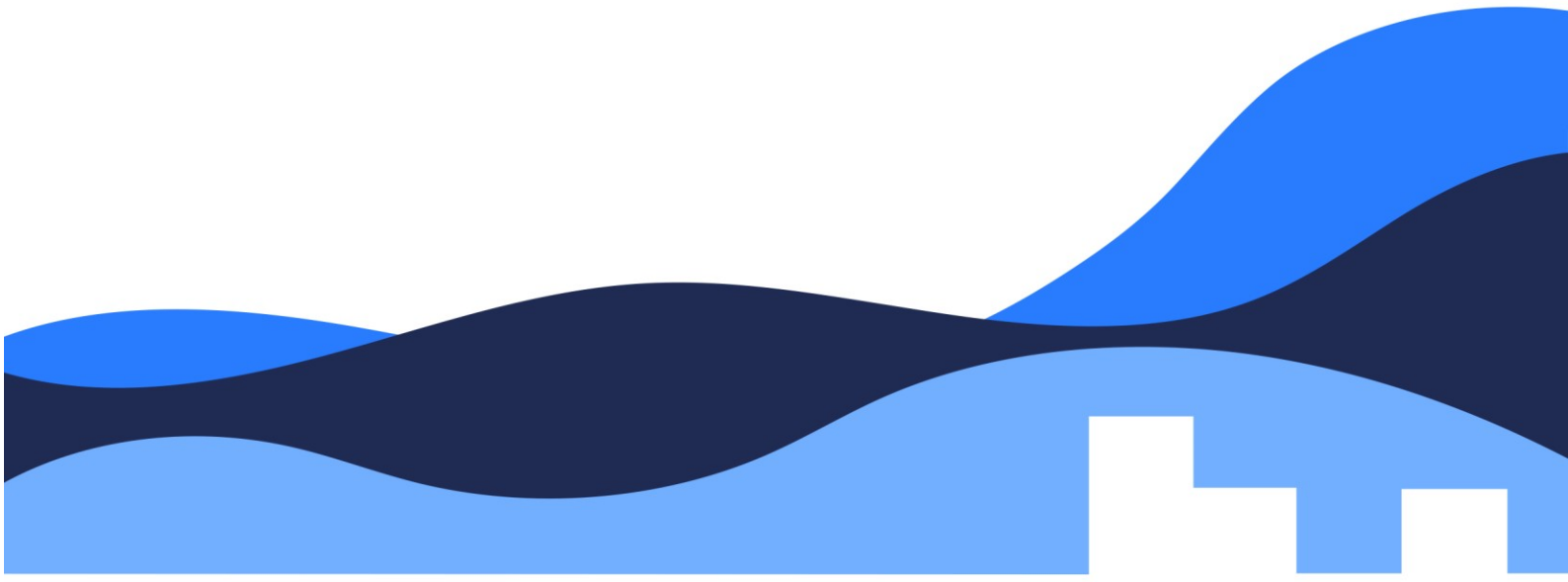
# DWC Guiding Protocol

## For the Assessment of Digital Water Governance Systems with Particular Focus on Favourableness to Innovation



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| Abstract | This deliverable introduces the guiding protocol for Work Package (WP) 3 of the digital-water.city project. It serves as an overarching framework to link the methodologies and results of the different WPs and to allow for comparability between different case studies conducted within WP3. To facilitate research on digital water governance systems in urban areas, the guiding protocol introduces a 'Governance Assessment Framework'. This framework helps identify non-technical factors that enable or hinder the uptake of information and communications technology (ICT) solutions to sustainability issues in the water sector. |
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Dissemination level of the document

| | | |
|---|---|---|
| X | PU | Public |
| | PP | Restricted to other programme participants |
| | RE | Restricted to a group specified by the consortium |
| | CO | Confidential, only for members of the consortium |

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## List of Acronyms and Abbreviations

| | |
|---|---|
| AR | Augmented Reality |
| DWC | digital-water.city |
| EU | European Union |
| GIS | Geographic Information Systems |
| GW | Collaborative Planning and Group Ware |
| ICT | Information and Communications Technology |
| NGO | Non-Governmental Organisation |
| QR | Quick Response |
| R&D | Research and Development |
| WP | Work Package |

## Glossary

**Coordination and Cooperation**

Coordination means that different stakeholders (organisations) develop strategies, plans etc. separately, but take into account (inform and/or consider) the work and interests of other relevant stakeholders. Cooperation, by contrast, means the joint elaboration of strategies, plans etc. and even joint action (Margerum & Robinson, 2015; Pahl-Wostl & Lebel, 2011).

**Decentralisation**

Decentralisation describes the extent to which power over decision-making in a system is dispersed among its members (Mintzberg, 1980). Vertical decentralisation refers to the extent to which formal decision-making power is delegated down to the chain of line authority while horizontal decentralisation designates the extent to which power flows informally outside this chain of line authority (Mintzberg, 1980). A system, in which decision-making authority lies exclusively with the central government, is thus centralised to a maximal extent. A system, in which governments on subnational levels have all decision-making authority, is, in turn, maximally decentralised.

Importantly, vertical and horizontal decentralisation are not mutually exclusive. Digital water governance, in this sense, features a combination of both. Decision-making powers in





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the water and in the digital domain have both been devolved vertically, for instance, from national ministries to local authorities, and horizontally: due to the cross-cutting nature of digital water governance, a multitude of stakeholders has been increasingly involved in consultation and decision-making.

**Governance**

Governance can be defined as the various institutionalised modes of social coordination to produce and implement collectively binding rules, or to provide collective goods (Börzel & Risse, 2010, p. 114).

**Governance Modes**

Governance modes refer to the various forms through which governance can be realised. One widely used classification is the distinction between bureaucratic hierarchies, networks and markets as the main governance modes. They may be understood as ideal types in the Weberian sense since, in reality, any individual mode will rarely occur in isolation (Pahl-Wostl, 2009). An operationalisation of how these governance modes manifest in different governance contexts makes them amenable to empirical investigation (Pahl-Wostl, 2015).

**Hierarchical Governance**

In hierarchies, coordination is achieved through top-down orders based on legitimate authority (Pahl-Wostl, 2015). Using a top-down approach, the focus is on the setting of objectives and rule-making, the allocation of tasks and responsibilities, and on lines of control (Bouckaert & et al., 2016). Prototypes of hierarchical governance are bureaucratic organisation and firms (Bouwma, Gerritsen, Kamphorst, & Kistenkas, 2015).

**Market Governance**

Market governance relies on prices to coordinate exchange between self-interested actors (Bouwma et al. 2015, based on Williamson 1985). Markets are based on a combination of formal and informal institutions and non-state actors are dominant (Pahl-Wostl, 2015).

**Networked Governance**

Networks are based on informal institutions and states as well as non-state actors (Pahl-Wostl, 2015). In networks, coordination is achieved through interactions "between actors whose interorganizational relations are ruled by the acknowledgement of mutual interdependencies, trust and the responsibilities of each actor" (Bouckaert and et al. 2016, p. 36). Networked governance integrates distributed capacities for problem solving and policy-making by making use of governance networks that can self-organise within bounds to help support certain policy-making functions (Huppé, Knoblauch, & Creech, 2012).

**Hybrid Forms of Governance**

Hybrid forms of governance are a combination of governance modes. Most governance settings in the real world are characterised by such hybrid forms of governance (Pahl-Wostl, 2015).

**Digital Water Governance**

Adapting a water governance definition by Pahl-Wostl (2015) to the specific context of digital innovation, we define digital water governance here as the social function that regulates





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the management of water resources and provisions of water services by the means of ICT solutions at different levels of society. It comprises all actors, processes, regulations, structures and ICT solutions involved.

**Digitisation and digitalisation**

In the context of this project, we distinguish digitalisation and digitisation. Digitisation describes the material process of converting analogue streams of information into digital bits (Brennen & Kreiss, 2016). Digitalisation, by contrast, refers to the adoption or increase in use of digital or computer technology by an organisation, industry, country, etc., and thus to the way digitisation is affecting economy and society (OECD, 2017). In the water sector, relevant digital technologies applied in this process include data collection devices and equipment such as sensors, monitors and satellites, data processing systems such as geographic information systems (GIS) and modelling software, but also data sharing tools such as cloud computing, among others.

**Innovation**

"An innovation is a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process). The definition uses the generic term 'unit' to describe the actor responsible for innovations. It refers to any institutional unit in any sector, including households and their individual members" (OECD, 2018, p. 20).

**Learning** according to Pahl-Wostl (2009)

> **Single-loop learning** refers to a refinement of actions to improve performance without changing guiding assumptions and calling into question established routines. Incremental changes in established practice and action aim at improving the achievement of goals. This kind of learning might also include a first improvement of the capacity to make and implement collective decisions.
>
> **Double-loop learning** refers to a change in the frame of reference and the calling into question of guiding assumptions. 'Reframing' implies a reflection on goals and problems (for example by resetting priorities, including new aspects and changing boundaries of system analysis) and assumptions on how goals and solutions can be achieved. Such reframing occurs within structural constraints. Therefore, social learning processes are an essential part of double-loop learning which might lead to changes in the actor network characterising the governance system. Improvement is achieved by experimenting with innovative approaches and new kinds of measures.
>
> **Triple-loop learning** refers to a transformation of the structural context and factors that determine the frame of reference. This kind of societal learning refers to transitions of the whole regime (e.g., change in regulatory frameworks, practices in risk management, dominant value structure). Transforming requires recognition that paradigms and structural constraints impede an effective reframing of resource governance and management practices. Learning processes involve actors that go far beyond the established governance system. Transformation implies a change in paradigm and, in the end, of underlying norms and values. The structural change will lead to a transition of actor networks where new actors come into play, boundaries and power structures are changed and new regulatory frameworks are introduced.





