Governance assessment for circular economy based on water resources (GOCIWA)

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ABSTRACT
This document presents the main output from Task 4.1: A tool for Governance assessment for circular economy based on water Resources (GOCIWA). Our objective is to provide a manual for systematic, qualitative assessment of the conditions, drivers and barriers to circular economy based on water-smart solutions in different governance contexts. GOCIWA builds on previous tools for water governance assessment but pays more attention to multi-sector interactions and the interplay between social and material factors. It was developed through an extensive literature review, then tested in the project demonstration cases and revised. The assessment consists of five steps; definition of scope, by mapping focal action situations, descriptive assessment of the wider societal contexts, structural context and specific context in question, and evaluation, where the descriptive findings are related to a set of evaluative questions, to identify and nominally rank barriers and drivers stemming from the different context levels. The evaluation is summarised in a simple scorecard, which provides an overview of the alignment across contexts and dimensions and provides a starting point for stakeholder dialogue and comparison between cases. The five steps are carefully explained and accompanied by simple assessment charts, operationalizing the key topics and questions for each step. Furthermore, the tool provides a detailed manual for application and support material, in form of an exemplary interview guide and an Excel sheet for data collection and analysis.

KEYWORDS
Water-smart solutions, governance, innovation uptake, transition, circular economy, industrial symbiosis

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Executive summary

Natural resources are continuously being over exploited by the world's population. Water, as an essential natural resource, is under pressure as consumption for individual, industrial and agriculture purposes continues to grow. To counteract the depletion of resources, the concept of a circular economy – where waste is considered as a resource and kept in the loop for as long as possible – is gaining prominence in policy and practice, as well as academic debate.

WIDER UPTAKE is situated in this discourse and development, aiming to increase resource efficiency, limit emissions and develop circular economy based on water-smart solutions. The project demonstrates six different technological solutions concerned with the reuse of wastewater and/or resource recovery from wastewater, in five countries. In order to achieve wider uptake of the demonstrated technologies, there is a need to gain more systematic knowledge of how they fit with existing governance contexts, including infrastructure and resource flows, as well as actor-networks and institutional frameworks. To meet this challenge, the project has developed a governance assessment tool, the *Governance assessment for circular economy based on water resources (GOCIWA).*

GOCIWA builds on previous tools for water governance assessment, but applies a broader system perspective, where multi-sector interactions and the interplay between social and material factors is taken into account. It was developed through an extensive literature review on water governance and circular economy, before being tested on the demonstration cases within WIDER UPTAKE and subsequently revised, based on the experiences from these assessments.

The tool was developed with the purpose of providing practitioners, as well as researchers, with a stepwise and context sensitive manual for assessing the drivers, barriers, and potential for implementation of water-smart solutions. The assessment is largely qualitative, based on desk study and stakeholder interviews. It consists of five steps. It begins by delineating the scope of the assessment, by identifying the physical resources, water management solutions, main actors, sectors, and governance systems in question. Together, these constitute a network of action situations, which may be different in different cases.

Secondly, the wider contexts of the considered water-smart solutions, meaning trends and developments in the broader social, environmental, economic, and political settings that provide the background for the studied actions, are mapped. In the third step, the tool guides the analyst through a systematic assessment of the structural context, considering the interaction between different sectors and administrative levels in scale and time, the strategies, and instruments available to different stakeholders, actor-networks and roles, perspectives and goal ambitions, responsibilities, and resources, as well as prevailing technologies and procedures that may influence innovation uptake.

Fourth, the specific context of the studied case of water-smart solutions is assessed, with a focus on how previous decisions, context-specific circumstances (e.g., in terms of resources, proximity, local entrepreneurship, actor capabilities, etc.), and ongoing processes linked to the studied solutions (e.g., in terms of communication, stakeholder involvement, form of contracts or agreements).

Finally, the assessment tool provides a set of evaluative questions that allow the analyst to assess the effect of all above factors on the studied water-smart solution, how they are aligned, and how factors may change over time. The evaluation is summarised in a simple scorecard, which provides an overview of the alignment across context levels and dimensions and provides a starting point for stakeholder dialogue and comparison between cases.

The five steps are carefully explained and accompanied by a set of simple assessment charts, outlining the dimensions, and operationalizing the key topics and questions for each step. Furthermore, the tool provides a

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detailed manual for application and support material, in form of an exemplary interview guide and an Excel sheet for systematic data collection and analysis.

