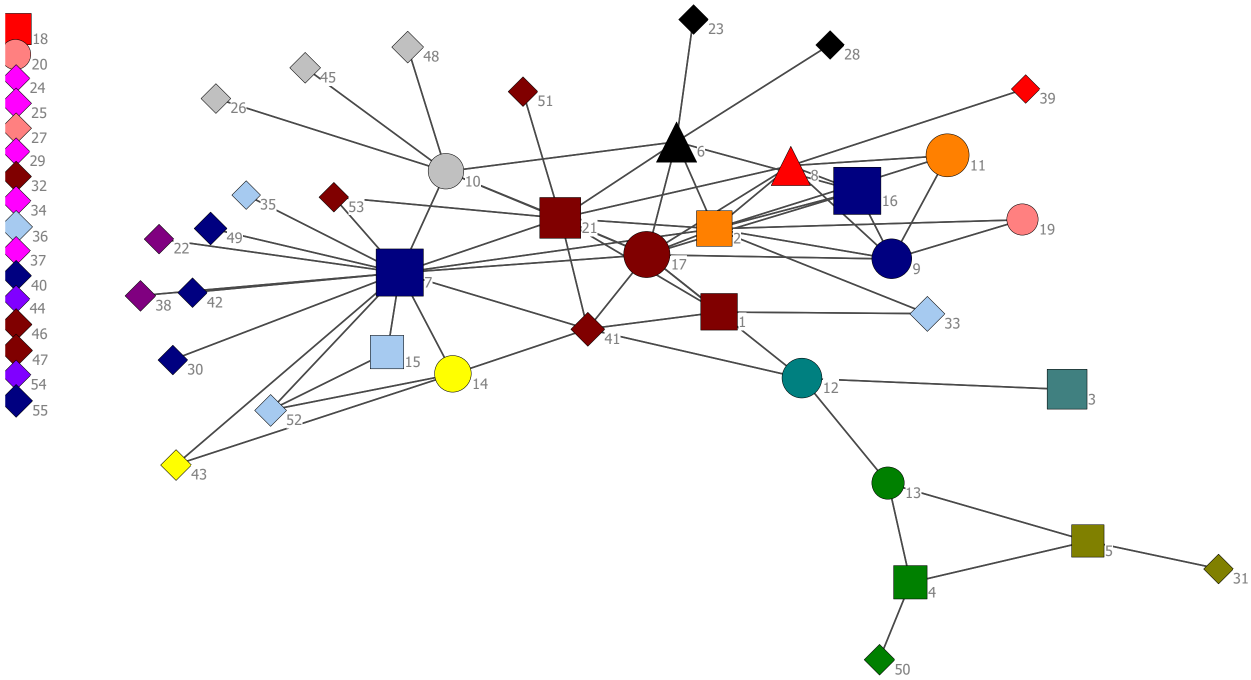

Figure 22: KURAS network displaying strong ties
(colors according to employer, shapes according to dominant institutional logic)

Elimination of all ties except for the strongest ones, creates a network showing its most important connections and core components. As illustrated in Figure 22, this procedure divides the KURAS project into one large component and 16 isolates. Unlike Klima 2050, KURAS does not disintegrate into several smaller components, but persists as one. Notable is the bowtie-shaped structure surrounding node 7, a coordinator from TU Berlin (navy blue), which appears to fulfill a gatekeeper role, connecting six pendants to the core network and providing shorter geodesic distances between several indirectly connected nodes. This function becomes especially evident, since each node is sized according to its betweenness centrality. Further important cutpoints are nodes 13 and 12 – their bridge providing a link between the main cluster and five peripheral nodes from GEO-Net (green) and the University of Hannover (olive green). Moreover, node 10 (light grey) links its three colleagues from IWW to the main part of the network. Interestingly, there is a difference between the two coordinating partners, as the most central nodes of KWB are concentrated in the middle of the network, whereas the two most central nodes of TU Berlin are located on opposite sides of it. This my be due to the fact, that node 7 focused on wastewater, while node 16 worked mainly on storm water, resulting in deviating proximities to various participants.

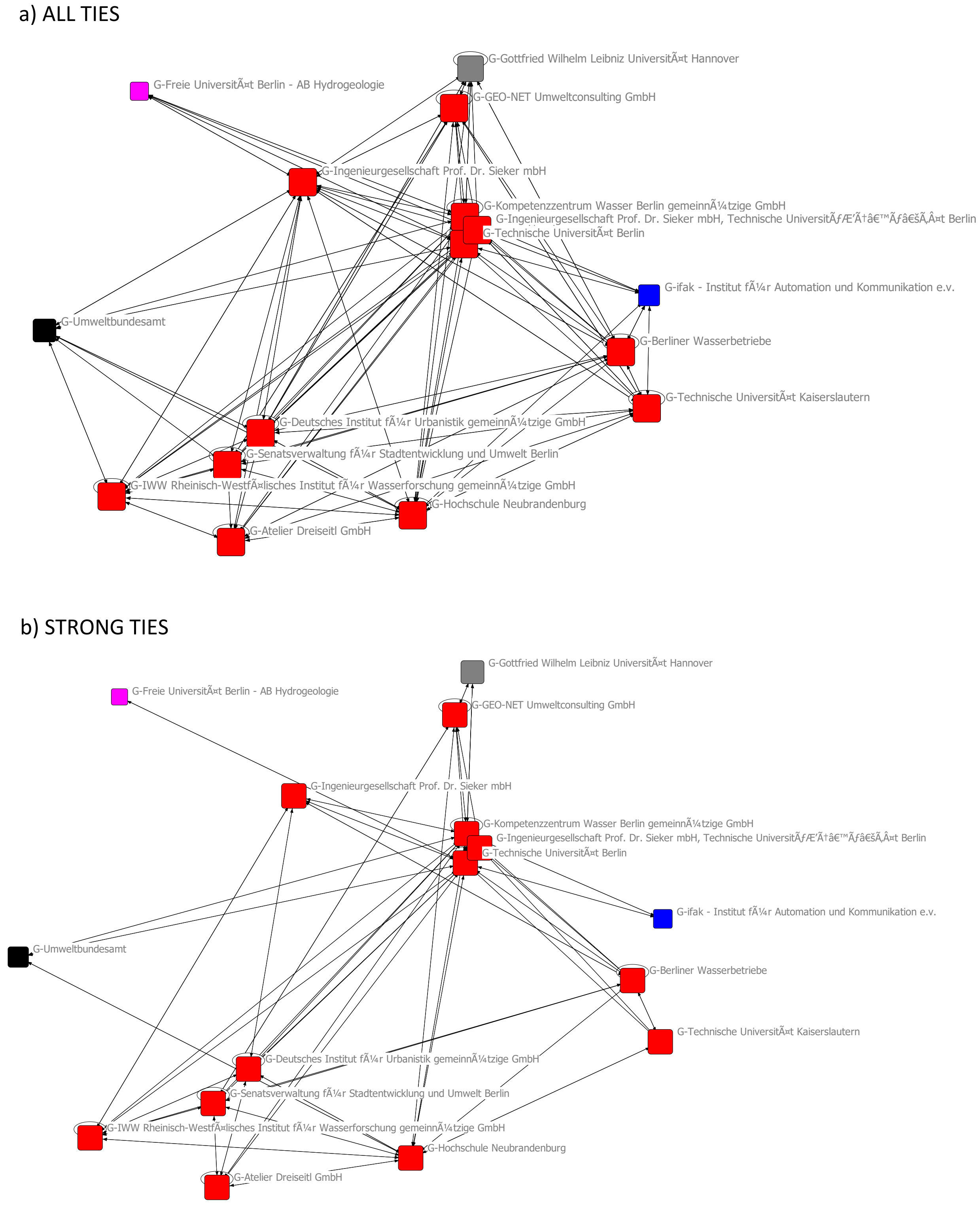

Figure 23: KURAS actors collapsed by organization, a) all ties, b) strong ties

When all nodes are collapsed by organization – as seen in Figure 23 – proximities between various companies and universities become visible. Nodes with the highest k-cores of 10 are represented by a red color, whereas grey (9), black (7), blue (6) and pink (4) indicate incrementally smaller k-cores. In contrast to the Klima 2050 network, KURAS remains as one component even if only strong ties between organizations are observed. Only the distances between several nodes become larger, because their direct links are removed, nevertheless all organizations can still reach each other. This becomes more apparent when directly compared to Figure 17, as nine partners of Klima 2050 are not red, and conclusively have a rather small k-core, in contrast to four partners of KURAS.

Creating an ego-network of the most central actor was accomplished in the same manner as for Klima 2050. Removing ego from its network however, does not result in any fragmentation, as the second most central node alone, has ties to all other nodes. Just like Klima 2050, KURAS appears to be very robust (see Appendix E, Figure E2).

5.2.3 Comparison

Table 4: Dominant institutional logics of actors in %

Institutional Logic	Klima 2050	KURAS
Hydraulic	54%	48%
Water sensitive	38%	43%
Water market	8%	10%

As shown in Table 4, the hydraulic logic prevails in both networks. If the percentages of a single logic are compared between the two networks, differences appear to be minimal. The true extend of this data emerges, when the percentages of one network are compared in relation to one another. The dominance of the hydraulic logic is more distinct in researchers from Klima 2050, where it outweighs the water sensitive logic by 42 %, compared to KURAS, where the relative difference is only 11 %. In contrast, relatively more KURAS actors follow the water sensitive and water market logic. This result confirms the impressions gained both in the qualitative and quantitative parts of the document analysis (see 5.1 Document Analysis) as well as the different sections of the statistical analysis (see 5.3 Statistical analysis).

Table 5: Dominant institutional logics of the ten most central actors according to Eigenvector score in descending order

Klima 2050			KURAS	
Dominant Logic	Eigenvector	Central Actors	Dominant Logic	Eigenvector
Hydraulic	0,271	1	Hydraulic	0,258
Water Sensitive	0,260	2	Hydraulic	0,258
Hydraulic	0,229	3	Water Sensitive	0,255
Water Market	0,206	4	Water Sensitive	0,235
-	0,205	5	Hydraulic	0,224
Water Market	0,170	6	Water Sensitive	0,213
Water Sensitive	0,170	7	Water Market	0,212
Water Sensitive	0,169	8	Water Sensitive	0,207
Hydraulic	0,165	9	Hydraulic	0,207
Water Sensitive	0,163	10	Water Market	0,206

Considering the ten most central actors from each of the two networks, several notable observations can be made. As presented in Table 5, the actor with the highest Eigenvector centrality score, is dominantly hydraulic in Klima 2050 and KURAS alike. In addition, both actors work in research and coordination at the same time, explaining the high connectedness with their colleagues. One other distinct feature is the water market logic's disproportionately high representation among the ten most central actors, the consequence being that economic values appear to be more popular amidst key actors. Other than that, hydraulic and water sensitive logic are evenly matched in KURAS, whereas the hydraulic logic is underrepresented in Klima 2050 with only three concordant actors. This is a contrast to the share of each logic in the entire project and could hint at shifted rationalities among key actors with respect to water sensitive values. On the other hand, a coincidence cannot be ruled out, especially since the fifth most central actor of Klima 2050 has not participated in the survey and therefore has not provided any institutional data.

While the hydraulic logic dominated both research networks, the distribution between different age groups varied significantly. Klima 2050 is characterized by a very similar share of the hydraulic logic in all ages, representing about 52 % to 56 % of the participants. On the other hand, KURAS exhibits large differences between groups, the youngest actors having almost twice as many hydraulic actors with 63 % compared to the oldest with 33 %. The average age did not deviate a lot between Klima 2050 and KURAS being 44,7 and 42,2 years, respectively. Figure 24 depicts that a major difference between both research projects lies in the two nodes, that are characterized by the highest centrality measures of each network. In KURAS both have less than 5 years of experience working in their field, while in Klima 2050 both have more than 16 years of experience. This distinction is consistent throughout the entire networks, as Klima 2050 possesses 25 actors or 52 % with more than 16 years of experience, whereas KURAS has 8 actors or 38 %. As the participation rate of KURAS was relatively low, this result may not be representative for the whole network. One possible explanation would be, that many senior researchers did not participate in the survey, whereas in Klima 2050 many did.

A similar phenomenon can be observed in regard to employment level. KURAS features almost even numbers of entry level, experienced and manager positions among the survey participants. Klima 2050 on the other hand is dominated by experienced personnel, which constitutes 54 % of the survey's answers. Except for PhD students, there are almost no entry-level employees in the Klima 2050 network. Every actor, that is highly central, belongs either to the experienced or supervising category, as seen in Figure 25. Furthermore, nodes tend to be clustered alongside other nodes of the same category. Most PhD students form a tight cluster in the upper right corner, a looser cluster in the lower left corner is composed of supervisors and numerous experienced employees are located in the center of the network. KURAS lacks such a clustering, instead various categories appear to be evenly spread among nodes. Both networks contain three executives. The proportion of hydraulic to water sensitive is 2:1 in Klima 2050 and 1:2 in KURAS.