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**Polycentric governance**

Polycentric governance systems consist of multiple centres of authority and distribution of power along with effective coordination structures. According to Vincent Ostrom,

> "[p]olycentric connotes many centers of decision-making which are formally independent of each other.... To the extent that they take each other into account in competitive relationships, ...[they]...enter into various contractual and cooperative undertakings or have recourse to central mechanisms to resolve conflicts..., the various political jurisdictions in a [functionally interlinked] ...area may function in a coherent manner with consistent and predictable patterns of interacting behaviour. To the extent that this is said to be so, they may be said to function as a 'system'" (Ostrom et al. 1961, p. 831)

**Stakeholder**

„[A]ny person, group or organisation with an interest or 'stake' in an issue, either because they will be affected or because they may have some influence on its outcome. Stakeholders may include other government bodies."(Ridder et al. 2005).

**Sustainability**

Sustainability is defined as "meeting the needs of the present without compromising the ability of future generations to meet theirs." (World Commission on Environment and Development, 1987). For development to be sustainable, it must take account of social, ecological, and economic factors (United Nations Economic and Social Commission for Asia and the Pacific, 2015).

**Water Governance**

Water governance is the social function that regulates development and management of water resources and provisions of water services at different levels of society. It comprises all actors, processes and structures involved. Good water governance guides water use towards a desirable state and away from an undesirable state (Pahl-Wostl, 2015).

**Water Management**

Water management refers to the activities of analysing and monitoring water resources, as well as developing and implementing measures to keep the state of a water resource within what has been negotiated as desirable bounds (Pahl-Wostl, 2015).

**Water Governance and Management System**

A water governance and management system is the interconnected ensemble of political, social, economic and administrative elements that performs the function of water governance and of water management. These elements embrace institutions as well as actors and their interactions (Pahl-Wostl, 2015).





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## Executive Summary

European cities face major challenges to achieve the desired level of sustainability in the management of urban water systems. The main goal of the project digital-water.city (DWC) is to improve the integrated management of water systems in five major European urban and peri-urban areas by leveraging the potential of data and innovative digital technologies. In the cities of Berlin, Milan, Copenhagen, Paris and Sofia, DWC develops and demonstrates 15 advanced ICT solutions to address current and future water-related challenges. These challenges include protecting human health, improving the economic performance and cost-effectiveness of water infrastructures and involving citizens in urban water management, among others.

Based on three case studies in Berlin, Milan and Paris, work package three (WP3) aims to draw out good practices and 'lessons learnt' for future decision-making in management areas where water and ICT governance intersect. Conceptually, the introduction of ICT solutions by public authorities to be used by the public, as in the three case studies, is best understood as a citizen-government interaction in which information flows between different stakeholders are restructured, in this case from the government to the citizens ('G2C'). The question is how to ensure that these innovative ICT solutions are not only developed, but also successfully implemented and used by end-users ('uptake'). To analyse barriers to and enablers of such innovation, WP3 analyses which governance factors hinder or encourage end-users to take up innovative ICT solutions.

To ensure a coherent analysis of the governance systems in the different city case studies, WP3 was tasked with providing a guiding protocol. The guiding protocol introduces a Governance Assessment Framework that aims to identify non-technical factors relevant for the successful implementation of ICT solutions in digital water management and give concrete recommendations for their uptake. The guiding protocol serves as an overarching framework to allow for comparability between the different case studies conducted within WP3. Furthermore, it is an attempt to link the two bodies of literature around ICT and water governance, which have yet to be merged. Therefore, the guiding protocol provides a novel approach, adapting existing governance assessment frameworks to the particular challenges of the governance of ICT solutions to water management.

The guiding protocol proposes a generic framework that should not only guide governance assessments within the DWC project but can also be applied in assessments of digital water governance systems beyond the project context. It proposes to assess the uptake of ICT solutions in the water sector in three steps: The first step consists of a description of the city case study, its broad characteristics, and the analysed ICT solution(s). The second step consists of applying a 'Governance Assessment Framework' to help identify factors that enable or hinder the uptake of ICT solutions and their sustainability benefits in each case study. The Governance Assessment Framework provides a systematisation of different themes concerning the digital governance of water into five dimensions of governance and a set of hypotheses as well as a set of questions guiding the empirical research. In a third step, the findings from the analysis will inform the development of a written synthesis that examines the influence of several aspects of the governance system on the uptake of ICT solutions to water management.



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# 1. Introduction

## 1.1. Objective of WP3

The use of integrated, real-time information and communication technology (ICT) solutions, such as sensors, monitors, geographic information system (GIS) and satellite mapping and other data sharing tools in urban water management, is believed to contribute to social, environmental and economic sustainability (Bjornlund et al., 2018). However, factors that enable or hinder the uptake of innovative ICT solutions aiming at greater sustainability in urban water management as well, as the risks of greater reliance on ICT solutions, are still poorly understood.

Against this backdrop, the digital-water.city project (DWC) pilots 15 innovative ICT solutions for water management in the five cities Berlin, Copenhagen, Milan, Paris and Sofia. WP3 explores enabling and hindering factors as well as risks of ICT solutions to water governance. It does so by closely analysing the development and uptake of three of the piloted ICT solutions: An early warning system of bathing water quality in Paris, an Augmented Reality (AR) mobile application for groundwater visualisation in Berlin and a 'serious game' to raise awareness of water reuse in Milan. The question is how to ensure that innovative ICT solutions to water management are not only well developed, but are also successfully implemented and actually used by end-users ('uptake') in the long-term. To analyse barriers to and enablers of such sustainable innovation, DWC analyses which governance modes hinder or encourage end-users to take up innovative ICT solutions ('innovative governance' and 'innovation friendly governance'). Therefore, WP3 analyses both governance structures and ICT solutions in the local setting of each case study to give policy recommendations. The question is approached from two angles within WP3. Firstly, based on case studies, 'lessons learnt' about the sustainable uptake of ICT solutions of the DWC project to governance are drawn out (Project Deliverables 3.4 and 3.5). Secondly, a policy matrix (Deliverable 3.2) maps existing political and legal structures on water governance and ICT governance to shed light on their intersections and resulting opportunities and problems. WP3 focusses on overarching societal and ecological factors whereas WP1, WP2 and WP4 deal with technical aspects.

## 1.2. Objective of this Document

This guiding protocol serves as an overarching framework to ensure comparability in analysing digital water governance systems between the different case studies within WP3 as well as beyond the project context of DWC. For this reason, the guiding protocol introduces a Governance Assessment Framework that aims to identify non-technical factors relevant for the successful implementation of ICT solutions in digital water management and give concrete recommendations for their uptake. In short, the Governance Assessment Framework presented in this document has been developed to answer the following research questions:

- What are governance conditions/modes at the different stages of the transformation processes that enable and facilitate the uptake of ICT solutions in urban water management?
- What barriers hinder the uptake of ICT solutions in urban water management?





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- What are favourable governance conditions/modes at the different stages of transformation processes that enable and facilitate public participation in innovation in urban water management?
- Does the application of ICT solutions lead to (more) sustainable water management? Under what (governance) conditions?
- Digitalisation can be seen as a learning process of adopting innovation. How open are the respective governance systems to learning processes?

This guiding protocol sets the scene to answer these questions by providing conceptual clarifications of relevant key terms (see section 1.2), introducing the Governance Assessment Framework (see section 2) and giving guidance on its application in practice (see section 3). As outlined below, this framework builds on the theoretical foundations of the DROP and DESSIN tools and a review of relevant literature, as well as stakeholder consultations during a World Café Meeting held in Berlin in September 2019.

The approach outlined in the following sections is important and novel for several reasons. Firstly, a profound analysis of relevant governance systems is a prerequisite for the successful uptake of the ICT solutions and, in the end, for achieving sustainability goals. In this line, important 'lessons learnt' and 'good practices' can be drawn from pilot studies which will improve future decision-making on larger scales. In this context, DWC is an attempt to link the two bodies of literature around ICT and water governance, which have yet to be merged. Therefore, the guiding protocol provides a novel approach, adapting existing Governance Assessment Frameworks to the particular challenges of the governance of ICT solutions to water management. Secondly, iterative processes of developing ICT tools can help to increase their acceptance among users and harness their environmental benefits. Thirdly, the in-depth study of case studies enables identifying risks and challenges of an increased reliance on ICT solutions in water management. Finally, as empirical research into the nature and characteristics of involving citizens in Smart City projects remains scarce (Gooch, Wolff, Kortuem, & Brown, 2015), this research also sets the scene to fill this gap.