GOCIWA can be useful for investigation as part of public planning processes, as well as for comparative studies and actors wanting a systematic, independent assessment of institutional drivers and barriers before starting or proceeding with a more specific initiative to implement or upscale water-smart solutions generating circular economy based on water resources.

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1 Introduction

WIDER UPTAKE aims to facilitate industrial symbiosis as a means to increase resource efficiency, limit emissions and develop circular economy based on water-smart solutions. The project will identify and demonstrate measures to overcome barriers related to:

1. 'Monitoring and control of health and quality risks'
2. 'Circular-economy and efficiency potential'
3. 'Governance and business models for industrial symbiosis'
4. 'Measuring water smartness and progress towards SDG'.

It includes demonstrations in Norway, the Netherlands, The Czech Republic, Italy, and Ghana of:

- Wastewater reuse for agriculture and urban greening
- Phosphorus recycling, biogas, and biochar utilisation
- Production of biocomposites for manufacturing materials with resources recovered from the whole water cycle

The barriers to wider uptake of water-smart solutions are not only technological but also organizational, regulatory, social, and economic. Therefore, WIDER UPTAKE has a work package dedicated to governance challenges and business models. The tool for Governance assessment for circular economy based on water resources (GOCIWA) presented in this deliverable is an output from the first task in this work package. The tool has been developed by a multi-disciplinary team of researchers from the mentioned countries. This process had three phases. First a prototype was developed, based on pre-existing tools and recent research literature. Secondly, this prototype was tested in initial assessments linked to the project demonstration cases. The results from these assessments provide input to further work on governance, business models and policy recommendations in WIDER UPTAKE. Lastly the tool was revised, based on the application experiences.

Due to Covid-19 it was not possible to meet physically within the project team and illness hampered the work in some cases. Moreover, conducting interviews with key stakeholders via online tools and phone was challenging in some of the countries. However, a total of 40 stakeholder interviews and 10 virtual meetings with the research team were carried out, and the testing showed that it is possible to apply the tool without travelling and arrangement costs.

Chapters 2 and 3 present the objective and intended target groups. The overarching perspective and core concept of the tool are described in chapter 4. Chapter 5 discusses the context levels and dimensions addressed, while chapter 6 presents a set of assessment charts with descriptive questions for the respective topic areas. A set of evaluation criteria, for application following the descriptive assessment, are presented in chapter 7. Chapter 8 describes how to carry out the assessment, step by step. Chapter 9 is a summary conclusion of the main document.

The theoretical background of the tool is presented and discussed in Annex 1. Annexes 2 and 3 provide an exemplary interview guide and data collection sheet, as supplements to chapter 6.

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2 Objective

A tool for systematic assessment of the governance contexts for water-smart solutions is important as technology development has already reached quite far. The solutions may contribute significantly to a sustainability transition, both in terms of water management, material resource use, responsible production and consumption and the shift towards a renewable energy system. However, some of the most critical remaining barriers are:

- Regulatory and institutional barriers, preventing application of the solutions
- Social acceptance
- Skills shortages within utilities, regarding circular economy concepts
- Conservative value chains, with limited focus on innovation
- Mismatch between market needs and the solutions

All these fall within the area of governance, which we may define as:

"… the combination of the relevant multiplicity of scales, actor-networks, goals, strategies, responsibilities and resources that forms a context that, to some degree, restricts and, to some degree, enables actions and interactions in the uptake of innovations [in urban water management]." (Bressers et al. 2013:6)

While there are common, overriding drivers and barriers, diverse governance regimes have evolved in different countries and regions to regulate the development and management of water resources and services. Our objective is to

provide a tool for systematic assessment of the conditions, drivers and barriers to circular economy based on water-smart solutions in different governance contexts.

Thus, the tool does not go into evaluation of what policy measures or instruments that are more or less apt to facilitate water-smart solutions (this will follow in subsequent tasks in WIDER UPTAKE).

The Governance assessment for circular economy based on water resources (GOCIWA) builds on frameworks previously developed for assessing governance aspects of complex water management challenges. Contextual Interaction Theory (CIT) and the connected DROP governance assessment framework is used as basis.[1] The DROP framework is primarily for integrated resource management concerning water scarcity and drought, but its principles have also been applied to assess governance factors enabling innovation in urban water management, in the DESSIN project.[2] The DROP approach is practice-oriented, aiming to assess to what degree the governance context is supportive or restrictive for the realisation of chosen solutions or policies. However, it is mainly concerned with water governance as such. The focus on water-smart solutions and transitioning towards a circular economy requires a broader perspective, where the interaction between social factors, technology and resource systems across multiple sectors is considered. Hence, we also draw upon insights from more recent frameworks designed to address complex water resource management challenges, sustainability transitions and circular economy.

