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Faculty of Life Sciences
Albrecht Daniel Thaer-Institute of Agricultural and Horticultural Sciences

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Master Thesis

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Intermediation in Policy Translation

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Infrastructure Multiplicities at the Roof Junction

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Contents

List of Abbreviations

BMUV	Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz
BreWa-BE	Begrenzung von Regenwassereinleitungen bei Bauvorhaben in Berlin
BWB	Berliner Wasserbetriebe (Berlin Water Works)
BuGG	Bundesverband GebäudeGrün e.V.
DSM	Decentralized Stormwater Management
GR+	GreenRoofPLUS (GründachPLUS)
GT	Grounded Theory
IBB	IBB Business Team
ICT	Information and Communications Technology
RWA	Rainwater Agency Berlin
SA	Situational Analysis
SenUMVK	Senatsverwaltung für Umwelt, Mobilität, Verkehr, Klimaschutz
SenWEB	Senatsverwaltung für Wirtschaft, Energie, Betriebe
UV	UltraViolet

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1 Introduction

1.1 Background and Problem Statement

Contemporary cities grapple with challenges induced by climate change, amplified by dense urbanization and surface sealing. Despite pleas to pursue climate adaptation strategies to mitigate heat, air pollution, drought, and floods, political ambitions do not translate into meaningful change. Actors recognize the importance of a paradigm shift in stormwater management and city greening. Decentralized stormwater management (DSM) and green roofs are increasingly becoming part of new buildings or entire districts, often through binding legal requirements (Pallasch 2021). Visionary new construction projects showcase integrated and innovative solutions for a greener city, but efforts to redesign the built environment typically only result in piecemeal solutions or isolated pilot projects.

Ambitions of local and state governments to address the built environment for climate adaptation are becoming more commonplace and expenditures of retrofitting exceed those of new build in developed countries (Dixon and Wilkinson 2016). However, the challenge of retrofitting the heterogeneous built environment eludes one-dimensional, top-down solutions (Hodson and Marvin 2015a). Therefore, the study of the complexities of retrofitting Berlin's infrastructures to introduce DSM can be a significant contribution to understanding the governance for more sustainable cities.

In 2017, the House of Representatives in Berlin passed a resolution to endorse DSM as a component of their climate change adaptation strategy. The aim was to alleviate the load on the central sewer system and enhance the health of local water bodies. To achieve this, a goal was set to detach 1% of the areas linked to Berlin's mixed sewer system per year. Additionally, a pilot project for retrofitting within the area of the mixed sewer system was to provide innovative solutions. Regarding the new build, DSM should be integrated from the beginning.

As a key player, the Rainwater Agency (RWA) was founded in 2018 by the Senate Administration for Environment, Mobility, Traffic and Climate Protection (SenUMVK), in coordination with the Berlin Water Works ("Berliner Wasserbetriebe" - BWB). The RWA's mandate was to engage with diverse actors such as property owners, civil actors, and practitioners to support a comprehensive stormwater concept for Berlin, as

well as a green roof funding program called initially “1.000 Green Roofs,” and later “GreenRoofPLUS” (GR+).

The introduction of DSM in the city is not a straightforward task as the unearthing of water flows from the hitherto hidden realm of underground infrastructures entails shifting relations at the surface (Moss 2000). However, the opportunity to ‘green’ roof surfaces was suggested as an activation of unrealized potential, considering that roof areas account for 40-50% of ‘unused’ area (Mentens et al. 2006). Green roofs have numerous advantages for the city, including stormwater attenuation due to the retention of about 50% of annual rainfall. Coupled with the expected cooling effect, green roofs are well aligned with the goals laid out in the 2017 resolution.

Regarding new construction, the systems to be integrated can already be included at the initial planning phase. In contrast, retrofitting existing buildings involves penetrating dense local layers, potentially leading to conflicts, negotiations, and unstable boundaries (Sims 2015). These local conditions give rise to place-specific capacities and motivations, dispersed among a heterogeneous arrangement of things and people (Hodson and Marvin 2016). A disconnect exists between fragmented local initiatives - with their individual values and goals - and an urban strategy aimed at applying retrofitting efforts on a larger scale. This discrepancy limits the effects of both approaches. Urban strategies are not adopted by local projects, which in turn remain ad hoc, piecemeal, and fragile. Even though they focus on local goals, they remain reliant on urban and national funding. This situation creates tension between urban strategic orientations and more place-specific alternatives.

A middle-ground approach that acknowledges local specificities and values while concurrently being guided by an overarching urban strategy could reconcile this tension and bridge the gap between the extremes of the urban-local spectrum. Coordinative agents such as intermediaries are posited to be instrumental in assuming this role. However, the effectiveness of these intermediaries remains an empirical question. Although they have been found to effect transformative change, albeit incrementally (Moss 2009), their integration within a wider network might provide crucial insights into their agency and effectiveness (Beveridge 2019). The concept of the ‘junction’ - intersections and interfaces of various elements – echoes callings for coordination and strategic alignment. Here multiple assemblages and interpretations of the situation intersect, resulting in unstable boundaries and relations. These boundaries require

various actors to interpret and act to stabilize relations, practices, and boundaries once again (Jensen et al. 2015).

Despite the establishment of intermediaries like the Rainwater Agency, designed to facilitate coordination, and the GR+ that together embody a strategic orientation, progress has been limited. The push for DSM and the GR+ policy, despite high hopes, have not led to widespread mobilization of roof areas. This underscores an ongoing challenge of effectively translating urban visions into tangible, socio-material change.

1.2 Research Objective, Questions and Design

My research objective is to explore the interplay between the GR+ policy, the RWA as an intermediary actor, and attempts of retrofitting at the 'roof junction'. By doing so, I aim to engage with the complexity of relations that enable and constrain strategic interventions. Rather than settling for one-sided analyses that blame the challenges on unsuitable socio-materiality of Berlin's buildings, weak policies, or ineffective intermediaries, I strive for a more nuanced understanding. The insights on the complex interrelations within the situation could provide insights on potential alignments.

The core research question guiding this study will be:

What is the interplay between the Rainwater Agency, the GreenRoofsPLUS-policy, and the situation of multiple existing and alternative infrastructures?

The multiplicity within the situation will be examined using five corresponding sub-questions. This approach begins with a focus on the retrofitting of **existing infra-structures**, then subsequently explores the emergence of **alternative configurations**.

A) Existing Infrastructures

1.) What are the capacities of the RWA to translate the GR+ policy for retrofitting green roofs?

2.) What are the limitations?

3.) What is the role of GR+ for the intermediary work of the RWA?

B) Alternative Configuration

4.) What is the engagement with the dominant discourse of the SolarCity?

5.) What is the engagement with the minor discourse of Rain-to-Tree?

In the thesis I will employ Situational Analysis (SA), a qualitative research approach that originated in the Grounded Theory (GT) tradition. Despite its roots in GT, SA centres not on actions or processes but the situation at large to develop a holistic understanding of its relationality and interaction. To pursue this objective, heterogeneous materials were gathered for analysis including interviews, observations, and documents. An iterative process of coding, (re)drawing maps and writing analytical memos helped to gain a better understanding of the complexity at play in the situation. Moreover, attention to the various elements such as things, humans, dominant or minor discourses lead to challenge monolithic portrayals towards a more nuanced understanding.

The research is significant as it provides a holistic yet differentiated account of the interplay between intermediation, policy translation and the built environment. This might offer a productive perspective to probe the situation for implications to be translated into actionable advice.

1.3 Research Outline

The organization of this thesis unfolds as follows: Chapter 2 sets the theoretical framework for research by providing an account of the four categories of sensitizing concepts integral to the situation under scrutiny. This analysis embraces a relational perspective on the situation centred around the roof junction, explores the technologies of DSM and green roofs, examines policy translation, and assesses the role of intermediation. Chapter 3 is dedicated to an explication of the research method, Situational Analysis, and the data collection strategy as well as processes of interviewing, transcription, and coding. This section also explicates mapping techniques and discusses the criteria set for ensuring data quality. In Chapter 4, key findings are presented, each substantiated with empirical evidence drawn from the research. Chapter 5 takes these findings further into a thorough discussion, interpreting their significance in relation to the defined research questions. Finally, Chapter 6 concludes the inquiry, summarizing major insights and acknowledging potential limitations and an outlook.

2 Theoretical Framework

2.1 Relational Perspective

2.1.1 Introduction

To lay the ground for a relational approach, Situational Analysis and the Social Worlds/Arenas framework are combined with Assemblage Thinking. While the former focuses more on discursive formations without neglecting the material actants in the situation, the latter highlights the enmeshed human-nonhuman elements. The combination prepares the further analysis of multiple interrelations.

2.1.2 Situational Analysis and Social Worlds/Arenas Framework

Grounded Theory (GT) has been developed by Barney Glaser and Ansel Strauss in their seminal work "The Discovery of Grounded Theory" in 1967. Since then, major works of Anselm Strauss and Corbin in 1990 and Kathy Charmaz in 2006 further developed GT in more pragmatist/Interactionist and constructivist terms (Clarke et al. 2022).

Adele Clarke has been a long-time scholar and practitioner of GT working with figures such as Anselm Strauss and Susan Leigh Star. Situational Analysis (SA) can be seen as a revision and extension of GT (Clarke 2003, 2005a). Her ambitions of "[d]is-articulating grounded theory from its remaining positivist roots" (Clarke 2005a, p. xxxiii) entail a number of shifts in methodological and theoretical commitments. Foremost, SA supplements

> "the traditional grounded theory root metaphor or social process/action with an ecological root metaphor of social worlds/arenas/negotiations/discourses as an alternative conceptual infrastructure that provokes situational analysis at the meso-level" (Clarke 2005a, p. xxxiii).

The analytic focus is on the broader situation of inquiry. Attention is drawn to complexity and differences while also including silences and power relations. An important analytical step is the delineation of the situation which is empirically constructed in the process of making maps and memos (Clarke 2005a; Clarke et al. 2015a, 2018). An early root of the situation can be found with pragmatist John Dewey (1938) who stated that a "'situation' is not a single object or event … but … [It] binds all constituents into a whole [and] it is also unique" (quoted in Clarke et al. 2022, p. 6).

To grapple with the complexity found in the situation of inquiry SA employs different kinds of maps and analytic memos throughout the research process. Each map offers a distinct perspective and can be linked to poststructural theoretical contributions.

Messy situational maps include the array of heterogeneous elements found within the situation. Human and nonhuman actants as well as discourses and various other elements are intentionally scattered in an unordered way to display the complexity and allow for creative engagement with the material. SA in this regard is inspired by Deleuze and Guattari's rhizomes and assemblages (Clarke et al. 2022). In an introductory quote on rhizomes in "A Thousand Plateaus" they remarked: "[T]he rhizome pertains to a map that must be produced, constructed, a map that is always detachable, connectable, reversible, modifiable, and has multiple entryways and exits" (Deleuze and Guattari 1988, p. 22). Nonhuman actants are an essential part of situational maps and remind the researcher of the multiple agencies at play in a situation. The notion of an assemblage extends this perspective and is elaborated further below.

Social Worlds/Arenas Maps are based on the interactionist concepts of social worlds and arenas that offer an ecological perspective on the relationality within the situation (Clarke et al. 2018). The social worlds framework as a theory/method package (Clarke and Star 2008) derives its name and some core assumptions from Anselm Strauss' social world perspective (Strauss 1978). Social worlds are conceptualized as "universes of discourse" to highlight the relational embeddedness of meaning. In defining discourses, Adele Clarke and Susan Leigh Star (2008) assert that they are "assemblages of language, motive, and meaning, moving toward mutually understood *modus vivendi—ways* of (inter)acting" (p. 116).

But the framework goes beyond meaning-making to include collective action and shared objects. Arenas consist of an ecology of social worlds that are related by means of mutual concern and commitment to action. The analysis revolves around the "relations and action across the arrays of people *and things* in the arena" (Clarke and Star 2008, p. 113) including representations, discourses and processes. Interactions among social worlds lead to negotiations, conflicts and formation of shared commitments (Clarke and Star 2008). These inter-world dynamics and negotiations are described as an "*improvisational choreography*" (Clarke et al. 2018, p. 161) foregrounding the fluidity and temporality within social arenas.

Social worlds despite their coherent appearance can segment into subworlds. Segmentations and intersections trigger forces of change, fragmentation and splintering so researchers must stay aware of the fluidity of social worlds. Analytically, an important task is "to discover such intersecting and to trace associated processes, strategies and consequences" (Strauss 1978, p. 123). To approach these intersections, strategies include the identification of other relevant social worlds and bridging agents in-between (Strauss 1978).

Research within the symbolic interactionist tradition on tools, human-nonhuman interactions and infrastructures also formed important avenues for inquiry in the social worlds framework. The rich canon of research also brought forth a toolbox of sensitizing concepts such as the boundary object developed by Star and Griesemer (1989). Boundary objects "exist at junctures where varied social worlds meet in an arena of mutual concern" (Clarke and Star 2008, p. 121). The original motivation has been to develop a more ecological understanding of translation compared to the relatively power-infused and one-way translation of Callon (1984) among others. Boundary objects are used by multiple social worlds and due to their interpretive flexibility enable heterogeneous translation and cooperation without consensus (Star and Griesemer 1989; Clarke and Star 2008).

SA includes aspects of discourse analysis, especially inspired by Michel Foucault. Part of this is realized by the analysis of extant narrative, visual and historical discourses alongside interviews and ethnographic work (Clarke et al. 2018). Drawing on Maarten Hajer's (1995) work on discourse, the concept of a story-line that creates a coherent narrative of a discursive position can be helpful to grasp discourses. Additionally, framings often organized around generative metaphors offer "a perspective from which an amorphous, ill-defined, problematic situation can be made sense of and acted on" (Rein and Schön 1993, p. 146). Complementary to Hajer's story-lines, policy framings and meanings become evident "through the *stories* participants are disposed to tell about policy situations" (Rein and Schön 1993, p. 148). As my research does not primarily focus on discourse analysis a detailed conceptualization of discourses, as characterized by the theoretical approaches of Foucault and Hajer, is not pursued in-depth. Sensitivity towards the use of metaphors that create coherence as well as forms of in- and exclusion inform the positions within the respective map. Moreover, building on Deleuze and Guattari, Clarke et al. (2018) underscore the importance of minor

discourses alongside major discourses. These represent marginalized positions and allow an ‘alternative reading’ of the situation.

2.1.3 Assemblage Thinking

Assemblage thinking is currently utilized within the literature of Science, Technology, and Society (STS) and beyond. The concepts originated in a set of philosophical works by Deleuze and Guattari (culminating in *A Thousand Plateaus* published 1980 in French). The concept of assemblage has since then developed into further and at times markedly different ‘theories’, such as adaptations by Bruno Latour (2005), Manuel DeLanda (2006) dubbed ‘assemblage theory 2.0’, and discussions within geography (Anderson and McFarlane 2011).

Definitions of an assemblage are scattered in the works of Deleuze and Guattari, while the offspring are in part contradictory up to the point of academic arguments over the ‘true’ application and meaning of assemblage (most pronounced in (Buchanan 2017)). Hence, there is no dominant paradigm neither in the work of Deleuze and Guattari nor after (Müller and Schurr 2016), but as a concept it can be made analytically productive (Buchanan 2020). An often-cited elaboration that also demonstrates the poetic language of Gilles Deleuze defines an assemblage as:

> “a multiplicity which is made up of many heterogeneous terms and which establishes liaisons, relations between them across ages, sexes and reigns – different natures. Thus, the assemblage’s only unity is that of co-functioning: it is a symbiosis, a ‘sympathy’. It is never filiations which are important but alliances, alloys; these are not successions, lines of descent, but contagions, epidemics, the wind” (Deleuze and Parnet 1987, [1977], p. 69).

A central thread within assemblage approaches connotes that assemblages relationally bind heterogeneous elements into a new entity (DeLanda 2006; Anderson and McFarlane 2011). From nation states to cities, from people to material objects, from policy documents to everyday utterances – what becomes part of the assemblage depends on how it enters into relation, or how it is affective on or affected by the assemblage (Buchanan 2020).

Multiplicity and emergence are at the heart of much assemblage research, emphasizing the never fully formed or static, always in the process of becoming (Anderson and

McFarlane 2011; Savage 2020; Dovey 2009). The forming of a new entity (not unlike a system or actor-network) results in the emergence of properties and agency not realized before. This is attributed to the enactment of elements' capacities that depend on the relations to respective counterparts, so that the properties of the whole cannot be reduced to the properties of its parts (DeLanda 2006). An example is that of a bowman mounted on a horse (Deleuze and Parnet 1987, [1977]). Each element – the warrior, the bow, and the horse – have their distinct properties and only in combination do they exert capacities leading to some sort of war machine. Other examples could include the human body, cities, music or in my case policies.

Critique on the use of assemblage relates to its manipulability, which probably accounts for part of its success (Anderson and McFarlane 2011) but "carries clear risks. For example, when a term is chameleon-like, disposed to meaning too many things, it can end up meaning everything and anything, and thus nothing at the same time" (Savage 2020, p. 332). Even though there is no dominant interpretation of assemblage, it can serve as a 'middle term' and analytical perspective (McFarlane 2011).

Importantly, although Müller and Schurr (2016) discern that in related research "[a]lmost everything today is 'assembled' – made up of precarious socio-material relations" (p. 217), assemblages are neither each and everything nor simply heaps of people and things (Buchanan 2020). Ian Buchanan, a leading author in studies on Deleuze, decidedly advocates to return to the origins of assemblage thinking, namely the works of Deleuze and Guattari, to caution against equating assemblages simply with 'systems' or 'machines' (Buchanan 2017, 2020). Assemblages (*agencement* in French that would better translate into arrangement) have a logic as well as inner and outer limits that specify what the assemblage can be before turning into something else. They are not accidental, but drawn together by wish/desire, and so it "is the underpinning *organization of desire* that matters, not the bits and bobs, and this is true for all varieties of the assemblage" (Buchanan 2020, pp. 65–66).

Some leading questions are offered by Buchanan (2020) to operationalize the concept of assemblage: "Given a specific situation what kind of assemblage would be required to produce it?" (p. 22) or concerning the material-semiotic dimensions of assemblages, we can ask how 'matter becomes material' and 'semiotic matter becomes expressive' or 'performative' entering assemblages (Buchanan 2017). How do assemblages pull

discursive (policy texts, conference talks) and non-discursive elements (people, computer, roofs, soil layers, rain) together in a temporarily stable entity?

2.2 Retrofitting as Infrastructure Integration

2.2.1 Multiplicity

To conceptualize retrofitting as infrastructure integration, it is important to understand that the urban landscape is already populated by socio-technical systems, such as buildings, streets, heating, and ICT. Therefore, attempts to establish new configurations like decentralized stormwater management do not occur in a vacuum but must consider the multiple interactions with heterogeneous arrangements. This multiplicity of socio-technical systems, forms of urban governance and understandings of sustainability enables and constrains the capacities of embedded reconfiguration (Hodson et al. 2017).

Brian Larkin (2013) advocates for an anthropology of infrastructure as these networks are fundamental for the functioning and lifestyle of modern societies. He defines infrastructures as "built networks that facilitate the flow of goods, people, or ideas and allow for their exchange over space" (p. 328). In other words, they are "matter that enable the movement of other matter" (p. 329). But reducing infrastructures to their technical functioning would ignore a wide range of effects from the emotional, political to the aesthetic (Larkin 2013). Perceiving infrastructures as socio-technical systems underscores that the social and technical elements are inherently intertwined (Moss 2020; Graham and Marvin 2002). Although buildings are commonly not categorized as infrastructures, my research seeks insights by analysing them *'as an infrastructure'* (Winthereik and Wahlberg 2022) to problematise their entanglement.

The innovative potential of technological artefacts is not realized in and of itself but in relation to the specific place and existing socio-technical systems. Therefore, the potential to harness "experimental processes of embedding a multiplicity of infrastructures or schemes simultaneously in a city […] needs to be better understood" (Hodson et al. 2017, p. 9). The interactions of these infrastructures are not predetermined but actualize within place-specific 'experimental assemblages'. To fully grasp these multiplicities, the advent of competing claims of other new socio-technical systems within the same territorial context enrich the picture further. Therefore, this research also includes instances of new – new interfaces along the old – new retrofitting situation. Categories to judge the interplay of existing and multiple new configurations encompass complementary, merely co-existing or conflictual (Hodson et al. 2017).

2.2.2 Infrastructure Integration

In their introduction to a special issue on infrastructure integration, Monstadt and Coutard (2019) sensitize urban studies to look beyond single infrastructure domains as these socio-technical systems are not neatly delineated but increasingly 'nested' and interwoven. The "interconnectivities, interdependencies and multiple interfaces and hybrids between infrastructure domains" (Monstadt and Coutard 2019, p. 2192) emerge as important objects of inquiry especially given the persistence of calls for more integrated planning.

Visions of integration often associated with the buzzword nexus are usually normative and idealized in a pursuit of progress (Monstadt and Coutard 2019; Williams et al. 2014). Just as the concept of multiplicity and reconfiguration highlights the need for a place-specific and relational embedding of infrastructures, overly simplistic portrayals of integration risk being blind for the situatedness of infrastructures. Monstadt and Coutard (2019) use the terms infrastructure un- and rebundling to point towards the processes of engaging with the manifold configurations that populate cities.

Facing the heterogeneous and fragmented arrangements of multiple intersecting and interfacing infrastructures, intermediation and practices that create, maintain or disrupt boundaries (boundary work) are suggested to set these different domains productively in relation. In the pursuit of re-bundling infrastructures, one must acknowledge the varying motivations and abilities of all stakeholders, including service users, policy-makers, and utilities (Monstadt and Coutard 2019). This further underscores the potential necessity for coordinative actors, such as intermediaries, to navigate urban complexities.

To operationalize these insights, the framework by Moss and Hüesker (2019) will be used as a sensitizing concept that helps to explore different dimensions of infrastructures coupling. The following point towards crucial cornerstones of (mis)alignment between infrastructural domains:

Socio-materiality describes the interwoven relationship and co-constitution of human and nonhuman actants. It highlights the materialities that are enmeshed in processes of "socio-technical reassembling" (Moss and Hüesker 2019, p. 2228).