Due to its overarching character, the guiding protocol is not only interlinked with other tasks and deliverables of WP3 but also with those of other WPs within the DWC project (see Figure 1). On the one hand, the review of different strands of literature presented in this document can be used in the preparation of other deliverables of the DWC project, such as in the initial market assessment of WP5 (Quadruple Helix Brief (Deliverable 5.3)) and in designing the policy matrix (Deliverable 3.2). On the other hand, certain deliverables can benefit from the insights gathered by assessing the digital governance systems in the respective case studies. Thus, the Governance Assessment Framework that is presented in this document will guide the governance assessments of the different case studies and inform the reports on perception, acceptance and use of digital solutions (Deliverable 3.4, 3.5). Ultimately, the findings generated through the application of the Governance Assessment Framework can also supplement the policy recommendations that will be presented at the end of the project (Deliverable 3.3).





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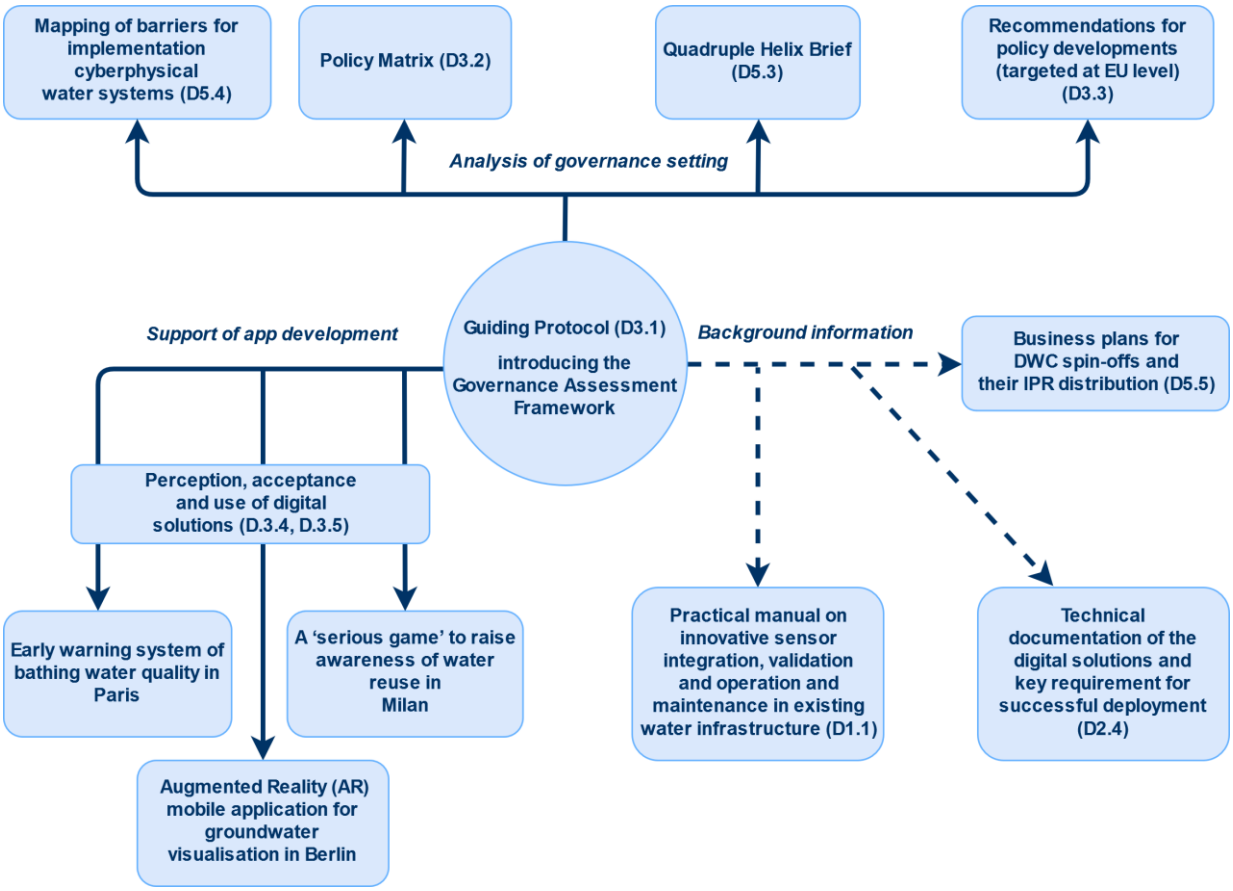
Figure 1: Linkages of the Guiding Protocol to Other Project Activities




## 1.3. Setting the Scene: Innovation and Governance in the Context of WP3

European cities face major challenges to achieve the desired level of sustainability in the management of urban water systems. Powerful and innovative digital technologies such as mobile devices, sensor networks, real-time monitoring, machine learning and modelling tools have the potential to improve the management of water infrastructures significantly. In addition, they can increase the quality of service provided to citizens and the levels of awareness and collaboration between utilities, authorities and citizens in urban water management. However, concerns regarding lacking ICT regulation as well as insufficient data protection, interoperability, congruent ICT ontologies and cybersecurity remain and hinder the uptake of innovative ICT solutions in water management.

In DWC WP3, the main starting point is that the digital water governance system is critical for enhancing the benefits of ICT solutions in urban water management and decreasing potential adverse effects. Digital water governance is a cross-sectoral issue requiring a transdisciplinary and multi-level approach (Rouillard et al. 2014). While definitions for the term ICT governance exist, these often locate ICT governance solely within the realm of corporate governance. So far, concise definitions of ICT governance in the context of urban water systems are lacking. Thus, we will start by proposing a working definition of *digital water governance* before proposing further conceptual clarifications.

Adapting a water governance definition by Pahl-Wostl (2015) to the specific context of digital innovation, digital water governance can be defined as the social function that regulates the





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management of water resources and provisions of water services by the means of ICT solutions at different levels of society. It comprises all actors, processes, regulations, structures and ICT solutions involved. In the context of innovation uptake in urban water management, governance can be analysed looking at "the combination of the relevant multiplicity of scales, actor-networks, goals, strategies, responsibilities and resources that forms a context". This context restricts and enables specific actions and interactions in the uptake of innovations in urban water management (Rouillard et al., 2014).

Another important clarification refers to the concept of innovation. According to the OECD, "an innovation is a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process). The definition uses the generic term "unit" to describe the actor responsible for innovations. It refers to any institutional unit in any sector, including households and their individual members." (OECD, 2018, p. 20). Rouillard et al. have defined innovations more specifically in the context of urban water management: "Innovations are associated with technologies, understood as concrete measures, products or tools, that have led or are leading to what can be considered a significant change in urban water management locally" (Rouillard et al., 2014, p. 14). While technical aspects are dealt with in other WPs, we focus on social and organisational aspects in WP3.

## 1.4. The ICT Solutions to Be Analysed in WP3

While 15 innovative ICT solutions in five cities are piloted in the DWC project, WP3 focuses on the following ICT solutions:

- Development of a mobile application in Paris to communicate bathing water contamination risks to residents. Based on the total number of visitors of the single bathing site of la Villette in Paris (53,000 in 2017), Paris' authorities expect a rise to 100,000 annual users with the opening of new bathing sites in the region until 2024 and many more during the Olympic Games. DWC aims at reaching 30% of the future visitors of the bating sites with their mobile application, i.e. 30,000 citizens.
- Development of an Augmented Reality (AR) mobile application in Berlin visualising geology and groundwater to highlight their relevance as drinking water resource and "hidden part" of the water cycle. In Berlin, drinking water production relies mainly on managed aquifer recharge using the natural underground for treatment and storage. Although functioning very efficiently, the natural underground is invisible for drinking water consumers. The goal of "making groundwater visible" is to increase trust in the natural treatment technique, highlight the excellent drinking water quality and foster tap water consumption against bottled water. The initiative will accompany the action of local non-profit associations such as 'a tip: tap' and increase public acceptance of future investments to strengthen treatment capacities and upgrade barriers for the removal of e.g. trace organic compounds in the urban water cycle. DWC aims to reach 20,000 Berlin citizens every year with wide dissemination at guided waterworks tours, public events, school initiatives and the installation of QR codes at the city's drinking water dispensers and along the publically accessible well sites.
- Development of a 'serious game' in Milan to raise awareness and engage the public to overcome social and economic barriers to water reuse. The game-embedded web-based visualisation tool will allow citizens to interact with data and support the


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understanding of the complexity of the nexus of water availability, carbon emissions, energy consumption, food crop productivity and climate variability. It aims to show that the nexus is not only theory, and to communicate the benefits of water reuse in term of the nexus. DWC aims to reach more than 5,000 citizens in the Lombardy region in Italy by fully incorporating the game in the communication strategy of CAP, the water utility in Milan.

At their core, these three pilot innovations are about restructuring information flows between different stakeholders. To examine the influence of ICT on public participation in urban water governance, Mukhtarov et al. (2018) present a helpful typology comprising four categories of citizen-government interaction in the context of ICT-facilitated public service provision. These include

- citizen sourcing (C2G): the public helps the government to be more responsive and effective (Linders, 2012);
- government as a platform (G2C): information and knowledge passes from a government to citizens;
- "Do it yourself" government (C2C): citizens use ICT to play games, exchange experiences and self-organise for learning and action; and
- collaborative planning & groupware (GwC): ICT-induced participatory forms of planning with face-to-face interaction between citizens and a government representative.

Applying this typology to the DWC project, all three ICT solutions can be characterised as a G2C interaction as they are mainly about information and knowledge passing from government to citizens. Applying the above-discussed definitions, the three interventions may additionally be described as *innovative* G2C interactions: They are innovative in so far, as they approach existing problems not only in a way that differs significantly from previous approaches to these problems but also apply ICT in a new context.