GOCIWA is largely qualitative. It addresses the interplay between processes at different levels and scales. The roles and functioning of relevant actor networks, their motivations, goals and ambitions, distribution of responsibilities and resources, and relevant policy instruments are considered. Special attention is paid to the interaction between institutional, ecological, and technological factors. Synergies and trade-offs between sector policies, and between various stakeholder interests are also taken into account.

[1] Bressers et al. 2013, and Bressers et al. 2016. For more information and full references, see Annex 1.
[2] Rouillard et al. 2016, see Annex 1 for further detail.

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It aims to provide a simple aid for assessment and ultimately to facilitate wider uptake of water-smart solutions by illuminating drivers, synergies and potential benefits and increasing the awareness of remaining challenges and their implications in specific national and regional settings.

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3 Target groups

The tool is intended for researchers and consultants, as well as public and private decision-makers who want to get an overview or make a "diagnosis" of the governance context, possible barriers, and potential for implementing circular water-smart solutions and developing industrial symbiosis based on reuse and/or resource extraction from water in a specific case or area.

The tool explains key concepts carefully and does not involve complex metrics. Thus, it is well suited for interdisciplinary teamwork. A step-by-step procedure is explained in chapter 7, and results are analysed and summarised in simple ways, to make for easy dissemination and dialogue with different types of stakeholders.

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4 Approach

4.1 Concept of governance

There is a wide variety of perspectives on what defines water governance and how it best may be assessed for different purposes. "New governance" models tend to shift away from a perspective centred on the functional exercise of water management, towards a society-centric, multilevel, collaborative and market-based view.

Contextual Interaction Theory (CIT) sees governance as a multi-actor process where many factors are of influence, but only in so far as they affect the motivations, cognitions and/or resources of the actors. These three main actor characteristics are not only influenced by their social interaction, but also by many external factors forming a multi-layered context with three levels:

1. A **specific context**, including factors like the geographical place where the project or initiative the assessment relates to, and its case history, consisting of previous decision-making and framing.
2. A **structural context**, encompassing the specific context, which includes the established governance regime and the relevant property and use rights.
3. A layer of **wider contexts**, consisting of wider societal developments and trends.

We apply the same set of distinctions, but since our focus is on circularity and industrial symbiosis, engaging originally separate industries in collaboration to generate value from more circular use of resources, we also draw on other strands of research. Beside recent literature on circular economy and industrial symbiosis, these include the Institutional Analysis and Development (IAD) framework, with its focus on institutional processes and more specific action situations, where individual and corporate actors manage natural resources, and socio-ecological system (SES) perspectives, which provide more finely grained analyses of the interaction between actors, governance, and resource systems.

We also draw on socio-technical transitions research, which has a focus on complex system interactions, such as how established socio-technical regimes (e.g., institutions, sunk investments and vested interests) may create path dependence and hinder the uptake of sustainable innovations. Moreover, this perspective takes into account how changing alignments and external events (extreme weather events, market shocks, pandemics etc.) may open "windows of opportunities" for implementation of novel technologies, and how such processes may be actively supported by governance. The insights and methodologies associated with these strands of literature are discussed and fully referenced in Annex 1, on the theoretical background of the tool.

The mentioned literature emphasizes the interaction between social and material processes, and how this takes place at different levels, with different degrees of structuration. Whereas the DROP framework focuses on the Structural context, we thus include the Specific context and the Wider contexts in GOCIWA, as illustrated in Figure 1.