Multiple spatialities are simultaneously involved so that infrastructure un- and rebundling occur on scales ranging from the local to the urban and beyond (Hodson et al. 2017; Monstadt and Coutard 2019). Additionally, differences between places with

their respective capacities and situated capabilities and motivations challenge the implementation of universal plans of urban redesign (Hodson and Marvin 2016).

Complex temporalities indicate a variety of temporal orientations, such as dynamics, durations, and timings, which affect the potential of synchronizing reconfiguration efforts. Trends, non-linear pathways, investment cycles and windows-of-opportunity all exemplify the complexity of temporal (mis)alignments (Moss and Hüesker 2019).

Politics of infrastructure coupling are at play despite the often neutral and technical framing of policy-makers (Williams et al. 2014, 2019). Power relations and the selective promotion of social interest also pervade efforts of infrastructure reconfiguration and are also structurally manifest in regulations, standards, and incentive structures.

These four dimensions underline and give background to the insight [references] that the challenges of directed change of the urban socio-technical systems are largely non-technical (Moss and Hüesker 2019).

2.2.3 Junction

The concept of ‘junctions’ grounds the perspective on infrastructure integration within a territory of intersecting assemblages (Jensen et al. 2015). Scholars using the junction terminology echo the assertion mentioned above that an analysis of socio-technical systems as separate entities ignores the complexity of interconnection “be it technically, institutionally or organizationally” (Späth and Rohracher 2015, p. 274). The spatial proximity of these assemblages creates interfaces and intersections that challenge established boundaries and social practices (Jensen et al. 2015). The incongruence of the boundaries and functions of socio-technical systems creates further tensions and ambiguities (Jensen et al. 2016).

In their study on the advent of harbour bathing, they argue that it is enabled by urban transitions in Copenhagen’s stormwater management. They assert that this innovation is the “product of embedded actors’ different interpretations and responses to place-based tensions and ambiguities among the infrastructures, systems, and practices that constitute the urban fabric” (Jensen et al. 2015, p. 555). Actors engage in boundary work to re-establish boundaries and interdependencies (Jensen et al. 2016) but do so from their “myopic sociomaterial positions and perspectives” (Jensen et al. 2015, p. 557). Negotiations between differently situated actors over boundaries and practices can realize the transformational potential of these ‘hot situations’ (Jensen et al. 2016).

Coherent strategic orientations and coordination in these unstable situations are rare. Additionally, attempts to establish common visions transported in policies may collide with contradictory interpretations and prevailing uncertainties (Jensen et al. 2015). Reflecting on the potential of policy interventions Späth and Rohracher (2015) emphasize that "new interconnections of different infrastructures, policy fields, social worlds and visions – despite the complexity of such processes – are not merely contingent" (p. 279). Junctions may even turn into catalysts of change when approached with a sensitivity for temporal, socio-spatial and institutional dynamics at play in these situations (Späth and Rohracher 2015). Importantly, the integration of infrastructure can create knock-on effects of one socio-technical system onto the other. These mediations and negotiations at sites of infrastructure couplings can be decisive for future configurations (Rohracher and Köhler 2019).

2.2.4 Retrofitting

Conventional retrofit involves small-scale maintenance and repair measures that may include newer materials or appliances but is mostly consistent with preserving the status quo (Graham and Thrift 2007). This work is usually not integrated into a larger scheme and hence invisible to policy makers, while maintenance and repair measures could serve as entry points for more meaningful mitigation and adaptation options (May et al. 2013).

The ambition to leverage urban retrofit projects leads scholars to call for a 'systemic' or 'urban retrofit' (May et al. 2013; Eames et al. 2017b; Hodson and Marvin 2015b). Pursuing an urban retrofit involves "to understand how bundles of these interventions are applied at scale and the ways in which this involves systemic reconfiguration of cities and the socio-technical infrastructures and built environments that sustain them" (Hodson and Marvin 2016, p. 4).

A selective emphasis on objects (e.g. streets, buildings and pipes) or people (e.g. homeowners, policy-makers and practitioners) would neglect that urban retrofit is fundamentally socio-technical (Hodson and Marvin 2015a, p. 266), which is compatible with relational concepts developed above. Additionally, it is multi-scalar in the sense that urban retrofit projects are shaped by global flows and affiliations as well as local contingencies, which proof to be highly complex in their own right due to "dense local layerings and interpenetrations of social, cultural, and technological networks" (Sims

2015, p. 31). Integration of new structures or networks within the existing context of application, is not merely technically complex but potentially contentious (Ibid.).

A wide range of implicated actors hold a multitude of concerns or "competing and alternative framings of retrofit" (Hodson and Marvin 2015a, p. 268) that can be lost in a strategic attempt to remake the urban fabric in an overly top-down fashion. To contrast the diverging approaches to retrofit Hodson and Marvin (2016) conceptualize efforts to remake the city in relation to their scalar constitution with 'retrofitting ON' to account for the urban scale and 'retrofitting IN' for more localized projects.

Retrofitting ON is constituted through strategic orientations formulated at the constructed urban scale which are driven by policies and business-interests. This ideal type is managerialist and formal in approach. The framing is techno-centric and centres on the buildings as a technical problem to be fixed (Hodson and Marvin 2016). Smith and Stirling's (2007) concept of 'governance on the outside' depicts the urban landscape as an ultimately knowable socio-technical system in respect to its boundaries, processes and consequences. This renders the governance process seemingly "rational and synoptic—providing self-evident frameworks for identifying an objectively 'best' plan for intervening in the socio-technical system" (Smith and Stirling 2007, p. 358).

In their case study of Greater Manchester, they associate this ideal type with strategically designed working packages with a closure around best options and a categorization of building types for prioritized use of funding. Responses within a techno-economic framing are aligned with national targets and shape inclusion of the public rather instrumentally for building legitimacy (Hodson and Marvin 2016).

In contrast to this, retrofitting IN encompasses the myriad 'local' projects in neighbourhoods, streets and houses which are initiated to pursue local motivations and unfold place-specific capacities. In Hodson and Marvin's (2016) case study of Greater Manchester, the alternative projects emerging as the conceptual basis for retrofitting IN are place-based communities. In contrast to initiatives associated with national or urban governments, these local projects are fragmented, often ad hoc and propelled by voluntary activities. Involvement of the government is primarily linked to policies and funding schemes. The important role of place-specific motivations and values leads to diverse locally embedded retrofit activities across the city. Despite their alternative framing, these projects are not completely decoupled from dominant interest that inform

national and urban responses such as inter-city competition or economic priorities. This is in part due to their reliance on funding from EU, national or metropolitan programmes creating tensions with local intent. Multi-scalar interdependencies and ambiguities create a dynamic "situation and requires those leading initiatives to actively work to hold together and negotiate these priorities" (Hodson and Marvin 2016, p. 14).

What can be shown in this ideal-type juxtaposition is how both – ON and IN – are entangled. The former risks a problem of legitimacy and socio-material misalignments by overriding local contingencies. A gap between vision and manifest change results from a "limited, connected and effective capacity to implement these city-regional strategic priorities" (Hodson and Marvin 2016, p. 15). Alternative retrofit efforts remain fragile, caused in large part by fragmented projects and limited resources, and still dependent on national or urban funding schemes. The heuristic enables us to understand how interventions with different scalar orientations are co-constitutive and could benefit from an integrative perspective (Hodson and Marvin 2016).

This tension might be resolved by what Hodson and Marvin (2016) call 'retrofitting WITH' that builds on engagement and understanding between urban policymakers and actors in local retrofit projects, to inform and enact an urban retrofit agenda. This resonates with an "inclusive urban retrofit agenda [that] reflexively reconcile[s] each of these competing, though often complementary, framings through consultation, experimentation and consensus building, remaining aware of specific local contexts throughout the process" (Eames et al. 2017a, p. 253). Therefore, place-specific capacities and capabilities of humans and the locally embedded materiality are crucial to be incorporated in urban strategic interventions. The likely needs for coordination and networking can motivate the emergence of "an aggregating body" (Eames et al 2017a., p. 255) or intermediary.

2.3 Decentralized Stormwater Management

New challenges urge many cities to redesign their drainage infrastructure. Rapid urbanization and resulting high degrees of impervious surfaces result in a number of adverse effects that are exacerbated even further under conditions of projected climate change scenarios (Guerreiro et al. 2018). Urban heat-island effect (Yang et al. 2016), urban flooding (Brown et al. 2009) or pollution of receiving water bodies (Nickel et al. 2014) are only some of the urban stresses that have been linked to the prevailing urban fabric and current stormwater management.

Conventional approaches to urban drainage follow a logic of fast conveyance of stormwater runoff out of the city (Chocat et al. 2001). The sole reliance on grey infrastructure entails negative hydrological effects. The discharge of polluted stormwater or wastewater in case of combined sewer overflows after severe stormwater events impedes the ecologic integrity of receiving waters (Nickel et al. 2014). Conventional upgrades of grey infrastructure, such as large-scale retention volumes, to adjust to the changed flow regimes would be too costly and space underground is limited. Additionally, these measures only target the effects and not the causes of an altered urban water regime (Kaiser 2006).

Decentralized stormwater management is considered a viable solution based on retention of stormwater at the source to minimize urban runoff (especially peak flows) while increasing evaporation and infiltration - approximating a pre-development flow regime. This potentially relieves the piped wastewater infrastructure and therefore reduces the occurrence of combined sewer overflows to improve the health of receiving water bodies (Kaiser 2006; Wong and Brown 2009; Pallasch 2021).

Even though the technical feasibility and multiple benefits of sustainable water management have been established and lead to widespread agreement on their desirability, adoption in urban areas lags behind (Dhakal and Chevalier 2017). In research involving experts from utilities and urban planning, Trapp et al. (Trapp et al. 2017) found that most hurdles to innovation in water infrastructure relate not to technical challenges, but can be related to ‘institutional arrangements’, such as sectoral planning, legal frameworks, lack of political leadership or a risk-adverse mindset.

To enable sustainable water management at an effective scale, a coordinated and integrated approach to water management is the needed counter-model to prevailing institutional fragmentation (Roy et al. 2008). But this is not a straightforward task as a multitude of new actors are coming to the fore that are implicated by a reordering of space, costs and responsibilities (Moss 2000). Urban drainage systems buried underground are skilfully hidden from the everyday gaze and thus remained for long a highly technical and expert-dominated domain (Star 1999; Kaika and Swyngedouw 2000). Decentralized stormwater measures such as troughs, wetlands or green roofs bring “to the surface not only water flows […] but also—in a figurative sense—the social relations that underpin waste water management” (Moss 2000, p. 76).

Regarding the situatedness of DSM measures, the local context was found to be important for a successful implementation. The decisive factors encompass the material environment but also the financial, political and legal context. The presence of leading actors such as dedicated city departments as well as other related authorities and practitioners further enables the uptake of DSM (Suleiman et al. 2020). However, even in one city a multitude of diverse projects exist that warrant attention to their specific incentives, capabilities and constraints (Soler et al. 2018). To “embrace this diversity” (Papasozomenou et al. 2019, p. 368) is offered as an instrumental approach to suit instruments to the respective project. This could be organized as a policy package for supporting project types, guided by a comprehensive strategic plan to identify the place-specific potentials and priorities for promoting DSM.

2.4 Green Roofs

2.4.1 Green Roof Basics

To qualify as a green roof, the basic components are vegetation that grows on top of a substrate or growth medium (Shafique et al. 2018). Yet, many green roofs feature a layered design that additionally include a drainage layer – potentially also with further retention volume – and an impermeable membrane (Lamond et al. 2014).

The greening of roofs has been practiced throughout history, but a renewed interest stems from the need to adapt the existing building stock to challenges exacerbated by climate change for cities. Due to their multiple benefits of addressing heat, stormwater attenuation, biodiversity enhancements and more, green roofs are seen as ‘no regrets’ solutions for climate adaptation. The issue of retrofitting the built environment with greening measures has been taken up by local and state governments, so that expenditures for retrofitting the built environment surpass those of new construction. However, the marketability is different from other technologies such as PVs and the emphasis lies on municipal activities to promote green roofs by building codes, mandates and financial incentives (Dixon and Wilkinson 2016).

2.4.2 Technical and Engineering Considerations

According to Wilkinson and Feitosa (2016) to assess the suitability for a green roof retrofit, several technical and engineering considerations must be considered for a design that fits the specific structure. The focus here will be on structural demands with a short enumeration of other factors and practices:

Evaluation of the existing roof's type, age, and condition are crucial. Experts need to conduct a structural investigation to determine the building's load-bearing capacity and identify any damage. The age of the building influences construction decisions, and a choice must be made between intensive and extensive green roof systems, considering their load-bearing implications.

Intensive green roofs are heavier and costlier to retrofit than extensive ones. If the building's capacity is insufficient, structural reinforcements may be required, which can be expensive and potentially need certification. This can limit the economic liability of the retrofit, so that extensive green roof designs are often preferred in case of limited capacities.

Other factors include the roof's membrane, insulation, and drainage because their condition, lifespan, and capacities co-determine the suitability of a retrofit. Green roofs can double the lifespan by protecting it from degrading factors like rainfall, UV light, and temperature changes. Concerns about potential damage to the building mainly stem from potential leakages in the membrane and blockages in gutters and downpipes that can cause hidden defects, leading to significant damage before being detected. Heritage protection can be a major hurdle when the visual impact and preservation of character are crucial. Different jurisdictions have varying classifications and allowable interventions. Easily reversible structures may be recommended in some cases.

Regarding practices, regular maintenance includes pruning, weed control, plant nutrition, and structural upkeep is an important issue to guarantee the functionality of a green roof. Access for installation, amenity use, and maintenance must be provided.

In conclusion, a multitude of building characteristics are to be included in the assessment and design of a green roof retrofit. The necessity of professional expertise, as well as the use of regulations and standards, increases the reliance of owners on practitioners and guidance.

2.4.3 Stormwater Attenuation

Pluvial flooding or surface water flooding occurs after events of heavy rain. Especially in dense city centers with a high degree of sealed surfaces, the stormwater accumulates rapidly. The sudden onset and high velocity are characteristic and prove dangerous for communities surprised by an unpredicted flood. Conversely, recurring shallow floods

for short periods of time can be seen as ‘nuisance flooding’ that leads to costly repair work and insurance requirements in the long-run (Lamond et al. 2016).

A higher risk for pluvial flooding derives from the major trends of rapid urbanization with a densification and sealing of surfaces as well as climate change. The latter is predicted to result in heavier rain events despite a potentially lower average volume of rainfall (Jha et al. 2011; Lamond et al. 2016). While urbanization trends will likely exacerbate flood hazard problems in the near future, the effects of climate change might be the most significant in the long-term (Jha et al. 2011). Nevertheless, the design of cities is a major challenge to address adverse effects of climate change. Urban areas significantly alter the hydrological cycle, potentially leading to extreme conditions of either intense rainfall or drought due to variable rainfall volumes (Mentens et al. 2006).

The redesign of surfaces to accommodate green roofs aims to address these issues. Their capacity to story water mainly within the substrate or dedicated drainage layers can help mitigate the effects of heavy rainfall. Three effects contribute to a more balanced flow regime: the absorption of water delays the onset of runoff from rain events, the retention of water reduces the total runoff, and the delayed release of water distributes the runoff over a longer period. The retention of annual rainfall volumes ranges from 45% (extensive: 100 mm substrate) to 75% (intensive: 150 mm) (Mentens et al. 2006) while some green roof suppliers state higher numbers for specific retention green roofs. While these percentages of retention are promising and green roofs effectively reduce average flow volumes, “they are not so good at reducing storm flow peaks” (Villarreal et al. 2004, p. 297).

The potential to address multiple challenges with the redesign of previously ‘unused roof area’ that amounts to 40-50 % of a city’s sealed surfaces (Mentens et al. 2006; Villarreal et al. 2004) is promising. However, the effects of green roofs on their surrounding are not uniform but area and location of roofs are significant factors for instance for stormwater attenuation (Lamond et al. 2016). Nevertheless, the most important factor remains the volume for retention (Villarreal et al. 2004) so that intensive green roofs are to be preferred from this standpoint.

2.4.4 Costs and Benefits

The multiple benefits of green roofs accrue to different actors and at different scales (Lamond et al. 2014). Figure 1 below offers an overview of benefits taking effect

specific to scale and beneficiary. The building scale is further differentiated into owners/investors and occupiers. In some cases, owners are also inhabiting the building so that the two categories collapse.

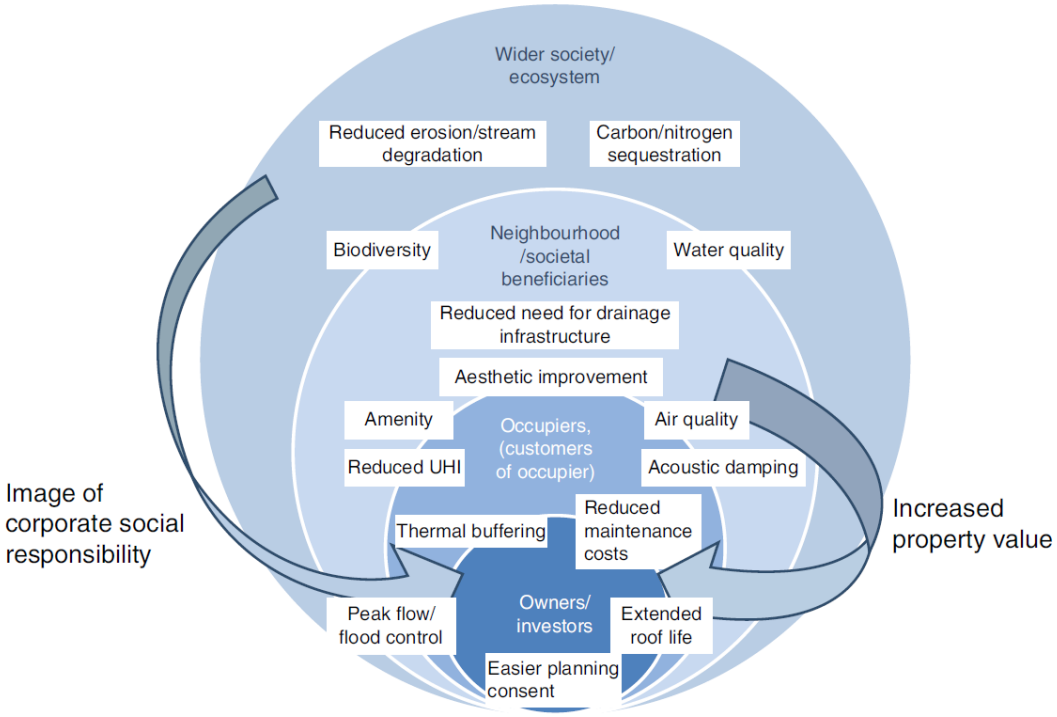

Figure 1: Benefits of Green Roofs (Lamond et al. 2014, p.6)

In their study, Lamond et al. (2014) found that the benefits of green roofs affect the surrounding that extends far beyond the individual building, encompassing the neighborhood (or quarter) and the wider society. Only a small fraction of benefits directly involves the owners, namely an easier planning consent in case of building regulations, and reduced costs related to a protected roof membrane. Other benefits for the owners result from the interaction with wider scales, such as an increased market value of the building or reputation gains through interpretations of the wider public. However, the costs are almost exclusively borne by the owner unless incentive schemes offset them. Therefore, in case of insufficient amortization without significant discounts, funding schemes or reductions of runoff fees "the stormwater features of green roofs do not benefit the installer" (Lamond et al. 2016, p. 100).

The assessment of costs and benefits on the building scale needs to acknowledge the full range of benefits beyond stormwater concerns. Additionally, the local government

must offer incentives to internalize the positive effects on the wider community. This is even more the case as retrofitting green roofs "can only be accomplished with the support of the owners and occupiers of suitable properties" (Lamond et al. 2014, p. 2).

2.5 Policy Translation

A host of scholars from different disciplines like geography (Peck 2011; McCann and Ward 2013), policy studies (Lendvai and Stubbs 2007; Clarke et al. 2015b) and anthropology (Wedel et al. 2005; Shore et al. 2011) share the ambition to conceive of policy not as a straightforward process from formulation to implementation. Despite this shared conviction, each approach is based on different assumptions or at least chooses a particular vocabulary. I will proceed to emphasize policy translation the way it is applied in policy studies but follow Mukhtarov (2014) that the inclusion of matters of scale and the concept of assemblage more pronounced in critical geography can be a fruitful endeavor.

Despite the ubiquitous use of the term policy, there is no consensus on its meaning and application. I will offer here the definition of policy as "course of action adopted and pursued by a government, party, ruler, statesmen etc" (Wedel et al. 2005, p. 35). But the authors at the same time caution us to not dwell on the question of what a policy is, but to rather ask "What do people do in the name of policy?" (Wedel et al. 2005, p. 35). Others interposed that policy cannot be seen as a clearly demarcated thing, but as a process that unfolds and emerges as it travels (Kingfisher 2013).

The use of assemblage within policy studies is seen as a corrective to the narrow focus on words and ideas that dominates the literature of the 'interpretative' and 'argumentative turn' (Clarke et al. 2015b). Policies "are neither purely ideational nor exclusively material; rather, they are hybrid entities consisting of various actors, norms, knowledge and material components" (Berger and Esguerra 2017, p. 1).

Qualitative studies on policy translation and assemblage should reveal the labour of arranging a multiplicity of elements into some form of coherence despite forces of change or 'lines of flight' (Baker and McGuirk 2017) or put differently:

> "To focus on policy assemblage is to examine how multiple heterogeneous components are arranged to create governable forms. Through strategically harnessing the relational capacities of multiple component parts, assemblages represent a *gathering together* of political

> imaginations, rationalities, technologies, infrastructures and agents towards steering individuals and groups in particular directions" (Savage 2020, p. 328).

Neglecting the material aspects of policies leads to a "narrow use of policy translation to focus on key policy actors [and processes of] framing, reframing and modifying the meaning of ideas that travel" (Mukhtarov 2014, p. 76) across boundaries and scales. What the statement symbolizes is the attention on the meanings of policies and how they shift strategically. Meanings in policy are of central concern "because they point to the constructed, conjunctural and contested character of policy" (Clarke et al. 2015b, p. 20). Policies do not move through a vacuum, but people and places further their own interpretations. Place-specific understandings are subject to ongoing negotiations and become manifest in narratives that link problems of the past to promising solutions of the future (Clarke et al. 2015b).