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## 2. Presentation of the DWC Governance Assessment Framework

This chapter introduces the DWC Governance Assessment Framework and outlines how it can be applied to the respective case studies. To do so, it will first provide some background on the framework and then, in a second step, move to discussing its application. To apply the framework, each of its dimensions will be operationalised through a set of questions to guide interviews and further research.

Instead of developing a Governance Assessment Framework from scratch, the frameworks developed in other projects with similar research interests serve as a starting point. Particularly relevant are insights from the Interreg DROP and DESSIN projects (see boxes 1 and 2).

**Box 1: The Drop Governance Assessment Framework**

The INTERREG IVb DROP project ("Benefit of governance in DROught adaPtation") (2013-2015) aimed at enhancing the preparedness and resilience to water scarcity and drought in North-West Europe.

Part of the project was the development of a Governance Assessment Framework to analyse water governance settings and enable effective drought adaptation (Bressers et al., 2014). The model draws attention to the governance conditions that can hinder water resources management policies and projects under complex and dynamic conditions.

The DROP Governance Assessment Framework builds on 'Contextual Interaction Theory'. In this theory, operational decision-making and implementation processes are studied examining three actor characteristics: motivations, cognitions and resources. The theory assumes that relevant actors derive their capacity and power from these three factors. They are influenced by case-specific circumstances and the general context such as technological development (Bressers et al., 2016) (see Figure 2). Also, the governance structure can exert direct influence on the motivations, cognitions and resources of the stakeholders involved and thus on the process and its likelihood of success. The three characteristics of the actors shape the process, but are, in turn, influenced by the course and experiences in the process and can therefore change during the process. Key actor characteristics drive social interaction processes but are also reshaped by the process. Deliberate strategies of actors involved can force such changes both within other actor groups and within their own group or organisation.

In DROP, this procedure was used to assess the context of regional drought settings as well as to formulate regional roadmaps to optimise regional governance settings.

**Box 2: The DESSIN Governance Assessment Framework (Rouillard et al. 2014)**

The DESSIN project (2014-2018) demonstrated and promoted innovative solutions for water scarcity and water quality related challenges and demonstrated a methodology for the valuation of ecosystem services. The project was funded by the Directorate-General Research and Innovation of the European Commission.

DESSIN applied the DROP scheme of drought resilience to the context of innovation uptake in urban water management. It therefore represented a spatial shift in water governance, applying it to the city dimension. Thus, it drew on the DROP framework to cover relevant





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dimensions and criteria, and used existing knowledge to make questions more applicable to the context of innovation uptake in urban water management.

Building on these existing frameworks carries several advantages. Firstly, both Governance Assessment Frameworks provide a coherent theoretical basis for the analysis of governance in European environmental policy regimes. Secondly, DESSIN analysed innovation uptake in urban water management building on a modified DROP Governance Assessment Framework. Thus, there are considerable thematic overlaps to the research objective in DWC. Finally, the existing frameworks have already been tested and have a high policy and practice relevance: the data generated can be easily applied and translated into good practices and policy recommendations.

The DWC Governance Assessment Framework proposed here adjusts the DESSIN and DROP Governance Assessment Frameworks by aligning them with the objectives of DWC WP3 and thus focusing on *digital* water governance in particular. Also, in contrast to the DESSIN framework, the DWC framework presents not only guiding questions but also hypotheses derived from research findings (see section 2). It is important to note, though, that these hypotheses are primarily meant to structure the assessment of governance rather than to provide a set of hypotheses which are all ready to be tested. To facilitate the linking and structuring of different research areas which are engaged with digital water governance but are yet to be merged, the hypotheses offered in this guiding protocol are deliberately left broad. Ideally, they will serve as inspiration for more specific hypotheses which can be specified in case studies.

DWC assumes that multi-actor processes can be understood by looking at motivations, cognitions and resources of the stakeholders involved in the process (H. Bressers et al. 2014: 10). These characteristics of stakeholders are influenced by their circumstances, which again originate from previous decisions (seeFigure 2 below). The governance context can also directly influence motivations, cognitions and resources of stakeholders, and, in doing so, the process of innovation uptake itself. In other words, DWC conceptualises governance as a context that is structuring action instead of perceiving governance as the action itself. Such an angle acknowledges that the same or a similar action/intervention may lead to different outcomes depending on how the wider (political) culture, motivations and resources of relevant actors play out in different contexts. Thus, in each case study, the DWC Governance Assessment Framework assesses the structures and qualities of governance systems rather than governance actions themselves.

The governance system as a whole can be thought of as consisting of five dimensions (H. Bressers et al. 2014; H. T. A. Bressers et al. 2016). In our context, these are:

- **Administrative levels and hydrological scales** relevant for the uptake of the digital solution;
- **Actors, networks and communication channels** relevant for the uptake of a digital solution;
- **Perceptions of the governance problem, narratives and goal ambitions** of these actors;





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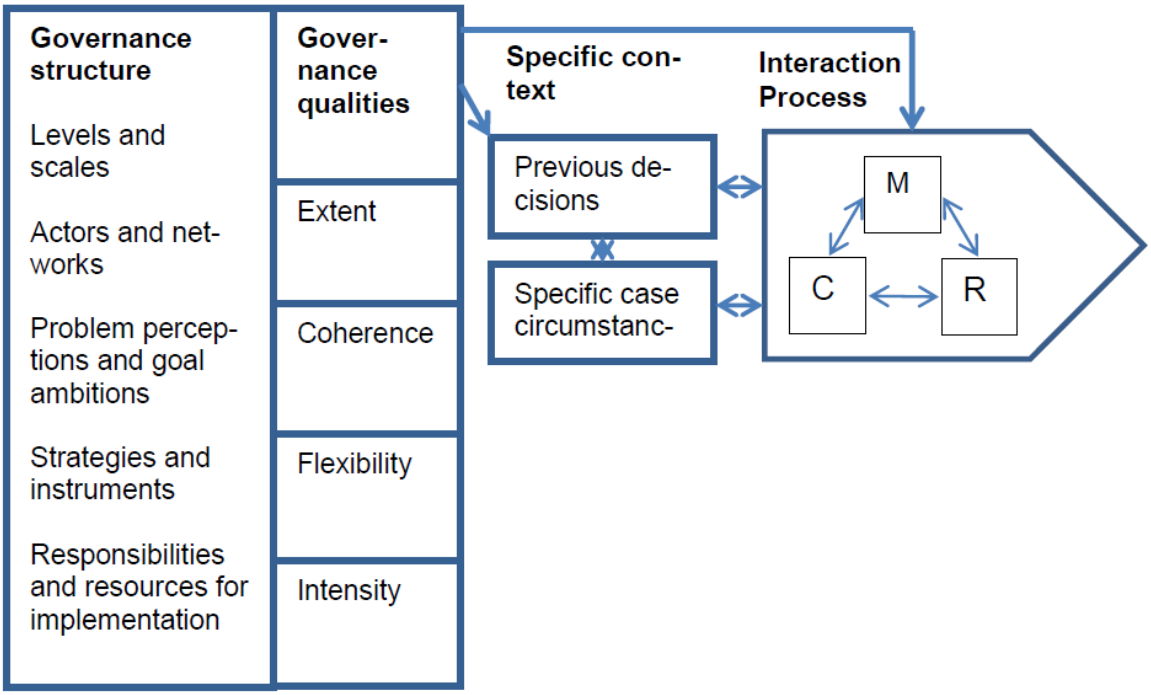
- **Strategies and instruments** relevant actors apply to realise their goal ambitions as well as policies and regulatory frameworks that enable and/or constrain these actors in realising their goal ambitions;
- **Responsibilities and resources** for implementation of relevant actors.

**Figure 2: Governance Assessment Framework**




Source: Bressers et al. 2014, 11

The Governance Assessment Framework structures the research process. To gather concise information, sets of guiding questions and hypotheses for each dimension of the 'governance structure' were specified. The hypotheses and guiding questions (see Annex 2) of the Governance Assessment Framework guide the analysis of each of the five dimensions along four criteria of "governance qualities": extent, coherence, flexibility and intensity. The guiding questions may be best understood as a starting point for assessing individual cases and should be adjusted to the respective city contexts (see section 3 for more information).

The hypotheses and guiding questions were derived from both scientific and more policy-centred research and grey literature on innovative and innovation-friendly modes of digital water governance in the context of urban water management. This was done searching Google Scholar, Scopus and SCCI using combinations of relevant key words (e.g. participation, ICT governance, urban, water management, public involvement, innovation, digital, smart city, transition, transformation, barrier, benefits, enablers, change). The findings of a World Café session, held during DWC kick-off meeting (Berlin, September 2019) with representatives of utilities of the five pilot cities, also informed the development of the guiding questions and hypotheses by providing crucial information on the status quo of digital water governance. The session showed that there is still no common understanding within the water sector of what the term 'ICT governance' denotes in the context of technological innovation in the sector. The session also illustrated that in the different cities, digitalisation has been integrated quite differently. Furthermore, finding solutions to





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technical challenges associated with the introduction of new technologies often overshadow political or social risks and challenges in the water sector. Overall, an overarching policy framework for governing ICT solutions in the water sector remains largely absent.

The following sections will present each dimension of the governance structure and respective guiding questions, along with the relevant sources and hypotheses on which they are based in more detail.