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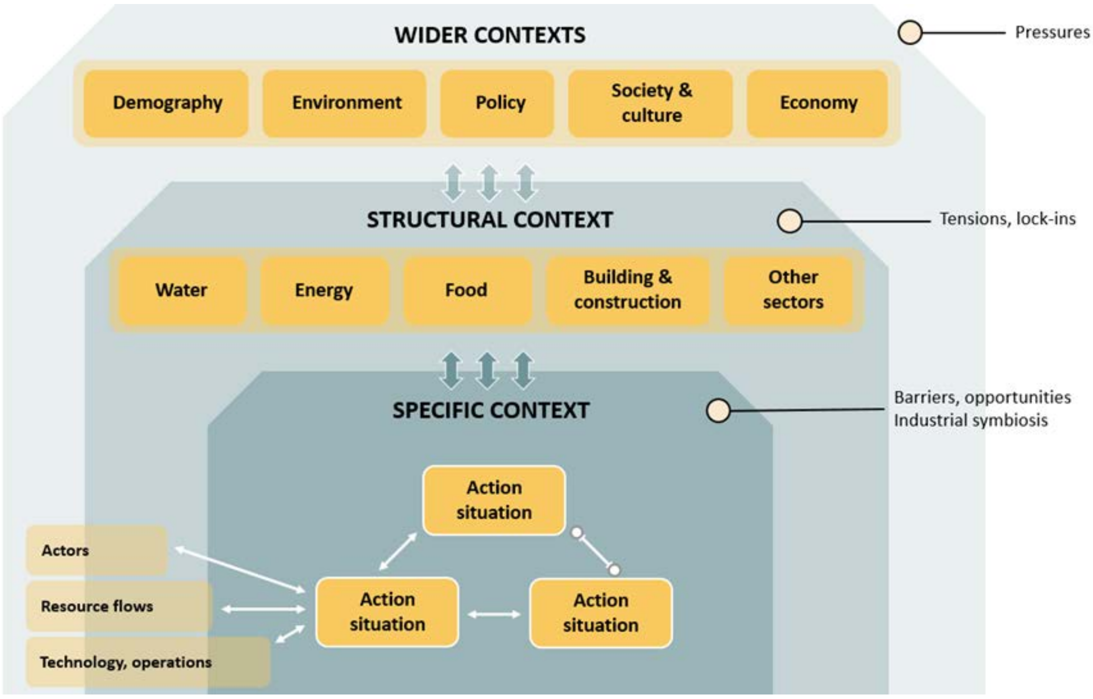

Figure 1: Overarching concept for the governance assessment

As we are concerned with resource flows and interactions that span across established sectors, different governance regimes – not only that of water, but also food, energy, building & construction, and possibly also other industries – may form parts of the structural context, depending on the sectors and interactions that are relevant in each study case.

The specific context does not relate to a singular technology, problem, or decision, but to a chain of action situations whereby water-based resources are, or may be, managed for sustainable value creation according to circular economy principles. Here, we take into account resource systems, as well as operations and technology, and how they interact with actors and institutions in the different segments of the value chain. The following chapter describes in more detail how we define the different context levels and their dimensions.

4.2 Networks of action situations

To define the boundaries for the case under study, identification of the specific networks of action situations – with the resources, technologies, actors, and governance regimes that exist in that particular case – constitutes the starting point of the assessment.

Action situations can be understood as spaces where actors make decisions and take actions, choosing among available options in light of information about the likely actions of others and the benefits and costs of potential outcomes. This may for example be related to production, infrastructure investment, selection of specific treatment procedures or marketing strategies. Action situations can be formal and quite strictly regulated, such as in the case of wastewater treatment, or more informal, such as a group of urban farmers making joint decisions about distribution of land or irrigation. Action situations comprise institutions and knowledge, as well as operational factors and impacts on ecosystem services. However, our aim in this initial step is simply to identify the focal action situations and their basic elements, including the resources, actions, actors, and relevant governance systems.

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4.2.1 Resources

By resources we refer to the physical resources (such as treated water, sewage sludge, phosphorus, nitrogen, etc.) as well as the broader resource systems, e.g., water management, agriculture, industry and/or urban planning, involved in the given case. Our concern here is to identify the sectors involved in the case under study. We also want to specify what kind of *resource units* are being considered; the types of water, chemical and biological components, plants, animals and/or products involved in the value chain.

4.2.2 Focal action situations

Focal action situations refer to the main activities and interactions considered in each case. This may be production, distribution and reuse of treated water, or a longer chain which also involves production of energy and other products, such as food, biochar, fertilizers or biocomposites. Simple mapping of the considered activities, or kind of operations and technologies involved, is essential to define the scope for the remainder of the assessment. Interactions and outcomes may also include other expected and desired impacts, such as soil improvement or local climate regulation linked to hybrid solutions for urban spaces where nature-based solutions (NBS) are combined with traditional technical solutions.

4.2.3 Actors

Actors are the organizations and/or individuals that routinely extract and (re)use resource units (e.g., water, phosphorous, biochar) from the resource systems in each case. They include utilities, farmers, biogas plant operators, fertilizer and biocomposite producers, and their end-users.

4.2.4 Governance systems

Governance systems are considered as the prevailing set of processes or institutions through which the rules shaping the behaviour of the users are set and revised. In this initial step of the assessment, we simply want to identify which overarching governance systems or frameworks that are brought into play in the specific case. These may be mainly the systems for management of water resources, environment, and agriculture, and/or climate and energy, but also include urban planning, industry and/or building and construction (as in some of the WIDER UPTAKE demonstrations), and possibly others.