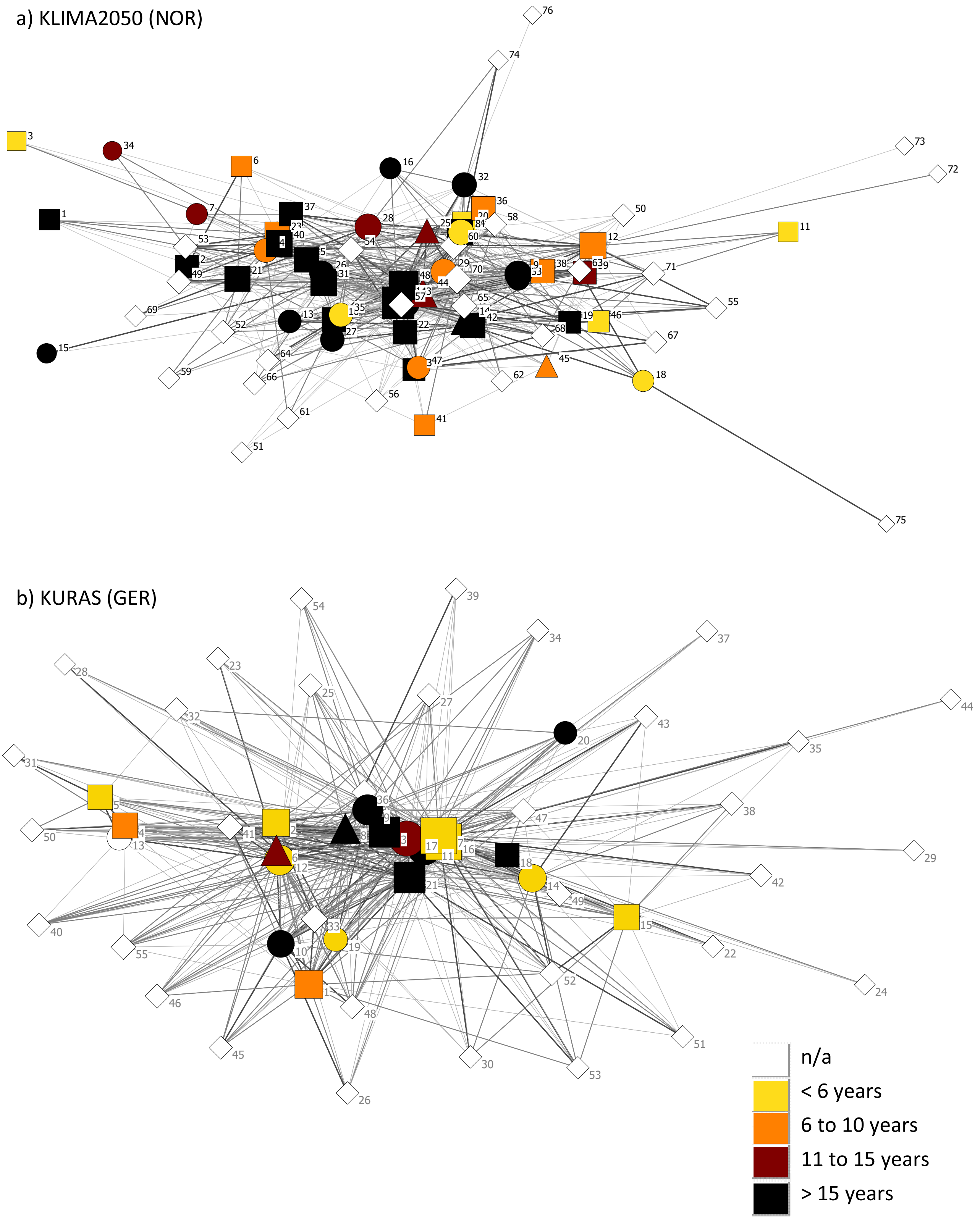

Figure 24: Experience of actors in the networks of a) Klima 2050 and b) KURAS

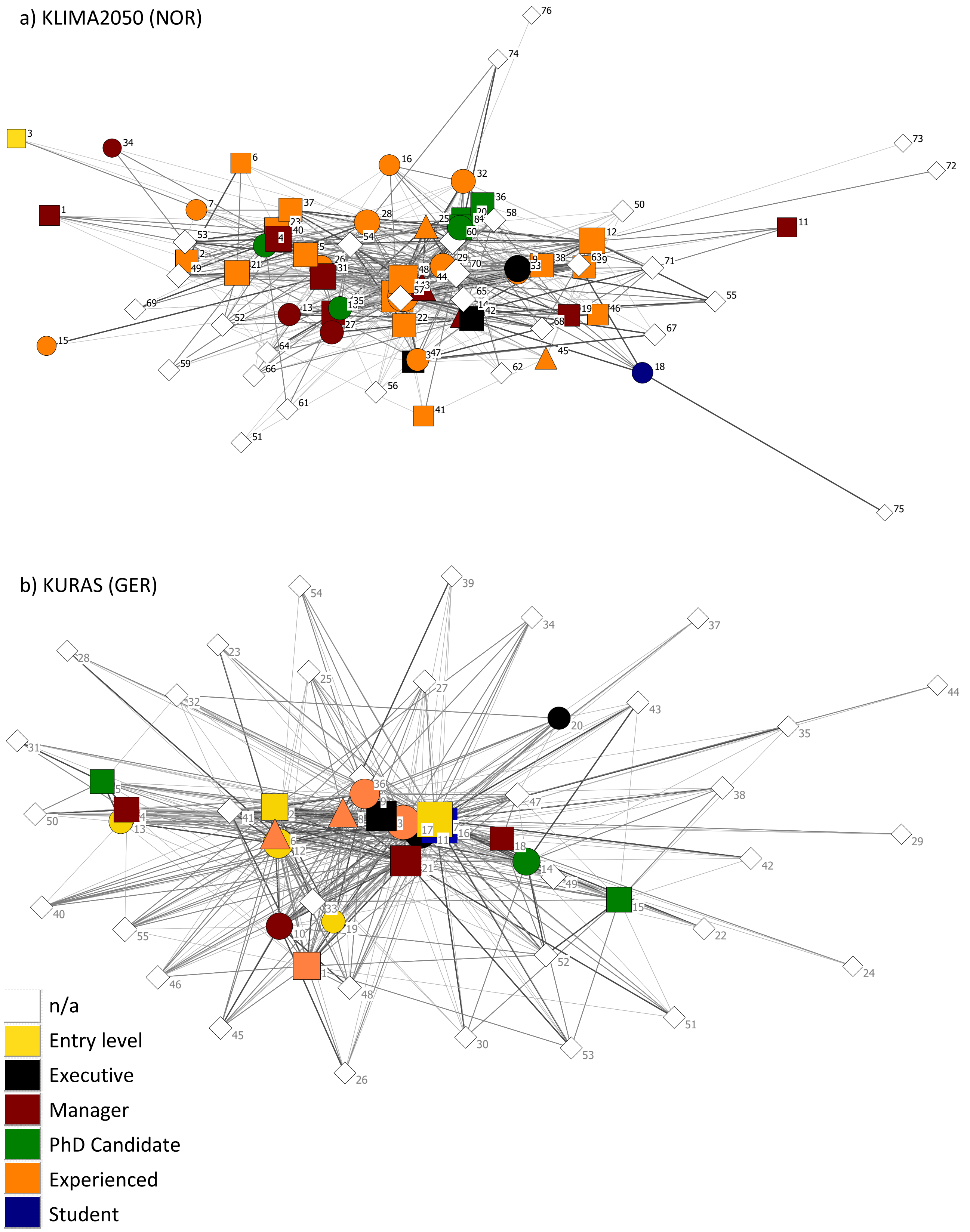

Figure 25: Employment level of actors in the networks of a) Klima 2050 and b) KURAS

Although fewer people have participated in the KURAS survey, resulting in a higher possibility of missing ties and unintended asymmetry, the network still exhibits a higher average degree than Klima 2050 and consequently a larger density, as shown in Table 6. The network's average distance is about 11 % lower for KURAS than for Klima 2050, thus compactness – a measure based on the sum of geodesic distances between every pair of nodes – behaves equally. This discrepancy becomes more evident, when looking at Klima 2050's diameter – the largest geodesic distance in the network – which is twice as high compared to KURAS. Aside from these differences both networks consist of one component, culminating in a connectedness of 100 % and zero fragmentation.

Table 6: Network properties of both cases

Research network	KURAS	Klima2050
Average Degree	17.273	16.974
Density	0.320	0.226
Average Distance	1.680	1.892
Compactness	0.660	0.594
Diameter	2	4
Components	1	1
Connectedness	1	1
Fragmentation	0	0

One difficulty in comparing both research networks, lies in the varying participation rates and network sizes. Especially the fact that 48 participants from Klima 2050 provided network data whereas it was less than half that many in KURAS, hinders meaningful comparisons. The more people participate in the survey, the higher its accuracy and the number of ties. The network representation at hand probably lacks a few ties compared to the real-world network of KURAS, because data is only available for 21 people. One other factor lies in the fact, that not the entire set of actors in the Klima 2050 network was known from the beginning, resulting in the necessity of an additional open-ended question and the distribution via newsletter. None of the 21 actors, who were added in this manner, were included in the original list. Therefore, no ties between these nodes could be registered. Moreover, none of the 55 original actors have reported any ties to the 21 new ones. Consequently, the theoretically possible number of edges is higher than the realistically expectable number of possible ties. Hence, density and average degree are negatively biased. This imbalance can be remedied to a certain extent by comparing the 55 nodes of KURAS to the 55 original nodes of Klima 2050 and excluding the 21 additional nodes. The result are two networks, each containing 55 actors, of which 32 and 21 respectively have participated in the survey.

Table 7: Network properties of both cases (Klima 2050 adjusted)

Research network	KURAS	Adjusted Klima 2050	Δ to unadjusted Klima 2050
Average Degree	17.273	16.691	-0.283
Density	0.320	0.309	0.083
Average Distance	1.680	1.692	-0.200
Compactness	0.660	0.654	0.060
Diameter	2	3	-1
Components	1	1	0
Connectedness	1	1	0
Fragmentation	0	0	0

Table 7 compares the properties of KURAS and the adjusted Klima 2050 network, while showing the absolute difference each Klima 2050 parameter has changed, compared to Table 5. As the adjustment removes 21 actors, of which 16 have actively participated in the survey, the participation rate is reduced and accordingly the average degree declines. Other than that, all network attributes approach the numbers of KURAS. Although the average degree has decreased by 2 %, the network's density has actually increased, almost reaching KURAS' density, as the number of possible ties was diminished by 1365 or 48 %. Measures of the geodesic distance, such as average distance and compactness have converged to KURAS' values for the same reason, benefiting from a loss of poorly interconnected nodes. The elimination of peripheral nodes caused the diameter to drop by 25 %. Ultimately, none of Klima 2050's network properties, except for the diameter, deviate from KURAS' values by more than 4 %. Both networks have the same size, consist of one component and are characterized by very similar attributes, with KURAS having slightly higher cohesion overall.

5.3 Statistical analysis

Table 8: Statistical analysis of various centrality measures

Centrality measure	Klima 2050	KURAS	p-value
Degree	20.417	30.476	**0.004**
Betweenness	45.466	47.622	0.913
Closeness	135.48	77.52	**0.000**
Eigenvector	0.114	0.182	**0.000**

As presented in Table 8 the networks of Klima 2050 and KURAS have significant differences in regard to several centrality measures of their respondents. Degree and eigenvector centrality reveal that on average KURAS participants have a significantly stronger connection among each other. Closeness centrality indicates how 'close' a node (ego) is to every other node, by adding the geodesic distances between ego and each node from the network. As both, Klima 2050 and KURAS consist of only one component and all nodes are (in)directly connected to each other, this measure is easily applicable. Although the significantly higher value of Klima 2050 is partly due to the higher number of network members, this is not the sole reason for the difference. Instead, a lower density of ties results in longer distances between different nodes. Betweenness is the only network-attribute that shows no statistically significant discrepancy.

Figure 26 visualizes the contrast between the eigenvector centrality of Klima 2050 and KURAS respondents. As opposed to degree, eigenvector centrality measures not only the number of ties, that a certain node (ego) has, but rather the centrality of all nodes that ego is connected to. Several central actors from the Norwegian network are heavily interlinked with their colleagues, resulting in a few nodes possessing a higher eigenvector value than the most central node of KURAS. However, the vast majority of Klima 2050 members feature an eigenvector centrality, that is significantly lower than the mean of KURAS members. In addition, with a value of 0.06 the standard deviation is 20 % higher than the 0.05 exhibited in KURAS, indicating a broader dispersion of centrality among researchers from Klima2050.

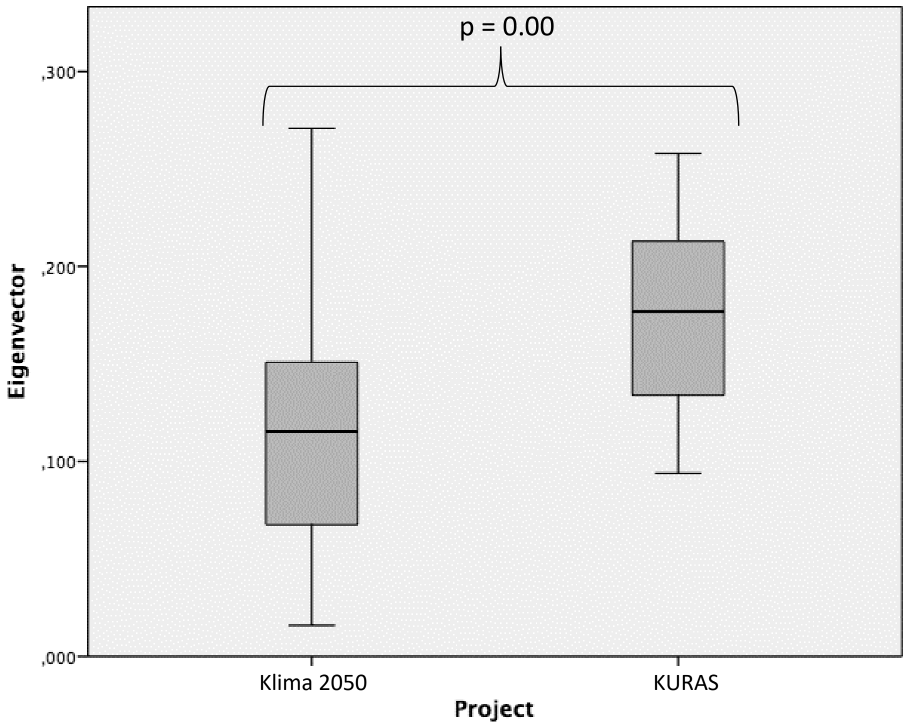

Figure 26: Distribution of respondent’s eigenvector centrality for Klima 2050 and KURAS

Concerning the formal organizational structure, steep hierarchies are historically dominant and hence, correspond with the hydraulic logic. The implementation of flat management structures is a modern trend, beginning to diffuse among various industries. It is accompanied by the tendency, that career trajectories are primarily dependent on an employee’s competence rather than his or her years of service to the organization. As such, particularly modern high-tech companies exhibit no correlation between career level and age, in contrast to the traditional course of promotions (Borgatti et al., 2013). Figure 27 demonstrates the age of employees in regard to their career level. Age and career level are positively correlated in both research projects, indicating that traditional vertical hierarchies are still present. Yet, the correlation is only significant in Klima 2050 (p = 0,007), not in KURAS (p = 0,144). As illustrated in the graph, the 95 % core of manager-level employees tends to be slightly younger than its counterpart from professional-level employees. Although this does not qualify KURAS to be dominated by flat management structures, it does indicate that compared to Klima 2050 some KURAS partners have less steep hierarchies, implying a relatively weaker hydraulic logic. In spite of these details, the analysis manifests that organizational structures of both research projects are still heavily influences by traditional hydraulic values.