## 2.1. Levels and Scales

In the Governance Assessment Framework underpinning this research, levels and scales are conceptualised as hydrological scales (e.g. catchments, water bodies, rivers, lakes, surface run-off, sub-surface flows, reservoirs, pipes, drains, tanks, gutters, houses, gardens, parks) and administrative levels (i.e. municipal, regional, national, European) relevant to digital water governance in the particular case study context.

**Findings from relevant literature**

*Fragmentation*

The reviewed literature shows that in water management, multiple levels are interrelated to form complex, nested systems of rules that tend to maintain the status-quo (Markard, 2011; Marlow, Moglia, Cook, & Beale, 2013; Taverne, 2006). In a similar vein, the European Innovation Partnership on Water (EIP Water, 2014) identified fragmentation of tasks and powers across multiple organisations as a major barrier to innovation in the water sector.

*Decentralisation*

Leigh and Lee (2019) find that decentralised water technologies can alleviate disproportionate access to urban water services, enhance the energy efficiency of compact and mixed-use development, and attract more financial resources. Additionally, they can create opportunities for community involvement and inter-sectoral collaborations. Rijke et al. (2013) suggest that decentralised and informal governance modes are particularly effective in early stages of transformation processes (i.e. adaptation and transition processes), whilst formal and centralised approaches become more effective during later stages of transformation. They argue that in the later stage centralised governance approaches can enable greater knowledge sharing within and across organisations through collecting, collating, synthesising and distributing project outcomes and lessons learned and, as such, effectively make use of the resources available (i.e. financial and human capital, knowledge).

**Hypotheses**

H1: The degree of centralisation of the water governance system has an influence on the opportunities of public involvement in urban water management.

Degree of centralisation → devolution of decision-making power to subordinate levels → changed opportunities for public involvement

H2: The degree of fragmentation and territorial integration has an influence on the uptake of the ICT solutions.

Degree of fragmentation and territorial integration → coordination between levels and across scales → consideration of interactions between levels and scales → influence on innovative and innovation friendly modes of digital water governance → influence on the uptake of ICT solutions





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**Guiding questions**

The first step is to describe which scales and levels are relevant to the digital water governance in the specific case. Subsequent question address different aspects on the performance and quality of these levels and scales. Potential questions include:

| Criteria | Guiding Questions |
|---|---|
| Context | • What **administrative levels** (i.e. public authorities at municipal, regional, national, European level) are relevant for innovation uptake? And why?<br>• Which **authorities** in particular? And why?<br>• How do they become **responsible** (e.g. general responsibility for digital water governance)?<br>• Which **hydrological scales** do they relate to? |
| Extent | • Are important **administrative levels not involved** in the decision-making process? With which effect?<br>• Does **coordination** between different administrative levels or hydrological scales exist? If yes, to what extent?<br>• Does **cooperation** between different administrative levels or hydrological scales exist? If yes, to what extent? |
| Coherence | • Are there **conflicts or synergies** between **administrative levels**? What are examples for those synergies or conflicts?<br>• Are there **conflicts or synergies** between **hydrological scales** and **administrative levels**? What are examples for those synergies or conflicts?<br>• Is **fragmentation** occurring as a result of decentralisation? |
| Flexibility | • Can **all administrative levels** potentially take **leadership/participate** in shaping digital water governance?<br>• Is it possible for **new levels or scales** to **take leadership/participate** in shaping digital water governance? |
| Intensity | • Is one particular **administrative level dominant** in shaping digital water governance?<br>• Is **one particular actor** within a particular administrative level **dominant** in shaping digital water governance? |

## 2.2. Actors, Networks and Communication Channels

In the context of DWC, actors and networks include the range of public authorities, private companies, civil society organisations, political activists and other stakeholders, and the inter-organisational structures (e.g. fora), involved in, benefiting from or impacted by the digital water governance system.





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**Findings from relevant literature**

*Relevant stakeholders*

Stakeholders influencing innovation uptake in the urban water management system are diverse. In this project, they are grouped according to their stake in the decision-making process (Butterworth & Morris, 2007):

- Key organisations **responsible** for water management and related sectors that make decisions or effect changes in policy and practice (e.g. policy makers, municipal/local government personnel, service providers, regulatory authorities, architects and planners, policy analysts and advisors etc.);
- Actors that **influence** and can pressure decision-makers directly (e.g. civil society, water user groups, individuals professional associations, unions);
- Local 'leading lights' (activists or champions) working to address **cross-cutting** issues such as sustainable development, poverty, gender, and environmental degradation;
- Those who can support, reinforce and strengthen research activities and **recommendations** (e.g. academia and research organisations);
- The media that provide means by which innovation can **reach wider audiences** and the public (e.g. profession magazines); and
- Banks and other **investment** agencies, including the donor community, who fund infrastructure and other activities (including research).
- Other actors may include technology-related actors such as laboratories, manufacturers, and distributors (Rouillard et al. 2006). Brouwer and Huitema (2018) suggest so-called policy entrepreneurs, i.e. highly talented and exceptional bureaucrats, who are constantly on the alert for new opportunities (for policy change) and have the capacity to ''sell'' and ''market'' innovations. What distinguishes policy entrepreneurs from other participants in the policymaking process is their above-average willingness to take risks.

*Barriers to actor cooperation*

The literature identifies several barriers that impede the above-mentioned stakeholders from cooperating effectively on water management issues. A lack of strategic and planning capabilities within and across organisations hinders innovation uptake in the water sector, in particular due to actors being small and largely independent of each other while having very different interests (EIP Water, 2014). In addition, sectoral fragmentation, i.e. a lack of integration and collaboration between sectors, is a barrier to innovation in the water sector (EIP Water, 2014). Limited exchange between relevant stakeholders such as innovators, manufacturers, distributors, and end-users can also reduce the usability of innovations and act as a major obstacle to their uptake (Rouillard et al. 2006).

*Collaboration and participation in the innovation process*

Much of the reviewed literature highlights that innovation uptake benefits from greater exchange and collaboration between actors (Pouwels & Koster, 2017). Potential approaches include "communities of practice" (Wenger & Snyder, 2000), "communities of innovation" (Coakes & Smith, 2007), "living labs" (Almirall & Wareham, 2010) or "learning alliances"





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(Verhagen, Butterworth, & Morris, 2008) to enhance institutional learning through fostering informal debates about problems and potential solutions.

Some studies suggest that increased participation and consultative networks foster system transformation and innovation uptake (e.g. Makropoulos et al. 2013; Smits et al., 2008). In this context, ICT tools can help to understand social and political realities in water governance, e.g. through collecting public opinion, public narratives and lived experiences of citizens, thus playing a broader role than simply enabling or hindering public participation (Mukhtarov et al., 2018). Others remain critical of the benefits of participation, arguing that convincing examples of successful citizen involvement in urban innovation in smart city projects are lacking (Gooch et al., 2015; Hering, Waite, Luthy, Drewes, & Sedlak, 2013).

Similarly, some authors criticize innovative participatory instruments such as citizen apps as insufficient:

> *"While citizen apps create opportunities for people to discuss and convey their opinion to the government, there is no way to ensure that the opinions of people are being heard and considered in government decision making." (Desouza & Bhagwatwar, 2012, p. 134).*

Similarly, Mukhtarov et al. (2018) argue that ICT tools provide only few opportunities for citizens to engage in deliberations and exercise authority over decisions on urban water governance.

*Deliberation, citizen awareness and empowerment*

ICT tools alone are not sufficient to trigger change towards participatory governance of urban water systems (Mukhtarov et al., 2018). Thus political innovations are needed rather than technological ones (Mukhtarov et al., 2018). Rather than automatically triggering social and political change, ICT tools may be used for understanding social and political realities in water governance, e.g. through collecting public opinion, public narratives and lived experiences of citizens. Thus, by enabling a greater understanding of these realities in water governance, ICT tools play a broader role than simply enabling or hindering public participation (Mukhtarov et al., 2018).

However, this potential of ICT tools to increase citizen's understanding of social and political realities in water governance is challenged by the digital divide in urban areas. Often, the active involvement of particular segments of the population in order to empower them is hampered if they lack the ICT skills or access to relevant technologies (Paskaleva, 2011). Therefore, an in-depth consideration of potential target groups is crucial when designing ICT solutions that aim at environmental benefits by inducing behavioural change, as the potential for behavioural change differs across the population (Brauer et al., 2016). Such solutions might also benefit from game-like elements that can motivate behavioural change of users (Brauer et al., 2016).

*Social learning*

Pahl-Wostl (2009) has highlighted the importance of societal learning processes for improved water governance. Learning processes lead to a transition of actors' networks with new actor groups coming into play. She proposes a stepwise approach of assessing learning processes comprising single-loop, double-loop and triple-loop learning (see glossary).





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**Hypotheses**

H3: Communities of practices enhance the openness of relevant stakeholders to innovative and innovation-friendly modes of digital water governance in urban water management.

Establishing community of practice → ↑ exchange and deliberation on innovative and innovation-friendly modes of digital water governance, policy and public involvement → ↑ learning → ↑ openness to these modes

H4: The digital divide challenges the potential of ICT solutions to contribute to resource-efficient and sustainable water management.

Digital divide → exclusion of certain segments of the population → limited impact of the app → ↓ environmental benefits

H5: ICT solutions that foster public involvement in urban water governance can contribute to resource-efficient and sustainable water management.