4.3 Wider contexts

The Wider contexts level refers to the broader social, economic, and political settings where the governance regimes are situated, including the effects of market dynamics, environmental and cultural change, etc. Examples may be for instance demographical change, extreme weather events, and climate change. Wider context thus refers to wider trends and developments in which the actors in a specific case may have very limited or no influence on. The Wider contexts do not determine but provide a social and material backdrop that makes some actions easier than others. They may exert considerable influence on the scope for innovation, for instance by creating new demands for water cycle services, thus also opening opportunities for uptake of new technologies. Our Governance Assessment for Circular Economy based on Water Resources will therefore address such exogenous drivers and pressures, which may be found at global, national, and local level.

It is necessary to have a grasp on how these exogenous influences are perceived and develop over time, as they frame the structural (see 4.4) and specific contexts (see 4.5). While some developments serve to maintain existing systems, other developments work as pressures for change and impact positively on the scope for implementation of new water-smart solutions. In this section, we distinguish between different wider contexts. However, in carrying out the assessments it is necessary to understand these contexts in relation to each other. Although there may be common tendencies, their impact may vary from case to case, depending on their alignment and interaction with the structural and specific context in question.

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4.3.1 Demography

An understanding of the current demography and predicted demographical change within the case country is needed, as the population size, its geographical distribution and growth rate can have great impact on the wastewater sector. Urbanisation can put pressure on water resources and sanitation services in densely populated city regions, and population growth can influence the access to water and sanitation services.

4.3.2 Environmental context

The environmental context includes changes in the natural environment and society's ability to cope with potential changes. These changes are e.g., climate change and the possibility of more frequent floods and droughts. Aspects relating to water scarcity, pressures on water resources, energy sources and consumption are key factors included in the assessment. Scarcity of other resources and increasing concern with conservation and biodiversity are other broad developments that may put pressure on existing systems.

4.3.3 Political context

The scope for implementation and upscaling of new water-smart solutions is influenced by overarching political developments that frame the governance regimes involved in the focal action situations. Issues and priorities on the global agenda, such as the sustainable development goals (SDGs) and the Paris Agreement, are included here. Likewise, the level of political stability, general form of government, opportunity for individuals and organizations to partake in decision- and policymaking are included in this dimension.

4.3.4 Economic context

This wider context covers the state of the economy through indicators such as gross domestic product (GDP) per capita, GDP growth rate, and national employment rates. Additionally, the national industry structure is assessed, as the position and relative contribution of an industry to the national economy may influence its potential when it comes to industrial symbiosis. Available statistics on water and sanitation services provide important information. Low coverage may suggest the need to prioritise conventional or least cost solutions. However, where substantial new investments are expected, there can also be a high potential for implementing water-smart innovations. This, in turn, will depend on other economic, political, and cultural factors, as well as the environmental context. The assessment should also take potential urban-rural divides into account.

4.3.5 Socio-cultural context

The socio-cultural context includes aspects such as the general level of education (using e.g., the UN Human Development Index) and environmental awareness in the population (regarding e.g., climate change and circular economy). Another key aspect is whether we are dealing with a culturally homogeneous society or a context where different languages and cultural assumptions pose barriers to the dissemination of information and co-production of knowledge. Power distance and the level of trust in public authorities, based on historical experience, are other relevant influences. These may be deep-seated and influence the acceptance of new solutions. The social value/cultural construction of water is another aspect, which may be important, though difficult to assess.

4.4 Structural context

The structural context pertains to governance structures, property and use rights, as well as practices that prevail with a certain stability through time and broadly characterize the current situation and tend to hold for most similar cases in a region or country.

The structural context may be influenced by individual transition cases or projects, but to a lesser degree than the specific context. For this governance assessment, the focus is delimited to the governance regimes implicated in the network of action situations under study. The assessment takes a system perspective, considering both

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institutional and material aspects of the established production and consumption patterns in the sectors included in the assessment. Existing infrastructure and resource systems are considered, and we pay special attention to the interaction and interface between sectors.

4.4.1 Levels and scales

Governance has a multilevel character, spanning across various levels and scales, e.g., jurisdictional, spatial, temporal, etc. While spatial scale may be conceived in terms of different levels, temporal scales can be associated with different timeframes, and jurisdictional scales tend to be defined as clearly bounded legal-administrative units (counties, towns, etc.). Scale is an important issue, since human institutions do not map coherently on to the biogeophysical scale of the resource, either in space or time.