An important alignment of geographic and policy studies' accounts can be seen in the attempt to understand policy translation as "simultaneous processes of transportation and transformation" (Berger and Esguerra 2017, p. 1). The movement of policy across places, scales and boundaries entails unanticipated shifts, uncertainties that are beyond the control of policymakers. Therefore, policies cannot be assumed to transport the initial policy intent in stable form across contexts as they ultimately "acquire a life of their own"(Shore and Wright 2011, p. 3). Shifts occur when meanings strategically or tacitly change in interaction moving to new contexts, but also through new or altered relations between humans, material objects and discursive achievements. The process of translation is subject to power plays and domination, but in a more dispersed sense that grants the state an important but not privileged role (Berger and Esguerra 2017).

How a policy is translated and what actors – be they people, institutions, documents, or previously benign objects – are proving crucial in the process remains an empirical question. Attention to the movement and transformation of policies can reveal the work of translators, such as intermediaries, that via their positionality between and across boundaries mediate meanings, places and sets of interests (Clarke 2005b). In their work on how intermediaries translate Beveridge and Guy (2011) state that "intermediaries should be seen as having not only the potential to help and hinder the realization of policy objectives, but to transform the meaning of these objectives into viable practices" (p. 105).

Kingfisher's (2013) work on policy providers and street-level bureaucrats studied the crucial function of actors that administer and deliver services with respect to policies. While official policymakers attempt to purposefully craft policies that reflect certain visions of change, it is the selective assembling of policies on the 'frontline' that materializes their effects. These transformations also occur due to differences of knowledge and experiences developed through direct interactions with people and places beyond formal directives and procedures. However, this 'talking back' to policy is limited by the materiality and power relations inherent in policy. Highlighting the embeddedness of policy actors in specific networks, "translation and assemblage work occurs in particular contexts, in relation to situated constraints, possibilities, and agendas" (Kingfisher 2013, p. 101).

2.6 Intermediation

Intermediaries have increasingly gained attention within the academic literature during the last decades. The growing interest is rooted in the advent of governance as a more dispersed and networked approach compared to relatively centralized state control. These intermediary actors perform new roles and functions within the context of shifting relations (Moss 2009), "oiling the wheels on which networks depend" (Beveridge 2019, p. 181). Despite their often 'hidden work' that progresses rather incrementally in the background of political processes and technological advancements, many credit them to be "crucial to transform governance of urban infrastructure" (Moss 2009, p. 1481) or central to enabling a transition to gain momentum (Kivimaa et al. 2020a). Additionally, intermediaries are chosen as entry points for analysis because their distinctive 'in-betweenness' points towards 'arenas' of action (Moss 2009) or wider networks of affiliated actors and their activities (Beveridge and Guy 2009; Beveridge 2019). Intermediaries can also hold a space for multiple actors and framings to gather and negotiate (Hodson and Marvin 2009). However, the transformative effects of intermediary actors must be evaluated in their respective situation as the context of intermediation is both enabling and disabling. Therefore, an analysis of intermediaries must also consider their interactions with the social, technical and spatial dimensions. An enabling context providing the necessary resources can be crucial as their agency is bound up with their relations to enact the envisioned change (Marvin et al. 2011).

To be foregrounded in this thesis is the inherently relational nature of intermediary work that is strongly linked to their 'in-betweenness' that enables them to "intermediate

between different scales, between technologies and different social contexts, between different meanings and between different sets of interests" (Moss and Medd, 2005, cited in Beveridge 2019, p. 183). The notion of a 'systemic intermediary' (van Lente et al. 2003) highlights work that is not limited to bi-lateral relationships, but essentially functioning at system level. Importantly, these systems include myriad nonhumans or 'things' potentially playing vital roles in the functioning of networks (Moss 2009). Even an equation of intermediaries with human actors or organization seems inaccurate since following a review of relevant literature "any-thing can be an intermediary – it may be human or nonhuman, a business, a non-governmental organisation (NGO) or state actor" (Beveridge 2019, p. 181).

Research on intermediaries, especially within the transition literature, compiled typologies of intermediaries (Kivimaa et al. 2019) and long lists of intermediary functions (Sovacool et al. 2020) which serve as helpful resources but can at times be too extensive in scope. Another approach focuses on three types of relational work: networking, aligning and translation (Moss et al. 2009). To summarize: 'networking' associates intermediaries with the creation of new actor constellations that share a purpose and are situated within a mutable context, while 'aligning' works on already existent relations between actors. 'Translation' in this typology focuses on the labour of shaping meanings for a specific context in the pursuit of objectives. As developed earlier, the translation of a policy in the following analysis will include a simultaneous transportation and transformation that not only focuses on meanings but also on shifting relations.

Kivimaa et al. (2020b) offered a heuristic that distinguishes intermediary functions specifically related to policy. They pointed out that intermediaries can fulfil a vast array of functions with respect to policies that can analytically be distinguished along an 'upward' and 'downward' schema. Within the implementation phase, the translation of a policy has been found to be accompanied by functions of coordination, interpretation and "selling policy to target recipients" (Kivimaa et al. 2020b, p. 429). Moving the policy 'downward' successfully also entails a clear vision to champion the policy in the target arena. The policy meaning should be clearly communicated to those affected most by the policy so they can make sense of it (Jenkins 2007). The corresponding 'upward' functions are conceptualized as the complementary movement of aggregating experiences and expectations, acting as a common voice of stakeholders as well as

influencing the policy making and revision (Kivimaa et al. 2020b). Even though this oversimplification of policy translation is not in line with the messy process developed earlier, the perspective underlines intermediaries' position in-between connecting actors across scales.

Other literature that contributes to an understanding of specific intermediary roles discusses intermediaries as 'government-' (Kivimaa 2014) or 'policy-affiliated' (Talmar et al. 2022). Government-affiliated intermediaries are owned or initiated by the government. They exist alongside or instead of traditional policy instruments and typically act at least in part autonomously. Kivimaa (2014) stresses the point that a perceived distance from the government that signals neutrality can be important for government-affiliated intermediaries to be effective. However, neutrality of intermediaries is proposed to not be extended towards technological options but rather to clearly advocate for a vision to communicate directionality. Additional factors of success that are mentioned include financial independence and a secured operation for a prolonged period of time. In the same vein, Talmar et al. (2022) discuss intermediaries as policy interventions that are especially long-term in scope. Policy-affiliated intermediaries are positioned between policy principals and front-line operations. Their long-term orientation and unique position require a certain independence from the official government. A degree of autonomy is supposed to enable intermediaries to adapt their practice to align with a changing context and needs.

The 'intermediary policy spaces' contribute to shifting of policies' meanings and relations. Stone (2012) coins these "new policy spaces of soft law and governance networks" (p. 493) to conceptualize the work of transnational organizations. Helpful for my analysis is the distinction between 'soft' and 'hard' transfer of policy. Intermediary actors are usually more involved with 'soft' activities such as facilitating, networking and communication of broader ideas and knowledge. While at the same time, government officials are tasked with 'hard' transfer of instruments and practices that include resolutions, regulation and legislation. As the activities of intermediary or nonstate actors are limited in their scope of instruments, they often enter into coalitions with governmental organisations (Stone 2012).

Intermediaries' unique position – within 'interstitial spaces' – is not only a window on the wider networks they are embedded in, and how they change relationally, but intermediaries are regularly enmeshed in political contestation. Analytically, that can be

used as an entry point to study moments of negotiation and tension (Beveridge 2019). Furthermore, the portrayal of intermediaries as essentially not neutral is compatible with the term ‘strategic intermediaries’ which are “deliberately positioned to act in between by bringing together and mediating between different interests” (Medd and Marvin 2008, p. 282). Focusing on the strategic potential of intermediaries should not obscure the fact that the spectrum between strategic orientation and those even unaware of their intermediary work is wide and roles never fixed but shifting (Moss 2009). More directed efforts of governance, for instance to facilitate the ‘implementation’ of a technology, are political (Moss et al. 2009) in the sense that goals, technologies or concerns are selectively bundled and represented. Thus, intermediaries do not automatically assume a neutral position when mediating between sets of interest (Hodson and Marvin 2009). Therefore, we have to ask, “whose interests and priorities shape interventions and how?” (Hodson and Marvin 2010, p. 482).

The strategic orientation is evident when intermediaries “advocate particular socio-technical solutions or trajectories” (Kivimaa et al. 2019, p. 1068). Beveridge and Guy (2011) in their study of how an EU directive becomes realized in practice ‘on the ground’ link intermediation with translation as understood in Michel Callon’s classic paper on scallops (1984). Intermediaries’ translation, they state “is about getting a range of actors to realign their preferences, understandings and, in the process, their practices in very specific contexts” (Beveridge and Guy 2011, p. 103). Furthermore, translation depends on their capacity “to enrol, cajole and even coerce actors into new networks of […] practices” (Beveridge and Guy 2011, p.97). The development of the theoretical framework can help to shed light on the role of intermediaries in the wider networks as intermediation “is a concept in need of other concepts” (Beveridge 2019, p. 187).

3 Methodology

The structure of this chapter unfolds as follows: First, the methodological approach of Situational Analysis and the situation of inquiry are introduced (section 3.1). Subsequently, I provide an overview of the collected materials, elucidating the modes of data collection including interviews, videos, documents, and observations (section 3.2). For data analysis, the techniques of coding (section 3.3) as well as mapping and analytical memos (section 3.4) are explained. Considerations of abduction and research quality are presented next (section 3.5).

3.1 Situational Analysis

3.1.1 Rationale for Research Design

The overall research design of my study aligns with the relational concepts outlined before by employing Situational Analysis which zooms in on the situation. As this approach is associated with the Grounded Theory tradition, it follows a qualitative as well as interpretative orientation (Clarke et al. 2018).

Grounded Theory and Situational Analysis as methods abductively help to build an understanding of the research objective from the data collected. This approach allows researchers to be sensitive to emergent processes in the empirical data, to gain an analytical handle on the situation and work towards theorizing in the research process (Clarke et al. 2018).

3.1.2 Situation of Inquiry

Delineating the situation is of foremost importance at the beginning and throughout the research process as the situation can be fluid and its boundaries fuzzy (Clarke et al. 2018). To handle the multiple directions of policy processes, a methodological advice is to search for a ‘vantage point’ to “select small sites that open windows onto larger processes of political transformation” (Shore and Wright 2011, p. 12).

In this case, the situation is most strongly centred around the roof junction with a focus on relations and arrangements directly involving the Rainwater Agency and the GreenRoofPLUS policy but potentially incorporating relations beyond those. A detailed account of the relationalities and social worlds involved in the situation can be found in the results section (chapter 4) with a corresponding map (Figure 2).

SA's turn towards complexity in the situation is substantiated by the inclusion of varied positionalites and differences. Emerging dynamics, processes, connections, boundaries, and potential conflicts in the data guide the research focus further.

3.2 Data Collection & Sampling

3.2.1 Overview

Within the bounds of the situation heterogeneous materials and sources are included in the data collection (Table 1), such as interviews, observations, and extant narratives (e.g., documents, visual data). The inclusion of non-human elements necessitates attention to materials, tools, and practices within the situation. The goal is a comprehensive understanding of the situation. Following the GT tradition, SA also employs theoretical sampling which involves purposively selecting participants and other data sources for their potential contribution to theorizing (Clarke et al. 2018).

To balance the requirement of associating perspectives with distinct social worlds while preserving anonymity and confidentiality, I adopted a pseudonym system. For interviews and videos, an abbreviation for the associated organization together with a number for different occasions, was employed. Notations like 1.1 and 1.2 indicate repeated statements from the same person (e.g., RWA1.1 and RWA1.2). Another format has been chosen for observations: to avoid cross-referencing that might reveal identities, the abbreviation of the organization or other pragmatic signifiers were used. The abbreviation only denotes the representative of the organization without further characterization (e.g., OB6-RWA).

Table 1: Data Sources

Pseudonym	Type	Location	Date	Mode
RWA1.1	Interview	Spreepark	20.08.22	Face-to-face
RWA1.2	Interview	virtual	20.03.23	Zoom
RWA2	Interview	Klimatag	10.09.22	Face-to-face
RWA3	Interview	Klimatag	10.09.22	Face-to-face
RWA4	Interview	Tausendwasser Fair	15.03.23	Face-to-face
RTWB	Interview	-	21.03.23	written
OWNER	Interview	virtual	31.03.23	Zoom
DOC-A	Document	Abgeordnetenhaus 0212[1]	14.03.17	written
DOC-E	Document	Eckpunktepapier RWA[2]	xx.05.18	written
DOC-P	Document	GR+-Richtlinie[3]	xx.12.22	written
OB1	Observation	Spreepark	20.08.22	participation
OB2	Observation	Haus d. Demokratie 1	06.09.22	participation
OB3	Observation	Klimatag	10.09.22	participation
OB4	Observation	Solar-Gründach Congress	20./21.10.22	participation
OB5	Observation	InfraSpree Fair	09.11.22	participation
OB6	Observation	Lenné-Symposium	18.11.22	participation
OB7	Observation	Tausendwasser Fair	15.03.22	participation
OB8	Observation	Haus d. Demokratie 2	28.03.22	participation
SenUMVK1.1	Video	Regenreihe #6[4]	03.05.22	Pre-recorded
SenUMVK1.2	Video	Regenreihe #8[5]	26.01.23	Pre-recorded
IBB1	Video	Regenreihe #6[6]	03.05.22	Pre-recorded
IBB2	Video	Regenreihe #8[7]	26.01.23	Pre-recorded
FOR	Video	2. public forum RWA[8]	03.03.21	Pre-recorded

[1] Abgeordnetenhaus Berlin 2017.
[2] Senatsverwaltung für Umwelt, Verkehr und Klimaschutz Berlin 2018.
[3] Senatsverwaltung für Umwelt, Verkehr und Klimaschutz Berlin 2022.
[4] Stock, Heike 2022.
[5] Stock, Heike 2023.
[6] IBB Business Team 2022.
[7] IBB Business Team 2023.
[8] Berliner Regenwasseragentur.

3.2.2 Interviews, Videos and Documents

Within the spectrum of interview structure from survey interviews (structured) to non-structured narrative interviews, semi-structured interviews cover the middle ground. The researcher's interview guide frames the interview questions and provide some directionality while interviewees can explicate their experiences and co-produce the interview situation (Gläser and Laudel 2010).

As most participants of the study were experts in relation to the situation, expert interviews were chosen. Experts are defined relative to the specific research problem as they have specialized knowledge or experience relevant within the situation. Their expertise can provide valuable insights into processes, support or challenge the researcher's intuition, and highlight aspects that may have been overlooked in the preparatory phase. Identifying suitable experts as potential participants is of central importance to gain reliable and relevant information (Gläser and Laudel 2010). At the same time, SA cautions researchers to look for silences or marginalized perspectives to disrupt overly monolithic portrayals (Clarke et al. 2018).

The interview guide was created to give orientation in preparation and during the interview for interviewer and interviewee alike (Gläser and Laudel 2010). The scope has been chosen to strike a balance between adequately exploring the topics of interest without overwhelming the participants either in securing their agreement to interview or during the interview itself. The initial questions were designed to encourage broad responses, allowing for the interviewee's elaboration, before gradually narrowing down to address specific areas of interest. The first questions usually spawned lengthy responses that could also be related to other questions. Therefore, this format enabled the interviewee to shape the course of the conversation within the frame of the topic.

Due to the iterative process of data collection and simultaneous analysis, new insights and interests lead to adjusted interview questions. Additionally, adjustments were made to provide tailored questions specific to requested interview participants (Charmaz 2014). While all participants were experts with respect to the situation, their different field of expertise and perspectives necessitated alteration of question sequence or the questions themselves. The core topics covered remained the same throughout the different interview guides (see Appendix 3).

In the interview request (see Appendix 2), I provided various options for conducting interviews, from face-to-face to mediated methods such as video telephony and telephone. Two interviews took place virtually using Zoom, which facilitated synchronous, non-verbal communication, dialogue, and in-depth discussion. Verbal consent was given at the beginning of the interview. These interviews were video recorded for later transcription and analysis. One participant chose to provide a written response, the structure provided by the interview questions and supplemented with additional material. This method allowed the interviewee to elaborate their response within their preferred timeframe. However, the asynchronous nature of the communication limited the interviewer's ability to probe further, resulting in shorter and less detailed data compared to synchronous interviews.

Informed by theoretical sampling concerns, including diverse interviewees was crucial for obtaining varied perspectival data. To address the low response rate from certain individuals or groups, alternative data sources were utilized. The gathering of extant narratives, including here videos, is part of SA's data collection strategy (Clarke et al. 2018). Videos related to the situation and work of the RWA are linked on their website and hosted on different video platforms. These videos were saved, transcribed, and coded to make them amenable to analysis. This approach provided an opportunity to gather perspectives and framings from a range of actors, whose relevance is determined by their potential contribution to theory building and their actual involvement in RWA practices. Given that the individuals responsible for GR+ at the SenUMVK and the BWB were unavailable for interviews, the most suitable approach to gaining insights into their perspectives was to utilize existing resources.

To facilitate the analysis, interviews and the audio of videos were transcribed. The CAQDAS-software MAXQDA provided tools for transcription and subsequent analysis, such as coding. Choosing coherent rules for transcribing relative to analytic requirements is recommended. The level of detail contained in the resulting transcript is preferably chosen suitable to the analytic needs of the research (Kuckartz 2012). In this study, emphasis is placed on content, comparability across diverse data sources, and readability. Another decisive factor was the ease of application due to the amount of audio and video material. Consequently, dialects, speech breaks, and errors in grammar or pronunciation were omitted to smooth the language used in resulting transcriptions.

Gathering information when ‘studying up’ often involves interviews and here also video recorded presentations or discussions as the important sources to get access to individuals in powerful institutions. However, the inclusion of other data sources is important to check for purposes of triangulation (Wedel et al. 2005).

The selection of documents was guided by various factors such as being mentioned during interviews or videos, their effect on the situation as documents-in-use (Asdal 2015), or as means of triangulation. The types collected include a policy document, a guideline, and an announcement. Selecting and deciding which documents to follow is already an analytic task. According to a recent definition of documents, they share three basic properties: First, documents all entail some form of action, whether they record, represent etc. Second, they are relational as they form relations to an outside, an ‘environment’ or ‘context’ in which they are embedded but also have capacity to affect and change. Third, documents are material with characteristics beyond mere meaning that in turn also shape the content and their integration into practice. Bringing something into the document - an order, an issue or a thing - stabilizes what been taken up and makes it moveable or governable (Asdal and Reinertsen 2022). The analysis of documents, their use in the situation as well as how they (re)shape issues could have been considerably expanded but remained limited to three central documents.

3.2.3 Observations

The notion of ‘studying up’ is echoed by the assertion that participant observation among policy elites is often difficult to realize due to limit access. Therefore, a research project “[s]tudying the state and systems of governance calls for a more ‘nonlocal ethnography’ approach” (Shore 2011, p. 170). I operationalized participant observation by attending a variety of events, including numerous fairs and conventions, a congress, and a symposium. These events ranged in formality, from highly structured environments to more relaxed, leisurely atmospheres.

An ethnographic orientation predominates much of assemblage research to deliver “in-depth qualitative understanding (to make multiplicity, process, and labour visible) of situated contexts (to enact uncertainty)” (Baker and McGuirk 2017, p.433). The multi-scalar and -sited nature of policy translations poses considerable challenges to an ethnographic approach if this is to correspond with long-term commitment, immersion, and participant observation. In their reflection on assemblage methodologies, Baker and

McGuirk (2017) confront these limitations with infusing the methods of semi-structured interviews and documentary analysis with an ethnographic sensibility.

Therefore, another critical source of data in this study was observational, gathered during participation in multiple events throughout the research process. This approach enabled spontaneous interviews with various employees from the Rainwater Agency at different times and locations. The interviews lasted between 5 and 40 minutes, conducted with verbal consent as well as without an interview guide or verbatim recording. This approach was chosen to maintain immersion and encourage open dialogue. Directly after these interactions, I recorded the key insights via voice memos.

Alongside this, I also kept a record of general observations made during these events, jotting down notes in a notebook or recording voice memos. I also documented noteworthy contributions from speeches, presentations, and discussions. Key insights of voice memos were subsequently transcribed and included in individual documents for each event.

3.3 Coding

The data analysis followed several strategies proposed by scholars of GT and SA respectively. The role of coding in GT is to systematically break up the data for subsequent analysis, allowing researchers to identify patterns, relationships, and emerging themes in the data. A productive tension during coding evolves from generating analytic distance from the data while simultaneously being grounded in the empirical data. Iteratively, the researcher moves closer to conceptualization (and away from mere description) as some codes gain in salience by ways of repetition or theoretical contribution. This process is inherently interpretative (Charmaz 2014).

The coding process can be separated in two cycles: initial and focused coding (Saldaña 2013). The process is not necessarily demarcated in a clear order because new data can generate new initial codes that complement, or challenge established focused codes.

3.3.1 Initial Coding

Initial Coding (also referred to as Open Coding) in GT is the first phase of data analysis, where researchers closely examine and label raw data to identify processes and categories of conceptual value for the studied phenomenon. When following the practical advice on coding developed by Katha Charmaz (2014), the initial codes are either formed as Process or InVivo Codes (Saldaña 2013). Process codes use gerunds to

preserve actions and force the researcher to grasp the processes enacted through or in the data segments. InVivo codes represent participants own terms, remain close to the data, but highlight significant expressions that condense meanings (Charmaz 2014). Initial codes were produced through close reading of two central interviews with codes for every 2-5 lines. The codes were formulated in German to match the language of the interviews. After a quick review, the codes appeared too descriptive and resembling mere summaries of the content. In another iteration of the open coding process, I followed scholarly advice to translate the codes into English for a better use of gerunds and to move farther away from the original towards the conceptual (Tarozzi 2019). InVivo codes were kept in German for later translation during the write up. This process resulted in over 1.500 mostly individual codes to be structured in the subsequent phase.