ICT solutions fostering public involvement → ↑ awareness, exchange and learning → behavioural change → ↑ resource-efficient and sustainable water management

**Guiding questions**

The first step is to describe the characteristics of actors and networks before turning to quality and performance aspects. Potential questions may include:

| Criteria | Guiding Questions |
|---|---|
| Context | • **Which actors** are actively **involved in the uptake** of the digital solution? And why?<br>• **Which actors** are only **involved as affected** by or beneficiaries of the innovation? And why?<br>• What **forms of dialogue** (e.g. public participation, expert fora, communities of practice etc.) exist between actors? Are they informal or institutionalised? Why is this the case?<br>• Are **new communication channels**, such as social media, considered? If yes/no, why? If they are used, are they considered successful? |
| Extent | • Are **all relevant actors** involved in the relevant fora for innovation uptake? If certain actors are excluded, what are the reasons for this exclusion (e.g. digital divide)? |
| Coherence | • How would you describe the **interactions and opposition** between actors?<br>• Does **coordination and/or cooperation** between actors exist? If so, **what actors play a crucial role in coordinating and enhancing cooperation**?<br>• Are there actors with a **mediating role**? |
| Flexibility | • Is it possible for **new actors** to be included in relevant fora, e.g. communities of practices? |
| Intensity | • Is there a strong **influence (or pressure) from one or more specific individual actors** ("policy entrepreneurs") and/or **coalitions of actors** towards supporting/preventing innovation uptake? |





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| | |
|---|---|
| | • What role do **civil society/grassroots organisations** play in supporting/preventing innovation uptake? |

## 2.3. Problem Perceptions, Narratives and Goal Ambitions

Problem perceptions, narratives and goal ambitions are, in the context of DWC, the different perceptions and positions of relevant stakeholders towards digital water governance and their relevance for enabling/constraining innovation in urban water management. Goals, and their definitions, depend largely on the perceptions of the problems at hand. An engineer or a water utility representative, for example, is likely to have a different perception of how certain urban water management problems can be solved than a social scientist or a representative of a civil society organisation.

**Findings from relevant literature**

*Involving users in developing ICT solutions*

Particularly when citizens are involved in evaluating and developing innovative ideas for smart cities, innovativeness and user benefit do not necessarily align (Gooch et al., 2015). This points to different ambitions of relevant stakeholders. Research finds that potential users of innovations in water management do not necessarily use the most innovative solution, but the one they perceive to be the most satisfactory one, influenced by factors such as uncertainty, habits, privacy concerns and cost of change (Eggimann et al., 2017). Although Gooch et al. (2015) agree that ideation through crowdsourcing does not yield radical, breakthrough ideas they find that users still seem to be better at developing ideas that provide solutions to their problems compared to experts. This challenges the notion that a solution that is considered innovative always provides a solution to a given problem that is superior to a solution considered less innovative. At the same time, it highlights a tension between innovativeness and user-friendliness that has to be taken into consideration in the research process.

Desouza and Bhagwatwar (2012) analysed 20 “citizen apps” intended to solve complex urban problems and found that all were developed by professional developers, often based on the developers perception of the app’s user benefit. Thus these apps “were developed with citizen in mind but not necessarily with their involvement” (Gooch et al., 2015).

*Problem perceptions and concerns*

Privacy, health and cost concerns are a major obstacle to innovation uptake in urban water management. A core obstacle to data-driven urban water management, such as applying smart metering, is consumer back-lash as a result of misinformation and concerns for privacy, health and costs (Eggimann et al., 2017). Worker’s unions have also pointed to unsolved questions of data access and sharing and raised concerns about regulatory loopholes once Internet of Things-enabled devices are applied in water management (Vereinte Dienstleistungsgewerkschaft (Ver.di), 2018). Questions of data protection, misuse and ownership were also described as a major barrier to digitalisation in the World Café Meeting. Others have pointed to the security risks associated with greater reliance on ICT tools (Ntuli & Abu-Mahfouz, 2016). Also, workers’ unions are concerned that rigid digitalisation in the water sector will lead to adverse effects for workers, such as job losses (Vereinte Dienstleistungsgewerkschaft (Ver.di), 2018).





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*Change in practices and learning processes*

The necessary adaptation to increased data availability requires a change in engineering and management practices which consider the adoption of new types of models and takes into account uncertainty and risks (Eggimann et al., 2017). However, the general tendency towards risk aversion in urban water management poses a barrier to innovative change (EIP Water, 2014). When only little evidence of innovative solutions is available, pilot studies and trials can promote uptake and reduce uncertainties (Marlow et al., 2013). Also, policy entrepreneurs with their above-average willingness to take risks can promote change (Brouwer & Huitema, 2018).

Several studies have identified a lack of cultural change in water management practitioners' behaviour towards more openness for emerging and multi-disciplinary approaches (Hering et al., 2013; Marlow et al., 2013). In a similar vein, Pahl-Wostl (2009) pointed towards the importance of societal learning processes that can change paradigms and underlying norms and values.

**Hypotheses**

H6: The extent to which potential users are involved in developing ICT solutions in urban water management issues influences the user benefit of the solution.

Extent of involvement of potential users in developing ICT solutions → change in the orientation towards problem solving → influence on user benefit

H7: Involving potential users in developing ICT solutions in urban water management issues hinders innovativeness with respect to solutions solely created by developers.

Close involvement of potential users in developing ICT solutions → ↑ relying on familiar and approved concepts → ↓ innovativeness

H8: A system in which relevant governance actors are open to learning processes facilitates the uptake of innovative ICT solutions.

Openness to learning processes → ↑ adaptations in the governance system → uptake of ICT solutions

**Guiding questions**

The first step is to describe what positions are held by different actors and what is stipulated in the relevant policies before assessing their quality and performance. Drawing on these ideas, potential questions may include:

| Criteria | Guiding Questions |
|---|---|
| Context | • Are **different perceptions** present in the debate on the uptake of the digital solution take? Which are they? And why? |
| Extent | • How **similar/different is the goal** associated with the uptake of the digital solution from the **status quo**? |
| Coherence | • To what extent do **views/arguments/positions support each other,** and to what extent are they in **competition**? |
| Flexibility | • To what extent do actors engage in **reframing narratives**? Under what **circumstances**? |





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| Criteria | Guiding Questions |
|---|---|
| | • Are **compromises** made in the process of innovation uptake? Why (not)?<br>• Are **potential users and their perspectives involved** in developing and evaluating digital solutions? Why (not)?<br>• Have there been **unforeseen events** that have changed the process of the uptake of digital solutions?<br>• Does **new knowledge of the system** (e.g. ecological, social, economic) play a role in enabling uptake?<br>• To what extent have **narratives, power and regulatory frameworks changed** during uptake? |
| Intensity | • To what extent does **one/several perspective(s) dominate** the process of uptake? And why?<br>• Is **innovation uptake a primary concern** for both users and developers? Why or why not? |

## 2.4. Strategies and Instruments

Strategies and instruments are, in the context of DWC, the particular approaches and the regulatory, economic and voluntary forms of policy action influencing the uptake of innovative ICT solutions in the urban water sector. Findings on this governance dimension, in particular, will feed into the development of a policy matrix to be compiled in WP3 of the DWC project.

**Findings from relevant literature**

*Financial policies and the regulatory environment*

Policy instruments on urban water management can create barriers to innovation uptake (e.g. when they forbid specific activities or by-products, see (Rijke et al., 2013)) but can also drive innovation uptake (e.g. by requiring new standards (Desouza & Bhagwatwar, 2012)). The current standard of public procurements in the European Union, for instance, can impede innovation uptake by preferring lowest cost offers and proven technologies (EIP Water, 2014). In addition, the cost of certifying multiple products in multiple countries is prohibitive, resulting ultimately in a limited deployment of technologies to only few large scale processes per country that justify the costs. This ultimately often leads to the adoption of sub-optimal technologies (EIP Water, 2014).

The EU water sector is characterised by a complicated regulatory environment along/across the various political hierarchy levels (see 2.2.1 Levels and scales) that results in fragmentation (e.g. different regulations and standards per region) (EIP Water, 2014). Although many entrepreneurs have obligations for ICT governance, there is no tool or guideline on good practices and factors that enable or hinder ICT solutions. Thus, homogenising requirements across the EU has the potential to stimulate innovations and their diffusion at lower costs (EIP Water, 2014). The European Single Market for Water provides a starting point for such a homogenisation (Anzaldi Varas, 2018).





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*Privacy and data protection policies*

Privacy and data protection policies have also been identified as being at the core of constraining and enabling digitalisation in the water sector (Eggimann et al., 2017). In the particular case of mobile apps, the success of citizen apps efforts will depend heavily on the development of open data standards (Desouza & Bhagwatwar, 2012). Standards are essential for the inter-operability of applications across geographical scales and multiple sectors, for increasing the diffusion of applications that leverage open data (Desouza & Bhagwatwar, 2012).

In the particular case of GIS platforms that address certain sustainability challenges, Stuermer et al. (2017) argue that four conditions need to be present to maximise societal benefit. They need to have an open licensing regime with the right to use and modify the platform for anyone, a participatory culture throughout the entire lifecycle, decentralised quality control of the platform as well as diversified funding.

**Hypotheses**

H9: Existing standards which give preference to low(est) cost offers and proven technologies hinder innovation uptake.