In water-smart solutions, different sectors (e.g., water, agriculture, energy, construction) and scales of operation tend to be involved. This step in the assessment addresses the administrative levels (EU/regional, national, subnational, municipal) implicated in the studied sectors, and their interaction. It seeks to identify what their scale and time orientations are, e.g., where do they draw the boundaries for the resource systems and interactions to be governed. Institutional interplay in cross-scale and cross-level contexts can be relatively balanced or highly asymmetric, and this can strongly impact the scope for water-smart value chains. The industries and actors considered for industrial symbiosis may also operate on different scales. The level of complexity and possible incongruencies in this dimension may be associated with barriers. Structures that increase coherence and collaboration, on the other hand, may be conducive.

4.4.2 Strategies and instruments

This dimension covers the rules, policies and regulatory practices that may facilitate or hinder uptake of the water-smart solutions in question. We distinguish between legislative and regulative instruments (e.g., requirements), economic and fiscal instruments (e.g., subsidies, taxes, loans), cooperative (e.g., public-private partnerships) and communicative instruments, including new forums, knowledge missions and information campaigns. How strategies and plans at EU level are transposed and implemented at the national level, and how the priorities in one sector, such as water and wastewater, interact with the priorities and concerns in another sector, such as agriculture, are important questions. What are the main structural barriers, and what are their severity, as seen/experienced by local stakeholders? Are there other, underlying tensions or gaps in current policy and regulations? To what extent stakeholders engage in advocacy, lobbying, strategic networking, and other forms of institutional work to promote water-smart solutions and industrial symbiosis are other central topics. Benchmarking and sustainability or CE monitoring activities are also highly relevant.

4.4.3 Actors and networks

While the main actors have been identified in the initial step of the assessment, this dimension considers the multiple actors and networks in the studied governance context in more detail. Different categories of stakeholders may take different roles in sustainability transitions. Whereas policymakers and public authorities may have a central role in financing the pre-competitive phase of sustainable innovations, they may also be pro-active in creating niches. On the other hand, there are cases where sustainability issues are low on the agenda and policymakers have to be pushed by social movements to enforce more conducive legislation. Incumbent firms may also sometimes resist, and sometimes actively contribute to a supportive environment. NGOs and consumers, as well as researchers, consultants and individual actors may further be important, as entrepreneurs, intermediaries, or lobbyists.

Since circular economy based on water resources will involve actors and stakeholders from multiple sectors and levels (e.g., regional, national, and internationally operating actors), mapping of different relevant stakeholder categories, their networks, and what roles they take is particularly important. Both formal and informal network relations in and between the involved sectors and industries are considered. To what extent and how public decision-makers from the involved sectors interact, how industry networks are distributed geographically and

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how they can be characterised (centralised/decentralised, strong/weak ties, information/collaboration, etc.) are central questions.

4.4.4 Perspectives and goal ambitions

CIT emphasizes the role of actor motives and perceptions. While objectives may be different, stakeholders may also share the same objectives, but relate them to different goals and ambitions. What visions, goals and perspectives that prevail in policy white papers, roadmaps, and political statements from key stakeholders in the different sectors involved are important. To what extent are these conflicting or aligned? What arguments are put forward by utilities and business actors? Different institutional logics, both in the water sector and the other sectors involved, may impede, or facilitate the introduction of water-smart solutions. Likewise, the social acceptance among users and the general public may be variable, linked to established production and consumption patterns, institutions, norms, and values. Which angles or framings that are brought up in the discourse around a problem or solution, may influence the degree of support and scope for innovation. Have these remained stable over time, have they changed significantly in recent times, and/or are they likely to change in the foreseeable future?

4.4.5 Responsibilities and resources

This dimension focuses on the distribution of responsibilities, rights, and other resources among the key stakeholders. Here we need to consider both the multiple levels and the different sectors involved in the studied cases. Sector organization and ownership are important aspects. Utility services are currently delivered and managed by a broad network of public agencies, private corporations, and third sector agencies, which may be associated with responsibility shifts. Moreover, not only formal responsibilities, but also those based on tacit norms should be considered (e.g., water conservation may be deeply embedded in some communities and cultures, but not in others).

Property and user rights define how actors may control, use, and dispose of resources. The access to and distribution of financial resources is a central aspect. Moreover, human capital, in terms of organization size, number of management and employees, their education and skills influence the scope for innovation in and between enterprises. Transitioning towards a circular economy tends also to require new skills and knowledge, related to process development and implementation of smart technologies, as well as environmental management and planning. Fusion of management and entrepreneurial skills is also needed to develop and implement new business models. Social capital refers to the benefits associated with close relationships, in the form of shared values, trust, cooperation, and reciprocity. This, as well as cultural capital, including knowledge, ideas, habits, common language, and identities are important elements.