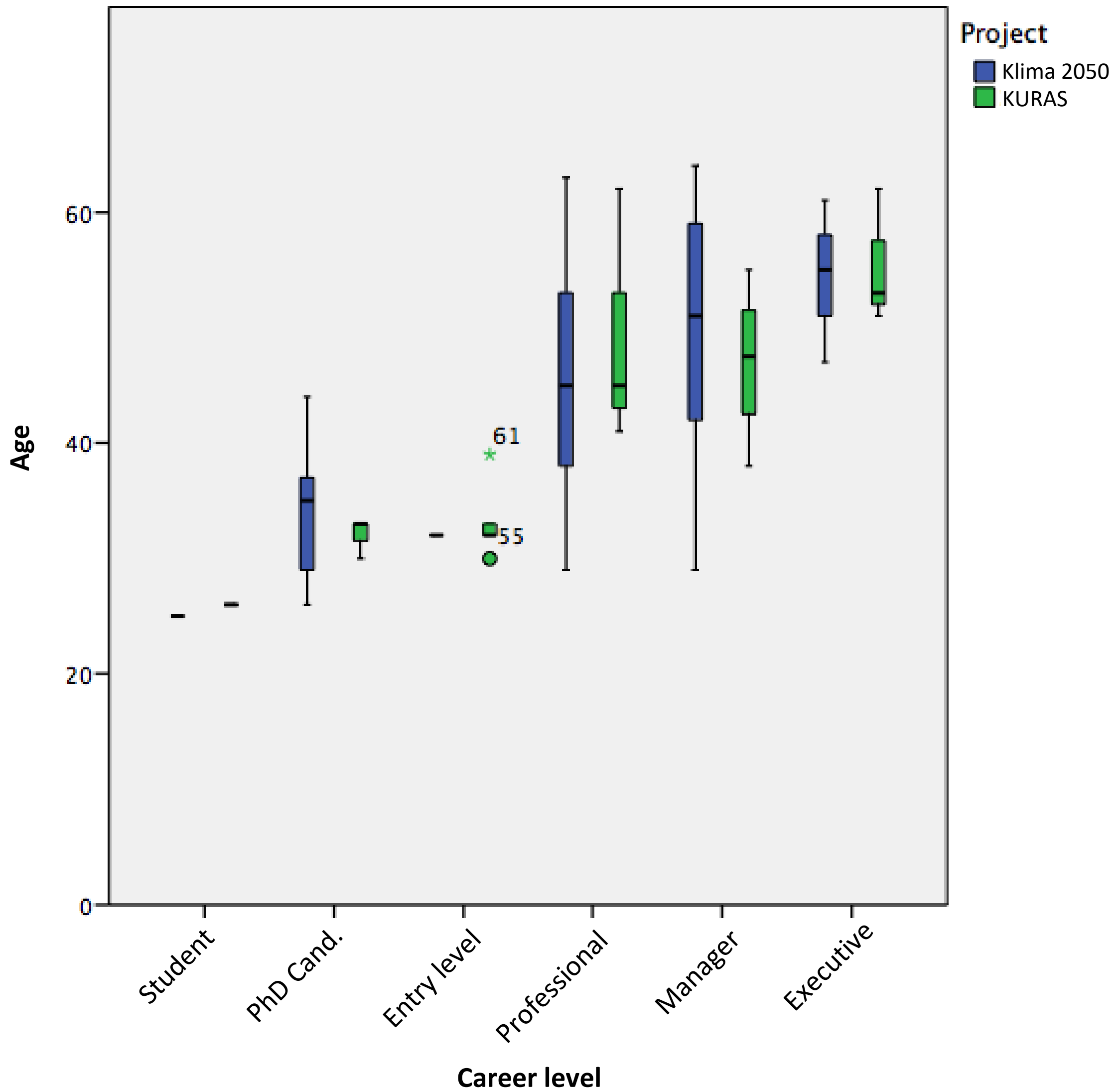

Figure 27: Age of employees with respect to their career level

One further aspect that sets both research networks apart from each other is the participants' educational background. The most frequently studied university subject among Klima 2050 respondents was civil engineering. Other frequently studied courses include engineering fields from hydrology to material and chemical engineering. Environmental or social studies constitute a minority, instead most subjects are closely linked to the rationalities of the hydraulic logic. KURAS members on the other hand, are characterized by a diverse background of environmental studies and include fewer hydrologists and civil engineers. Rather, various fields from technical environmental protection to environmental engineering and environmental planning are present, all of which indicate rationalities that are closer linked to the water sensitive logic. Only few actors from both networks have studied economics, rendering comparisons unfeasible.

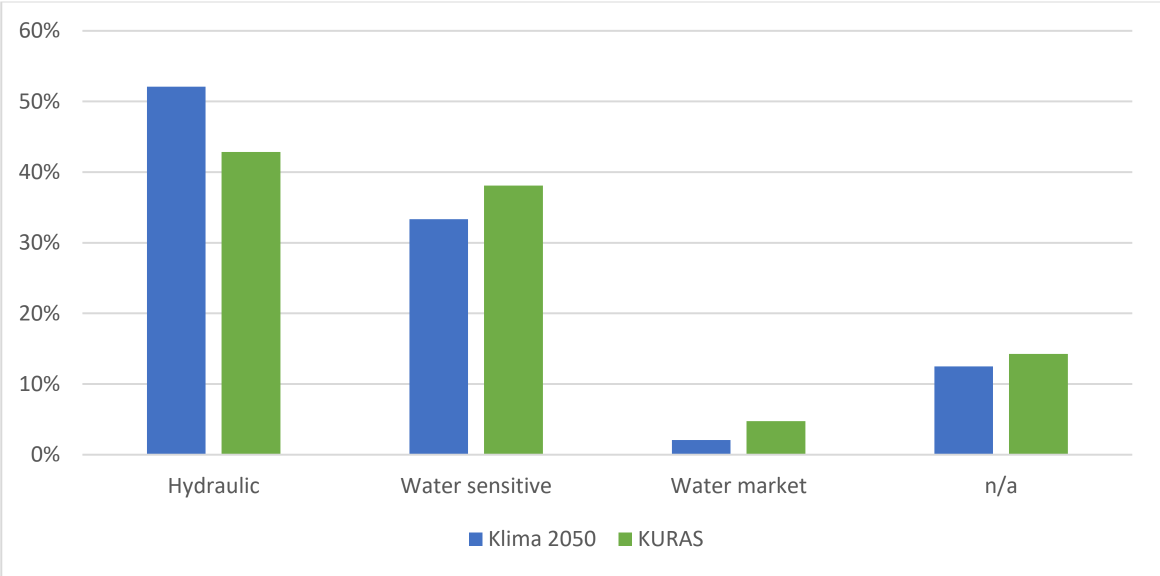

Figure 28: Categorized research questions of both projects

A second examination is based on answers that were given in regard to each participant's research question. Researchers were asked to describe their main research question in a few words. These descriptions were assigned to the institutional logic, which they reflected most (see Appendix F, Figures F1 and F2). Questions regarding topics such as hydrological modeling, protection of buildings, development of pipe-flow models and water drainage are categorized as mostly hydraulic. In contrast, research questions that deal with decision-making processes, sustainability of water cycle services, societal structures, learning from nature etc. are deemed to be water sensitive. The WML was hardly represented and focused on questions concerning economic valuations and insurance data. A few participants provided answers that were not evaluable, like 'storm water' or 'adding practical examples', while others have not answered at all. Nevertheless, a general trend is recognizable in Figure 28, since the ranking of logics is comparable with the results obtained in the document analysis. The hydraulic logic is the most common one among research questions of both networks, while the water sensitive logic follows closely, and the water market logic is rarely present. Although the absolute differences between the two networks are comparably small, an interesting inclination can be detected considering the relations between different logics. Klima 2050 has a higher percentage of hydraulic questions than KURAS, which in turn has greater proportions of the two emerging logics. These minor deviations can result from the particular composition of survey responders and hence, are prone to be changed if more researchers participate in the survey. Still, they do support the finding of the document analysis, that KURAS appears to have relatively more water sensitive elements in its records than Klima 2050, as the same trend continues in respect to the researchers' main queries. All in all, a difference between the two research projects is noticeable, however the general tendency in regard to the strength of different institutional logics is identical.

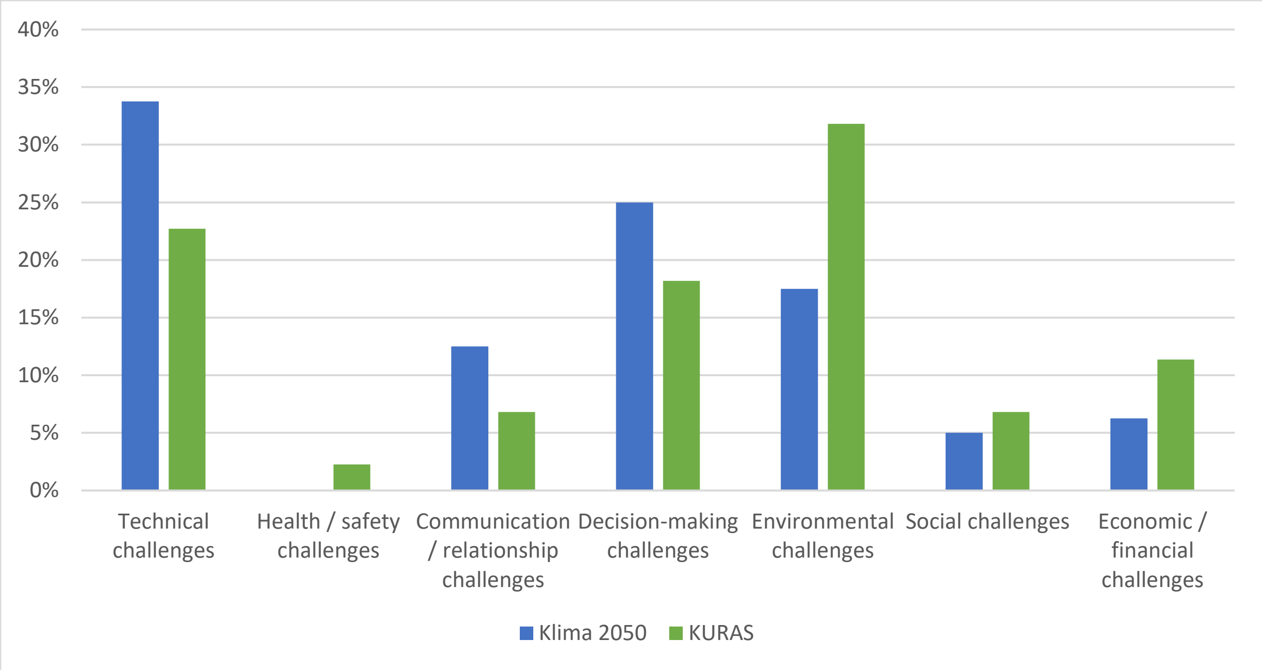

Figure 29: Challenges addressed by participants' research

In an additional question, actors were asked to select the main challenges their work is addressing. Every participant could choose several challenges but could not weight what share of the research is allotted to which specific topic. It must be pointed out that four of the seven listed areas, displayed in Figure 29, correspond to the water sensitive logic. Therefore, it is hard to determine a relation between the three logics. The data provides information however, that can be used to compare the two research projects with one another. A majority of KURAS members work on environmental challenges. Technical challenges come in second and are closely followed by decision-making. In contrast, the focus most frequently chosen by Klima 2050 members are technical challenges. All questions, relating to the water sensitive logic fall behind. This comparative evaluation suggests that technical aspects and hence the hydraulic logic are of higher importance in the Norwegian project than in the German one. Economic and financial aspects possess only a minor role in both research projects. Still, the percentage of KURAS is almost twice that of Klima 2050.

The trends in both, course of study as well as research focus, support the conclusion which was derived from the documentary analysis: Klima 2050 appears to be more hydraulic and less water sensitive than KURAS. Although the water market logic seems to have an auxiliary role in both cases, it is relatively stronger among KURAS members.

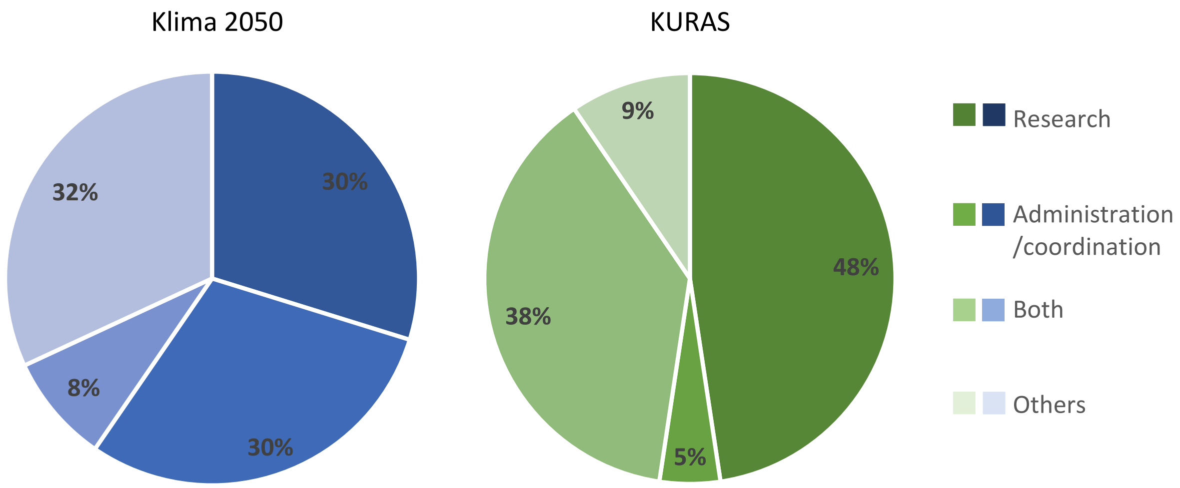

Figure 30: Roles of network members

Various membes of the two networks perform different tasks. Some are studying specific topics in their research field, others act as coordinators or administrators. While there is the given option to fulfill either task, there are also members who consider themselves to do neither, including stakeholders, observers, partners and board members. There are several major differences between the networks, as shown in Figure 30. Almost one third of Klima 2050 members do not regard themselves as researchers or coordinators within the projects, whereas only 9 % of KURAS' associates do not perform these tasks. While there are very few people working exclusively in administration and coordination, more than a third of KURAS personnel combine these resposibilities with research work. Klima 2050 on the other hand, is characterized by a contrary relation. The most striking difference lies in the fact, that 62 % of Klima 2050 members are not part of its research activities, whereas this share amounts to only 14 % in KURAS.

One possible explanation for this finding is the dissimilar distribution of employment levels. Figure 31 depicts that almost a quarter of KURAS' staff consists of entry level employees. In Klima 2050 they only account for 2 % of all members, professional level employees in contrast, take up more than half of all participants. As entry level staff in a research project would typically work as researchers rather than external observers or board members, this would partly explain the discrepancy between the two networks.