Standards preferring lowest cost offers and proven technologies → market entry for innovations is hampered → ↓ innovation uptake

H10: High risks and uncertainty around adopting new management practices make innovation uptake in urban water management less likely.

High risks and uncertainty of adopting new management practices → ↑ probability of sticking to old practices due to risk aversion → ↓ innovation uptake

**Guiding questions**

The first step is to describe strategies and policy instruments relevant for innovation uptake before assessing their quality and performance. Drawing on these ideas, potential questions may include:

| Criteria | Guiding Questions |
|---|---|
| Context | • **Which strategies and policy instruments** are relevant for the innovation (e.g. standards)? Do they reflect a **regulative, incentive, communicative, or technical approach**?<br>• In particular, what **pricing policy and financial cycle arrangements** exist? What **costs** do they include (e.g. capital, maintenance, resource, environmental)?<br>• Who is **providing the funding** needed for innovations to become implemented? |
| Extent | • **How (specific rules, mechanisms)** do the different strategies and policy instruments (intentionally or unintentionally) **facilitate** innovation uptake?<br>• In particular, **how** do **pricing policies and investment cycles** influence innovation uptake? |





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| Criteria | Guiding Questions |
|---|---|
| Coherence | • Are there any (intended or unintended) **synergies** and/or **conflicts** between strategies and instruments? |
| Flexibility | • Can policy-makers **adjust policies and instruments** to support innovation uptake?<br>• If so, to what extent have **underlying assumptions, norms and values been changed** through these adjustments?<br>• In particular, can **pricing policies and/or timing of expenditure** be adjusted as a way of facilitating innovation uptake? |
| Intensity | • Are **strategies and policy instruments effective** in encouraging innovation uptake?<br>• In particular, are **pricing policies and/or timing of expenditure adequate to raise/support resources** for innovation uptake?<br>• Do **several actors provide funding for innovation uptake**? |

## 2.5. Responsibilities and Resources

Responsibilities and resources are the allocation of tasks, powers and capacities within the digital water governance system influencing innovation uptake in urban water management.

**Findings from relevant literature**

*Allocation of responsibilities*

Again, fragmentation of tasks and powers across multiple organisations potentially creates barriers to innovation uptake (EIP Water, 2014). For example, water quality monitoring agencies may focus on measuring chemicals that are part of their statutory duties, rather than attempt to measure emerging pollutants (and adopt relevant innovations for measuring those) (Rouillard et al. 2006).

The predominant governance mode (i.e., the various forms through which governance can be realised; see glossary) influences a governance system's capacity for effective cooperation as well as for the coordination of tasks (Pahl-Wostl et al., 2019). The distinction between hierarchies, networks and markets as ideal-typical governance modes has proven useful for analysing complex and hybrid governance settings (Pahl-Wostl, 2019). Nevertheless, some scholars argue that hybrid governance modes characterised by a synergistic interplay between governance modes are most suitable to deal with complex water management challenges and enhance effective coordination (Pahl-Wostl, 2019; Pahl-Wostl et al., 2019). As different governance styles operate according to different logics, the combination of these styles is, however, by no means straightforward (Pahl-Wostl, 2019). Instead, incompatibilities and contradictions may lead to ineffective and inefficient approaches and even to severe conflicts rather than expected synergies (Pahl-Wostl, 2019).

*Financial constraints*

Investment cycles and financial constraints influence innovation uptake. SMEs moving ahead with innovative solutions in the water sector still face a lack of financial resources (both in total funding and continuity) for further development, customisation, demonstration and commercialisation (EIP Water 2014; Rouillard et al. 2006). Similarly, water companies face,





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in some circumstances, a low pay-back on investments and weak profitability, which can limit interest in risky initiatives such as innovation uptake (EIP Water, 2014).

Innovation uptake is also highly dependent on investment cycles which, in the water sector, are oriented towards large-scale, long-term investments: transformation therefore usually occurs in times of massive needs of re-investment (Markard, 2011). Water service providers' revenues are often linked to the volume of potable water used by customers, so widespread implementation of alternative water sources and/or water conservation measures can reduce revenues (Mitchell, 2007). Properties connected to centralised infrastructure also pay standing charges to cover the capital cost of the infrastructure. This is a significant component of customer bills, so decreasing the reliance on centralised water provision would therefore not necessarily be reflected in a significant cost saving to the community, which reduces incentives for uptake of innovative urban water management options (Marlow et al., 2013).

**Hypotheses**

H11: The degree of centralisation of decision-making influences the speed of innovation uptake

Degree of centralisation of decision-making → Complexity communication and decision-making channels → Influence on speed of Innovation uptake

H12: A lack of funding in the water sector hinders the uptake of ICT solutions.

Lack of funding → prioritisation of covering running costs → ↓ resources available to promote ICT solutions → uptake of ICT solutions is hindered

**Guiding questions**

The first step is to describe the allocation of tasks and the resources available to execute those tasks. Potential questions may include:

| Criteria | Guiding Questions |
|---|---|
| Context | • What are the **mandates** (as set by statutes and regulations) of the different actors that are of relevance for the innovation uptake?<br>• What **modes of governance** (hierarchy, market, network, hybrid, polycentric) are dominant in the governance system?<br>• What **technical, financial, knowledge, social, cultural** (e.g. norms, values, symbols, artefacts) **resources** are available/used to encourage innovation uptake? |
| Extent | • Are there any **"missing" types of mandates** and resources for enabling innovation uptake? |
| Coherence | • Does **the allocation of responsibilities and mandates** create **cooperation or struggles** on innovation uptake? Why (not)? |
| Flexibility | • Can **roles, responsibilities and resources be adjusted** to support innovation uptake? In particular, does **capacity-building** play a role in innovation uptake? Why (not)?<br>• Are **roles, responsibilities and resources allocated** in a way that allow addressing governance problems related to innovation uptake in a flexible way? |





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| | |
|---|---|
| Intensity | • Are **responsibilities and statutory powers** (i.e. specific legal authority granted to enforce/enable mandates) **effective** in enabling innovation uptake? Why (not)?<br>• Are **sufficient resources** allocated to enable innovation uptake? Why (not)? |





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# 3. Guidance for the Application of the DWC Governance Assessment Framework

The guiding protocol proposes to assess the case studies in three steps. The first step involves introducing the case study. The second step involves answering the guiding questions laid out in the Governance Assessment Framework as outlined the previous sections. The third step consists of moving from the question-answer format to developing a synthesis of innovation uptake and governance system influence. Developing the synthesis will be structured along the five governance dimensions (levels and scales; actors, networks and communication channels; perceptions of the governance problem, narratives and goal ambitions; strategies and instruments; and responsibilities and resources).

The next pages describe the stepwise application of the Governance Assessment Framework to the respective case studies to be conducted in Deliverables 3.4 and 3.5.

## 3.1. Step 1: General Case Study Description

The analysis should start by briefly introducing key social, environmental and economic characteristics of the case study (e.g. size, population, etc.), and its main challenges (e.g. in particular those related to innovation uptake). After that, the ICT solution and its key purposes (e.g. water quality improvement, water scarcity, flood risk reduction) should be described. Moreover, it can be important to illustrate technical barriers to its uptake (e.g. mismatch with existing infrastructure, complexity of technology) before turning to non-technical factors in the governance assessment.

## 3.2. Step 2: Application of the Governance Assessment Framework

The next step involves answering the proposed guiding questions regarding governance factors on innovation uptake (developed in chapter 2) based on desk-research and interview evidence. A detailed step-by-step guidance through the interview can be found in the appendix. The questions developed serve to diagnose the influence of governance factors on innovation uptake, guide the analysis in a comprehensive manner, ensure consistency and comparable results, and support the development of the syntheses (section 3.3). The questions suggested are model interview questions that can be used as drafted, or adapted to the particular context of the city case.

Ecologic Institute will be responsible for collecting data for the case studies in Berlin and Milan, while IRSTEA will conduct the data collection for the Paris case study. In the respective case studies, they will analyse the data collected, identify key knowledge gaps and guide the next data collection step.

**Box 3: On Carrying Out Interviews (Rouillard et al., 2014)**

Guiding questions will be answered based on data collected during interviews. Target interviewees might be: operators of urban water services; river basin / water authorities; local council planners; regulatory agencies; R&D organisations; manufacturers / distributors; civil society representatives (e.g. environmental NGOs, consumer groups), etc.

The interview questions should encourage the interviewee to describe and explain the role of governance in the process of innovation uptake. While some of the questions listed under Annex 1 can be used in the interviews, it is highly recommended to follow a more gradual approach and apply standards of good practices in carrying out interviews. This





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means starting with open questions before asking more specific and targeted ones in order to ensure that the interview is not biased towards particular factors or dimensions.

Potential topics to start the interview may be past involvement with urban water management at the time of innovation uptake or previous experiences with ICT solutions in the sector.

Within the data collection process, the following approach is recommended:

- Based on personal knowledge, documentary evidence and existing contacts, to try and answer as many questions as possible, and single out important ones;
- Identify key knowledge gaps, and carry out a small number of interviews (e.g. 4-5) with relevant stakeholders and experts;
- Expand as necessary.