4.4.6 Prevailing technologies and procedures

Pre-existing technologies and solutions may influence, and potentially prevent, the adoption of new technological solutions. Therefore, it is necessary to have an overview of the existing solutions related to e.g., water and wastewater treatment, irrigation, use of fertilizers and biocomposite materials. The predominance of certain technologies within sectors and systems could result in potential lock-ins and path-dependence, hindering wider uptake of water-smart solutions. To what extent existing technologies are interrelated and depend on each other and whether more circular solutions may be added and developed incrementally within existing systems or represent a radical break from the existing ways of doing things, are therefore important questions.

4.5 Specific context

The specific context refers to the case or specific setting where the development of new water-smart solutions is considered. The particular geographical conditions and case history, agency of actors, including previous decisions-making and framing, are important aspects.

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4.5.1 Previous decisions

The case history and previous decisions may exert a considerable influence on the scope for water-smart solutions. Some of these decisions may relate to aspects such as land use planning, management and organizational changes, community response to environmental challenges, or knowledge development and participation in R&D projects, etc. Strategic decisions, for example whether one aims to be a frontrunner in technology or has adopted ambitious sustainability goals, could also be of relevance. Additionally, previous local elections and policy entrepreneurs, and/or how critical events have been managed are of relevance.

Of particular relevance are previous decisions regarding infrastructure, given that water infrastructure is complexly intertwined with other infrastructures, often represents large investments, and tends to have very long lifetimes. Characteristics of the current distribution system and treatment facilities, for example the availability of space, or the absence or presence of biogas production, have a bearing on the kind of solutions that may be implemented and their viability. Pre-existing systems and practices, for example with regards to waste sorting, irrigation patterns and equipment in farming, user preferences and requirements to construction materials (e.g., colour, weight, etc.) will also influence the scope for water-smart innovations. Past decisions as regards stakeholder dialogue and information to the public may influence the level of engagement and acceptance for new solutions among users and citizens.

4.5.2 Case-specific circumstances

The specific context will also include a number of site-specific factors that may influence the feasibility and potential for wider uptake of the solutions. The geographical location of the activities will be associated with specific resource systems and local climate conditions influencing the availability of treated wastewater as well as the feasibility, performance, and benefits of water-smart solutions. The location relative to other infrastructure, e.g., gas grids, efficient roads, etc. will also matter.

The proximity between actors is important when it comes to industrial symbiosis. The distance to and type of farming in the region, distance to providers of other raw materials and users, etc. will influence the potential for circular value creation based on water resources. In small economic contexts, where funds for investments are scarce, the choice to implement new solutions tends only to be made if there is an evident economic return. In a longer-term perspective, future scenarios with respect to local/regional population growth, densification, industry, and urban development are also important.

Local/regional policy agendas and sustainability visions can provide incentives and sanctions to enhance circular economy. For example, there may be specific policies on waste management, innovative and green public procurement, smart specialization, and support schemes to promote green business development. Innovation capacity and local/regional market environment, including the specific socio-economic, political, and cultural settings are other dimensions.

4.5.3 Process

A lack of interconnectedness and cohesion of the network relations at the national governance level need not be replicated in a specific case. Among the factors that were identified as critical to innovation uptake in the DESSIN project, are commitment to compromise, the necessity to build political support, and the role of “entrepreneurs” and coalitions.[3] Partnership design and communicative strategies, especially as to how the challenges and solutions are framed and linked to other issues (for example, climate change adaptation, local food production, urban liveability, poverty reduction) can exert considerable influence on innovation uptake. Attention should also be paid to how regulative, economic, and communicative instruments from multiple levels interact and create specific barriers and opportunities in the specific case.

[3] Rouillard et al. 2016, for full reference and further information see Annex 1.

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5 Descriptive assessment charts

This chapter presents a set of assessment charts for the initial case definition and three context levels, as discussed in the preceding chapter. The charts operationalize the different elements, by specifying topics and key questions to consider for the respective contexts and dimensions.

The descriptive assessment charts are followed by a set of evaluative assessment criteria, presented in chapter 6, and a step-by-step manual for application in chapter 7.