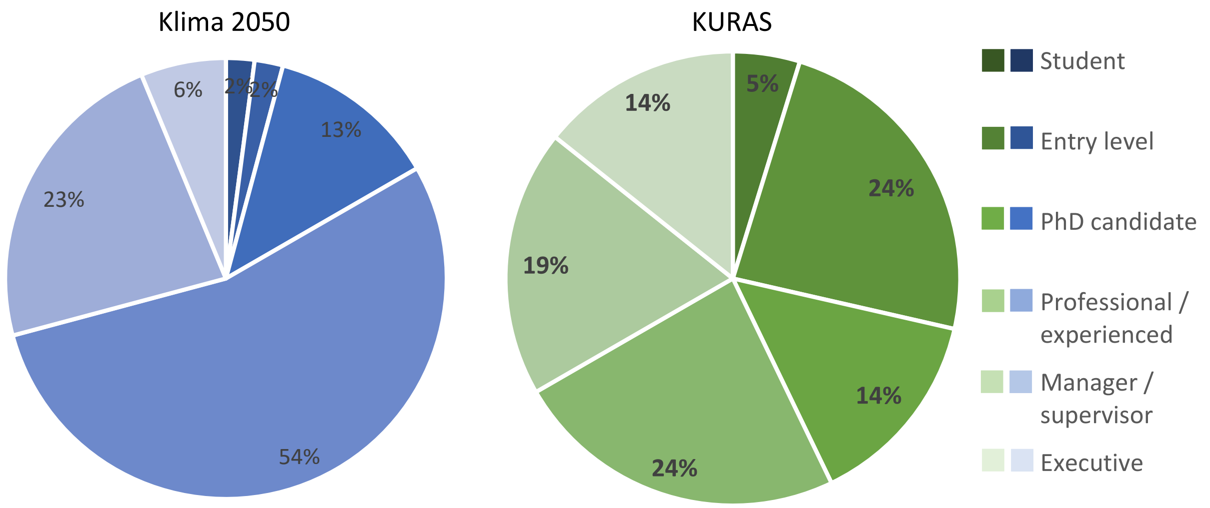

Figure 31: Employment level of network members

Several of the eight survey questions used to determine the dominant institutional logic of each participant, reveal differences in the respondents' rationalities of both research projects. Figure 32 displays the answers of survey participants to question 10 regarding their preference for mechanisms in adapting to climate change. Almost half of Klima 2050's members suggest that investing in research and development of new technology should be prioritized. Less than a third of the respondents favorize the education of participation of the public. In KURAS this disparity is less distinct, as both options have an equal number of supporters. A further difference is noticeable regarding market mechanisms, the option corresponding to the water market logic, that has been identified as the weakest logic so far. Consistent with previous analytic results it is the weakest of the three logics, with less than fifth of all respondents selecting market mechanisms as their favorite option. Of the first and second preferences, market mechanisms were the least chosen option in Klima 2050 and hence, by far the most frequent third preference with 55 %. KURAS members on the other hand, have selected this option as their second preference in 57 % of the cases. Only 29 % considered market mechanisms to be the least desirable choice.

Concerning the values, that are inherent in institutional logics, Figure 33 demonstrates the contrast between the dominant hydraulic and the emerging water sensitive logics. While 53 % of Klima 2050 members believe that the hydraulic values of security, safety and social equity should be most influential in water management, approximately 36 % attached more importance to the water sensitive aspects of environmental and social sustainability. The proportions in KURAS however, were reversed, as 62 % chose the water sensitive option and only 33 % selected the hydraulic option. Coherent with the results of prior methods, inspecting survey questions individually revealed various similarities as well as differences between the two research projects, indicating that the urban water sector is situated in a period of change.

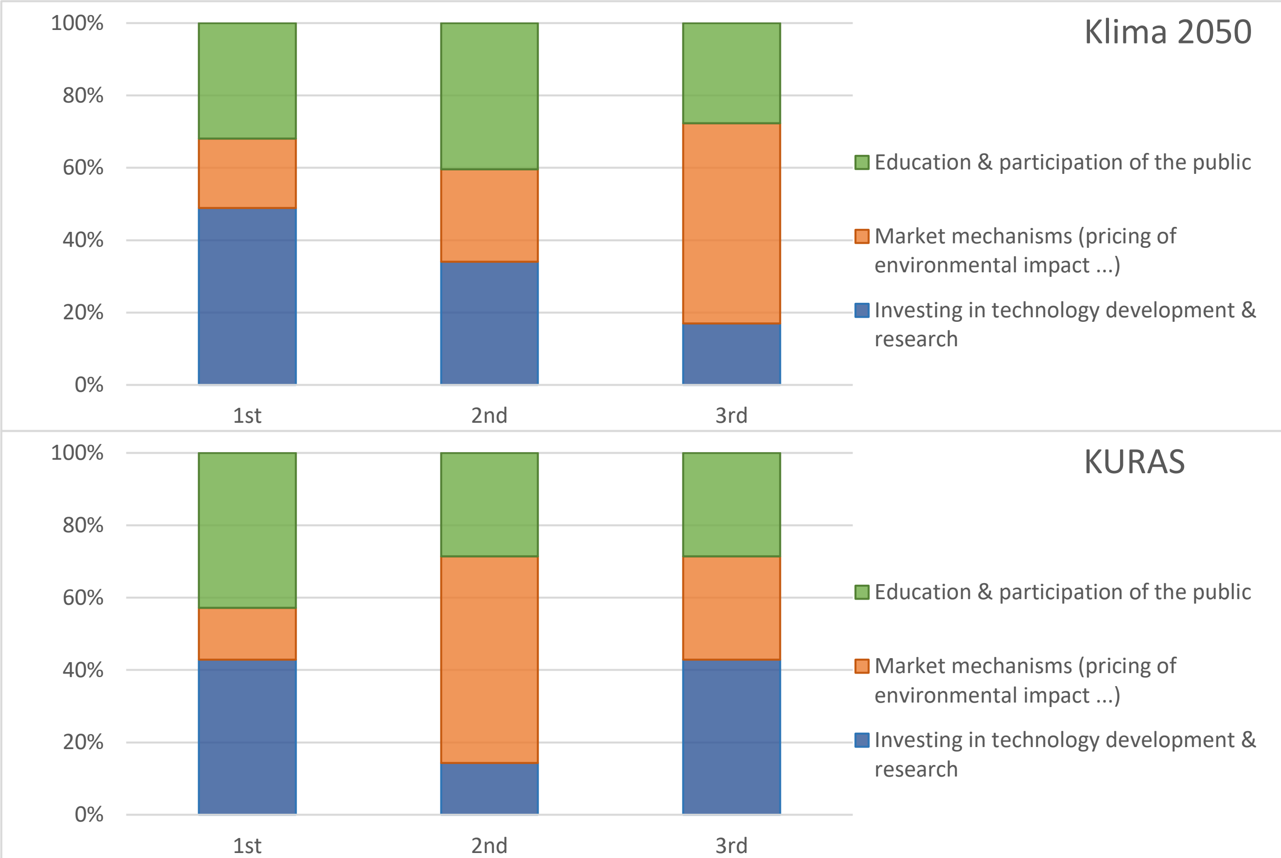

Figure 32: Ranking of preferred mechanisms for adaptation to climate change

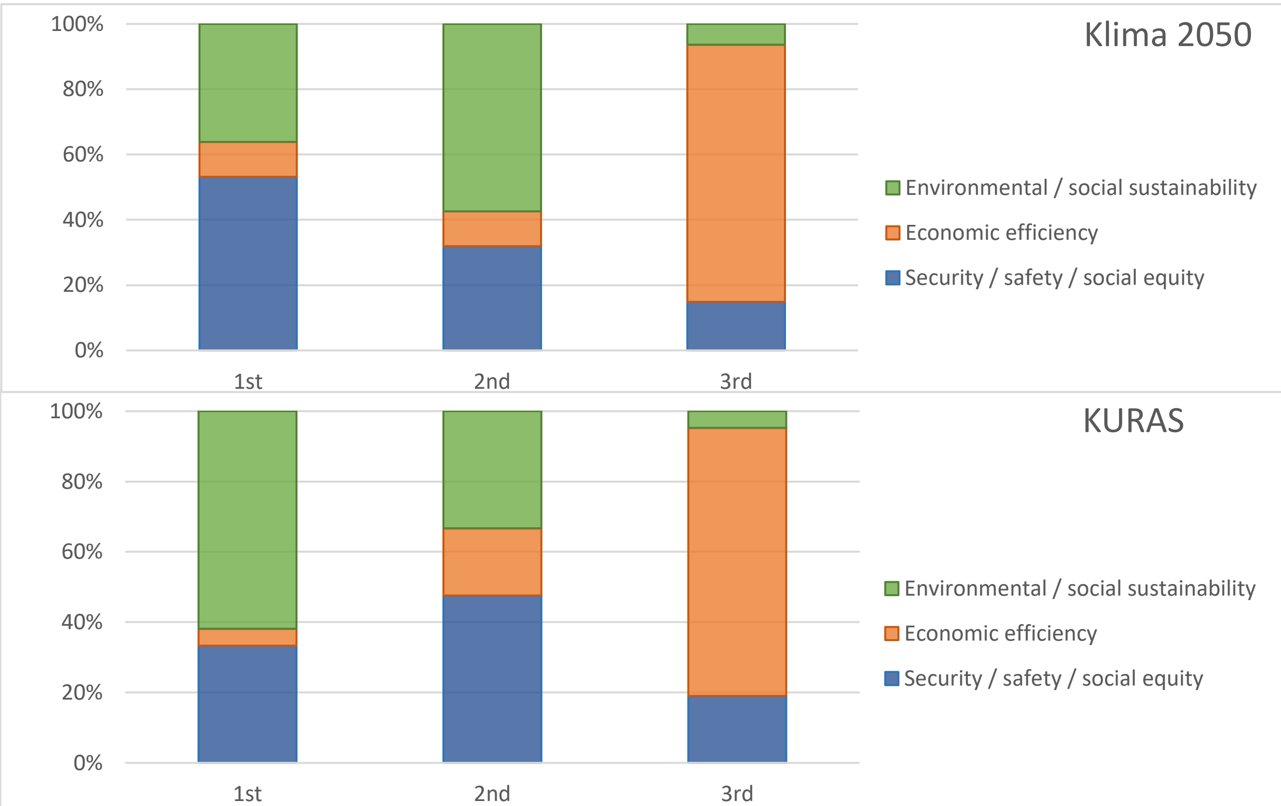

Figure 33: Ranking of values according to the influence they should have on water management

5.4 Interviews

As described in chapter 4.2.3, one central actor of each research project was interviewed. The semi-structured individual in-depth interviews were guided by a set of central questions, that could be adjusted depending on the interviewee's responses. As the researcher from Klima 2050 had previous knowledge of the KURAS project, questions in regard to the comparison of both projects were implemented. The KURAS researcher however, was not aware of any details regarding Klima 2050 and hence, the questions were confined to KURAS. Detailed summaries of the two interviews are included as Tables B1 and B2 in Appendix B.

The first interview revealed, that the hydraulic dominance in Klima 2050 was no surprise to the questioned researcher. SINTEF and NTNU, two technically oriented organizations employing many engineers, fulfill key roles in the research project. Therefore, Klima 2050 in general and working package 2 in particular, consists mainly of employees that focus on technical issues and have their strengths in various fields of engineering. The water sector tends to be more conservative and while a paradigm change has been observed in recent years, it proceeds slowly. Nevertheless, many researchers are motivated to contribute to the change and to a positive environmental impact, as seen in the rise of the water sensitive logic. In addition, a significant number of Klima 2050 partners are from the public sector and are naturally interested in the ecologically responsible adaptation to climate change, as this is perceived as the government's responsibility. Goals related to the water market logic however, are only of secondary importance to most engineers. The understanding of water being a public good and of the government being accountable for adaptation measures in regard to storm water, are additional reasons for the water market's smaller influence. Compared to Klima 2050, KURAS was judged to have stronger water sensitive and water market logics. This is due to the interviewee's assessment, that the effects of climate change are more visible in Germany, forcing researchers to take environmental and economic aspects more seriously, whereas the awareness of future challenges is still relatively low in Norway. There is a necessity to create artificial lakes and to actively pump storm water away from flooded areas, resulting in an increased consciousness of researchers in Germany with respect to the effects of climate change on the environment and the livability as well as to the costs of preventive and reactive measures. In contrast, water tends to be taken for granted by many Norwegians, as quality and quantity are high, resulting in a limited interest for research. However, recent extreme weather events and an improving media coverage steadily lead to a rising public awareness.

In the second conducted interview, the questioned KURAS researcher suggested that the dominant institutional logic of the project might depend on the working group. While researchers studying waste water systems were deemed to be more hydraulic, the colleagues from storm water research might have a stronger WSL and WML. In recent years, a general shift towards environmental and economic priorities is noticeable as costs as well as sustainability are increasingly considered. This statement supports the assumption of the Klima 2050 interviewee, that there is a high awareness for water market and water sensitive aspects among German researchers. Moreover, the strength of the WSL was explained with the goals of the project. Since

KURAS considered environmental, sustainability and livability effects of the evaluated measures, the partner organizations were generally interested in water sensitive aspects, as were their employees. The WML was also represented, as the costs of the studied measures were explicitly examined, and one partner worked specifically on economic topics. However, economic evaluation was not the main goal of the project, profit-oriented partners were in the minority and hence, the water market logic remained the least powerful one.

Both researchers have observed different rationalities among project members, reflecting the three institutional logics. However, a rivalry between the logics was not apparent. Furthermore, there was a consensus in both interviews in regard to the influence of the hydraulic logic on practical work. Many aims of the two research projects correspond to water market and water sensitive rationalities. However, the fact that a majority of participants has an engineering background, leads to a high reliance on hydraulic expertise in the practical approach of reaching these goals. Therefore, researchers are mainly working on technical challenges in order to ensure environmentally and economically sustainable solutions.

Considering the social network characteristics of the two projects, KURAS' greater cohesiveness can be attributed to the project structure. Many tasks were dealt with collectively, the teams being composed of researchers from different organizations. Thus, communication and coordination within and between organizations happened regularly in form of meetings and emails. In Klima 2050 by contrast, many employees from the public sector were interested in results but communicated comparably less than their colleagues from the private sector. However, public partners accounted for the greater proportion of participating organizations. While some active members have solid strategies of inter- and intraorganizational communication, this is not the case for every participant.

One major difference was uncovered with respect to future developments of the institutional logics in the water sector. The Klima 2050 researcher believes that a change has already started and will continue, because ultimately, a holistic approach is needed. Technical, environmental and economic factors alike, have to be considered as they are equally important. The KURAS interviewee on the other hand, feels that the logics have reached a stable state and further developments might result in negative consequences. Especially the consideration of economic efficiency has increased and is already affecting the implementation of research ideas.

6 Discussion

This thesis presents a method of combining the institutional logics perspective with social network analysis. An application of the method was conducted by means of two research groups, based in Germany and Norway, respectively. The research aimed for a better understanding of the nowadays rising paradigm shift, as a result of new challenges in the urban water sector.

Limitations

The study was subject to several limitations, one of the biggest being the fact that the two research projects were only examined at one point of time, making any conclusions about the development in regard to the social network as well as the distribution of institutional logics impossible. Although the study has yielded results identifying the extent of an observed paradigm change in the UWS, only an examination over a period of several years, could determine the continual progress of this change.