### 3.3. Step 3: Documenting Findings in a Synthesis

After conducting interviews with relevant stakeholders, the interview material will be coded and analysed along the five governance dimensions proposed in the Governance Assessment Framework. Based on this, enabling and hindering non-technical factors conducive to the uptake of ICT solutions for each dimension will be assessed. Finally, the findings should be documented in the form of a written synthesis structured along the five governance dimensions. This synthesis is the last step of the analysis, and is supposed to describe key processes, factors as well as risks influencing innovation uptake in the particular case study. The synthesis should be based on the answers to the guiding questions and written by the city case study leader (in an iterative review process involving other researchers and potentially interviewees). The objective for those developing the synthesis is to maximize neutrality and objectivity by taking into account different stakeholders and their positions and by placing emphasis on facts and general principles. Based on the case study findings, the synthesis should provide recommendations on specific modifications of the governance system in order to enhance the uptake of ICT solutions and to maximise their environmental benefits in the particular case.





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## 5. Appendix

**Annex 1: List of guiding questions to inform the interview guideline**

***Levels and scales***

| Criteria | Guiding Questions |
|---|---|
| Context | • What **administrative levels** (i.e. public authorities at municipal, regional, national, European level) are relevant for innovation uptake? And why?<br>• Which **authorities** in particular? And why?<br>• How do they become **responsible** (e.g. general responsibility for digital water governance)?<br>• Which **hydrological scales** do they relate to? |
| Extent | • Are important **administrative levels not involved** in the decision-making process? With which effect?<br>• Does **coordination** between different administrative levels or hydrological scales exist? If yes, to what extent?<br>• Does **cooperation** between different administrative levels or hydrological scales exist? If yes, to what extent? |
| Coherence | • Are there **conflicts or synergies** between **administrative levels**? What are examples for those synergies or conflicts?<br>• Are there **conflicts or synergies** between **hydrological scales** and **administrative levels**? What are examples for those synergies or conflicts?<br>• Is **fragmentation** occurring as a result of decentralisation? |
| Flexibility | • Can **all administrative levels** potentially take **leadership/participate** in shaping digital water governance?<br>• Is it possible for **new levels or scales** to **take leadership/participate** in shaping digital water governance? |
| Intensity | • Is one particular **administrative level dominant** in shaping digital water governance?<br>• Is **one particular actor** within a particular administrative level **dominant** in shaping digital water governance? |

***Actors, networks and communication channels***

| Criteria | Guiding Questions |
|---|---|
| Context | • **Which actors** are actively **involved in the uptake** of the digital solution? And why?<br>• **Which actors** are only **involved as affected** by or beneficiaries of the innovation? And why?<br>• What **forms of dialogue** (e.g. public participation, expert fora, communities of practice etc.) exist between actors? Are they informal or institutionalised? Why is this the case?<br>• Are **new communication channels**, such as social media, considered? If yes/no, why? If they are used, are they considered successful? |
| Extent | • Are **all relevant actors** involved in the relevant fora for innovation uptake? |





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| | |
|---|---|
| | If certain actors are excluded, what are the reasons for this exclusion (e.g. digital divide)? |
| Coherence | • How would you describe the **interactions and opposition** between actors?<br>• Does **coordination and/or cooperation** between actors exist? If so, **what actors play a crucial role in coordinating and enhancing cooperation**?<br>• Are there actors with a **mediating role**? |
| Flexibility | • Is it possible for **new actors** to be included in relevant fora, e.g. communities of practices? |
| Intensity | • Is there a strong **influence (or pressure) from one or more specific individual actors** ("policy entrepreneurs") and/or **coalitions of actors** towards supporting/preventing innovation uptake?<br>• What role do **civil society/grassroots organisations** play in supporting/preventing innovation uptake? |

***Problem perceptions, narratives and goal ambitions***

| Criteria | Guiding Questions |
|---|---|
| Context | • Are **different perceptions** present in the debate on the uptake of the digital solution take? Which are they? And why? |
| Extent | • How **similar/different is the goal** associated with the uptake of the digital solution from the **status quo**? |
| Coherence | • To what extent do **views/arguments/positions support each other,** and to what extent are they in **competition**? |
| Flexibility | • To what extent do actors engage in **reframing narratives**? Under what **circumstances**?<br>• Are **compromises** made in the process of innovation uptake? Why (not)?<br>• Are **potential users and their perspectives involved** in developing and evaluating digital solutions? Why (not)?<br>• Have there been **unforeseen events** that have changed the process of the uptake of digital solutions?<br>• Does **new knowledge of the system** (e.g. ecological, social, economic) play a role in enabling uptake?<br>• To what extent have **narratives, power and regulatory frameworks changed** during uptake? |
| Intensity | • To what extent does **one/several perspective(s) dominate** the process of uptake? And why?<br>• Is **innovation uptake a primary concern** for both users and developers? Why or why not? |





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*Strategies and instruments*

| Criteria | Guiding Questions |
|---|---|
| Context | • **Which strategies and policy instruments** are relevant for the innovation (e.g. standards)? Do they reflect a **regulative, incentive, communicative, or technical approach**?<br>• In particular, what **pricing policy and financial cycle arrangements** exist? What **costs** do they include (e.g. capital, maintenance, resource, environmental)?<br>• Who is **providing the funding** needed for innovations to become implemented? |
| Extent | • **How (specific rules, mechanisms)** do the different strategies and policy instruments (intentionally or unintentionally) **facilitate** innovation uptake?<br>• In particular, **how** do **pricing policies and investment cycles** influence innovation uptake? |
| Coherence | • Are there any (intended or unintended) **synergies** and/or **conflicts** between strategies and instruments? |
| Flexibility | • Can policy-makers **adjust policies and instruments** to support innovation uptake?<br>• If so, to what extent have **underlying assumptions, norms and values been changed** through these adjustments?<br>• In particular, can **pricing policies and/or timing of expenditure** be adjusted as a way of facilitating innovation uptake? |
| Intensity | • Are **strategies and policy instruments effective** in encouraging innovation uptake?<br>• In particular, are **pricing policies and/or timing of expenditure adequate to raise/support resources** for innovation uptake?<br>• Do **several actors provide funding for innovation uptake**? |

*Responsibilities and resources*

| Criteria | Guiding Questions |
|---|---|
| Context | • What are the **mandates** (as set by statutes and regulations) of the different actors that are of relevance for the innovation uptake?<br>• What **modes of governance** (hierarchy, market, network, hybrid, polycentric) are dominant in the governance system?<br>• What **technical, financial, knowledge, social, cultural** (e.g. norms, values, symbols, artefacts) **resources** are available/used to encourage innovation uptake? |
| Extent | • Are there any "**missing" types of mandates** and resources for enabling innovation uptake? |





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| | |
|---|---|
| Coherence | • Does **the allocation of responsibilities and mandates** create **cooperation or struggles** on innovation uptake? Why (not)? |
| Flexibility | • Can **roles, responsibilities and resources be adjusted** to support innovation uptake? In particular, does **capacity-building** play a role in innovation uptake? Why (not)?<br>• Are **roles, responsibilities and resources allocated** in a way that allow addressing governance problems related to innovation uptake in a flexible way? |
| Intensity | • Are **responsibilities and statutory powers** (i.e. specific legal authority granted to enforce/enable mandates) **effective** in enabling innovation uptake? Why (not)?<br>• Are **sufficient resources** allocated to enable innovation uptake? Why (not)? |

**Annex 2: Research questions and corresponding hypotheses**

| Research question | Responding hypotheses |
|---|---|
| What are favourable governance conditions/modes at the different stages of transformation processes that enable and facilitate innovation in urban water management? | H3: Communities of practices enhance the openness of relevant stakeholders to innovative and innovation-friendly modes of digital water governance in urban water management.<br>H4: Involving potential users in developing ICT solutions in urban water management issues brings about higher user benefit than a solution solely created by developers. |
| What are favourable governance conditions/modes at the different stages of transformation processes that enable and facilitate public participation in innovation in urban water management? | H1: The degree of centralisation of the water governance system has an influence on the opportunities of public involvement in urban water management.<br>H4: Involving potential users in developing ICT solutions in urban water management issues brings about higher user benefit than a solution solely created by developers<br>H8: A system in which relevant governance actors are open to learning processes facilitates the uptake of innovative ICT solutions. |
| Does the application of ICT solutions lead to a (more) sustainable water management? Under what (governance) conditions? | H5: ICT solutions that foster public involvement in urban water governance can contribute to resource-efficient and sustainable water management.<br>H6: The extent to which potential users are involved in developing ICT solutions in urban water management issues influences the user benefit of the solution. |





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| Research question | Responding hypotheses |
|---|---|
| What barriers hinder the uptake of ICT innovations in urban water management? | H2: The degree of fragmentation and territorial integration has an influence on the uptake of the ICT solutions.<br><br>H4: Involving potential users in developing ICT solutions in urban water management issues brings about higher user benefit than a solution solely created by developers.<br><br>H9: Existing standards which give preference to low(est) cost offers and proven technologies hinder innovation uptake.<br><br>H10: High risks and uncertainty of adopting new management practices make innovation uptake in urban water management less likely.<br><br>H11: The degree of centralisation of decision-making influences the speed of innovation uptake.<br><br>H12: A lack of funding in the water sector hinders the uptake of ICT solutions. |
| Digitalisation can be seen as a learning process of adopting innovation. How open are the respective governance system to learning processes? | H3: Communities of practices enhance the openness of relevant stakeholder to innovative and innovation-friendly modes of digital water governance in urban water management.<br><br>H7: Involving potential users in developing ICT solutions in urban water management issues hinders innovativeness with respect to solutions solely created by developers. |





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