3.3.2 Focused Coding

Focused Coding is the second phase in coding in which the researcher scans the generated initial codes for the most frequent or significant codes that contribute on a more analytic or theoretical level "without sacrificing the detail" (Charmaz 2014, p.138). This active and interpretative engagement with the empirical data and initial codes to move towards a more conceptual organization of the data results in the "skeleton of your analysis" (Charmaz 2014, p.141). Practically, this involved a re-reading of the material alongside the codes. The most striking codes with a conceptual contribution were selected and recorded on index cards. The cards allowed for tactile handling of the material into piles and manual organization.

A reflexive stance towards preconceived ideas is crucial to not simply import dominant concepts or theories which are not grounded in the data into the analysis. Awareness of one's taken-for-granted assumptions can enable a productive confrontation of extant theories with the data or an understanding of the researcher's bias (Charmaz 2014). The most helpful organizing principle during the coding process was to probe for the socio-materiality, spatialities, temporalities and politics in the situation. These preconceived ideas appeared broad enough to guide the analytic process without predetermining the outcome.

Important to note is that the coding techniques of GT as well as the emergent codes and categories are used to ground the analysis in the empirical evidence. Coding helps the researcher immersing oneself and knowing the data. SA and constructivist GT share many assumptions and points of departure, but they are essentially distinct in their goal

setting. While GT is concerned with "*action* and interaction[…], the fundamental focus of SA is on *relationality*" (Clarke et al. 2018, p.108). Employing both methods within larger projects can be fruitful. In any case, they are not fully integrated as "*these are two different kinds of analysis pursued separately"* (Clarke et al. 2018, p.109).

3.4 Mapping and Memos

A major contribution of SA is the analytic strategy of mapping. The situation as the unit of analysis is 'empirically constructed' through mapping as well as subsequent analysis and memoing (Clarke et al. 2018).

Situational maps are made (and remade) at the beginning of the inquiry and "lay out major human, nonhuman, discursive, historical, symbolic, cultural, political, and other elements in the research situation of concern" (Clarke et al. 2018, p.17). These maps are intentionally messy to facilitate the adding of numerous small and large elements of the situation without prior categorization as well as provoking uncommon relations and groupings of adjacent elements. Portraying the complexity inherent in puzzling situations is one aim of these maps, but another pragmatic use is to remind the researcher of all the elements once they find their way onto the map. In an ordered version of situational maps, the elements are grouped according to categories such as human and nonhuman actors, discourses, temporal and spatial elements, implicated actors etc. Relational maps are also based on situational maps and draw relations from one element or actor to other elements on the map. Additionally, reflection on the nature of each relation can be made analytically productive in memos. It is in these maps that nonhuman elements are presented on equal footing as other elements whereas the next two maps focus more on discursive formations and positions (Clarke et al. 2018).

Social Worlds/Arenas maps are an important mapping technique in SA. These maps are conceptually rooted in the social worlds/arenas framework (section 2.1.2). In my case, the Social Worlds/Arenas map is centred around the roof junction as the collision point of interest for related social worlds and arenas. Following the advice of Sarah Glück (2022), the Social Worlds/Arenas map has been drafted with help of relational maps focussing on the relevant social worlds identified.

Positional maps are the last mapping technique in SA. Major positions and silences are depicted along "particular axes of concern and controversy" (Clarke et al. 2018, p.18). Instead of positioning individual and collective actors on the map, the full host of

discursive positions present in the situation are depicted. This is compatible with the assertion that actors can advocate for multiple, even contradictory discourses.

In the tradition of Grounded Theory as well as Situational Analysis, memos play a crucial part in the analytic process alongside coding and mapping. Memos offer a space for researchers to reflect on choices in the research design, data analysis, and challenges in the research process. They enable researchers to record their ideas, assumptions, and questions that arise during the analysis, potentially leading to new insights, even surprises about emergent categories and concepts to be used in the eventual write up and theory development. Additionally, memos help illustrate the research process to ensure transparency and rigor (Clarke 2019; Charmaz 2014; Clarke et al. 2018).

3.5 Abduction and Quality Criteria

Another important component of (Constructivist) GT and SA in the analytic process is abduction which refers to the "tacking back and forth between the empirical materials of a study and trying to analyze and conceptualize them more abstractly" (Clarke et al. 2018, p.27). This iterative movement allows for confrontation of emergent concepts with empirical data that is followed up by theoretical sampling to bring in new data for analysis and further iterative cycles. Abduction takes the position of the researcher within the situation of inquiry seriously, rejects the researcher as tabula rasa and challenges prior experiences, ideas and assumptions in a reflexive process. This engages the tension between conceptual work and analysis grounded in the data mentioned earlier (Clarke 2019; Charmaz 2014; Clarke et al. 2018).

Triangulation was practiced to ensure quality criteria of the research. This involved the use of multiple data sources and methods. The research design therefore helped to get a comprehensive understanding of the phenomena (Flick 2019). Together with abduction, emerging insights could be tested by either confronting them with previous research or new data.

4 Results

This chapter aims at presenting insights and corresponding empirical evidence gathered from the collected material in the processes of coding, mapping, and creating analytical memos. The statements are presented according to the structure of the research questions (cf. section 1.2). First, the Social Worlds/Arenas map is presented as the project map (section 4.1). Then, statements regarding the GreenRoofPLUS-policy (section 4.2) and the Rainwater Agency (section 4.3) are presented. Additionally, three emergent categories were identified in the initial and focused coding process that do not pertain to a single social world (section 4.4). The built environment with its (mis)alignments (section 4.5) and two emerging alternatives (section 4.6) offer a further embedding in the situation. Finally, a short summary highlights the key findings (Section 4.7).

4.1 Project Map

To foreground the relationality within the situation, the Socio Worlds/Arenas map was chosen as the project map. The map (Figure 2) presents the relevant social worlds and arenas present in the situation around the roof junction. The choice of social worlds and arenas was based on the empirical evidence and my understanding of the salient interrelations and negotiations.

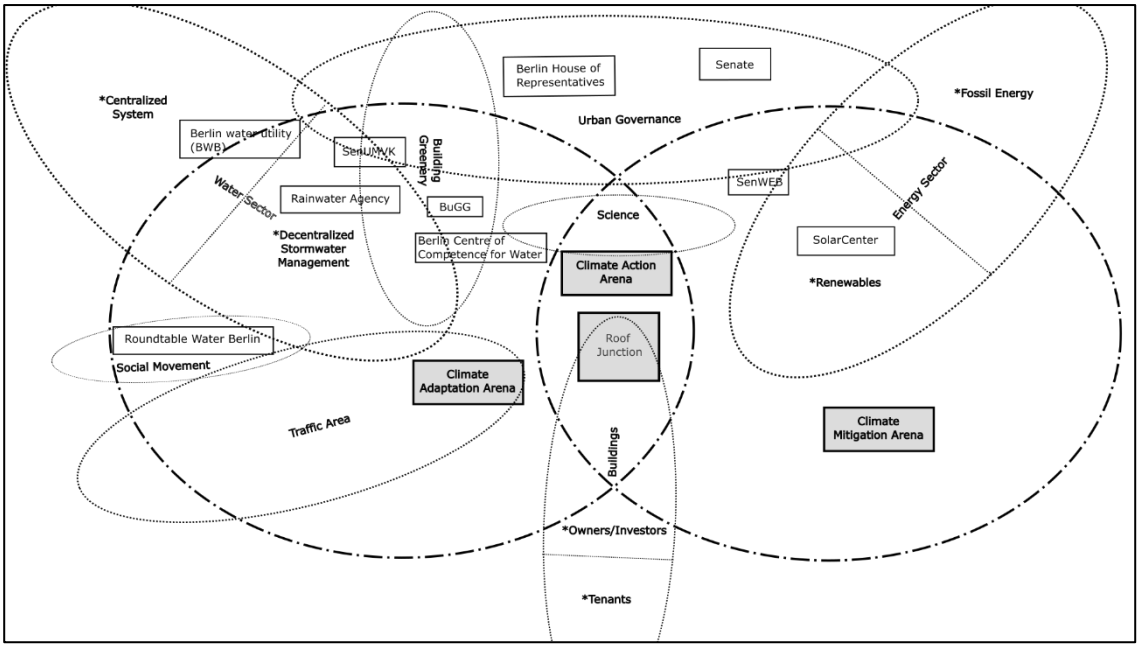

Figure 2: Social Worlds/Arenas Map (Figure created by the author)

The major social arenas that intersect with the roof junction are the Climate Adaptation and Mitigation Arenas which themselves overlap to form the Climate Action Arena. Because most social worlds of interest are embedded in or intersecting with the Climate Adaptation Arena, this was analysed in more detail. Some social worlds, such as Building Greenery and Traffic Area, would also intersect with the Climate Mitigation Arena due to their potential contribution to CO2 storage or reduction. However, for an improved focus and readability of the map the current design was chosen.

Within the Climate Adaptation Arena, several significant social worlds warrant mention. The Water Sector is first, which divides into the Centralized System—most notably housing the Berliner Wasserbetriebe (BWB)—and the Decentralized Stormwater Management, which includes the Rainwater Agency (RWA).

The Building Greenery World intersects with these, where the Bundesverband GebäudeGrün e.V. (BuGG) emerges as a central interest group. The Urban Governance, encompassing Berlin's government, intersects with both the water and greenery sectors. Within this governance is the Senate Administration for Environment, Transport and Climate Protection (SenUMVK), a pivotal policymaker for GR+ and a founding member of the Rainwater Agency.

While these major social worlds have been highlighted, there are several minor social worlds that also play critical roles. The Science sector, represented by the Berlin Centre of Competence for Water, provides essential information to other actors and programs. The Traffic Area, on the other hand, represents a potential space for the implementation of greening measures.

Furthermore, situated between the Decentralized Stormwater Management segment and the Traffic Area is the social movement 'Roundtable Water Berlin' (RTWB). This group is distinctively positioned due to its alternative configuration of the 'Rain-to-Tree' proposal.

In-between and the only social world directly intersecting with the Roof Junction are the Buildings that are further segmented into Owners/Investors and Tenants due to their distinct incentive structures and agencies for decision-making.

Within the Climate Mitigation Arena, the Energy Sector was identified to be the most salient regarding the Roof Junction. The Energy Sector is segmented into Fossil Energy and Renewables. Within the Renewables segment, the SolarCentre is an intermediary to

promote the vision of the SolarCity in Berlin. The Senate Administration for Economy, Energy, and Enterprises (SenWEB) bridges the gap between Urban Governance and Renewable Energies due to its involvement with solar-related policy and regulation.

The interrelations as well as capacities and limitations for collective action within the Climate Adaptation and the central Climate Action Arena are explored below.

4.2 GreenRoofPLUS

This section presents findings that are directly related to the GR+ policy. For this purpose, the findings were grouped into four sub-sections, namely the general policy aims and its design (4.2.1), the revision of GR+ (4.2.2), the related 'Second Level' discourse (4.2.3) and finally actors' evaluation of the policy (4.2.4).

4.2.1 Policy Aims and Design

The GR+ policy aims at promoting the installation of green roofs on Berlin's existing buildings to redesign the urban surface (DOC-G). The GR+ policy document connects urban greenery to residents' quality of life, which Berlin aims to enhance through strategies that promote urban greening. Additionally, urban greenery is associated with resilience and sustainability, addressing the challenges of climate change, biodiversity loss, and the consequences of a growing city. Green roofs are also linked to DSM (DOC-G). The goal is related to large areas in total being covered with vegetation and many roofs being retrofitted (IBB1).

It was evident from the interviews and documents that the policy is associated with innovative potential (DOC-G, SenUMVK1.2). On the one hand, the retrofitted roofs are intended to act as best practice examples in the face of difficult conditions such as limitations of load-bearing capacity, challenging roof types, and heritage protection. On the other hand, innovation is also linked with a perspective of added values. Biodiversity and retention roofs, as well as potential combination with solar technology, are aspects associated with this innovation (DOC-G).

The policy is structured around two distinct schemes: regular funding and the 'Green Roof Lab' (GR Lab). The latter is geared towards promoting innovation in relation to technical, social, integrative, and participative criteria (DOC-G). The GR Lab's *"toolbox for experimentation"* (SenUMVK1.1) pledges to cover up to 100% of installation costs to encourage innovative projects. These GR Labs are expected to serve as role models and contribute to the urban community by impacting 'the quarter'

(SenUMVK1.1). An ‘expert committee’ (SenUMVK1.1), comprising the BWB, BuGG, SenUMVK, RWA, and specialists in landscape planning and biodiversity, evaluates the criteria of a GR Lab for each corresponding application. The GR Lab committee officially convenes solely for the purpose of evaluating GR Lab applications (DOC-G, SenUMVK1.2), which is *“not as regular as one would think”* (RWA1.2). The criteria *“set the bar high”* (SenUMVK 1.1), and as a result, only one Green Roof Lab has been successfully funded in more than 2.5 years of GR+.

The primary actors tasked with implementing the GR+ policy are the RWA, who provide initial consultation, the IBB, who oversee program administration, and the SenUMVK, who act as policymakers and analysts (SenUMVK1.1). The RWA elaborated on their role and specific message stating: *“Our goals regarding the Green Roof Program are to raise awareness among people, to sensitize them to the idea of implementing it, and to make them aware that it may be beneficial not only to have a green roof but also to manage rainwater differently on their property, potentially even achieving complete disconnection if feasible. […] It’s not just about implementing a green roof but comprehending how to maximize its benefits, both for oneself if it’s one’s own property or for a property under one’s management. It also benefits the city as a whole”* (RWA1.2).

4.2.2 Revised Policy

The revised GR+ took effect on 01.01.2023 and features multiple adjustments and additions. Adjustments include the addition of façade greenery, the specific funding of biodiversity roofs as well as combinations with solar technology. Furthermore, the new framework includes increased financial incentives and covered planning costs. Finally, the substrate thickness can be adjusted more flexibly to structural conditions by requiring shifting emphasis from a minimum to an average thickness (DOC-G, SenUMVK1.2, RWA1.2). Funding criteria in general are established to manifest minimum quality requirements for green roofs and façades. The design of fundable façade greenery is less regulated than that of green roofs due to a lack of experience, so that the functionality of the green façade is foregrounded (SenUMVK1.2).

The inclusion of façade greenery was positioned as the main addition of the revised GR+ (IBB2). Selected added values especially regarding cooling were highlighted to be larger than those of green roofs. Therefore, the promotion of façade greenery and

particularly a combination roof greenery were included. The combination of both measures was associated with cascading effects and DSM (SenUMVK1.2).

The changes were attributed to the involvement of actors both within and outside of the bounds of Berlin through aggregation and exchange of experiences and knowledge (SenUMVK1.2, RWA1.2). The RWA and IBB make direct experiences in the exchange with applicants. The RWA aggregates and communicates its experiences to the senate administration. Ongoing dialogues with involved stakeholders, such as those during the Green Roof Lab committee meetings, not only address specific applications but also facilitate discussions about the general policy. All these exchanges together were suggested to inform the policy design (RWA1.2). The RWA also stated the initiation of professional exchanges: *"Through consultations on green roofs or the application of green roof funding, we gather insights on what qualifies for funding and what doesn't, as well as the reasons behind it. We also become aware of potential needs for adjusting the program to address specific requirements"* (RWA1.2). But the reliance on other actors became evident: *"Such a professional exchange thrives on the desire and acceptance of the stakeholders involved"* (RWA1.2). City dialogues were also performed by the SenUMVK but without initiation of the RWA (SenUMVK1.2, RWA1.2).

4.2.3 'Second Level' Discourse

Various actors, particularly associated with the SenUMVK, regularly invoked the metaphor of a 'Second Level' of the city (SenUMVK1.1, OB7-senumvk). Within this discourse, Berlin's liveability was significantly attributed to its greenery. In contrast, the density of Berlin and a projected exacerbation with reference to the 'Growing City' were associated with adverse effects. In this representation, the inner city is increasingly afflicted by heat, pollution, noise, a lack of greenery, socio-economic disparities, heavy rain, and flooding. Urban greenery and decentralized stormwater management were proposed to mitigate these negative impacts, contrasted with traditional grey infrastructure and impermeable surfaces that were argued to aggravate these problems (DOC-G, SenUMVK 1.1, SenUMVK 1.2).

The limitation of available space on the ground, especially in the inner city, to expand greenery and decentralized stormwater management, was frequently highlighted in the 'Second Level' discourse. Therefore, activating roof and façade areas through greening measures were proposed as solutions to adverse effects of climate change and

urbanization under conditions of limited space (DOC-G, SenUMVK1.1, SenUMVK1.2, OB6-SenUMVK2).

The diverse benefits of green roofs and façades were highlighted within this context. These benefits include stormwater attenuation, improved air quality, recreational value for urban residents, and habitats for a variety of animals and plants. The positive effects of façade greening were particularly emphasized, potentially enhancing biodiversity, the water cycle, cooling both outside and within the building, insulation, and aesthetics (DOC-G). The metaphor of an *"air conditioner"* (DOC-G, SenUMVK1.1) was juxtaposed with the image of a dense city as a *"heat store"* or *"tile stove"* (SenUMVK1.1).

The funding area of GR+ specifically ties the multiple effects of green roofs and façades to the mitigation of the burdens of a dense and growing city, such as heat stress, noise, and a general lack of greenery (SenUMVK1.1, SenUMVK1.2). The RWA has also advocated responding to the challenges of a dense and growing city mentioned above, through targeted promotion of green roofs and façades, given their multiple benefits (RWA1.2). The listed burdens were spatially aggregated into a map. Within the map different burdens such as heat and noise were neither accumulated nor differentiated. The resulting map was ultimately translated into postal codes to facilitate the application process. Therefore, the funding map used by the IBB was organized around jurisdictional spatial units that can easily be presented as list of numbers (SenUMVK1.1, IBB1).

4.2.4 Evaluation

The evaluation of the GR+ can be differentiated by focussing either on the policy itself or on the specific effects of green roofs and façades. Therefore, this section first presents praise and criticism of the policy and subsequently with respect to green roofs and façades.

The success of the initial programme phase has been questioned by many actors. The original name '1.000 Green Roofs' was taken literally by some actors (RTWB1, OWNER) and has been criticized for its limited scope: *"Even if the goal of greening 1,000 out of over 1.000.000 roofs in Berlin is achieved, there would be no measurable effect on the urban climate"* (RTWB1). Also, the focus on green roofs was challenged: *"Unfortunately, from a municipal economic perspective, it has a very limited objective,*

which is not based on a factual assessment of the three possible alternatives for improving urban climate resilience - roof greening, façade greening, and tree greenery promotion" (RTWB1).

When assessing the value of GR+, the RWA underscored certain unique characteristics and functions of the programme. The RWA expressed appreciation for GR+'s inclusiveness for all property owners: *"It is the only program that is truly available to every property owner, and that's what makes the program especially valuable to us"* (RWA1.2). Additionally, the specific targeting of the built environment was emphasized as a unique aspect of the GR+. The funding criteria were associated with promoting high-quality green roofs and façades that add value for inhabitants and the surroundings, such as biodiversity or cooling (RWA1.2).

Despite the potential benefits of the GR+ program, the RWA raised a critique about its limited scope, emphasizing the need for a more comprehensive approach that is technically more open and addresses the unique challenges of individual buildings and plots (RWA1.2). This critique was clearly articulated in the following quote: *"I consider this fixation on measures to be the wrong approach, because depending on where you are, one measure might be more sensible than the other in terms of its effect, and whether it's feasible or not, so why should we limit that from the outset?"* (RWA1.2). The interviewee furthermore strongly disagreed with the exclusion of ground-level measures in the design: *"I find it unfortunate that there is a green roof program that takes on roof greening but doesn't go the last mile and also support measures in the ground area that are equally sensible – infiltration is extremely sensible - why not promote that as well?"* (RWA1.2).

Assessing the importance of GR+ to further DSM in the built environment, an employee of the RWA clarified: *"So, the Green Roof Program is not the most crucial tool for us, nor is it the primary means of implementation for existing structures"* (RWA1.2). Instead, the value of the policy was rather associated with communicative processes: *"If you will, it is more of an awareness-raising measure than an implementation tool. That's how I would almost perceive it. I'm not sure if, ultimately, the Green Roof Program is the most essential instrument for achieving disconnection. I have my strong doubts about that"* (RWA1.2).

The case of an early applicant offered a differentiated perspective on the effects and limitations within a specific green roof retrofit project. An owner recalled the tedious application process: *"Then I said, yes, I want to apply for it, and then we received the application documents and had to provide an incredible amount of information. It was truly crazy, how cumbersome it was and all the details we had to provide. It was really an absolute paper war"* (OWNER). The interviewee stated that the difficulties of the application process resulted in a cost-benefit evaluation: *"That's when I asked myself, yeah, is it even worth it anymore? All the hours I've invested in it"* (OWNER).

The owner did not consult with the rainwater agency prior to application. The green roof retrofit did not include a connection of the roof to the yard and is therefore still connected to the central sewer system. The impact of the funding criteria became apparent in a significant shift in the final green roof design: *"Well, there were some other plans attached to that as well because originally we wanted to have a slightly larger terrace area and less green space, but with this funding, one of the conditions was that the green space should be higher. I believe we were only allowed 30% terrace area or something like that, there was some restriction, and then we redesigned it a bit. And then we just went with it because why not? If it's possible, then it's possible!"* (OWNER). When asked whether the motivation to install a roof terrace preceded the interest in funding, the interviewee agreed: *"We would have definitely done it, but probably with much less greenery. Now we have, I believe, 70-75% green space, whereas otherwise we might have had around 30%"* (OWNER).

Other actors focussed more on the underlying technologies of roof and façade greenery. An example is the relativizing assertion that "*a green roof is not the ultimate solution, but it's better than none"* (OB2-politician). In line with this assessment, a researcher publicly challenged the proposed cooling effects of green roofs for their surroundings. The combined effects of greening measures were underscored as important. Therefore, green roofs were argued to be only part of a more comprehensive solution because large areas of desealing and green infrastructure were noted to have more significant effects (OB4-researcher). This assertion of a limited cooling effect especially of extensive green roofs is further challenged due to their location very high above the ground and the target area of envisioned effects (OB2-RTWB). Green façades on the other hand were regularly portrayed with higher benefits especially regarding cooling of the surroundings and biodiversity (RWA1.2, SenUMVK1.2).