Unfortunately, not every network member responded to the survey request, resulting in an incomplete data set. Social network analysis is particularly dependent on a full data set, as small modifications, like a few missing ties, can result in a network representation that deviates significantly from the real-world network. Additionally, a complete set of response would have opened up alternative ways of network creation. One possibility would have been, to determine ties based on an AND instead of an OR rule. Founded on an intersection instead of a union principle, a tie would only be added if both participants stated that they had contact with one another. Moreover, the strength of the tie would correspond to the lowest contact frequency that either of the two actors reported. The resulting network would be more conservative, with fewer ties and therefore, a higher interpretability. Since the data was incomplete however, using the AND rule would have produced a network, where every node representing a non-responder would be an isolate without ties.

Furthermore, one of the research projects (KURAS) was already finished at the time of examination. Not only had the respondents to remember how they worked in the past, but also with whom they had communicated at that time and how often, making their answers prone to recall error. A second difficulty arose, because several people had already changed their job, had left on parental leave or were not reachable because of other reasons. Eventually, some former network members were probably not interested in participating in the survey, because the project was not active anymore. Combined, these factors resulted in a significantly lower response rate, compared to the other research project (Klima 2050).

For the sake of simplification there were only four contact frequencies to choose from in the social network question. More options would provide the participant with a fine gradation and better choices but would also make the question visually larger and more cumbersome to answer. The four options on the other hand are not very nuanced, as e.g. 'weekly' is very frequent in a project that spans several years, whereas 'less than every three months' is quite rare. Consequently, respondents have often chosen the only option in between these two: ‘every one to three months’. This is a wide range and could have been complemented by a further option, such as ‘every two to three weeks’, enabling a clear distinction between answers.

The two networks may seem to feature different density and cohesiveness simply because the number of respondents differs highly. If several strongly linked individuals do not participate in the survey, their nodes appear to be peripheral and the network density is lower than it should be. A second problem is the fact, that five people were added to the Klima 2050 network, because their names were listed in the open-ended question. These nodes significantly fewer ties than those listed in the closed-ended question. Ideally, they should have been included in the original list or should have at least answered the entire survey themselves.

To identify the dominant institutional logic of every actor, this study relied upon eight questions, each with three options to choose from. As every option represented a central aspect of one specific institutional logic, the overall dominant logic was concluded from the answers to all questions. However, these logics are only ideal types and do not exist in the real world. Using ideal types, involves focusing on exceptional and opposing characteristics. Similarities and connections between the ideal types are mostly neglected, as is the fact that they blend in a social system. In reality, rationalities are not divided in this way, but are heavily dependent on one another. The survey divided technical, economic and environmental aspects artificially, in order to discover how a participant would rank them. Admittedly, these aspects are much less distinct in reality. Technical tasks of an engineer often involve the optimization in regard to costs and benefits or the implementation of environmentally sustainable solutions, which in turn have effects on the financial balance. This mixture of influences occurs especially in the UWS, as various stakeholders are involved in every undertaking.

In addition, the determination of institutional logics necessarily involves the process of interpretation, since they are a sociological perspective that centers around motives and meanings. To allow such an interpretation, the survey participant is forced to choose between three options, arranging them according to preference from 1st to 3rd. There is no option, allowing the classification of several options as equally important. Neither can three options represent the full spectrum of possible answers for every question. A participant might think of a different aspect, which he would prefer to the three listed ones, but is unable to choose. Furthermore, a few participants who were not working with water engineering, but for example finance or decision-making could have difficulties with understanding and answering the questions. Interpretation was also needed during the document analysis, rendering it quite subjective. Most terms do not belong exclusively to one single category but can be used independently of the dominant logic. Although every categorized term tends to represent the rationality of a specific institutional logic, this method of documentary analysis is neither flawless nor perfectly objective.

Beside the challenges with identifying each actor’s dominant institutional logic and position in the social network, a few other obstacles occurred. The survey question “What did you study?” was not precise enough.

Most people listed one course of study, probably the last or most important one, whereas some respondents listed what they studied during their bachelor, master and PhD programmes. Others only stated 'MSc', or named their University. All in all, there were too many unusable answers, thus study courses were only examined qualitatively, numbers not being taken into account. A similar problem occurred when asking for the actors' main research questions. A few have not answered the question at all, indicating that it was not clear enough or not applicable to the individual, while some participants responded with general statements such as 'storm water', which cannot be evaluated for a suitable institutional logic. Obstacles of this kind have to be avoided, either by concretizing the question or by giving further explanations or examples.

Conclusions and implications

As predicted from the outset by using a direct replication logic, both research networks have striking similarities. However, the actual degree of resemblance was surprising, since major network parameters, such as average degree, density, average distance and compactness do not differ by more than 4 %, if only the 55 originally selected members of both respective networks are compared. Consisting of only one component, the two networks are not only very dense but also robust, as not even the elimination of central coordinators would cause fragmentation. All in all, KURAS is marginally more cohesive than Klima 2050 in every analytical aspect. This difference might yet become larger, if data on more network members would be available. As the number of ties can only grow if and when more actors participate in the survey, consequentially every cohesion measure would increase, too. Solely the addition of new nodes could result in a decline of cohesiveness, but as KURAS had a defined contingent of members and was completed by the time of the study, any inclusion of further nodes is impossible. One of the reasons for Klima 2050's slightly lower cohesiveness might be the fact, that the research project is characterized by blurred borders. The composition of participants and external advisors varies over time, coordinators do not dispose of a complete list of project members and partner organizations decide independently which employees work on the research at what time. This results in a situation, where many researchers communicate with a relatively small group of colleagues and there is not a single actor in the network who owns direct ties to everyone else. Five additional network members – unknown at the time of survey creation – were named in the open-ended question, which is a finding that supports this hypothesis. Since many actors did not respond to the survey and some participants probably did not recall any unlisted network members after reading a list of 55 names, there is a high probability that more unknown actors exist. If all 76 identified members of Klima 2050 are compared to the KURAS participants, statistically significant differences between various network characteristics are identified. KURAS researchers are characterized by higher degree and eigenvector centrality as well as a lower closeness score, all figures indicating a dense network. This is primarily due to the fact, that the additional network members tend to have fewer ties and a larger distance than their originally listed 55 counterparts. Furthermore, the elimination of weak ties provided social networks that differed highly between the two projects. KURAS persisted as one component, whereas Klima 2050 disintegrated into three components of different size, showing that fewer members of Klima 2050 maintain strong contact to researchers from other organizations. In fact, this observation is a suitable example for Granovetter's hypothesis (1973) that weak ties mostly link members of different small groups, whereas strong ties usually accumulate within these groups. Generally, the findings indicate that Klima 2050 is a highly clustered network, that is less coherent and has overall weaker interorganizational ties than KURAS.

In spite of these particular differences, the two networks exhibit high similarities in regard to most cohesion measures. Such a correspondence of network data might indicate high resemblance in regard to institutional logics. Through interactions and communication, members of a social group tend to develop a connection with one another, that is called a collective identity (White, 1992). This cognitive, normative and emotional connection arises from a perception of similar status among members (Polletta & Jasper, 2001). Collective identities may evolve and become institutionalized through the development of an institutional logic that characterizes the respective social group (Jackall, 1988). Members who identify with their social group also identify with the prevailing institutional logic (Thornton & Ocasio, 2008). Consequently they follow the norms and rules of the social group (Kelman, 2006; March & Olsen, 2010), safeguard the collective interests against contenders (Tajfel & Turner, 1979; White, 1992) and cooperate with each other.

Indeed, both research projects are dominated by the hydraulic logic, which has been prevailing historically in all industrialized countries. Moreover, the water sensitive logic is undoubtedly the second most influential logic whereas the water market logic is quite weak compared to its alternatives. The statistical analysis of institutional logics on the researcher level reveals no significant difference between the logic distribution among members of the two networks. The interviews revealed, that while environmental and economic goals guide both research projects, most members are focused on the technical aspects of climate adaptation. Therefore, water sensitive and water market values shape the research projects’ overall goals, yet the actual implementation is guided by hydraulic expertise. This supports the findings of all analysis methods, demonstrating a similar gradation of institutional logics in both networks. Nonetheless, a minor but persistent discrepancy emerges if all stages of data triangulation are considered, beginning with qualitative and quantitative documentary analysis to statistical analysis and finally social network analysis. Every analysis method reveals, that in relative terms the hydraulic logic is slightly stronger in Klima 2050, while both emerging logics tend to have a bigger impact on KURAS. Relatively fewer researchers focus on technical issues in KURAS, instead a majority of research questions deal with environmental aspects of the UWS. Study background of researchers is equally divergent, since most members of Klima 2050 have studied technical subjects such as hydrology of civil engineering. Although these are also present to a lesser degree among KURAS members, various courses of study like technical environmental protection as well as environmental engineering, sciences and planning, are much more common. Despite the traditional aim to provide drinking water and dispose of waste water, documents of KURAS specify different goals that are highly connected with the water sensitive logic, including the improvement of the livability in cities, the urban climate and the quality of waterbodies. Even though working package 2 of Klima 2050 encompasses research on blue-green solutions and other measures that relate to the water sensitive logic, the main goals in regard to the management of stormwater correspond highly to the hydraulic logic. The central aim is to diminish societal risks of climate change, which supports the hydraulic priorities on national welfare and the values of security and safety. A similar tendency is found in the quantitative document analysis, examining reports and papers that were produced by each research network as its main output. Klima 2050 had a 66 % higher frequency of hydraulic compared to water sensitive terms, whereas this margin was only 38 % for KURAS. A further query, showing a different approach to the water market logic between both networks is question seven of the survey. When asked which values should be most influential regarding water management, 52 % of Klima 2050 members considered security, safety and social equity to be the most important ones. KURAS members on the other hand focused on environmental sustainability and livability in 62 % of the responses. Coherent with the aforementioned bias towards an emerging water sensitive logic, the data examination revealed that, in proportion to the number of survey participants, slightly more KURAS actors followed the water sensitive logic than Klima 2050 actors. All of these observations also apply to the water market logic, but to a much lower degree, as it is comparably weak in KURAS and Klima 2050. Still, there are significant differences observable, e.g. in regard to water financing. Survey question number four revealed that German researchers favorize consumer funding as opposed to state funding, which is preferred by most Norwegians. This inclination is probably due to the system that was introduced in Germany in order to decrease per capita usage, strongly linking water prices to consumption. In contrast many Norwegians have chosen the hydraulic option, which includes water being paid for by the national public budget. This desire is presumably a consequence of the exceptionally strong state logic, and hence reliance on the government, that Norway is characterized by. The conducted interviews support these findings, as the Norwegian water sector, in general, is described as rather conservative and Klima 2050, in particular, consists mostly of engineers with a technical skillset and technologically oriented interests. Both, the water market and the water sensitive perspectives seem to be stronger among German researchers, since several recent changes caused an increased awareness of the environmental and livability effects of storm water and the costs of preventive and reactive measures.

In spite of these differences between the two research projects, the similarities remain overwhelming. More than a third of the respondents of each network are categorized as water sensitive. When actors of one group follow the same management paradigm, their interactions tend to strengthen views as demonstrated by the phenomenon of confirmation bias (Pahl-Wostl et al., 2011). Main factors reinforcing paradigm change are confrontations with crisis or catastrophe resulting in *cognitive variation* on the one hand and communication with actors following a different paradigm causing *social variation* on the other hand (Termeer & Koppenjan, 1997). Still, conflicting mental models are key barriers for communication and hence restrain opportunities for learning and reframing (Pahl-Wostl, 2007a). Only when actors become conscious of their own framing and begin to appreciate the existence of other deviating but justifiable framings, the possibility of reframing increases (Dewulf, Craps, & Dercon, 2004). Amongst others, several highly interlinked actors belonging to the most central cluster of the respective network, are categorized as water sensitive in both, Klima 2050 and KURAS. This can be attributed to cognitive variation caused by extreme weather events in Norway and Germany and social variation as the consequence of communication between researchers with different beliefs. Several studies showed that actors supporting non-dominant logics could only challenge a dominant logic because they were characterized by low authority and social status (Battilana, 2006). In turn, the water sensitive logic as observed in both cases, cannot be declared non-dominant, as several central coordinators and other actors of reputation were classified as being largely water sensitive. Conservative hydraulic actors also gave answers on multiple questions that were consistent with the WSL and hence, even researchers following the rationalities of the dominant HL, seem to accept water sensitive values and mostly prefer them to water market alternatives. No correlation between dominant logic and any other attribute was statistically significant, implying that the emerging logics are not confined to actors of specific age, job level or network centrality, but rather distributed throughout the entire network. Linking these findings with the research of Becker (1970) and Kerckhoff & Back (1965), it was determined that adopters of the water sensitive logic are not dominantly marginal actors, but evenly distributed throughout the network and hence, this field logic appears to have left the stage of a controversial innovation and instead found its way into the ranks of socially highly integrated actors. This conclusion answers the main research question and supports the finding of Pahl-Wostl et al. (2011), stating that the UWS experience a paradigm change from hydraulic to water sensitive logic. Although the theory of this transition is ahead of its practical implementations, the influence of the WSL is evident in Klima 2050 and KURAS alike. Particularly the overrepresentation of the WSL among Klima 2050's ten most central actors, indicates that the paradigm change has reached influential network members and the water sector is susceptible to a transformation. It remains unclear, whether the dominant role of the HL will soon be taken over by the WSL or if both logics will become equally established, competing and co-existing for a longer period of time as experienced in a few cases (Marquis & Lounsbury, 2007; Reay & Hinings, 2009). Previous research has described the situation of two logics existing in parallel, to be a temporary phenomenon (Hensmans, 2003; Hoffman, 1999). Influential actors attempt to stabilize the state of affairs and therefore the dominance of one logic (Thornton & Ocasio, 1999). Contestants support a new logic, challenging the established rationalities and beliefs. Ultimately, one or the other side is supposed to gain the upper hand, resulting in the respective logic to become dominant (DiMaggio & Powell, 1983). In the cases of Klima 2050 and KURAS, several key actors are already supporting the water sensitive logic. Concludingly, the networks are either amidst an open rivalry between two logics that have powerful endorsers, or both logics are beginning to merge into a hybrid version (Glynn & Lounsbury, 2005; Thornton et al., 2005).