4.3 Rainwater Agency

4.3.1 Initial Framing

The ‘key points paper’ (“Eckpunktepapier” - DOC-E) outlined the goals and means of the RWA and therefore further specified the initial resolution (DOC-A) of the House of Representatives. The necessity for founding the RWA was linked to the effects of climate change and urbanization. While the former was associated with intensifying rainfalls, the portrayal of a 'growing' and 'dense' city focused on sealed surfaces. The RWA was supposed to support the alleviation of problems resulting from the interplay of both: flooding, water pollution, and heat. A more resilient and liveable Berlin was envisioned with the RWA’s support of connecting actors, knowledge, establishing structures, and engaging with civil society. The activities were related to the promotion of 'effective and sustainable stormwater management' vis-à-vis the 'growing city'. This was argued to entail awareness building regarding the new build and retrofitting, but also integrated solutions to deal with limited land reserves (DOC-E).

Reading the documents with a focus on retrofitting, the RWA was mandated to work inclusively with private, public, and civil actors to support GR+ alongside a stormwater concept for Berlin. Stated as another central objective, 1 % of Berlin’s sealed surfaces were to be decoupled from the mixed sewer system each year (DOC-A, DOC-E). This goal was a translation of the success story in the Emscher region where actors managed to decouple the envisioned percentages over a longer period (RWA1.1).

The host of tasks mentioned can be summarized into the categories: communicating (advertising, mediating, discussion), informing (raising awareness, contact with research), connecting (networking, platform, aggregating), and agency (supporting new build) (DOC-E). The RWA stated to have conducted more than 1,000 consultations in total with 50% of these consultations directly linked to GR+ funding (RWA1.2). A member of the RTWB criticized the initial mandate limiting the RWA to *“'mediate, communicate, connect actors' and thus only the function of a PR agency instead of an acting (‘implementing’) agency"* (RTWB1).

4.3.2 DSM and the ‘Sponge City’

DSM as a new paradigm for a *“natural water regime”* (FOR-RWA) is contrasted with the current paradigm of *“pure discharge”* (FOR-RWA) also related to *“comfort of drainage”* (OB6-RWA). DSM was positioned as a response to adverse effects anticipated by climate change and the growing city such as sealed surfaces, heat stress,

drought, runoff and combined sewer overflow and pollution (DOC-A, OB7-RWA5). A clear link to climate adaptation was also regularly mentioned (FOR-borough, DOC-A). A planner argued that a perceived emphasis on heavy rains and flooding should not lead to a neglect of drought-related risks in Berlin (FOR-planner2). Others associated the effect of climate change on Berlin with extremes of either too hot and dry or too wet and flood-prone (FOR-RWA), also exemplified by the metaphor *"flooding in the desert"* (OB6-researcher).

The limited adaptability, including high costs and efforts of the central sewer system, were acknowledged so that DSM is to be promoted as a complementary measure (DOC-A). In cases of a mandated connection of plots, DSM can even be given as an alternative drainage system for connectivity instead of the central sewer system (OB7-SenUMVK4). The importance of a shift towards more stormwater management at the surface is highlighted: *"in the end there is no alternative [and we] must walk this path together"* (FOR-BWB).

DSM has grown in popularity in public discourse, politics, and professional fields: *"The issue of rainwater management has been recognized. It is an issue we all clearly have to grapple with. No doubt, we all know. The topic of climate adaptation has been internalized"* (FOR-borough, SenUMVK3). Nevertheless, further raising public awareness and public understanding of these issues was positioned as essential for the successful implementation of 'Sponge City' initiatives (FOR-intermediary, FOR-planner2). This includes built examples of DSM for awareness raising and education (FOR-borough). A planner offered similar advice regarding GR+ to raise awareness and popularity, which was linked to *"demonstrate[ing] what it means to design green façades, green roofs, green backyards, green courtyards - that it is possible and that there are very good examples to follow"* (FOR-planner2).

DSM, as part of the broader 'Sponge City' concept, was argued to necessitate a radical redesign of urban areas, with water-related issues now incorporated into the planning process (FOR-SenUMVK3, FOR-planner2). The vision of a 'Sponge City' is often depicted with cascading configurations of green measures from the roof to the ground-level (OB6-RWA). The vision of the "sponge city" is acknowledged to not be realised yet: *"We must bring the sponge city to life and keep it alive"* (SenUMVK1.1). Others lamented that the "sponge city" is regularly invoked but *"not yet filled with life"* (OB8-RTWB).

4.4 Emergent Categories

This section introduces three themes that emerged through the coding processes, pertaining to the role of the RWA in GR+ and beyond. The following subsections will present these themes sequentially: Roles and Responsibilities (section 4.4.1), Technological openness (section 4.4.2) and Integrated Planning (section 4.4.3).

4.4.1 Roles and Responsibilities

The stated perceptions of RWA's roles and responsibilities differed in focus. Regarding its relation to GR+ it has been called the *"precursor organization"* (SenUMVK1.1) by the senate administration. An owner associated the RWA with a *"governmental organization"* (OWNER). A member of the Roundtable Water critically asserted that *"in fact, for the most part, it has been reduced to mediating customers for the roof greening subsidy program"* (RTWB1). Making the RWA more popular was proposed as an effective response to the perception of RWA's unclear roles and responsibilities (OB2-politician). Generally, clarification of structures, finances, and competences in the field of DSM was argued for (FOR-borough).

An employee of the RWA underlined its associations at the beginning of the interview, stating: "*The Rainwater Agency is an initiative jointly established by the State of Berlin and the Berlin Water Companies. Legally speaking, we are located within the Berlin Water Companies and receive our funding from the State of Berlin through the Environmental Administration. I just wanted to clarify this from the beginning so that our affiliation is clear"* (RWA1.2). Additionally, a steering committee is involved (RWA1.2).

On the one hand, the interviewee further clarified its responsibilities in positive terms including the initial consult for DSM and GR+, providing information and training, sensitizing, assessing place-specific opportunities and challenges, and generally being *"very close to implementation"* (RWA1.2).

Interestingly, a delineation of responsibilities in negative terms followed. With respect to GR+, the RWA stated to not have a *"special role in relation to the green roof program compared to other programs"* (RWA1.2) and not being responsible for the administration of funding. Furthermore, the interviewee drew attention to not being specifically green roof specialists or *"the spearhead of roof greening in Germany"*

(RWA1). Operationally, the RWA was said to be *"not in any way responsible for planning, construction, operation, or for approvals"* (RWA1.2). Specifically, technical planning, checking the statics or any engineering services around the roof were also not included in the portfolio (RWA1.2).

Activities can also be categorized based on whether they are proactive or reactive in nature. A stated task of the RWA was to be *"truly proactive in the city, not just waiting for people to approach us […], but also to approach actors who could, should play a relevant role, to address them and somehow bring the topic into focus and see what the actors need to implement it"* (RWA1.2). At the same time, the necessity of prior interest especially of small owners to contact them for consultation was emphasized, so that enrolling small owners is particularly challenging. This was also linked to limited personnel resources and limited knowledge on Berlin's heterogeneous owner structure, an issue that partially resulted in the call for a more proactive acquisition of large owners (RWA1).

The employee of the RWA further criticized the limited set of activities: *"I mean, at the moment, we only have the option to raise awareness, actively engage with people, draw their attention to funding opportunities, and provide them with offers, informational resources, and such. However, that approach is not effective; it simply isn't enough"* (RWA1). The interpretation was shared by other actors that envision the RWA to be more proactive (FOR-borough, FOR-planner) and not only limited to communication services (RTWB1).

In this still evolving set of roles and responsibilities, a divide was evident regarding actors' suggestions to substantially expand the RWA's scope and more cautious accounts that emphasize the continuation of current efforts.

Visions of the RWA with more responsibilities included supporting integrated planning in the boroughs (FOR-SenUMVK3) and moving from the abstract to the concrete. Activities on a "*very very concrete level"* (FOR-planner) were proposed to involve presence locally with knowhow, guidelines, and technical consultation maybe even engineering implementation activities. The boroughs called for more cooperation and presence as they currently lack the expertise and criticised a concomitant shift of responsibilities towards their jurisdictions (FOR-borough). A re-focussing of the RWA on decoupling goals was another recurrent theme (RTWB1, FOR-RWA).

The founding actors SenUMVK and BWB which are also part of the steering committee highlighted that the RWA should not widen its roles and responsibilities too much. (FOR-SenUMVK3, FOR-BWB). Other actors were urged to fulfil their tasks and responsibilities instead of shifting Berlin's structural challenges to the RWA (FOR-SenUMVK3). The RWA should rather continue on its path together with other actors (FOR-SenUMVK3, FOR-BWB). Particular importance was placed on moving from plans and studies towards concrete action, planning and implementation: *"We can do many studies, but ultimately, it has to be specifically planned, implemented, managed and operated"* (FOR-SenUMVK3). The BWB emphasized the need for going the initiated path to the end because *"plans are great, but it's even better if they're implemented"* (FOR-BWB).

The BWB emphasized their role as operational partners complementing the RWA and finding operational applications for new ideas. Also, the BWB acts as a gatekeeper regarding the (de)coupling of plots from the sewer system (FOR-BWB). Investors are *"confronted with the brutal truth"* (FOR-borough) of a denied connection due to BreWa-BE. To clarify, the BreWa-BE denotes an information leaflet on limiting rainwater discharges in construction projects in Berlin and takes effect when owners redesign or repurpose part of the plot or building such as the roof. In consequence, rainwater with respect to this part (but only this part) must be retained on-site. The BWB explained to follow an established process, clarifying the new situation, and seeking solutions together in conversations with the investor (FOR-BWB). Regarding the current situation, an employee of the RWA lamented the lack of strong instruments to mobilize property owners and offered a perspective on a possible role of the BWB. This role included more proactive acquisitions by the BWB or even coercive measures, such as posing an ultimatum that for decoupling within a certain period (RWA1.1).

4.4.2 Technological openness

The RWA's mandate emphasized the importance of technological openness in advancing the concept of a 'sponge city'. This approach was proposed to encompass various measures, including grey water recycling, decentralized stormwater management, and the implementation of green/blue roofs (DOC-A).

As mentioned further above, the RWA voiced critique of technical fixation of the GR+ policy. Such a strong focus on green roofs and inflexible funding criteria was argued to create hurdles: *"It's hard enough to get to the implementation stage, so I try not to set*

the bar too high" (RWA1.2). The revised GR+ was appraised to show signs of flexibility as the programme now includes green façades, combinations with PV and biodiversity roofs. However, the policy currently was also viewed to fall short in terms of funding ground-level measures, despite the highlighted significance of such measures in addressing place-specific conditions. In a short assessment of greening measures, green roofs were placed as inferior in some respects to green façades and especially street trees (RWA1.2).

The orientation towards technological openness as lived practice translates into consultations about all technical options of DSM: *"We always provide advice that is open to all measures. So, it's not at all hidden, if someone comes to us because they are interested in the green roof program, then we don't just provide advice about the green roof program, but we give comprehensive advice"* (RWA1.2). I witnessed a consultation at a convention in which an employee of the RWA compared the available technical options relative to the place-specific opportunities and challenges (OB3).

The RWA also emphasized that each group of advocates or suppliers, lobbyists etc. favour a certain technical option which they push. Therefore, the task of the RWA to inform interested citizens about all technical options was highlighted. The given information is supposed to empower owners to choose the technical options that are the most suitable in negotiations with suppliers and planners (RWA1.2).

Despite an affirmative stance towards the promotion of high quality green roofs, the RWA also critiqued the focus on a specific set of funding criteria: *"To me, any green roof is a good green roof, but it is important to me that we move away from the idea that one particular measure is a panacea, and that it needs to be pushed particularly hard, only to end up disappointed that it has only been applied in so many places. Therefore, I don't really want to commit to a specific location for green roofs or even a specific quality, because that is often determined by the resources that can be invested"* (RWA1.2). For instance, a call for accommodating industrial halls in lightweight construction with limited feasibility for ground-level DSM measures due to area restrictions through lighter green roof design to alleviate heat stress were not included in the revision of GR+ (RWA1.2).

4.4.3 Integrated Planning

'Integrated planning' was often proposed as a solution to the issue of infrastructure integration. An actor explained this concept comprehensively, stating: *"One thing is clear: the water industry will not be able to stand alone with its needs and requirements, because ultimately, it requires an alliance of departments, authorities, landowners and so on to initiate this process. Then it's not just about water management measures and target functions, but also about climate protection, urban design and other challenges that must be considered together. Therefore, they can only be handled in integrative planning processes. And it's a big task to kick-start these processes. And I would say that thinking beyond individual projects, thinking about demonstrative projects and the systemic aspect, even in planning processes, I believe, is the biggest challenge we have to face"* (FOR-SenUMVK3).

For these processes to be effective, strategic coordination was proposed: *"a translation of the goals and a concretization of the goals that are to be achieved in the near future. [...] We need another goal adjustment and, if possible, also binding and accepted. And we need [...] the establishment and continuity of the planning processes"* (SenUMVK3). A concrete and binding strategic orientation such as a decoupling programme was mentioned (FOR-SenUMVK3, FOR-BWB). Fragmentation of decision-making competences across levels and departments was problematized (OB2-politician).

Integrated or systematic solutions were often associated with a larger scale such as the neighbourhood or quarter (OB6-researcher, FOR-planner), the borough or the city. Pioneering work with two boroughs together with the water utility and supported by the RWA was provided as examples of integrated planning (FOR-SenUMVK3).

Furthermore, the experimentation with integrated thinking in new constructions was portrayed as more feasible, spawning innovative solutions due to early coordination, and incorporating different demands in the initial plan. Innovative projects were mentioned to be used as role models and sources of valuable knowledge for enhanced retrofitting practices (FOR-intermediary, FOR-planner2). The RWA supports projects new build and translation of experiences and knowledge (FOR-planner2). Nevertheless, the RWA cautioned of a too optimistic portrayal of new build as integration of different demands and technological options is also challenging in new (FOR-RWA).

Another hurdle for integrated was associated with the fragmented ownership of buildings in Berlin (RTWB1). Also, difficulties to coordinate large heterogeneous groups within one building were highlighted. This was linked to the sheer number of owners, but also different incentives between investors and owner-occupants. Structural disincentives were explained to favour maintenance over renewal of building aspects. This related to decision-making practices and the possibility to bail out of costly measures in case of disagreement (OB8-owner).

A field that was related to DSM and the possibility of taking up water flows from buildings and plot is the traffic area. The opportunities to further DSM and retention volumes in streets are limited due to scarcity of space. Changing this was argued for to free space for other usages (FOR-planner, FOR-planner2). Contradictorily, the envisioned traffic transition was envisioned to pose even more area requirements on streets and pavements to accommodate space for public traffic and bicycles (OB7-SenUMVK4).

4.5 Existing Infrastructures

4.5.1 Socio-materiality

There was a high level of agreement that targeting the built environment is urgent and of crucial importance to further DSM in Berlin (RWA1, FOR-borough, FOR-planner). The built environment was stated to constitute *"a Berlin, which is indeed shaped by existing structures"* (FOR-planner). Retrofitting was positioned as a real challenge that must be faced *"when we say, at least 90 percent is in stock and we have to deal with it"* (FOR-borough). To do so, planners and practitioners were stated to be confronted with *"the difficulty of precisely engaging with the individual situation or problem"* (FOR-planner).

The feasibility of retrofitting green roofs was strongly linked to the socio-material properties of a roof or building. The shape of the roof as well as the load-bearing capacity were highlighted to enable or constrain the installation of a green roof on existing buildings (OB4-BuGG1, OWNER, RTWB1). Building properties were argued to set boundary conditions for retrofitting, so that owners are *"basically free if the statics play along"* and to realize *"everything within the limits of statics"* (OWNER).

Considerable constrains were expected regarding retrofitting green roofs on Berlin's buildings due to the interplay between the socio-material capacities of existing roofs

and the structural demands of green roof systems (RWA1.2). On the one hand, the suitability of Berlin's existing buildings was believed to be limited. On the other hand, the envisioned green roof design especially regarding minimum substrate thickness was assessed to place high demands on load-bearing capacities (RTWB1, RWA1.2). This was interpreted to often rule out the possibility of installing intensive green roofs (RTWB1).

The challenge of retrofitting DSM extends beyond the roof. Integrating greening measures in densely built structures was argued to be challenging. Mentioned were ground-level conditions which include pollution of the soil, groundwater levels or the use for parking lots (OB8-owner). Possibilities for infiltration were argued to be limited due to the extent of sealed surfaces of up to 80-90% on the plot. This led a planner confronted with demands of the BreWa-BE to exclaim: *"Should I take an immersion heater and evaporate the water or what?"* (OB7-planner). The usage of plot areas for building is often maximized leaving little area for other usages (OB7-practitioner). City trees suffer from the dense socio-material situation that limit growth of root and crown as well as water availability (OB2-RTWB). In contrast, the prevalent socio-materiality was also presented to offer opportunities as in the case of a disused heating pipe to be used as a volume for stormwater retention (OB8-owner).

The representation of materials on fairs of the water sector revealed a stark contrast of predominant hard-engineered artefacts such as metal pipes and pumps in contrast to marginally represented 'softer', green technologies (OB5, OB7). The humorous comment of *"steel, concrete and men"* (RWA4) conveys part of the picture gained at infrastructure fairs. The materiality of the intermediation in contrast depends for the most part on mediatized communication such as through e-mail, video calls and PowerPoint, as well as presence at professional and public events. At public events, the exhibition stand featured an interactive demonstration kit, allowing citizens to experiment with and understand the influence of various surface designs—including concrete, cobblestone, sand, and sedum representing green roofs—on the water cycle, thereby enhancing DSM understanding and interest. Moreover, materials offered by the RWA include brochures, webpages, flyers and more with information and depictions of greening measures that paint a positive picture of a greener Berlin (OB1, OB3).

4.5.2 Spatialities

Matters of place and scale appeared frequently in discussions on the retrofitting of DSM, green roofs, and façades. Berlin place-specific challenges were highlighted which include characteristics of the mixed sewer system, a high degree of sealed surfaces, drought conditions but also heavy rain (OB7-SenUMVK4, FOR-BWB).

Foundational documents of the RWA emphasized the development of place-specific measures and instruments for the promotion of DSM, a notion that still echoed with the RWA, the Roundtable Water, and urban planners who highlighted the critical need for incorporating of place-specific characteristics and local stakeholders (DOC-A, RWA1, RTWB1). Place-specific approaches to retrofitting were linked to a *"collaboration with the local civil society, our main concern now is to really get the local people involved in the topic of rainwater, rainwater management, and climate change in the city in general"* (FOR-planner). Therefore, solutions were proposed to not only be place- but also people-specific (RTWB1).

Place-specific opportunities and constraints were mentioned as an integral part of consultations about measures of DSM and the GR+ policy. Opportunities were associated with building properties and available green space on the ground in relation to roof area (RWA1.2, RWA2). To incorporate constrains, the RWA argued to also consider the personal funds of people for the realization of DSM or greening the building (RWA1.2). Calls for project-specific consultation were welcomed by the RWA (FOR-RWA) while the local presence was clarified to be limited due to the magnitude of Berlin's building stock (RWA1) and insufficient personnel resources (FOR-SenUMVK3).

The envisioned spatial unit for intervention ranged widely from *"the individual situation"* (FOR-planner) to the quarter (FOR-SenUMVK3) or redesigning the city (FOR-SenUMVK3). Targeting the spatial unit of the quarter for systemic change was argued to be important to achieve a better health and quality of life for residents. This includes relief against heat stress, drought, and flood events (RTWB1). Redesigning the quarter was linked to integrated planning and an adaptation of standards and procedures (FOR-planner). Even though site-specific challenges and its innovative solutions were suggested to inform the actors and be translated into new knowledge, the task of adjusting standards was located on the national scale (FOR-SenUMVK3). Additionally,

legal frameworks that regulate the water sector and DSM span the municipal, national and EU scale (OB7-SenUMVK4).

Boundaries were a recurrent theme regarding systemic solution: *"If we want to think in terms of quarter, then we will indeed face this conflict situation where we have private areas in the background and stressed city trees in the foreground"* (FOR-SenUMVK3). Associated challenges were mostly legal, coordinative, and insurance based (OB2). The success of measures such as DSM that cross boundaries (e.g., between plots or from private to public) was based on requiring to achieve win-win situations (FOR-RWA).

The RWA provided a variety of pilot projects with boundary crossing solutions that were realised without involvement of central actors such as the BWB and SenUMVK. These solutions were specific to the individual situation (RWA1.1, OB2-RWA). Experiences with innovation and integration in new build were proposed to inform retrofit projects (FOR-RWA). A practitioner evaluated the importance and feasibility of boundary crossing solutions. He stated that a reframing of the BreWa-BE regulation for more spatial flexibility could also further boundary crossing solutions as these could be instrumental for realising decoupling goals (OB5-practitioner).

The intersection of private-public boundaries in GR+ was mentioned as a potential conflict of façade greening of street-facing façades which were called the *"supreme discipline"* (SenUMVK1.2). Here the positive effect was estimated to be potentially highest aesthetically and with respect to cooling of the street space. Nevertheless, the conflict with insurance issues, space requirements and traffic was anticipated referring to the requirement of a special allowance (SenUMVK1.2).

Multi-coding is a spatial integration strategy that combines different uses in the same space at different times, such as utilizing a playground for stormwater detention during heavy rainfall due to limited space in a dense city (FOR-planner). In advocating for a 'sponge city' multi-coding was recommended together with interlinking, 'cascading' measures (OB6-RWA). Connecting green roofs to the ground-level (e.g., for infiltration) was emphasized to *"go the last mile"* (RWA1.2). Nevertheless, the RWA denied the assumption that green roofs are mandatory for decoupling plots and cascading as the importance of building greenery is relative to place-specific opportunities and constraints (OB6-RWA).

4.5.3 Temporalities

Temporal (mis)alignments were regularly present through invoking the image of windows-of-opportunity. To harness the potential of temporal dynamics an employee of the RWA proclaims: *"So, I am looking for windows of opportunity. Everywhere I go."* (RWA1). The enrolment of roofs, particularly private ones, for retrofitting green roofs was argued as often closely tied to the occasion of retrofit driven by motivations unrelated to stormwater issues. Therefore, without a retrofit occasion, the enrolment of roofs for retrofitting green roofs is limited and *"doesn't run by itself"* (SenUMVK1.2). Referring to the need of retrofit occasions and owners' prior interest, the RWA lamented: *"And that is simply the challenge, that renovations proceed slowly in a city. Less than 1% of the stock is renovated per year, so naturally, we make progress very, very slowly"* (RWA1.2). To exemplify this, the interviewed owner recalled the redesign of an acquired top floor as the main occasion for retrofitting a green roof with help of the GR+ funding (OWNER).

Another owner highlighted the potential of including stormwater management of adjacent plots during occasions of new build. This was presented as a potential solution to incorporate stormwater flows from multiple plots in the design of DSM measures in the new construction (OB8-owner).

A sense of urgency was often expressed. Contemplating the climatic situation in Berlin, a researcher exclaimed *"we need solutions now"*, arguing for the systematic installation of building greenery instead of relying on slow growing trees (OB6-researcher). Urgency was also prevalent in accounts to address multiple crises in urban spaces such as the pandemic and climate change. Nevertheless, these pressures were mentioned as windows-of-opportunity for interconnected thinking (FOR-intermediary).

4.5.4 Politics

In this segment, politics is presented with respect to participation and the prevalence of institutional incentives and disincentives. Also emphasized are calls for political pressure to adjust the incentives or enact programmes.

The initial framing of the RWA included the impetus to work with a full array of actors. Specifically, the RWA was founded with a mission to aggregate the BWB's expertise and include civil actors, owners and users of buildings as well as science and practitioners (DOC-A). Exchanges with the public are organized through different

formats. The RWA hosts a training programme for the interested public that allows for exchange with people that implemented DSM. Experiences gathered through over 1.000 (ca. 50% for GR+) consultations with owners are aggregated and communicated to the administration: *"We are probably a quite important, let's say, mouthpiece for the owners. Just like the IBB is, because the IBB also has this direct customer contact, just like we do. And insofar, we do convey what we get from our many conversations"* (RWA1). Public forums that the RWA hosted were suggested to allow for close exchange with the audience (FOR-RWA, FOR-intermediary). Public participation regarding GR+ did not occur prior to initiation of the policy but rather within the implementation process (RWA1.2). The presence at conventions, exhibitions and symposiums also allows for direct exchange with interested citizens (OB1, OB2, OB5, OB6, OB7).

The legitimacy of the RWA's work was linked to public participation and feedback. Engagement with the civil society was emphasized to inform *"how we can bring our mission to life and achieve the greatest value for Berlin"* (FOR-RWA). Additionally, the feedback by other actors such as the senate administration, BWB, and political actors confirmed the RWA's current path and alignment with its mandate (FOR-SenUMVK3, FOR-BWB, OB2-politician). An exemplary feedback underlines this: *"Yes, well, if the Rainwater Agency hadn't been invented [...] one would have to invent it, and I am very glad that it exists"* (FOR-borough). The Roundtable Water as a representative of public concerns and generally with a critical stance towards the BWB and political actors, continuously advocated for equal representation of inhabitants or tenants in the politics of decisions regarding DSM and GR+ (OB2-RTWB, OB8-RTWB, RTWB1).

Some actors sought political pressure to address economic and legal hurdles, adjustment of standards, allocation of more resources (RTWB1, FOR-planner, FOR-SenUMVK3) and the implementation of stronger instruments: *"Instruments, we need more instruments!"* (FOR-borough). Furthermore, the development of a decoupling program was proposed to guide coordinated action (FOR-BWB, FOR-SenUMVK3).

A recurring theme was the assessment of costs and benefits when weighing private costs against anticipated public benefits. The presented challenge lies in enrolling private owners for public interests such as urban climate and biodiversity (OB2-politician). Greening the building was associated with benefitting the surroundings, so that it

benefits the public beyond the investor's boundaries (SenUMVK1.1, SenUMVK1.2, OB6-researcher). Despite the apparent benefits of green roofs such as cost-reduction for tenants and positive impacts on climate and biodiversity for the public, the effect of the landlord-tenant dilemma represents a hurdle: *"The savings from the stormwater fee benefit the tenants and not the investor, which means that the investor will, even if they take advantage of subsidies, be left […] to cover the investment costs themselves, or should bear them […]. And this complicates the distribution of subsidies"* (RWA1.2). Another perspective came from an owner that realized a green roof retrofit with the GR+ funding. The owner stated that the benefits of comfort and increased market value clearly benefit the private owners benefit while taxpayer bears costs (OWNER). Therefore, the RWA argued to raise awareness of the public benefits of green roofs to *"demonstrate the true benefits they can bring to a city. It's important to understand that these are taxpayer funds at stake"* (RWA1.2). Another participant in a public discussion criticized that tax money should not be used for experimenting with DSM measures (OB7-practitioner2).

Recipients of funding were sorted according to housing size and various ownership forms - private, public, or housing associations - each with differing incentive structures, but large owners were often not sufficiently incentivized due to previous GR+ policy limitations. The GR+ revision aimed to rectify this and potentially leverage vast roof areas for retrofitting through incentives or direct acquisition, however, its effectiveness remains to be seen (RWA1.2).

4.6 Emerging Alternatives

4.6.1 Major discourse: 'SolarCity'

Solar world: In parallel to attempts for green roof retrofit, the pressure to enrol roofs for retrofitting from the solar sector is high. Roof areas were suggested as an important entry point to install solar technologies in Berlin (OB3-discutant). A policy mix has been designed to turn Berlin into a 'SolarCity'. This strategy includes a solar law which is combined with the funding program SolarPLUS and an intermediary called 'SolarCentre'. The Stadtwerke, a central actor, actively acquires roof areas for PV-module installation. Enrolling of roof areas was emphasized to be crucial to pursue the envisioned increase of solar energy in Berlin, but as the representative proclaimed: *"Only at first glance, this is a spatial conflict, but it is actually a synergy"* (OB4-senweb). This was mentioned along the multiple effects of a combination and

compatibility of designs of PV-modules and green roofs. A representative of the SolarCentre, an intermediary to coordinate efforts around the Masterplan Solarcity Berlin, reiterated the prior statement saying that PV-modules will cover all available areas including roofs and façades without forgetting green roofs. She further stated that *"the future is near"* and that "*it's not either-or, but rather both-and"* (OB4-solarcentre). Establishing PV-green roofs as the new standard was stated to require multiple activities: informing the public to put aside prejudices, supporting three years of maintenance as well as national funding of the combination. However, when I asked a representative of the SolarCentre directly about a potential coordination with the RWA on issues of GR+, she did not recall any instances of coordination (OB4-solarcentre).

Green roof world: Urgently responding to multiple crises was associated with the need for combined solutions as *"this decade counts"* (OB4-bmuv). The positive effects of building greenery were emphasized as important to provide quality of life in the quarter such as being a *"natural air conditioner"* or enhancing biodiversity (OB4-bmuv). The combination of green roofs and PV was portrayed as challenging or the *"supreme discipline"* but essentially a win-win situation (OB4-senumvk2). A representative of the SenUMVK praised the cooperation with the SenWEB stating *"There's not a sheet of paper that can fit between us"* but despite cooperation, it's *"not a matter of course"* (OB4-senumvk2). The combination of PV-modules with green roofs was emphasized as *"not a niche topic, but the future of roofs"* combining climate adaptation and climate protection for quality of life on the 'second level' of the city (OB4-senumvk2). The representative of the BuGG situated the combination against the background of climate change stating *"PV alone is not enough, we cannot save the world with that alone"* as cities must deal with heavy rain and heat (OB4-bugg). The importance to consider a combination of both systems was underlined in *"The question of the future is: PV with or without a green roof, so are we losing the green roof? PV is coming anyway"* (OB4-green roof supplier). The advantageous effects for PV-modules mostly centred around an increased yield due to a cooling effect of the green roof (OB4-researcher, OB4-bugg). Another central argument for a combination was the proposition of using the substrate as imposed load that fixes the modules without penetrating the roof membrane (OB4-bugg).

The revision of the GR+ was supposed to incorporate the synergistic framing and the political as well as legal push for solar energy in Berlin (IBB1, DOC-G). The combination of green roofs and PV-modules is signalled to be desirable (DOC-G, SenUMVK1.2). The revised GR+ funds combinations of green roofs and PV but limits the area for PV-modules to 50% and the area underneath PV-modules is now included in the fundable area but necessitates full greening instead of gravel (SenUMVK1.2, DOC-G).

Scepticism: Some actors challenged the desirability and feasibility of the integration. A participant at a congress questioned the combination of green roofs with PV stating: *"You can combine everything, but what goal am I pursuing with that?"* (OB4-participant). The claim that green roofs are advantageous for PV-modules due to a cooling effect that increases yields was challenged as scientific results were interpreted as ambiguous. Therefore, yield increases were stated as only secondary motivation (OB4-researcher2). A combination of PV-modules with solar thermics was offered as an alternative configuration for cooling of PV-modules (OB4-dgs).

Additionally, the retrofitting of one system onto the other was assumed to be challenging or not always feasible therefore a coordinated and simultaneous instalment is warranted (OB4-green roof supplier2). The architect was mentioned as a possible intermediary in new build and retrofit for the installation of green roofs and PV modules on the same roof, but they must be knowledgeable about the technological possibilities and political goals of climate adaptation and mitigation (OB4-discussion).

The role of plants was highlighted in this illustrative statement: *"Plants are incredibly clever, they outsmart us. Every crack is observed and plants have time, an incredible amount of time. And the selection that happens underneath is incredible. Plants have earned our respect there."* (OB4-green roof supplier3).

RWA: When asked about a potential conflict between PV and green roofs, the representative of the RWA responded: *"I try not to invoke this conflict"* (RWA1.2). The situation was further differentiated: *"One must look very closely: is this really competition or are we simply not successful enough with green roofs yet? […] [E]veryone has their eyes on the roofs and the green roof people are jealous that PV has such pressure. And then for them every roof where PV comes and there is no green roof: yes, PV has won. Yes (shakes head), but no. […] I believe we can only try and we*

are good at looking at how we can strengthen the instruments for greening roofs in the existing building stock, and how we can use this window of opportunity - solar is being installed on the roof - to check: is a green roof also possible? And if yes, now is the time, not later" (RWA1.2).

Proactive efforts by the Stadtwerke to install solar technology on Berlin's roofs were presented as a window-of-opportunity: *"We see that the Stadtwerke are acquiring projects and installing photovoltaics on a large scale on existing properties, and the Stadtwerke are a subsidiary of the Berlin Water Works. These are not anonymous people to us. We regularly meet in the corridor and we have already conveyed that, since we come from the same house, they should, when they acquire projects, also address the issue of roof greening and check whether it is feasible, because if they do not, well, then the train has left the station for a certain time. We see this"* (RWA1.2).

But regarding the different dynamics and the potential for a coordinated approached a more cautious statement was: *"I believe that we must be honest there. They are under enormous pressure to acquire projects and if the green roof gets in their way, they will not wait for it. This cannot be expected either, because politicians are really keeping a very close eye on them and are really demanding that they show success"* (RWA1.2).

4.6.2 Minor discourse: 'Rain-to-Tree'

'Rain-to-Tree' has been identified as a minor discourse that gained less attention and is promoted by the social movement of the Roundtable Water Berlin. The proposed configuration centres on channelling the captured rainwater from the roofs directly towards the street trees. This effort was contrasted with Berlin's decoupling goals and framed in contrast as recoupling (OB2-RTWB). This was stated to be mostly hindered by insurance and legal challenges and not so much technically. Therefore, calls for action were directed mostly at politics and the administration (RTWB1).

The RTWB critiqued the fixation of programmes for green roof installations in Berlin despite other options being more effective and feasible (RTWB1). They attempted to challenge the perceived technical fixation on green roofs and other measures by offering comparisons of options (infiltration, green roofs, façade greening and street trees) to enable an unbiased assessment. Street trees were positioned as the ultimate technological choice related to resilience measures (RTWB1, OB2-RTWB, OB8-

RTWB). An interest in improved conditions for street trees and technical options was also expressed by the RWA at a ‘Rain-to-Tree’ conference (OB2-RWA).

The feasibility of this configuration was underlined in: *“The collection of fresh rainwater that falls discontinuously from the sky using rain gutters and drains can be realized on all buildings. The basic installation for this exists by virtue of DIN standard on all existing buildings”* (RTWB1). The anticipated advent of solar technology was depicted as not challenging this proposal: *“Even if it should be necessary for a large part of the urban roofs to be equipped with solar technology in order to generate electricity and heat, the main function of a roof remains the collection of fresh rainwater falling from the sky as a resource for supplying urban vegetation. This, specifically the urban trees, in turn forms the basis for urban climate resilience”* (RTWB1).

4.7 Summary

Berlin’s GR+ policy promotes green roofs and façades on existing buildings to address the adverse effects of climate change, biodiversity loss and enhance quality of life. The policy was designed with two distinct schemes: regular funding and ‘Green Roof Lab’ which aims at promoting innovative ‘best practice roofs’ but with a low implementation rate remains to unfold its effects. Policy translation is overseen by the RWA, IBB, and SenUMVK, who provide consultation, administration, and policy making. A revised GR+, effective from 2023, includes façade greenery, higher incentives, combinations with solar technology and a more flexible green roof design. The GR+ policy was regularly associated with the metaphor of the city’s ‘Second Level’ that aims at activating Berlin’s roof space to reconcile the vision of a greener city with space limitations of the growing city. However, the policy’s scope and implementation faced criticism. Some argued for a broader approach considering individual building’s unique challenges and an openness towards other technological options such as ground-level measures. Additionally, the application process was described as tedious but the funding criteria being effective to produce high quality green roofs.

The RWA was tasked with promoting DSM in Berlin through building awareness about new builds and retrofitting in a growing city. They were delegated to work with diverse stakeholders to support GR+ and establish a stormwater concept for Berlin. A key aim was to disconnect 1% of Berlin’s sealed surfaces from the mixed sewer system

annually. However, criticisms of the RWA labelled it as more of a PR than an acting agency.

DSM was viewed as a solution to climate change and urban growth challenges, to complement the central sewer system and promote a broader ‘Sponge City’ concept. This was argued to demand a significant urban redesign, including cascading green measures from rooftops to ground level, and integration of water-related concerns in planning. Public awareness and understanding were argued to be critical for success.

The RWA’s role was debated, with calls to clarify its responsibilities. The RWA, funded by the State of Berlin and BWB, consults on DSM and GR+, assesses site-specific challenges and opportunities, and provides information and training. However, it stated to not be responsible for tasks like funding administration, technical planning, or construction. Actors advocated for the RWA to be more proactive. Opinions vary on whether the RWA’s scope should expand or continue as is. Some proposed more responsibilities, like local presence and technical consultation. However, founding actors cautioned against overloading the RWA and encouraged other actors to fulfil their obligations.

The RWA argued for technological openness and critiqued the GR+ policy for its narrow focus on green roofs and rigid funding criteria. While the revised GR+ policy demonstrates more flexibility, it has been criticized for not funding ground-level measures, which could address site-specific conditions. Green roofs, in some regards, were stated to be less effective than green façades and street trees. The RWA mentioned to advise on all DSM options and empower owners to negotiate with suppliers and planners. Despite supporting high-quality green roofs, the RWA cautions against viewing them as a one-size-fits-all solution.

The concept of ‘integrated planning’ has been proposed to address urban challenges by aligning the requirements of various stakeholders in a strategic and continuous process. Such integrated solutions are typically associated with large-scale implementations, like neighbourhoods or cities, and are considered more feasible in new constructions due to early-stage coordination. However, fragmented ownership and decision-making in the face of urgency and needs for coordination were presented as significant hurdles. A binding strategic orientation such as a decoupling programme was proposed. However,

challenges remain, such as the need for policy adjustments, resource allocation, and addressing legal and economic hurdles.

There is widespread agreement in Berlin about the importance of retrofitting existing structures for DSM. However, this is challenging due to the unique socio-material properties of each building, such as roof shape and load-bearing capacity. Beyond rooftops, the integration of greening measures in densely built structures faces hurdles, such as soil properties, limited areas on the plot and in the streets. Furthermore, the retrofit rate of 1% per year was argued to be a slow driver for change. A key issue mentioned was to mobilize and incentivize private owners despite a focus on public benefits. The revised GR+ policy aims to provide better incentives for large property owners, though the effectiveness of these changes is still uncertain.

In Berlin, there are growing efforts to integrate solar panels and green roofs, with the view that these combined solutions can help the city adapt to climate change. There's a push to make the city a 'SolarCity', backed by solar legislation, a funding program (SolarPLUS), and an intermediary body called 'SolarCentre'. This initiative includes combining green roofs with PV-modules, despite some scepticism around the effectiveness and feasibility of this combination. The revised GR+ policy partly funds these combined solutions, and the representative from the RWA argued that PV should be seen as an opportunity to promote green roofs, not as a competition. However, a central challenge is to coordinate efforts to realize solar as a window-of-opportunity.

At the same time, the RTWB is promoting an alternative solution 'Rain-to-Tree' to manage rainwater by 'recoupling' rainwater from the roofs directly to street trees. They argued that the barriers to this practice are more related to insurance and legal challenges rather than technical issues, calling for political and administrative action. The RTWB stated that urban trees are essential for urban resilience.

5 Discussion

The purpose of this chapter is to answer the research questions presented above by considering the situation of inquiry. For this purpose, the findings of the various collected materials reported in the results chapter are analysed with help of sensitizing concepts developed in chapter 2. Finally, methodological challenges and limitations are discussed.

5.1 Research Question:

The guiding research questions asks: **what is the interplay between the Rainwater Agency, the GreenRoofsPLUS-policy, and the situation of multiple existing and alternative infrastructures?** To answer the research question, the following sub-questions were formulated:

A Existing Infrastructures

1.) What are the capacities of the RWA to translate the GR+ policy for retrofitting green roofs?

2.) What are the limitations?

3.) What is the role of GR+ for the intermediary work of the RWA?

B Alternative Configuration

4.) What is the engagement with the dominant discourse of the SolarCity?

5.) What is the engagement with the minor discourse of Rain-to-Tree?

The following discussion chapter attempts to answer these questions against the background of the theoretical framework and results.

5.1.1 Sub-question 1: Capacities of the RWA in the Policy Translation

When expanding the analytic perspective to the whole situation in a relational approach, all of intermediary's relational functions were found to produce effects together. The relational functions of aligning, networking and translation (Moss et al. 2009) were chosen as the basic framework. Aligning was expanded with the dimensions of socio-materiality, spatialities, temporalities and politics (Moss and Hüesker 2019) to be found

within the situation of inquiry. Translation specified as policy translation that includes the transportation and transformation of meanings and relations (Clarke et al. 2015b) Therefore, these intermediary functions were included in the analysis to view the policy not in isolation but understand policy translation as embedded in a situation. The relations within the situation were found to enable and constrain the feasibility of retrofitting green roofs. In sum, a fruitful synopsis of relational concepts enabled a more differentiated picture of the interplay of elements and will therefore be used in this discussion.

The results suggest that enabling the movement of the GR+ policy involves establishing connections with the recipients of the funding. The policy moves through actors, such as the RWA and IBB, but also places to reach the target audience of the policy. One primary role officially assigned to the RWA is that of an initial consultation. Since the inception of the program, the RWA has successfully conducted more than 1.000 consultations. It's noteworthy to mention that 50% of these consultations can be directly linked to GR+ funding. Moreover, the RWA does not confine its activities to just consultations. It also actively promotes GR+ at various events such as exhibitions and speeches, raising awareness around the policy of a wider audience. In all these cases, the policy is mobilized by intermediary actors, foremost the RWA and IBB, to complement the 'hard' transfer of policymaking with their 'soft' functions (Stone 2012).

The study affirmed the multi-scalarity of policy translation (Clarke et al. 2015b) as these processes not only unfolded within Berlin, but policies and related experiences were being translated into the GR+ at different times of its development. Other cities with more or complementary experiences around greening policies for roofs, façades and yards have been involved before the initial GR+ and again for the revision. Policy ideas from cities such as Hamburg or Frankfurt were translated from their specific context into the situation of Berlin through city dialogues. Similarly, the 1% per year decoupling goal of the RWA originated in a markedly different context of the Emscher region. However, the role of a translator between cities was stated to lie more with the senate administration than the RWA. Adjustments to the specific situation appear to be warranted and intermediaries could play an important role in the transformative process.

These transformations of the GR+ by the RWA were found to proceed on different timescales. Firstly, changes occurred on a longer time horizon periodically. The inputs

for transformations of the policy vary. In the phases of the policy's initiation and subsequent revision, the RWA's own expertise and opinion for instance informed decisions about the funding area which focusses on the inner city and therefore the mixed sewer system. Also, experiences gained from owners and practitioners during exchanges or consultations are aggregated and translated to inform the decision-makers. Third, the RWA also initiates professional exchanges to convene on issues of mutual concern. This helps to align the policy with diverse dimensions, making it more robust and contextually relevant. The changes are periodic due to a two-year lifetime of the policy. By and large, these activities are in line with 'upward' intermediary functions (Kivimaa et al. 2020b) that inform and shape policymaking while professional exchanges or networking work rather sideward.

Secondly, the RWA also transforms the policy more regularly during interactions on the 'frontline'. The room of manoeuvre during interactions with owners highlights the importance of a relative autonomy from government officials (Kivimaa 2014; Talmar et al. 2022). At the same time, the work of translators to shift the meaning and focus of the policy is shown (Clarke 2005b; Kingfisher 2013). These changes occur for instance during consultations and are project-based. Within these exchanges, the RWA appears to have relative independence from the GR+ framework and leeway in consulting more openly. Thereby, the study confirmed the argument that intermediaries are not be seen as neutral conduits (Moss 2009). The resulting flexibility regarding technical options and funding are discussed further below in relation to alignment functions.