The emerging water market logic on the other hand, influences the UWS only peripherally. This may be due to the perception of water as a public good that should not be dominated by financial interests – a view that has established itself in industrialized countries and is only slowly changing, as shown for instance by the privatization of water in England and Wales in 1989. Interestingly, two of the top ten most central actors of each network follow the water market rationality. This demonstrates, that economic interests are still present to a substantial degree among key actors. If the centrality of an actor is seen as a representation of his power to spread information and influence others, this result would indicate that although financial aspects are not the primary focus of most network members, they do carry a certain weight in regard to decision-making processes. Every actor who was identified following the WML is either a professional or a manager. Neither entry level workers nor executives appear to act in accordance to the water market rationality. Additionally, the water market actors are not restricted to private companies but belong to the public sector and academia as well. However, they are limited to six actors in both networks combined and therefore, any explanation of the exact distribution would be highly speculative. In most questions of the survey, the water market option was by far the least popular. Markets and private firms as influential actors, economic expertise as an influential source of knowledge, economic efficiency as an influential value and economic evaluation of options as an influential decision-making foundation were chosen as the third preference by most actors in both networks and sometimes not chosen as main priority by anyone at all. In contrast, the response to question nine showed that a majority of participants – 60 % of Klima 2050 and 57 % of KURAS – recognize, that economic and financial challenges are the most critical challenges in the urban water sector today. This indicates, that most actors see economic aspects as powerful in reality but resist against them gaining more influence in the future and would choose technical and environmental values to be prevail, instead. Financial gain is not the primary goal, but rather a restriction. The inherent economic characteristics of various measures limit the possibilities but are not the main rationality that defines values and preferences. This is especially striking in regard to the results from question ten of the survey. When asked for preferred mechanisms to adapt to climate change in the water sector, 50 % of Klima 2050 and about 43 % of KURAS members stated that investing in research and development of new technologies is their highest preference, a further sign of the deep entrenched hydraulic rationality. Market mechanisms in comparison, were the least popular approach. Nevertheless, a difference between both research projects could be observed again. While market mechanisms were largely chosen as third and last preference by Klima 2050 members, most KURAS participants considered it their second preference, signifying once more, that water market values are of greater importance in the German research network.

Recent studies indicate that despite the emerging paradigm shift governments and utilities are still key factors in regard to decision-making, causing a central and highly institutionalized position of the hydraulic logic (Fuenfschilling & Truffer, 2014). Main ambassadors of both aspiring logics are researchers from various fields, though especially from economics and environmental science. Minor cohesion with regard to beliefs and values constitutes the main disadvantage of both emerging logics compared to the hydraulic logic. Actors representing the water market logic disagree about concrete pricing models and ways to introduce a price increase without penalizing lower-income consumers. Representatives of the water sensitive logic fail to achieve consensus on a definition of environmentally sustainable water utilization as well as conclusive statements on the potential of water recycling technologies. As long as no agreements are reached, the logics remain relatively unaligned and will continue to be in an inferior position to the established hydraulic logic. Nevertheless, the appearance of contesting logics resulted in an increased heterogeneity of the previously highly institutionalized organizational field. The water sector is no longer determined by a single belief system, but depends on the combination of all logics, making it more perceptible to change (Fuenfschilling & Truffer, 2014). These hypotheses are supported by the results of the study at hand, as the hydraulic logic accounts for approximately 50 % of the members of Klima 2050 and KURAS alike. Although this result proves that the hydraulic logic is still dominant and benefits from its highly institutionalized position, it does also indicate that the emerging logics have managed to increase their influence. The UWS, as specified by the two research networks, do no longer follow exclusively hydraulic values, but rather a compound of influences from all three field logics. Over the last years, especially many researchers appear to have reframed themselves in favor of the water sensitive logic. It remains unclear, whether this trend will continue, and the water sensitive logic will emerge as the new dominant rationality of the water sector, if it will exist in parallel with the so far prevailing hydraulic logic, or if a new hybrid consisting of the two logics will arise. To determine the future developments of the UWS, further research, in form of a longitudinal design, is required.

Subsuming the results of all utilized analysis methods, striking similarities between the two research networks are as noticeable as consequently observed differences. The hydraulic logic's dominance is still omnipresent, as it has been institutionalized over the course of centuries. Thus, it has constituted the core to the organizational functioning in the urban water sector up until now, whereas alternative logics remained relatively peripheral and lacked influence. However, we are witnessing a change in the water management, as two institutional logics have begun to emerge and to contribute to the organizational decision-making processes. Klima 2050 and KURAS are informative examples, demonstrating this shift from the functioning of the water sector being centered on one logic to being based on multiple logics.

	Logics provide **contradictory** prescriptions for action	Logics provide **compatible** prescriptions for actions
Multiple logics are core to organizational functioning	Contested (Extensive conflict)	Aligned (Minimal conflict)
One logic is core to organizational functioning, others are peripheral	Estranged (Moderate conflict)	Dominant (No conflict)

Figure 34: Types of logic multiplicity within organizations (Besharov & Smith, 2014)

In relation to Besharov & Smith's (2014) proposed ideal types of organizations, the results of this thesis can be seen as a materialization of logic multiplicity, as displayed in Figure 34. While various organizations in the water sector have resided in a stage of no conflict as long as the hydraulic logic was uncontested by contradicting rivals, the field developed and became more estranged, when the water sensitive and the water market logics began to emerge. The results of this thesis suggest, that a shift towards a contested field is ongoing, as the two examined research projects have numerous similarities in regard to the hydraulic logic's dominance as well as to their network characteristics, indicating the institutionalization of one logic over many years. However, several differences between as well as within both research projects were also noted. The survey participants exhibited considerable disagreements in regard to different questions, revealing that their rationalities corresponded to different institutional logics, depending on the inquired topic. Moreover, tendencies were observed, demonstrating divergent properties between the two projects in regard to their networks as well as the strength of the three logics. All of these indications imply, that the water sector is situated in a period of conflict, as the rationalities associated with different logic are in contest. It remains unclear whether the future holds a subsequent transition to an aligned field, since different logics develop to become compatible or whether once again one logic will be established as the dominant force in the water sector.

The developed methods of this study, combining the institutional logics perspective with social network analysis, are a tool to determine the strength of certain logics in an organization. The examination of different units of analysis – the social network on an *organizational* level and the network members on an *individual* level – with respect to their dominant rationalities on an *institutional* level, enables the association of *attribute* and *relational* data with the underlying *ideational* data. Consequently, results from different levels of analysis can be triangulated in order to solidify interpretations and inferences.

Conclusively, this thesis has established a new method to comprehensively investigate and provide greater insight into the relationship between institutions, social networks and individuals. Therefore, the method can be used as a basis for the scientific community to pursue various studies on subjects that have not been analytically linked before.

Perspective

One proposition for the future is the further development of the presented method of combining social network analysis with the perspective of institutional logics. The interpretation of actor's dominant institutional logic in particular, can be improved on the basis of the suggested techniques in order to increase the construct validity. In addition, a longitudinal study may be implemented, based on the results presented above. An examination over the course of several years has the potential to determine how actors adopt new logics and how the social network changes accordingly. Institutional change as well as developments in the social network are continuous processes, that were only studied in regard to one moment in time but appear highly promising if the analysis is repeated for several years.

A second perspective for future research is the conduction of interviews with every actor. Interviews have several drawbacks, requiring a lot of time and being vulnerable to data-handling errors and various interviewer-response effects. Nevertheless, personal interviews offer the possibility to interpret the interviewee's logic from his choice of words and behavior as well as to elicit additional information with the help of probing questions and hence, improve the recall of social ties (Brewer, 2000; Johnson & Weller, 2002). Additionally, face-to-face interviews benefit from increased response rates, because of a high rapport that is typically established during the study (Borgatti et al., 2013).

Further elements to consider are various questions in respect to the analysis of the cooperation effectiveness. Are groups more effective when every actor follows the same logic or if different logics are present? Should logics be evenly spread, or should one have superior numbers? Does a variety of logics encourage creative thinking, or does creativity thrive if everyone follows the same logic? How do different compositions of institutional logics affect employee satisfaction? Do people enjoy working with colleagues who follow opposing logics?

Taking everything into consideration, this thesis is the first approach to expand analytical measures by combining the institutional logics perspective with the analysis of social networks, personal interviews, surveys and documents. As no further literature in regard to such a method exists, it offers a high potential for the scientific community to base their future work upon these results. Subsequent studies could expand the combined analysis of social networks and institutional logics, as presented in this thesis, by incorporating subsections dedicated to the evaluation of the cooperation between actors and using this approach in a long-term setting, to longitudinally track the evolution of the institutional logics on the individual, organizational or societal level.

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Appendices

Appendix A

Survey Questions

Table A1: Survey questions [Klima 2050]

1. General information
1. What is your name?
Option to write an answer
2. Where do you work?
Select from a list of all organizations
3. How old are you?
Option to write an answer
4. What did you study?
Option to write an answer
5. What is your current employment level?
Select from list: Student; PhD candidate; Entry level; Professional / experienced; Manager / supervisor; Executive
6. How much work experience do you have in your field?
Select from list: < 6 years; 6-10 years; 11-15 years; > 15 years
7. What is your main role in Klima 2050?
Select from list: Research, administration / coordination; both; option to write an answer
8. How many working hours per week do you dedicate to Klima 2050 approximately?
Select from list: < 15 hours; 15-30 hours; > 30 hours
2. Key activities
1. What is your main research question? Please describe shortly.
Option to write an answer
2. What are the main challenges that your work at Klima 2050 is addressing?
Select from list: Technical challenges; Health / safety challenges; Communication challenges; Decision-making challenges; Economic / financial challenges; Environmental challenges; Social challenges; option to write an answer
3. Please rank the following actors in the water sector according to the influence they should have on water management in your opinion: Utilities / technical experts; Research community and general public; Market / private firms
Select from list: 1st; 2nd; 3rd;
4. Please rank the following funding sources according to the share they should have within water management funding in your opinion: State (national public budget consisting of taxes paid by citizens); Consumer (users pay according to personal consumption); Community (local groups of users, municipalities, ...)
Select from list: 1st; 2nd; 3rd;
5. Please rank the following sources of knowledge according to the influence they should have on water management decisions in your opinion: Technical expertise; Economic expertise; Transdisciplinary expertise (incl. Social, environmental, …)
Select from list: 1st; 2nd; 3rd;
6. Please rank the following organization forms according to the influence they should have on water management in your opinion: Vertical / centralized hierarchy; Flat network / wide participation; Multi-central public-private partnerships
Select from list: 1st; 2nd; 3rd;

7. Please rank the following values according to the influence they should have on water management in your opinion: Environmental sustainability / livability; Economic efficiency; Security / safety / social equity
Select from list: 1st; 2nd; 3rd;
8. Please rank the following decision-making foundations according to the influence they should have in the urban water sector in your opinion: Expert-based assessment (decisions based on recommendations of a few experts); Community-participation (considering opinions of all stakeholders and users); Economic evaluation of options (e.g. cost-benefit analysis)
Select from list: 1st; 2nd; 3rd;
9. Please rank the following challenges according to the critical impact they HAVE TODAY on the urban water sector in your opinion: Economic / financial challenges; Engineering / technical challenges; Environmental / social sustainability challenges
Select from list: 1st; 2nd; 3rd;
10. What should be the preferred mechanisms to adapt to climate change in the water sector? Investing in technology development & research; Education & participation of the public; Market mechanisms (pricing of environmental impact, …)
Select from list: 1st; 2nd; 3rd;
3. Social Network
1. How often did you communicate with the following Klima 2050 participants on average?
A list of 55 network members was included. For every member the respondent had to select between: A-weekly; B-Once every one to three months; C-Less than every three months; D-Never
2. If you had contact with any Klima 2050 participants not listed in the question above, please state their name and average frequency of contact (A-C) similarly to the previous question.
Option to write an answer
Thank you for your time
In case of further questions, would you allow me to contact you via email?
Select between: "Yes, please." and "No, thank you."
Do you have any comments?
Option to write an answer

An analogue survey in German was created for KURAS.

Appendix B

Interview summaries

Table B1: Interview summary Klima 2050

Institutional Logics

A) Do you see these different logics in Klima 2050?

There are differences between partners from the private and public sector. Private companies are more profit driven. However, several members want to make a difference. The public sector on the other hand tends to have a higher interest in environmental results.

B) Is there a rivalry between the logics?

No. The main aim of Klima 2050 is the reduction of risk associated with climate change. Therefore, the dialogue in work package 2 is mostly limited to technical performance. Environment and economic are secondary goals.

C) Do you have the feeling that people work together irrespective of their logic?

Most people in WP2 work together in terms of technical performance. I think there are more differences between the private and public sectors, than between logics.

D) What do you think is the dominant logic of Klima 2050? Why?

The hydraulic logic is the most dominant, because most members of Klima 2050, particularly WP2, are characterized by technical interests and strengths. SINTEF and NTNU are very technically oriented and employ many engineers who are focused on technical issues.

E) Which logic do you follow mostly?

Probably the hydraulic logic. Although as the WP2 leader, I am trying to be balanced and represent an average perspective.

F) Have things changed in the last years in regard to values and decisions? Are they approached differently today?

The water sector is conservative. The first guideline including local storm water solutions is from 2008. The interest increases and so does the number of installments. A blue paper released in December 2015 has helped. The progress of storm water management towards blue-green solutions is accelerating but is still slow. However, laws and regulations are supposed to address these issues and are already under review. That said, it should be emphasized that future storm water management will depend on both types of solutions, both traditional and open and local.

Water sensitive logic (WSL)

G) Is one of the reasons that environmental / social / sustainable aspects are so important today, that they are kind of “in fashion”?

Probably, mentioning the environment on the company webpage is helpful. Still, I believe that the companies and people in Klima 2050 are trying to contribute to the change. Some researchers are highly motivated to make a positive impact.

H) Do they help to secure grants?

This is possible, but researchers who work on environmental subjects do this, because they believe in them. In addition, most proposal templates (e.g. Norwegian Research council) ask about the environmental impact of the study, so you need to address these issues anyway.

I) Why is the WSL so strong?

It is strong because many researchers are motivated to contribute to a change in the water sector. Moreover, Klima 2050 is characterized by a large public sector, which in turn is responsible for adapting to climate change and are the "problem owner".

Hydraulic logic (HL)

J) Are environmental / social / sustainable aspects just goals or are they actually improved in practice or is the HL still the main influence on practical work?

The motivation of Klima 2050 is a reduction of the risk of climate change on the society. WP2 is very technical but focused on blue-green solutions. Therefore, researchers are practical and technically-oriented in their daily work in order to provide blue-green solutions with a positive environmental impact.

Water market logic (WML)

K) How influential is the WML during everyday work?

Economics definitely have an impact and are important in the work. In regard to the development of storm water management from closed to open local solutions, there are concerns about higher costs of blue-green measures. Moreover, one traditional solution has to be replaced by two or three new ones or hybrid solutions, which increases the costs. Therefore, research is aimed at improving the economic efficiency of blue-green solutions.

L) Why is the WML so weak in Klima 2050?

Storm water is the government's responsibility and hence, not perceived as a market good. People working for Klima 2050 are often engineers, who consider economic efficiency as a secondary goal. Nevertheless, water market influences are visible. The blue paper suggests a storm water management fee for homeowner, that is already a reality in Germany.