Probing the situation for the multiple dimensions relevant for the translation of GR+ and the retrofitting of green roofs more specifically proved insightful. The shaping of existing relations to create a fit between dimensions has been called alignment (Moss et al. 2009; Moss and Hüesker 2019). The four dimensions of socio-materiality, spatialities, temporalities and politics will now be discussed in turn to highlight the capacities for alignment.

A perspective on the socio-materiality of the policy translation foregrounds the underlying materiality of retrofitting at the roof junction and the intermediation process itself. The results underscored the assertion that the building properties play a central role when retrofitting building greenery (Wilkinson and Feitosa 2016). The built environment was mentioned to account for 90% of Berlin's structure, so that the task of retrofitting the heterogeneous building stock is crucial and urgent. Routinely

emphasized was the load-bearing capacity or statics of the building that must be suitable to support the weight of the green roof. This factor can be seen as the primary driver for favouring extensive roofs in most projects. These factors are minimally included in the revised GR+, especially through requiring an average substrate thickness instead of a more rigid minimum thickness. Against this background, the RWA can provide multiple options in the case of a building that is not suitable for retrofitting within the GR+ criteria. First, the RWA can offer other incentives outside of GR+ to promote a green roof such as the stormwater fee or other municipal and national funding programmes. Second, through consulting technologically open the RWA can broaden the view of potentials for installing DSM measures on the plot. Thirdly, in the long run, the RWA might be able to influence the policy design to better accommodate the recalcitrant materiality of buildings. In contrast, the materiality of intermediation activities itself proved radically different and was dominated by communication devices and media such as the website, brochures, and the exhibition stand. These devices transport a message through beautiful pictures that make envisioned urban futures legible and at the same time they act as connecting devices either embodied at a fair or virtually.

The spatialities at play analysed in the situation relate mostly to place and scale. Regarding place-specificity, the distinct capacities and motivations of a locality and related people were found to be important co-determinants of the success of retrofitting efforts. An emphasis on the need to include the site-specificity can be found in the concept of retrofitting IN (Hodson and Marvin 2016). In this research, the strategic orientation of urban governments was found to be restricted due to misalignments with diverging values ‘on the ground’. On the one hand, the enrolment of owners and the respective buildings is reliant on mobilization in terms of incentivizing owners to apply. The incentivization can be enabled or constrained regarding the alignment of the policy’s framing and benefits with place-specific motivations. On the other hand, the capacities of people and buildings are place-specific. People differ for instance in their available funds and the feasibility of retrofitting roofs can be influenced by intersecting assemblages. These assemblages include the underlying building and the ground-level of the plot among others. The RWA attempts to address these issues by incorporating the opportunities and challenges of each place for consulting on the most effective and feasible technological option including ground-level measures. An engagement with the diversity of projects through tailored approaches could leverage their potential (Suleiman et al. 2020; Papasozomenou et al. 2019).

Scale effects become evident in the multi-scalarity of any place such as the individual building. Not only the local scale exerts influences on the situation, but the entanglement with socio-economic and regulatory dynamics and priorities enables or constrains local initiatives (Hodson and Marvin 2016). Capacities of the RWA to mediate between different scales were evident through their positionality between the local and the urban. Facilitating flows of knowledge and communication per se, but also aggregating local experiences or representing urban strategy can be associated with capacities to bridge the scalar divide. Scalar interventions can be linked to strategic attempts to reframe the spatial unit of intervention, for instance through integrated planning of the quarter, borough or city. Also, boundary-crossing solutions challenge the delineation of the place by the jurisdictional boundaries of a plot. Therefore, the unstable boundaries of the roof junction could be harnesses to bring about innovative spatial solutions (Jensen et al. 2015) to further align spatialities of socio-technical systems and waterflows (Medd and Marvin 2008). This reframing of the relevant scale of retrofitting draws neighbouring assemblages of adjacent plots and the street area into the situation. The RWA plays a part in the interventions by promoting experimenting and learning mostly at new build or pilot projects. Yet, unless the GR+ is adjusted to include connectivity beyond green façades to encompass the ground-level plot area and beyond, these potentials for more integrated solutions cannot be realised.

Temporalities in the translation of GR+ were found to relate to intersecting dynamics that result in windows-of-opportunity (Moss and Hüesker 2019). One central dynamic is the retrofitting occasion of the single building or in a more aggregated sense referred to as the retrofit rate of Berlin. These instances draw together temporal timelines of a buildings socio-materiality, such as the lifetime of roofing tiles, or economically driven motivations to convert the roof into a loft with the GR+ policy. The retrofit occasions can be an effective driver for owners to plan a green roof retrofit for their building. Harnessing the retrofit occasions as windows-of-opportunity can be promoted by the RWA's attempts to make the policy popular. Furthermore, especially small owners and owner-occupiers were stated to contact the RWA. The BreWa-BE might also be an important factors as fundamental changes to the building, plot, but especially the roof force the owners to retain (part of) the stormwater at the site. Green roof's ability to attenuate stormwater without further land-take (Lamond et al. 2016) can act as a strong incentivizes.

The political dimension can be divided into the reliance on political actors to adjust prevailing institutional (dis)incentives and the engagement with civil actors. The disincentives include an asymmetrical distribution of costs and benefits among private actors and the public, but also investors and tenants. The findings corroborate that to promote an alignment of incentives municipal funding, fee reductions or other discounts must be formulated (Lamond et al. 2014). An adjustment of incentive structures especially for investors to realize amortization of costs could leverage their potential for retrofitting. The RWA is aware of this problem and could lobby for further adjustments to the policy or promote other incentives like reputation and increased market value (Lamond et al. 2014). Furthermore, a more proactive targeting of large owners could potentially lead to the enrolment of significant roof areas. The revised GR+ accommodates the concern of large owners but the funding rate is lower than for small owners and the bureaucratic application for each project remains. Nevertheless, the RWA already targets large owners proactively despite the GR+ not being ideal. Regarding the second aspect of political (mis)alignments, civil actors are included in the policy translation not just as funding recipients. Their experiences are aggregated by the RWA to inform decision-makers. Moreover, the RWA informs and attempts to empower property owners to represent their own interests vis-à-vis suppliers and practitioners. Raising awareness of the public might also result in political pressure to further the instruments and push for DSM.

Networking activities were associated with the RWA's work to create a context or open a space for exchange and action. Within this context, the RWA acts as a platform that can hold heterogeneous framings regarding the right measures and instruments (Hodson and Marvin 2009). The creation of these networks can for instance be linked to initiating exchanges around issues of mutual concern. Networking is also evident in the building of a network of actors around DSM which includes many actors involved with green roofs and façades. The capacity to mobilize actors may hinge on the creation of boundary objects (Star and Griesemer 1989) such as the 'Sponge City' or 'Second Level' discourse. Others frequently referred to 'Resilience'. The processes can be highly public and signal the importance of redesigning Berlin at conferences, public dialogues, or official working groups. Activities in the background such as unofficial meetings emphasize the often 'hidden work' of intermediaries (Moss 2009).

In summary, the unfolding of capacities depends on the respective counterparts to realize alignments. As some dimensions, such as socio-materiality or the retrofit rate, seem more resistant than others, the counterpart of the GR+ and RWA must adjust accordingly. The RWA has a unique position between actors, scales, technologies and social interest to unfold its agency through their official and unofficial roles.

5.1.2 Sub-question 2: Limitations of the RWA in the Policy Translation

As an intermediary, the RWA is defined by and situated in a network (Beveridge 2019) that also constrains the capacities for a successful translation. The embeddedness of the RWA also shapes the perception of its roles and responsibilities which were perceived as unclear or limited in scope. The malleability of its role could lead to a diluting of its mandate which was evident in calls to return to the initial decoupling goals.

Focussing narrowly on the translation, the limitations related mostly to failed mobilizations. For the policy to result in change 'on the ground', the people and places must be receptive. Mobilizing the people and places relies on either problematization or incentivization. Problematization relates to unstable boundaries and practices due to a colliding policy or what has been termed 'overflowing' (Jensen et al. 2015; Callon 1998). The BreWa-BE relates to the former, but this only takes effect in case of fundamental retrofit activities such as a redesign of the roof and therefore remains linked to the rate of retrofit. The latter could occur when the framing of the socio-technical system is challenged, such as in the event of pluvial flooding. Incentivization however potentially leads to more voluntary engagement but incentivizing several actors in the current scheme is not effective. Large owners are limited due to the de-minimis funding ceiling. Therefore, large housing associations and companies publicly or privately owned are not successfully enrolled as their funding of green roof retrofitting efforts would be limited to a small number of buildings. The limited enrolment of landlords stems from the so called 'landlord-tenant dilemma' according to which the tenants reap the benefits of investments such as green roof retrofits while investors must bear the costs (Lamond et al. 2014). Also, mobilized property owners can be deferred by the tedious application process or stringent funding criteria. Overly stringent criteria might also be associated with the Green Roof Lab policy segment. A very limited number of funded projects stands in stark contrast to the ambitious framing of the Green Roof Labs as pioneering projects.

For the transformation of the policy, the RWA is reliant on the uptake of impulses in revision and implementation because the capacities for change are dispersed among actors. The power dynamics in the collaboration with government actors attribute meaningful capacities to the 'hard' side of policy translation (Stone 2012). On the one hand, the senate administration might not include advice into the programme design. On the other hand, the IBB follows an application process that appears to be restricted to the formal criteria. During implementation the property owners might not be motivated by technical options that are not funded. Without compensation for ground-level measures of DSM, referring to public benefits or stormwater fee reductions might not be sufficient. Moreover, instances of circumventing the RWA altogether – here in the case of the interviewed owner – limits the RWA's capacity for change.

The results indicate that limitations of alignment are linked to the recalcitrance of existing relations as well as the coordinative effort to harness (partial) alignments. The need for a receptive context was underscored through the analysis of the relations found in the situation (Marvin et al. 2011; Suleiman et al. 2020). The (mis)alignments are again presented within the fourfold framework of socio-materiality, spatialities, temporalities and politics.

Misalignments of socio-materiality can result from the interplay of the policy criteria with building properties. As argued earlier, the building properties are a crucial factor when considering green roof retrofits and structural adjustments challenge the economic viability of the projects (Wilkinson and Feitosa 2016). Therefore, the structural capacity of a building must be accommodated in the policy translation. Minimum requirements of a multi-layered green roofs design and minimum 8cm substrate thickness limit the feasibility of retrofits on buildings with little load-bearing capacity. Exceptions for areas or building types that would benefit significantly from the possibility of affordable green roof retrofits cannot be realized in the current scheme. Despite the RWA's lobbying to include industrial halls that are especially exposed to heat and show limited potential for ground-level DSM implementation, changes have not been taken up. The current GR+ design also not funds the installation of a broader variety of DSM measures even though the multiple benefits mostly align.

Spatial misalignments result on the one hand from limited capacities of the RWA to engage with the place-specific opportunities and constraints. The myriad heterogeneous local initiatives are not integrated into a larger framework (Hodson and Marvin 2016).

The RWA is constrained in attempts to engage with the numerous owners in Berlin despite calls for a more local and proactive role of the RWA. The limited personnel resources and a stance of the BWB and SenUMVK to follow the current path keep the RWA in a more reactive role at least regarding smaller owners. On the other hand, reframing the scale of intervention implies coordinative work and legal hurdles. Restabilizing the boundaries and practices of the junction could provide impulses for more long-term change (Jensen et al. 2015). But this requires solutions tailored to the specificities of a place to drive innovation (Jensen et al. 2016). For instance, an up-scaling of boundary crossing solutions was advocated for, but the individual solutions need further institutionalization into standards and regulation. Moreover, a multiplicity of scales influences the situation. This demands the navigating of the multi-scalar regulatory landscape, spanning from urban to national and EU-wide standards.

From the study's findings, it can be inferred that limitations regarding temporal dynamics are due to misalignments as well as limited abilities to identify and harness alignments. This can be exemplified through the rate of retrofit that is in itself already a slow driver for change of the built environment. Additionally, not all retrofit occasions automatically lead to green roof retrofits as these rely mostly on voluntary decision-making by owners. More coercive measures, such as the BreWa-BE or an envisioned revision of the building code only take effect in new build or fundamental renovations. Another temporal factor that hinders a successful translation of GR+ and retrofitting of green roofs in general can be related to long application and installation process. Furthermore, the building standards are changing at a slow rate. Given these points, alignments of the stated slow dynamics with a sense of urgency that demands acceleration are difficult to achieve as both factors are unlikely to change.

Political misalignments have already been discussed with regards to asymmetrical benefits and costs that lead to failed mobilizations as well as the dispersed power that limits the transformation of the GR+ policy. What became evident is the need for actors championing the respective technological options also through provision of necessary resources to implement and support (Marvin et al. 2011).

Limitations regarding the formation of networks may be based on the capacity to create arenas around mutual concern that hinge on coordination such as through boundary objects. Boundary objects for heterogeneous translation and orientation of actors require interpretive flexibility (Star and Griesemer 1989; Clarke and Star 2008). While multiple

discourses of the ‘Sponge City’ and ‘Second Level’ are promoted in the Climate Adaptation Arena, build examples and a sense of political commitment are needed to fill these with life.

To conclude, the limitations often depend on the interplay between the extent of misalignments and the relative leeway to address these, so that addressing an especially resistant dimension requires adaptability of its respective counterpart. For instance, stable building properties that limit the feasibility of retrofit could be addressed with more flexible funding criteria or other incentives. Furthermore, potential alignments do not automatically lead to successful translation as they must be harnessed and coordinated. Therefore, limitations of the RWA to successfully translate the GR+ policy can be associated with a reliance on more powerful actors to provide stronger instruments or to adjust the current ones as well as the coordinative effort to actualize potentials.

5.1.3 Sub-question 3: Role of the GR+ Policy for the Intermediary Work

The GR+ policy also has manifold effects on the intermediary work of the RWA. To enumerate the different roles this response is structured into themes that highlight both the enhanced capacities as well as the limitations resulting from the RWA’s entanglement with the GR+ policy. The themes are capacity for enrolment, alignment of visions, GR+ as a sensitizing device and criticism of the RWA’s role. These will be discussed separately, followed by a short summary of the insights.

The analysis indicated a strengthened capacity of the RWA to enrol owners due to its official consulting role. The capacity to leverage the interactions with applicants for their own agenda points towards agency of the intermediary evident (Moss 2009). Additionally, the mutual transformation of the translated policy and translator underscore their entanglement (Clarke 2005b; Clarke et al. 2015b). The significance of this derives partly from the fact that 50% of consultations were GR+ related. The openness to all owners and targeted focus on the built environment align with the retrofit urgency expressed by the RWA. Small owners and especially owner-occupiers are mobilized by the GR+ policy to contact the RWA. Within the consultations, the employees of the RWA have room of manoeuvre to inform about all technical and funding options alongside a promotion of DSM measures. However, unclear remains how many owners can be mobilized to install other measures for instance in cases of limited green roof feasibility or GR+ criteria applicability. The promotion of green roofs

and façades as ‘no regret’ solutions, along with images of a green city, can be used for offensive advertising. However, the GR+’s funding focus on roofs and façades and the omitted connections to the ground-level might obstruct the uptake of additional DSM measures. The program’s success in engaging large property owners and investors is limited due to misaligned incentives. Whether a less restrictive funding scheme introduced in the revised GR+ will address this issue remains to be seen. Also, other effects such as an enhanced visibility or participation in wider networks due to the engagement with GR+ were not explicitly given in the data. In sum, the RWA’s involvement with the policy generates a significant number of exchanges, but the implementation rate is low, and the enrolment of large owners was mentioned as crucial. Hence, to ascertain the effect of the numerous consultations and other activities, other more indirect measures of success would need to be considered.

In this sense, GR+ has been associated with a sensitizing device that highlights the political willingness for a paradigm shift in Berlin. Just like the RWA, this embodies a vision for change and can potentially align various actors around a shared strategic orientation. Equally important might be the framing of added values for the quarter or city through promoting high quality roofs. However, the closure around a specific technological option is in tension with an openness to adjust to place-specific motivations and capacities (Hodson and Marvin 2016; Smith and Stirling 2007).

The study affirmed the alignment of framings around DSM and the ‘Sponge City’ with those of green roofs and the ‘Second Level’. Promoting green roofs and façades aligns with the DSM portfolio and the vision of a ‘Sponge City’ (Lamond et al. 2016; Pallasch 2021). These efforts generally aim to alleviate burdens arising from climate change and urbanization. Significantly, the common assertion to match the multiple benefits with their corresponding challenges is represented in the funding area of GR+. The resulting map, initially also informed by the RWA’s expertise, predominantly covers the inner city where the mixed sewer system is widespread. Nevertheless, the two diverge in their technological openness with the ‘Sponge City’ highlighting cascading effects, connectivities and a multitude of measures. Furthermore, the RWA and others advance multicoding to address limitation of space in a dense city that is invoked in the ‘Second Level’ discourse. Indeed, multicoding and boundary crossing solutions could activate potential of ground-level areas in the city but would entail meaningful shifts in relations and responsibilities of various implicated actors (Moss 2000). As a result, the RWA

might have to strike a balance between their work around GR+ to also further DSM measures and promoting solutions beyond the policy's framing.

The RWA's association with the GR+ policy has also sparked criticism. Most critiques revolved around the technical fixation, low success rate, and the limited role of the RWA. The latter refers to the perception that the RWA is primarily concerned with communicating the GR+ policy. The visibility of green roof efforts compared to other less visible activities such as unofficial exchanges or coordination with experts and administration might lead to this conclusion. A more distinct delineation and communication of its roles and responsibilities, along with a visible decoupling program, could help clarify the RWA's objectives and actions.

In summary, the entanglement with the GR+ policy entails mixed consequences for the RWA. The capacity enhancing effects mostly revolve around presence, visibility, communication and signalling. To leverage these rather 'soft' qualities, the RWA depends on the availability of 'hard' instruments for implementation (Stone 2012) together with a relative autonomy to adapt the policy to its needs (Talmar et al. 2022).

5.1.4 Sub-question 4: Engagement with the 'SolarCity' Discourse

In this section I discuss the engagement with an emerging discourse in Berlin that centres on the promotion of solar technology on roofs, predominantly PV-systems. Following the framework of alignment, the interface between green roofs and PV-systems is explored from the perspectives of the solar and green roof social world as well as the RWA.

Regarding the socio-materiality of a potential infrastructure combination of PV with green roofs, the properties of the socio-technical systems themselves and their interrelation with the building appeared to be relevant. Firstly, the building also imposes limitations on the feasibility of installing PV due to the load-bearing capacity among other factors. When comparing the weight characteristics of the systems it becomes apparent that the relatively lightweight PV-modules often prove more feasible than green roofs, especially when compared to the substantially heavier combined setup. Given these circumstances, and when focusing solely on structural demands, it's often more feasible to install the lighter PV modules alone. Secondly, PV modules and their mounting incorporate the substrate of green roofs in-between, creating a fully integrated, layered PV-green roof configuration. This setup alone allows for the

unfolding of multiple benefits. However, this layered configuration also introduces significant challenges. The plants growing under and around the PV modules must be contained to avoid overshadowing and reduced yields. Together with the weight consideration, this leads to an almost exclusive portrayal of PV-modules with extensive green roofs. Given these points, the knock-on effect of one infrastructure (PV) on another (green roofs) becomes apparent (Rohracher and Köhler 2019). The PV-system is privileged with respect to its political momentum, but also materially as it is more aligned with existing buildings' structural capacities. The fact that PV-modules are necessarily installed on top of the other system to ensure exposure to sun light, relegates green roofs to an extensive design with an entailed reduction in their effects.

In the envisioned retrofitting of roofs for greenery and PV-modules, the socio-technical systems collide spatially. The enrolment of a maximum number of roof and façade surfaces for the promotion of solar energy in Berlin is often interpreted as a spatial conflict with green roofs. Therefore, the framing of roof areas as unused potential from multiple social worlds leads to a 'hot situation' (Jensen et al. 2015). Within this situation of unstable relations and intersecting interests, actors try to restabilize boundaries. These attempts are evident in expressions that reframe the spatial conflict as actually a synergy or a win-win situation.

Another spatial alignment may occur due to the (coincidental) spatial proximity of the offices of the Stadtwerke and the RWA. Interestingly, the spatial component of communication and coordination efforts relates here to the embodied co-presence when meeting in the hallway. Therefore, coordinating and aligning consultation practices potentially not only follow formal but also informal arrangements.

Temporal dynamics are paramount in this case of infrastructure integration for several reasons (Moss and Hüesker 2019). Firstly, the stated urgency and entailed acceleration of efforts to install solar technology on Berlin's roofs results in a momentum for retrofitting roofs with PV. Secondly, the unfolding dynamic of the solar world has long- and short-term consequences for green roof retrofitting efforts. Long-term, the widespread installation of PV-systems on Berlin's roofs hinders subsequent green roof retrofits due to the layered configuration that prescribes an order of installation. Short-term, the retrofitting efforts need to be coordinated in a timely fashion not only with respect to construction work but also application processes. The coordination demands in terms of involved actors, timelines, financial resources and more can be considerable.

In case of effectively managing the coordination during acquisition and consultation as well as at the building, the momentum of solar technologies in Berlin can spawn windows-of-opportunity for retrofitting green roofs.

The political dimension is underscored by the pressure to promote solar energy in Berlin, resulting in comparatively strong instruments and proactive behaviour. The urban strategy might align better place-specific motivations (Hodson and Marvin 2016) by financially incentivizing investors. The legal and financial instruments to pursue solar technology offer effective 'hard' measures (Stone 2012). Notably, when comparing these two social worlds, the differences create distinct dynamics. The political pressure of the solar world translates into a sense of urgency and proactive acquisitions of roof areas. This dynamism is further stimulated by the alignment of solar energy with economic interests, given that energy has a solid business case compared to the multiple benefits of green roofs.

To conclude the discussion on the advent of solar in Berlin, the potentials for the socio-technical systems to co-exist, complement each other or be conflicting (Hodson et al. 2017) are derived from the (mis)alignments:

Only if solar energy production does not significantly reduce roof space, PV-systems and green roofs can coexist. However, façade greenery is unlikely to collide spatially with solar technologies given no widespread application of façade PV-system installations.