Comparison

M) Do you think, the WSL is stronger or weaker in KURAS? Why?

It is probably stronger in KURAS, because the project was initiated to address challenges, that are already visible. Storm water creates many problems e.g. in landscapes that were altered by industrial mining and where water has to be pumped away from the area or where flood protection measures like artificial lakes have been created. These solutions have high costs and create an awareness for the effects of climate change. There have also been some extreme weather events in Norway but the awareness for future challenges is still lower.

N) Do you think, the WML is stronger or weaker in KURAS? Why?

It is probably stronger in KURAS. German partners tend to have a higher focus on economics than Norwegians. This is supposedly due to a higher awareness of the costs. In Norway, water is still taken for granted by many people. Consequently, there is less interest in water related research, since the water quality is very high, and shortages are almost non-existent.

O) Why is the response rate higher in Klima 2050?

Mainly because of the fact, that the KURAS project had already ended and people did not feel as responsible anymore.

Future

P) How do you think, will the IL of UWS develop in the future?

A change has already started because of recent incidents. There is an increased media coverage and consequently a rising public awareness for environmental change. Ultimately, a holistic approach is needed, because sustainability has to be ensured equally in regard to environmental, economic and technical factors.

Network

Q) Why is KURAS more cohesive/ has higher density / more communication ties between respondents than Klima 2050? This result contradicted my first assumption, because the KURAS survey had fewer participants and I expected a lower density.

Klima 2050 is characterized by many public partners and fewer private companies. However, members from private companies are usually more active, whereas employees of public organizations are typically interested in being informed but communicate comparably less. There are differences between the individuals of course. Sometimes two or three are highly involved but it remains unclear how well they communicate with other colleagues.

R) Do Klima 2050 researchers tend to have more communication within their company and have fewer interconnections between companies?

This is different from company to company. Active members usually have a good strategy of inter- and intraorganizational communication. Moreover, many large public partners have their own forums to communicate with each other.

S) Do you think, there is a correlation between the network centrality of participants and their dominant IL?

A correlation should be expected. The water market logic might be peripheral, whereas the hydraulic and water sensitive logics could be more central. Especially water sensitive actors communicate a lot with each other.

Table B2: Interview summary KURAS

Institutional Logics

A) Do you see the three different logics in KURAS?

Yes, various logics can be seen, because members have different tasks. Some work on technical issues and are more consistent with the hydraulic logic. Others focus on economic or environmental challenges.

B) Is there a rivalry between the logics?

No, there is no apparent rivalry. Of course, every challenge – whether technical of environmental – stands or falls with the costs. As KURAS was aimed at evaluating methods, their costs were also examined. Nevertheless, they did not constitute the primary focus, because the methods were not implemented in practice.

C) Do you have the feeling that people work together irrespective of their logic? Or do people tend to work with others, who follow the same rationality.

Both. Researchers work together on specific tasks and may follow the same logic. However, KURAS was characterized by a mixed composition of members working together on the same level. As many people collaborated in regard to certain challenges, there was also a lot of communication between logics.

D) What do you think is the dominant logic of KURAS? Why?

It is probably different, depending on the working group. Researchers dealing with wastewater were supposedly more hydraulic. Those working on storm water may be dominantly water sensitive and have a stronger water marked logic, since there was a partner who worked specifically on economic subjects.

E) Which logic do you follow mostly?

I was the project coordinator of KURAS, but also a researcher in the wastewater field. Therefore, I am probably more hydraulic. However, I studied an environmental subject and have also water sensitive influences.

F) Have things changed in the last years in regard to values and decisions? Are they approached differently today?

The consideration of costs increases steadily in the last years. Environmental sustainability is also a topic that gains attention, as seen for example by the environmental reports being released each year by private and public organizations.

Water sensitive logic (WSL)

G) Is one of the reasons that environmental / social / sustainable aspects are so important today, that they are kind of “in fashion”?

This so called “green-washing” is quite common and customers prefer companies that strive to improve their environmental sustainability. Nevertheless, e.g. in Berlin there are municipal specifications that providers have to comply with. Therefore, there is an interest in these aspects.

H) Do they help to secure grants?

Definitely. Environmental impact as well as economic efficiency are relevant in regard to research funding.

I) Why is the WSL so strong in KURAS?

Part of the KURAS project was the consideration of environmental, sustainability and livability effects. Project partners wanted to participate because they were interested in these topics, as were their employees.

Hydraulic logic (HL)

J) Are environmental / social / sustainable aspects just goals or are they actually improved in practice or is the HL the main influence on practical work?

Research is conducted on many technical issues that have an environmental impact in practice. For instance, the high potential for energy saving in pumps is being actively studied.

K) Are there still dominantly vertical hierarchies in the UWS? Or do you see an organizational change?

This depends on the organization. Smaller providers typically have traditional vertical hierarchies. For research institutes this is much less the case. I am not sure about engineering firms, but I would estimate it to be somewhere in the middle.

Water market logic (WML)

L) How influential is the WML during everyday work?

There are differences between organizations. The market logic has less influence on research institutes, as economic factors are secondary. Engineering firms are naturally more interested in profitability and hence, experience a higher WML influence. Water providers are supposedly in-between them, as they have to operate in a cost-effective manner, but are sufficiently funded.

M) Why is the WML so weak in KURAS?

As mentioned before, the costs of the studied measures were also considered, but they were not the main focus. The KURAS project was highly focused on environmental factors and most partners were interested in these results, as profit-oriented companies were in the minority. Therefore, economic effects were of secondary importance.

Comparison

N) Do you think, the WSL is stronger or weaker in KURAS? Why is the WSL stronger in KURAS?

Unfortunately, I am not informed about Klima 2050 and cannot compare the two projects.

O) Why was the response rate lower in KURAS?

Mainly, because the project had already been finished. In addition, several employees have changed their job, were on parental leave etc. However, some partners have communicated sparsely during the project term, which has probably not changed.

Future

P) How do you think, will the IL of UWS develop in the future?

I believe, the three logics have reached a stable state. Any further changes might have negative consequences. Already, many research ideas have to be adjusted with respect to economic efficiency. This should not increase any further.

Network

Q) Why is KURAS more cohesive/ has higher density / more communication ties between respondents than Klima 2050?

This is probably due to the project structure. Many fields of work were dealt with collectively. Consequently, work had to be coordinated, meetings took place periodically and members exchanged emails frequently.

R) Did KURAS researchers tend to have a lot of communication between companies? This result contradicted my first assumption, because the KURAS survey had fewer participants and I expected a lower density.

Yes, many tasks were handled by groups of researchers, who came from different organizations. Therefore, the interorganizational communication was very prominent.

S) Do you think, there is a correlation between the network centrality of participants and their dominant IL?

The WML might be peripheral, whereas the HL would tend to be central, at least in the waste water section. In regard to storm water, both the hydraulic as well as the water sensitive logic might be central.

Appendix C

Documents selected as part of the documentary analysis

Table C1: Document list KURAS

1. Kurzbeschreibung: Konzepte für urbane Regenwasserbewirtschaftung und Abwassersysteme
2. Maßnahmensteckbriefe Regenwasserbewirtschaftung
3. Diskussionspaper Regenwasserbewirtschaftung
4. KURAS-Leitfaden: Zielorientierte Planung von Maßnahmen der Regenwasserbewirtschaftung
5. KURAS-Leitfaden: Zukunftsorientierte Anpassung der urbanen Abwasserinfrastruktur
6. Maßnahmenkatalog Abwasserinfrastruktur
7. Maßnahmenkombinationen Abwasserinfrastruktur
8. KURAS – Ein Überblick (Prof. Dr.-Ing. Paul Uwe Thamsen)
9. Zukunftsorientierte Anpassung von Abwassersystemen (Raja-Louisa Mitchell und Projektteam)
10. Vielfältige Potenziale der Regenwasserbewirtschaftung (Andreas Matzinger)
11. KURAS – in der Wasser-Praxis: Abwasserinfrastrukturen rechtzeitig vorbereiten - Werkzeuge und Konzepte für Betreiber (Jan Waschnewski)
12. „KURAS-Methode“ der zielorientierten Planung von Regenwasserbewirtschaftung (Darla Nickel)

Table C2: Document list Klima 2050

1. Annual Report 2016
2. Annual Report 2015
3. Specific stormwater solutions to be tested within the Research Based Innovation Centre (SFI) Klima 2050 (Kamal Azrague et al)
4. Review of stormwater management practices (Lensa Jotte et al)
5. Stormwater-related databases (Nathalie Labonnote)
6. Climate adaptation of buildings through MOM- and upgrading - State of the art and research needs (Steinar Grynning et al)
7. Trinn 1: Reduser overvannet i avløpsnettet ved å frakoble taknedløp (Mareike A. Becker et al)
8. Reliability analysis with Metamodel Line Sampling (Ivan Depina et al)
9. Effektiv vinddrevet lufting av tak (Lars Gullbrekken)
10. Hydrological performance of a blue-grey roof in a cold climate (V. Hamouz, T. Muthanna)
11. Overveldende mange veiledere om klimatilpasning (Åshild Lappegard Hauge)
12. User guides for the climate adaptation of buildings and infrastructure in Norway – Characteristics and impact (Åshild Lappegard Hauge et al)
13. Assessing the robustness of raingardens under climate change using SDSM and temporal downscaling (Guro H. Kleiven et al)
14. Nytt klima: Nye laster (Tore Kvande)
15. A regionalisation technique for urban ungauged catchments - a case study from Norway (Jonas Staven Mittet et al)
16. Note 02 Temasamling
17. Note 03 Temasamling
18. Note 04 Temasamling
19. Note 05 Temasamling
20. Note 06 Temasamling
21. Note 09 Temasamling
22. Note 12 Temasamling

23. Note 13 Temasamling
24. Note 15 Temasamling
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26. Note 20 Temasamling
27. Note 22 Temasamling
28. Note 35 Temasamling
29. Note 36 Temasamling
30. Note 37 Temasamling
31. Note 40 Temasamling
32. Note 41 Temasamling
33. Note 42 Temasamling
34. Note 43 Temasamling
35. Note 44 Temasamling
36. Moisture-resilient upgrading to blue-green roofs (Petter Martin Skjeldruma & Tore Kvande)
37. Climate Adaptation Framework for Moisture-resilient Buildings in Norway (Kim Robert Lisø et al)
38. Ventilated wooden roofs: Influence of local weather conditions -Measurements (Lars Gullbrekken et al)
39. Flood risk management in small catchments and urban areas with a klima 2050 perspective (G. Raspati et al)
40. Veiledere for klimatilpasning av bygninger og infrastruktur – oversikt og tematisk analyse
41. Klimatilpasning av bygninger og infrastruktur – samfunnsmessige barrierer og drivere
42. Utvikler kunnskapsportal for overvann (Edvard Sivertsen (SINTEF) & Anine Drageset (NTNU))
43. Stormwater management in urban small catchments under nordic climate conditions (E. Sivertsen et al)
44. Vi trenger nye løsninger for overvannshåndtering (edvard sivertsen og berit time)
45. Klima 2050 – hva skal vi gjøre? (Edvard Sivertsen, Berit Time & Tore Kvande)
46. Asset management of nature-based solutions: what information to collect for maintenance management- application in Trondheim, Norway (Rita Ugarelli et al)

Appendix D

Categorization of terms according to institutional logics

Table D1: Institutional categorization of words from Klima 2050 documents

No.	Word	#/page	#/page/document	Institutional logic
1	climate	87,5250	1,9450	WSL
2	Klima	50,8861	1,1308	WSL
3	building	29,4382	0,6542	HL
4	adaptation	28,9768	0,6439	WSL
5	change	28,5124	0,6336	WSL
6	Klimatilpasning	27,1750	0,6039	WSL
7	roof	25,9377	0,5764	HL
8	performance	22,2967	0,4955	WML
9	risk	21,1147	0,4692	WML
10	data	20,6006	0,4578	HL
11	buildings	19,5911	0,4354	HL
12	management	19,0693	0,4238	WML
13	roofs	16,6034	0,3690	HL
14	downscaling	16,1301	0,3584	HL
15	model	16,1012	0,3578	HL
16	runoff	16,0991	0,3578	HL
17	Design	16,0250	0,3561	HL
18	blue-green	15,5483	0,3455	WSL
19	future	15,1248	0,3361	WSL
20	values	14,3455	0,3188	WSL
21	infrastructure	12,5255	0,2783	HL
22	flow	11,5364	0,2564	HL
23	information	11,5322	0,2563	HL
24	methodology	11,1796	0,2484	HL
25	event	10,6407	0,2365	HL
26	infrastruktur	10,4600	0,2324	HL
27	rainfall	10,2676	0,2282	HL
28	systems	10,2361	0,2275	HL
29	green	10,1988	0,2266	WSL
30	analysis	10,1411	0,2254	HL
31	test	9,9334	0,2207	HL
32	peak	9,6253	0,2139	HL
33	method	9,5282	0,2117	HL
34	environmental	9,5125	0,2114	WSL
35	veilederne	9,5035	0,2112	HL
36	bygninger	9,4603	0,2102	HL
37	parameters	9,2961	0,2066	HL
38	planning	9,2877	0,2064	HL
39	maintenance	9,2557	0,2057	HL
40	measures	9,2115	0,2047	HL
41	capacity	9,1870	0,2042	HL

42	klimaendringer	8,9951	0,1999	WSL
43	infiltration	8,9832	0,1996	HL
44	aktører	8,8690	0,1971	WSL
45	framework	8,8596	0,1969	HL
46	methods	8,8482	0,1966	HL
47	area	8,8378	0,1964	HL
48	environment	8,7622	0,1947	WSL
49	construction	8,6320	0,1918	HL
50	assessment	8,5751	0,1906	WML
51	informasjon	8,5007	0,1889	HL
52	raingarden	8,0000	0,1778	HL
53	Blågrønne	7,8241	0,1739	WSL
54	reliability	7,7745	0,1728	HL
55	energy	7,7498	0,1722	HL
56	taket	7,5763	0,1684	HL
57	behov	7,4722	0,1660	WSL
58	reduction	7,4349	0,1652	HL
59	temperature	7,3458	0,1632	HL
60	process	7,3034	0,1623	HL
61	failure	7,2876	0,1619	HL
62	technical	7,1115	0,1580	HL
63	development	7,0777	0,1573	HL
64	observed	7,0533	0,1567	HL
65	knowledge	6,9930	0,1554	HL
66	Technology	6,8602	0,1524	HL
67	Engineering	6,8392	0,1520	HL
68	Laboratory	6,8008	0,1511	HL
69	impact	6,6479	0,1477	HL
70	partners	6,4626	0,1436	WSL
71	utbyggere	6,3922	0,1420	WSL
72	robustness	6,2619	0,1392	HL
73	Science	6,1699	0,1371	HL
74	material	6,0102	0,1336	HL
75	raingardens	6,0089	0,1335	WSL
76	function	6,0046	0,1334	HL
77	factor	6,0025	0,1334	HL
78	luftespalten	6,0000	0,1333	HL
79	changes	5,9606	0,1325	WSL
80	bygg	5,8285	0,1295	HL
81	sustainable	5,7788	0,1284	WSL
82	guidelines	5,6372	0,1253	HL
83	quality	5,5593	0,1235	HL
84	retention	5,4526	0,1212	HL
85	implementation	5,4191	0,1204	HL
86	hydrological	5,3887	0,1197	HL
87	Byggeindustrien	5,3565	0,1190	WSL
88	models	5,3547	0,1190	HL
89	vulnerability	5,3419	0,1187	HL

90	cost	5,3126	0,1181	WML
91	Scenarios	5,3121	0,1180	WSL
92	lufting	5,2417	0,1165	HL
93	velocity	5,1953	0,1155	HL
94	samarbeid	5,1486	0,1144	WSL
95	roofing	5,0149	0,1114	HL
96	Innovation	4,9447	0,1099	WSL
97	value	4,9370	0,1097	WML
98	metamodel	4,9333	0,1096	HL
99	processes	4,9062	0,1090	HL
100	decision	4,8711	0,1082	WSL
101	Group	4,8643	0,1081	WSL
102	partnerne	4,7971	0,1066	WSL
103	treatment	4,7894	0,1064	HL
104	moisture	4,7819	0,1063	HL
105	transport	4,7003	0,1045	HL
106	blue-grey	4,6111	0,1025	WSL

Table D2: Institutional categorization of words from KURAS documents

No.	Word	#/page	#/page/document	Institutional logic
1	Maßnahmen	20,21797	1,68	HL
2	Bewertung	7,033614	0,59	WML
3	Zukunftsorientierte	4,499355	0,37	WSL
4	Abwasserinfrastrukturen	4,321248	0,36	HL
5	Maßnahme	4,290514	0,36	HL
6	Anpassungsmaßnahmen	3,900936	0,33	WSL
7	Kosten	3,63241	0,30	WML
8	Empfehlungen	3,448208	0,29	WSL
9	Kanalnetz	3,107614	0,26	HL
10	Freiraumqualität	2,917921	0,24	WSL
11	Kläranlage	2,827508	0,24	HL
12	Anpassung	2,730019	0,23	WSL
13	quantifiziert	2,575522	0,21	HL
14	Dachbegrünung	2,29798	0,19	WSL
15	Oberflächengewässer	2,251355	0,19	WSL
16	Nutzen	2,183225	0,18	WML
17	Grundwasser	2,180532	0,18	WSL
18	Gebäude	2,08191	0,17	HL
19	Abwassersysteme	2,000191	0,17	HL
20	Umwelt	1,872827	0,16	WSL
21	Gebäudeebene	1,871998	0,16	HL
22	Stadtklima	1,86368	0,16	WSL
23	Oberfläche	1,792979	0,15	WSL
24	Biodiversität	1,768054	0,15	WSL
25	Untersuchungen	1,758174	0,15	HL
26	Niederschlagswasser	1,740379	0,15	WSL
27	Versickerung	1,73654	0,14	HL
28	Regenwassernutzung	1,651665	0,14	WSL
29	Wirkung	1,631243	0,14	HL
30	Stadtentwicklung	1,592055	0,13	WSL
31	Auswirkungen	1,588178	0,13	HL
32	Retention	1,578663	0,13	WSL
33	dezentrale	1,574178	0,13	WSL
34	Methodik	1,572249	0,13	HL
35	Infiltration	1,563636	0,13	WSL
36	Gewässer	1,552299	0,13	WSL
37	Betrieb	1,532101	0,13	WML
38	Abwasserinfrastruktur	1,517669	0,13	HL
39	Abwasser	1,47015	0,12	HL
40	Vielfalt	1,451643	0,12	WSL
41	Bemessung	1,449218	0,12	HL
42	Überlast	1,443942	0,12	HL
43	Investitionen	1,365999	0,11	WML
44	Universität	1,349699	0,11	WSL
45	Retentionsbodenfilter	1,34482	0,11	WSL
46	technische	1,338883	0,11	HL

Appendix E

Ego-networks of the most central actors of both research projects

Figure E1: Ego-network of node 17 from Klima 2050 remains connected although ego is removed

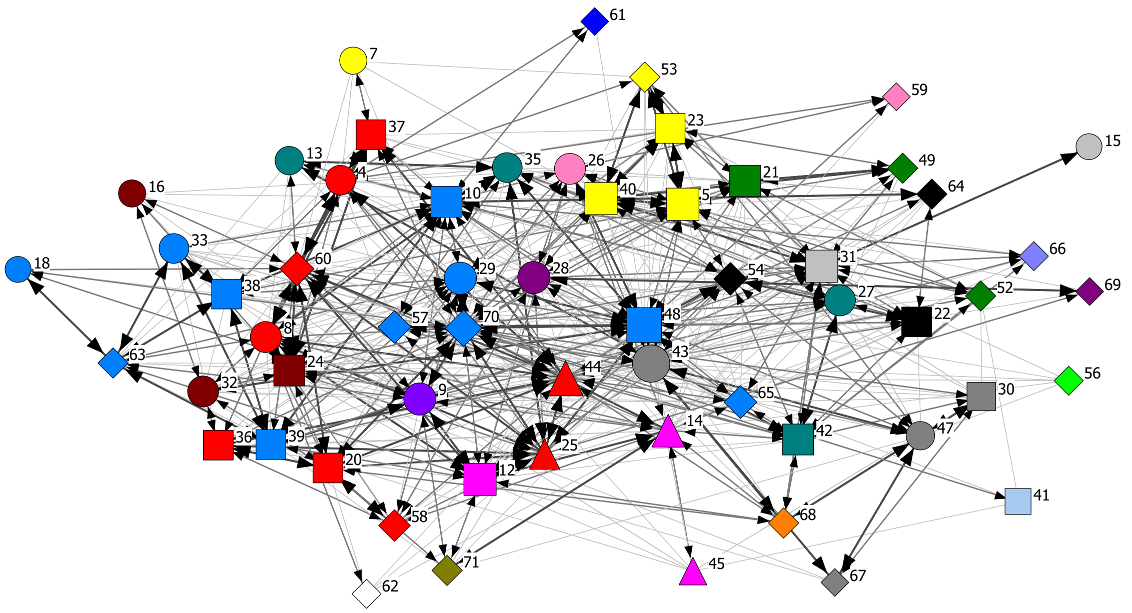
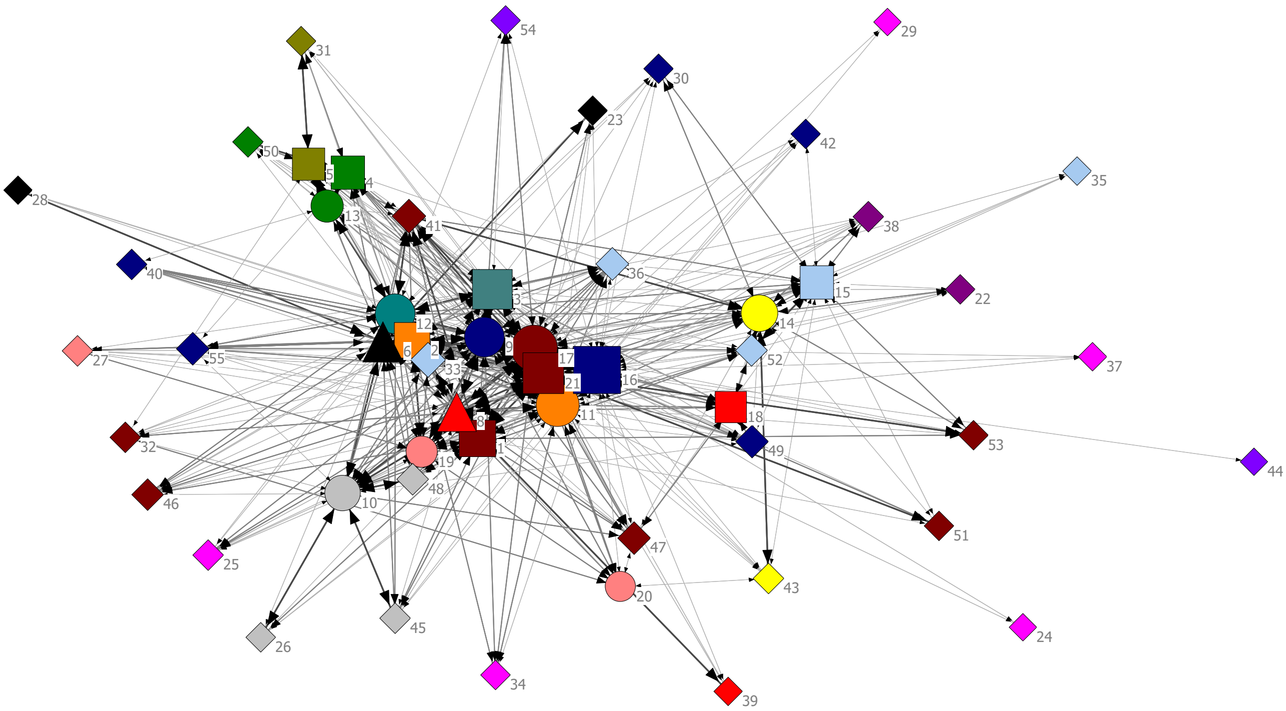


Figure E2: Ego-network of node 7 from KURAS remains connected although ego is removed



Appendix F

Institutional categorization of respondent's research questions (Survey question 2.1)

Table F1: Categorization of research questions from Klima 2050

No.	Research question	IL
1	Better flood forecasting and warning including in urban area in Cooperation With MET	H
2	Climate change and effects on extreme precipitation on fluvial and pluvial floods	WS
3	n/a	n/a
4	Flood risk management in small catchments under future land use and climate changes	H
5	Do not work in Research, work in flood risk and landslide risk management	H
6	Technical guidelines based on practical application of hydraulic physics	H
7	development of hybrid surface- and pipe-flow models	H
8	n/a	n/a
9	How to introduce systems thinking in storm water management?	WS
10	how to adjust risk management frameworks to small catchments	H
11	Water drainage and Storage on green roofs	H
12	Develop systems for run-off and water management, both quantity and quality	H
13	WP 2 storm water management in small catchments	H
14	How to develop efficient and robust solutions to handle stormwater quantity and quality	H
15	Water management and the delivery of climate services for end-users	WS
16	Storm water	n/a
17	What can we learn from nature?	WS
18	GIS tools to locate potential areas for SUD usage as a decision support for planner	H
19	How to build more robust buildings	H
20	Risk assessment of blue-green roof solutions	H
21	How are roads and road transport affected by climate change and what should we do?	WS
22	Change of logics and practices to succeed in adaptation to climate change in the built environment	WS
23	How can we decrease future loss of life and buildings due to landslides and floods?	H
24	Use of green roofs for storm water management in cold climates	H
25	Climate adaptation by maintenance and upgrading of existing Buildings - how can we utilize an understanding of societal structures to implement climate adapted upgrading	WS

26	Prevention and disaster risk management and sharing Insurance loss data	WM
27	Utvikling av metodikk for belsutningsprosesser	n/a
28	Adaptation of climate information to needs identified in Klima2050	WS
29	Mapping of stormwater-related databases	H
30	How to improve protection on existing buildings from weather events.	H
31	How can we reduce the risk from precipitation triggered landslides in a better and more efficient way than at present?	H
32	To establish a regional network for climate adaptation. To establish a good interdisciplinary organization for climate adaptation in the Municipality.	WS
33	Water treatment processes, and sustainability of water cycle services.	WS
34	What is hold-back time in different green roofs	H
35	What are the governance barriers that impede the development of sustainable urban water services?	WS
36	Decision process in the adoption of climate adaptation Initiatives	WS
37	How to estimate runoff from small catchments	H
38	Flooding - Hydrological modelling	H
39	Develop innovative treatment for stormwater	WS
40	n/a	n/a
41	How to maintain a robust and safe infrastructure, despite clima changes?	H
42	Adaption of bulidings and infrastructure to changing climate	H
43	Vulnerability, Bluegreen Solutions and resilient Buildings adapted to a changing climate.	WS
44	n/a	n/a
45	How does future climate and climate change impact airport operations	WS
46	How to build robust, moisture proof, sustainable and profitable buildings	H
47	The impact of climate changes to property operations and maintenance.	H
48	What social science factors contribute to climate adaptation?	WS

Table F2: Categorization of research questions from KURAS

No.	Research question	IL
1	Ökobilanz von Maßnahmen des Regenwassermanagements	WS
2	n/a	n/a
3	Auswirkungen von dezentralen RWB-Maßnahmen	WS
4	Beurteilung stadtklimatischer Auswirkungen von Siedlungswasserwirtschaftlichen Maßnahmen	WS
5	Modellierung des mikroskaligen Stadtklimas	WS
6	Anpassung städtebaulicher Planungsprozesse, Stakeholderintegration	H
7	Gesamtprojektkoordination, Koordination Forschungsschwerpunkt Abwasser, Forschung zur Abwasserzusammensetzung	H
8	Vernetzung der Regenwasserbewirtschaftung im Rahmen ökologischer Gesamtkonzepte	WS
9	Begleitung von Modellprojekten zur Übertragung in Simulationen, Hervorhebung der Verdunstung, Koordination der Gebäudeebene	H
10	Ökonomische Bewertung	WM
11	Quantifizierung und Messungen von Retentionsdaten der Gründächer	H
12	Welche Wirkung auf den Wasserhaushalt haben die Maßnahmenkombinationen im Bestand	WS
13	Bewertung der Maßnahmenwirkung auf das Stadtklima / Mikroklima	WS
14	Maßnahmeninterdependenzen, Modellierung von Überflutungsereignissen und Anpassungsmaßnahmen, Modellierung von Zukunftsszenarien	H
15	Unterlast in der Abwasserableitung	H
16	Regenwassermanagement auf Gebäude- und Quartiersebene	H
17	Entwicklung einer übergeordneten Bewertungs- und Planungsmethode für Maßnahmen der Regenwasserbewirtschaftung. Zusammenführung der im Rahmen der Methode erhobenen Ergebnisse unterschiedlicher Disziplinen/Partner.	H
18	Effizienz dezentraler Maßnahmen auf verschiedene Schutzgüter/integrierter Planungsansatz	H
19	Bereitstellung von Praxisbeispielen, Beitrag von Erfahrung aus der Praxis	n/a
20	Erarbeiten einer Entscheidungsmatrix zur frühen Definition von klimatischen Projektzielen	WS
21	n/a	n/a