The complementarity of both systems depends on several factors that are distributed among all dimensions. Firstly, plants must be considered with respect to their growth potential and the entailed maintenance requirements. Secondly, the RWA can harness the spatial and institutional proximity to the Stadtwerke for a timely coordination of projects. And thirdly, the political momentum that creates a sense of urgency for solar technology in Berlin must be matched with coordinative efforts and effective instruments to further green roofs. Attempts to black box the combination as the new standard or future of the roof will likely have to be accompanied by combined funding, adjusted standards, and practices.

A conflictual situation is likely to occur in absence of the aforementioned factors. In this case, the momentum of solar technology and proactive acquisitions of large roof areas will limit the potential of green roof retrofits further. Retrofit occasions have been an

important albeit slow driver of retrofitting green roofs, and capturing this potential for PV could be another undermining factor. This may be the case unless property owners are explicitly required to manage on-site stormwater through BreWa-BE.

5.1.5 Sub-question 5: Engagement with the 'Rain-to-Tree' Discourse

Socio-material and political aspects were most prominent when analysing the discourse around the proposed configuration 'Rain-to-Tree'. Regarding the former, a proponent of 'Rain-to-Tree' referred to the current configuration of roofs that are already equipped to collect and discharge rainwater. The suggested 'recoupling' involves a redirecting of rainwater towards the root space of nearby trees in the yard or street. Apart from the issue of connectivity across socio-technical systems and borders, a cistern introduces a temporal component by enabling water storage. The cistern's capacity to release rainwater over an extended period provides hydration for plants while buffering peak flows.

This practice of connecting roofs with trees through water flows aligns with the cascading configurations envisioned in the 'Sponge City' concept and leverages the potential of trees for cooling, enhancing biodiversity, and more. Bearing this in mind, the low profile of this discourse may be surprising. Yet, the benign technical requirements are outweighed by economic and legal hurdles regarding the allocation of costs and benefits as well as the intricacies of boundary crossing solutions. Proponents specifically address political and administrative actors to provide solutions to enable a widespread roll-out for sake of tree and city wellbeing.

Important in assessing the interplay between these two configurations is whether the analytic focus lies on the individual building or a larger scale. While connecting roofs to trees may offer multiple benefits and help decouple from the sewer system, trees only get extra water during heavy rain, as green roofs retain water until saturation. Without a cistern storing sufficient rainwater, the condition of trees will not improve during dry periods.

However, widening the perspective to an aggregate of buildings allows to conceive the complementarity of both systems. A 'recoupling' of the rain gutter from the sewer to the tree can be desirable in situations of limited feasibility of green roof retrofits due to unsuitable roof type, load-bearing capacity or an existing PV-system. Therefore, the alignment of goals of limited connectivity to the central sewer system and a promotion

of city green can be harnessed. This would require an appreciation of the ‘Rain-to-Tree’ configuration and addressing economic as well as legal hurdles inherent in boundary crossing solutions. As these solutions are already discussed and tested in multiple pilot projects, the integration of infrastructures beyond single plots may become feasible given the necessary coordinative capacity and political willingness.

5.2 Methodological Limitations

The limitations of Situational Analysis pertained mostly to the complexity of the research object. The multiple foci and data sources resulted in a labour-intensive project and the need to iteratively broaden and refocus again. The method is very process-oriented which can be generative as the researcher stays open for surprises. Yet, narrowing down the analysis to a sub-set of relations or a central controversy is advisable to handle the complexity of the situation.

In conclusion, the method/theory package of SA provided a versatile set of tools that is open to other relational approaches. The processes of mapping and memoing allowed for explorative analyses before refining and polishing the outcomes. Delineating the situation of inquiry is crucial to enter the field analytically while staying open to a shift of focus. In my case, centring the situation on the roof junction proved advantageous as both concepts have fuzzy boundaries despite a clear middle point.

6 Conclusion

The need for climate adaptation in urban areas has been acknowledged and a new approach to stormwater management takes a central role in city-wide adaptation plans. Pioneering new construction sites not only host DSM, such as green roofs and infiltration trenches, but also integrate them with adapted traffic areas or rainwater recycling. Ambitions to translate the vision for a greener city into a change of the built environment are bolstered by the relative ease to achieve innovation in new build. However, the vision of a paradigm shift towards decoupling vast areas of Berlin's sealed surfaces is yet to materialize. The RWA has been positioned to champion efforts that reconcile an urban strategy of retrofitting with the need for place-specific solutions. The GR+ policy was supposed to active unused space on the 'Second Level' of the city portrayed with pictures of lush roof gardens. Still, retrofitting remains a tenacious challenge that invites an analysis of the complex interplay between existing and emergent elements of retrofitting green roofs in Berlin.

To interrogate the situation, a relational approach that centres on the roof junction has been chosen. The RWA as an intermediary has been conceptualized as entangled with the GR+ policy to assess the capacities and limitations of realizing its relational functions. The workings of translation, alignment and networking on the relations found within the situation and those anticipated by emerging alternatives offered a nuanced understanding of the pitfalls and potentials of retrofitting green roofs with GR+.

In the pursuit of a Situational Analysis (Clarke et al. 2018), heterogeneous materials were collected including interviews, videos, documents and observations. The evidence gathered in the study indicate that current instruments and regulations not satisfactorily engage with the complexity of integrating green roofs into the built environment. A recent revision of the GR+ policy has been lauded to address some issues pertaining to weight distribution for enhanced feasibility, better incentives for large property owners and a stronger signal of added values. Yet, general criticism towards the narrow focus of GR+ remains. The adjustment for more flexible criteria and an expansion of technological options alongside the calls for stronger instruments reveal the spectrum of perspectives.

The RWA was found to be embedded in a network of relations. Within these associations, the intermediary strives for a more proactive role, a goal that is generally welcomed by all actors represented through my sampling. However, the ambitions are curtailed by the founding actors by re-focussing on the current path. Practices of a more proactive nature currently include attempts to enrol large property owners for retrofitting as well as the initiation of professional exchanges to reflect and adjust policies. The reliance of the RWA is emphasized by the need for supportive incentive programmes regarding the former as well as the interest and uptake of new ideas vis-á-vis the latter. The agency of the intermediary unfolds due to its unique position between scales, actors and technologies. This relates to the aggregation of knowledge to inform policy makers, networking to enable the flow of knowledge between hitherto unrelated actors, and the lived practice of technological openness in consultations.

The RWA and GR+ can be seen as entangled and part of a larger policy mix. Both policies work together and enable or constrain each other in sometimes unpredictable ways. Without considering the multiplicity of infrastructures and their interaction regarding potential (mis)alignments, the capacities and limitations of a successful policy translation are difficult to grasp. While alignments, for instance the incentives of owner-occupiers or retrofit occasions, can be turned into windows-of-opportunity, misalignments prove to be less malleable. The outcome of the discussion suggests that an adjustment of the respective 'counterpart' (i.e., GR+) could potentially accommodate slow to change relations, or a reframing for instance of the boundaries of a plot could re-open potentials for alignment. Interestingly, the dimensions were found to be interwoven, so that place-specificity is difficult to think without its socio-materiality. In the same vein, windows-of-opportunity that result from temporal dynamics on adjacent plots cannot be realized when adhering to the scale of individual buildings.

Similar patterns were found in the analysis of emerging alternative configurations to enrol roof areas. The 'future of roofs' does not only rely on (mis)alignments between green roofs and PV or rain-to-tree configurations, but also their relative alignment with the built environment. To exemplify this point, the political momentum and relative ease of installation of PV-systems have knock-on effects on the design of green roofs and create ambitions to realize PV retrofits as windows-of-opportunity. Conversely, the technical compatibility of 'Rain-to-Tree' with current roof designs does not translate into adjustments of GR+ and involved practices in absence of political pressure.

Concluding on the interplay between the RWA, the GR+ policy, and existing as well as alternative infrastructures, the effects of the interwovenness warrants most attention. In restating the notion that the context enables and constrains (Hodson and Marvin 2009) the possibilities for change, the findings suggest that this has to be expanded to encompass the entire situation of concern. Moreover, following the assertion that supportive actors in political and administrative circles are important for the success of DSM (Suleiman et al. 2020) brings powerful actors into the equation. However, a degree of autonomy of the intermediary (Moss 2009; Kivimaa 2014) proved to enable practices that address some imposed limitations such as consulting comprehensively.

The limitations of this study derive from the approach to analyse the whole situation which resulted in a projected that might be too broad in scope. That being said, some issues risked being lost in the analysis as they appeared relatively sparsely in the data. First of all, the central sewer system was only present remotely by means of ‘decoupling’ and with reference to the prevalence of the mixed sewer system in the inner city. Secondly, façade greenery appeared only recently and the effects of this addition in the GR+ policy could not be assessed due to the lack of empirical evidence. Thirdly, the shift in the institutional setting (Papasozomenou et al. 2019) since the resolution in 2017 and the founding of the RWA in 2018 could not be analysed and situated in longer term dynamics as this would go beyond the scope of the thesis.

Consequently, an engagement with the current institutional shift set against the background of former socio-political phases could be fruitful. In addition, the advent of façade greenery but also solar technology in Berlin could spark interesting inquiries. Lastly, a more focussed analysis of the most promising interrelations between socio-materiality, spatialities, temporalities and politics within the situation could provide more fine-grained insights.

Whether the high hopes for a systemic approach by the RWA (Papasozomenou et al. 2019) will eventually materialize remains to be seen. Alternatively, more one-way translations such as a proactive acquisition of roof areas or coercing property owners through ultimatums might result in the envisioned change, but override place-specific motivations and capabilities.

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Appendix

Appendix 1: Author's Declaration

I hereby declare that the present thesis has not been submitted as a part of any other examination procedure and has been independently written.

All passages, including those from the internet, which were used directly or in modified form, especially those sources using text, graphs, charts or pictures, are indicated as such.

I realize that an infringement of these principles which would amount to either an attempt of deception or deceit will lead to the institution of proceedings against myself.

01.06.2023

Berlin, date

Marius Friedrich Schuster

Appendix 2: Contact Letter

Anfrage zur Teilnahme an meiner Masterarbeit

Sehr geehrte/r _____,

ich möchte Sie freundlich bitten, an meiner Forschungsarbeit über Videotelefonie oder in Präsenz (30-45 Minuten) teilzunehmen.

Diese findet im Rahmen meines Studiums „Integrated Natural Resource Management" an der Humboldt-Universität zu Berlin statt. Inhaltlich geht es darum, welche Rolle Intermediäre bei der Übersetzung von Policies haben und wie sie diese mitbeeinflussen. Dabei fokussiere ich mich auf die Berliner Regenwasseragentur und Policies, welche auf die Umgestaltung der privaten Dachflächen von Bestandsgebäuden abzielen – vor allem das GründachPLUS Förderprogramm.

Das Interview findet als semi-strukturiertes Gespräch statt und orientiert sich an dem angehängten Leitfaden. Das Gespräch wird dabei aufgenommen, um es im Anschluss besser zu verschriftlichen, wonach es von mir anonymisiert und pseudonymisiert ausgewertet wird. Die Ergebnisse dienen ausschließlich der Erstellung meiner Masterarbeit. Eine entsprechende Datenschutzerklärung und -vereinbarung kann ich Ihnen auf Anfrage gesondert senden.

Ich würde mich sehr freuen, wenn Sie der Teilnahme zustimmen und mir in Bezug auf die Terminabstimmung Rückmeldung geben.

Mit freundlichen Grüßen
Marius Friedrich Schuster

Appendix 3: Interview Guidelines

Interviewleitfaden RWA - deutsch

1. Was sind die Ziele der Regenwasseragentur bzgl. des Bestands in Berlin?
2. Welche Rolle spielen (private) Dachflächen bei der Verwirklichung dieser Ziele?
3. Was sind die zentralen Herausforderungen bei der Umgestaltung des Bestands?
4. Welche Lösungen würden Sie dafür vorschlagen?
5. Bitte beschreiben Sie für mich die Entstehung und anschließenden Änderungen des GründachPLUS-Förderprogramms!
6. Wie schätzen Sie den Erfolg dieses Förderprogramms ein?
7. Welche Rolle spielt die Regenwasseragentur bei der Umsetzung des GründachPLUS-Förderprogramms?
8. Welche Bedeutung messen Sie dem GründachPLUS-Förderprogramm beim Erfüllen Ihrer Sanierungsziele bei?
9. Wie schätzen Sie das Potential der Berliner Bestandsgebäude für eine flächendeckende Dachbegrünung ein?
10. Inwiefern spielen standortabhängige Faktoren dabei eine Rolle?
11. Wie lassen sich Dachbegrünungen privater Dächer zeitlich in das sonstige Sanierungsgeschehen in Berlin einbetten?
12. Welche Einstellungen gegenüber Ambitionen der Dachbegrünung begegnen Ihnen, z.B. in der Öffentlichkeit oder der Politik?
13. Wo sehen Sie mögliche Konflikte oder Symbiosen bei der Gestaltung von Berlins Dachflächen?

Interview Guideline RWA – english translation

1. What are the objectives of the Rainwater Agency regarding the existing buildings in Berlin?

2. What role do (private) rooftops play in achieving these goals?

3. What are the central challenges in redesigning the existing structures?

4. What solutions would you suggest for this?

5. Please describe the establishment and subsequent changes to the GreenRoofPLUS funding program for me!

6. How do you assess the success of this funding program?

7. What role does the Rainwater Agency play in implementing the GreenRoofPLUS funding program?

8. What significance do you attribute to the GreenRoofPLUS funding program in fulfilling your renovation goals?

9. How do you assess the potential of Berlin's existing buildings for a comprehensive greening of rooftops?

10. To what extent do site-specific factors play a role in this?

11. How can the greening of private rooftops be integrated into the overall renovation activities in Berlin in terms of timing?

12. What attitudes towards the ambition of rooftop greening do you encounter, for example, in the public or in politics?

13. Where do you see possible conflicts or symbioses in the design of Berlin's rooftops?

Interviewleitfaden OWNER - deutsch

1. Was hat Sie dazu gebracht, das Gründach-Projekt zu initiieren und welche Ziele verfolgten Sie dabei?

2. Könnten Sie Ihre Erfahrungen während der verschiedenen Projektphasen schildern – von der Entscheidung für die Förderung bis hin zur Fertigstellung des Gründachs?

3. Welche Herausforderungen sind Ihnen im Verlauf des Gründach-Projekts begegnet und wie haben Sie diese bewältigt?

4. Wie bewerten Sie das GründachPLUS-Förderprogramm vor dem Hintergrund Ihrer Erfahrungen?

5. Beschreiben Sie Ihre Interaktionen mit der Regenwasseragentur im Verlauf des Projektes!

6. Welche Aufgaben der Regenwasseragentur haben Sie in der Zusammenarbeit als besonders wichtig empfunden?

7. Inwiefern haben die baulichen Gegebenheiten die Planung und Umsetzung der Dachbegrünung beeinflusst?

8. Wie wirkten sich lokale Gegebenheiten, wie Lage oder Topografie des Grundstücks, auf Entscheidungen und Planungen im Projekt aus?

9. Inwiefern spielten persönliche, bauliche oder politische Entwicklungen eine Rolle in der zeitlichen Abfolge der Dachbegrünung?

10. Ihrer Einschätzung nach, welche Interessen werden durch die Gründach-Förderung begünstigt und welche werden nicht ausreichend repräsentiert?

Interview Guideline OWNER – english translation

1. What prompted you to initiate the Green Roof project and what goals did you pursue?

2. Could you describe your experiences during the different project phases - from the decision for funding to the completion of the green roof?

3. What challenges did you encounter during the course of the Green Roof project and how did you overcome them?

4. How do you assess the GreenRoofPLUS funding program in light of your experiences?

5. Describe your interactions with the Rainwater Agency during the course of the project!

6. Which tasks of the Rainwater Agency did you find particularly important in the collaboration?

7. To what extent did the structural conditions of the building influence the planning and implementation of the rooftop greening?

8. How did local conditions, such as location or topography of the property, influence decisions and planning in the project?

9. To what extent did personal, structural or political developments play a role in the timeline of the roof greening?

10. In your estimation, which interests are favored by the green roof funding and which are not adequately represented?

Interviewleitfaden RTWB - deutsch

1. Wie sieht für Sie die Zukunft der Berliner Dächer aus?

2. Inwiefern lässt sich dies auf Berlins Bestandsgebäuden realisieren?

3. Was sind die zentralen Herausforderungen bei der Umgestaltung des Bestands?

4. Welche Lösungen würden Sie dafür vorschlagen?

5. Wie bewerten Sie das GründachPLUS-Förderprogramm (1.000 Grüne Dächer) vor dem Hintergrund Ihrer Vorschläge?

6. Wie schätzen Sie den Erfolg dieses Förderprogramms ein?

7. Welche Erfahrungen haben Sie mit der Berliner Regenwasseragentur gemacht?

8. Welche Funktionen der Regenwasseragentur sind Ihrer Ansicht nach zentral?

9. Wie schätzen Sie die Rolle der Regenwasseragentur bei der Umsetzung der Gründach-Förderung ein?

10. Wie schätzen Sie das Potential der Berliner Bestandsgebäude für eine flächendeckende Dachbegrünung ein?

11. Welche Rolle spielen dabei Ihrer Meinung nach die jeweiligen lokalen Besonderheiten?

12. Inwiefern sehen Sie einen Zusammenhang der Gründach-Förderung in Berlin mit dem weiteren Sanierungsgeschehen bzw. sonstigen Trends?

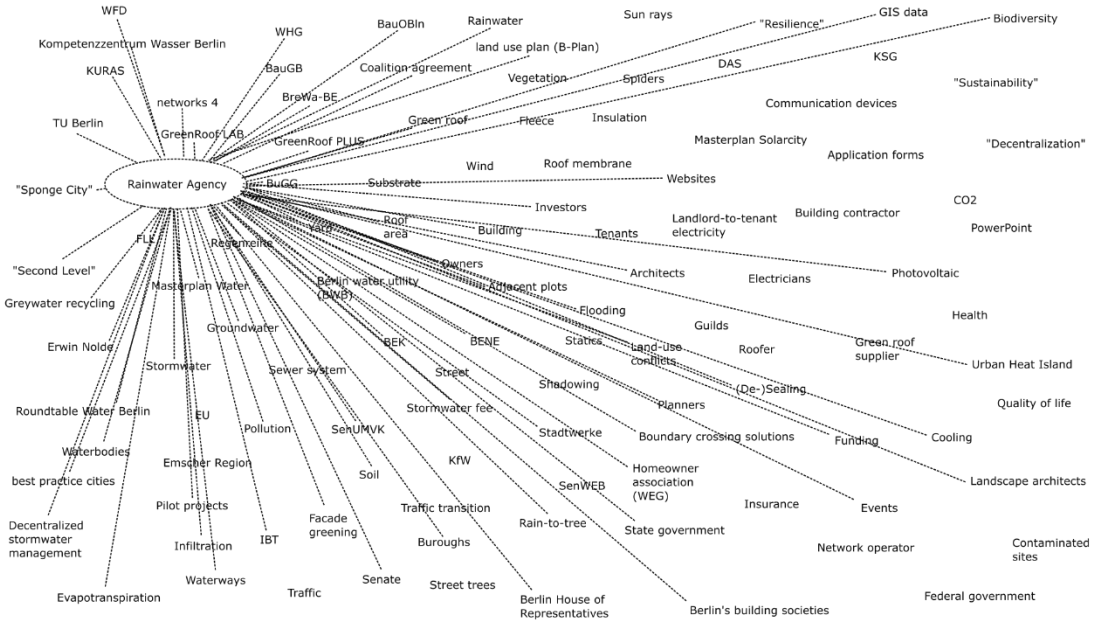
13. Welche Interessen sind Ihrer Meinung nach in der Gründach-Förderung in Berlin berücksichtigt, welche sind unterrepräsentiert?

Interview Guideline RTWB – english translation

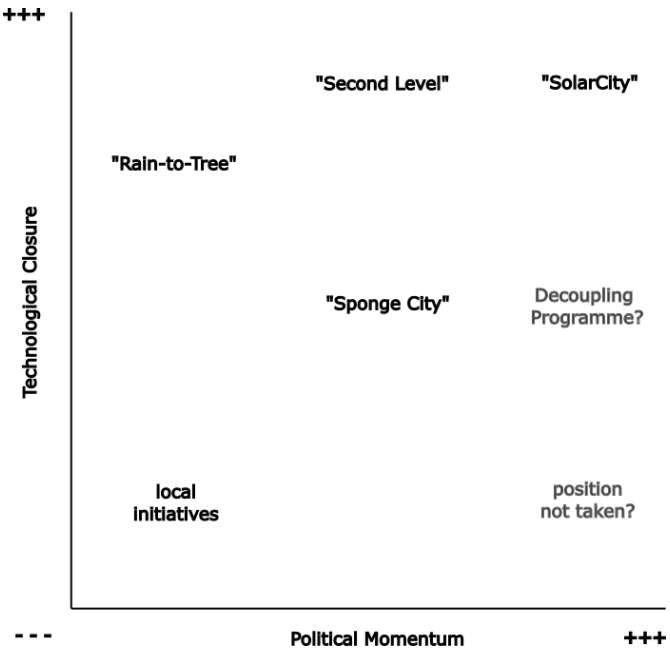
1. What does the future of Berlin's roofs look like to you?
2. To what extent can this be realized on Berlin's existing buildings?
3. What are the central challenges in redesigning the existing stock?
4. What solutions would you suggest for this?
5. How do you assess the GreenRoofPLUS funding program (1,000 Green Roofs) in light of your suggestions?
6. How do you estimate the success of this funding program?
7. What experiences have you had with the Berlin Rainwater Agency?
8. Which functions of the Rainwater Agency do you consider to be central?
9. How do you assess the role of the Rainwater Agency in implementing the green roof funding?
10. How do you assess the potential of Berlin's existing buildings for comprehensive rooftop greening?
11. What role do you think local specifics play in this?
12. To what extent do you see a connection between the green roof funding in Berlin and other renovation activities or trends?
13. Which interests, in your opinion, are considered in the green roof funding in Berlin, and which are underrepresented?

Appendix 4: Maps

Messy Situational Map



Relational Map RWA



Positional Map