5.1 Case definition

	Action situations
Resources	• What resource systems are implicated in the studied case of industrial symbiosis / water-smart solutions? • What resource units are involved in the chain of activities considered?
Focal action situations	• What are the main activities and decision points? • What are the focal solutions, technologies? • What are the desired outcomes (products, ecosystem services)?
Actors	• What categories of actors are involved?
Governance systems	• What sectors and governance systems are implicated?

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5.2 Wider contexts

	Wider contexts
Demography	• What is the projected national population growth? • What is the urbanisation rate, according to national statistics?
Environmental context	• What are the anticipated impacts of climate change on precipitation and water resources? • What are the main pressures on the water resources in the country? • To what extent is physical water scarcity a challenge? • To what extent is water quality a challenge? • What is the total discharge from wastewater in the country? • What are the implications of the identified pressures, for water cycle services? • To what extent is resource scarcity a recognised problem? • What are the prevailing climate targets and their relevance for uptake of water-smart solutions?
Political context	• How is the country rated, in terms of peace and stability? • What is the perceived level of corruption? • To what extent are citizens involved in public decision-making? • To what extent are the SDGs implemented in national frameworks, and how does the country perform in terms of the SDGs? • To what extent does the country engage in international cooperation on sustainable water management and CE?
Economic context	• What is the level of GDP per capita and GDP growth? • What is the unemployment rate? • How does the country score on the Human Development Index? • What are the largest industrial sectors, in terms of GDP and employment? • What is the reported degree of circularity (as per circularity gap reporting)? • What is the size of informal sector? • Are there regional differences (e.g., in terms of economic development and enterprise) influencing the potential for water-smart solutions? • How is the distributed access and level of service for clean water and sanitation?
Socio-cultural context	• What is the number and distribution of different language/ethnic groups? • What is the level of environmental awareness in the national population? • How is the public access to environmental information? • To what extent are there active pro-environmental NGOs, and what is their capacity? • What are the popular perceptions and attitudes concerning use and reuse of water resources (as noted in research or expressed in public media)?

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5.3 Structural context

	Structural context
Levels and scales	• For each of the considered action situations, which authorities and administrative levels are implicated? • In what kind of geographical areas and time horizons do their actions apply? • How is the interaction across sectors and administrative levels organized? • To what extent do the institutions at different levels depend on each other or are able to act productively on their own? • Have any of this changed markedly over time, or is it likely to change in the foreseeable future?
Strategies and instruments	• Which directives and regulations (EU/international, national, subnational) apply to the identified action situations? • What are the specific requirements of influence? • Are any of the regulations expected to change in the foreseeable future? • Are there overarching policy measures stimulating water-smart solutions (e.g., green transition package, national circular economy strategy, green public procurement etc.)? • Are there specific incentives or funding mechanisms available for development and implementation of water-smart solutions? • Are there any public-private partnerships or cross-sector innovation programs to develop and promote water-smart solutions? • Are there sector or industry-specific roadmaps (e.g., towards sustainability) that work in favour of water-smart solutions? • Are there any joint efforts to develop guidelines or standards that may support water-smart industrial symbiosis? • Are any circular economy monitoring, and evaluation instruments applied?
Actor networks	• What are the characteristics of the identified categories of actors (e.g., core activities, ownership, organizational structures)? • How are they implicated in the uptake of water-smart solutions? • To what extent and how do the actors interact? • Are there formal networks (e.g., industry associations) which focus on water-smart solutions? • Are there any explicit or underlying conflicts of interest? • Are there actors or stakeholders with a mediating or facilitating role?

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Perspectives and goal ambitions	• What are the prevailing actor perspectives on circular economy based on water resources? • What are their respective goal ambitions and targets? • How important or central are these goal ambitions, relative to the main objectives and activity of the respective industries? • What goals are stipulated in policy white papers and political statements (EU/international, national, sub-national) pertaining to the action situations under study? • To what extent is the public aware of water challenges and water-smart solutions? • Which various angles does the public discourse on water take? • Have any of these changed over time? Are they likely to change in the foreseeable future?
Responsibilities and resources	• What are the mandates of the public agencies related to the different action situations under study? • Are the roles of all formal institutions clearly demarcated and assigned? • Are there any activities that no authority currently has a clear responsibility for? • To what extent are private corporations and third sector agencies involved? • What financial capital or resources do the key actors have access to? • What is the size and education level of the actor organizations? • To what extent and how are data about resource flows and qualities available and shared? • To what extent do the actors engage in research and development? • How is the institutional culture of the actors characterized (focus on learning and innovation, bureaucratic vs. market-oriented, lean, etc.)? • What is their reputation, to what extent are they trusted by their users and the public? • Have any of these changed over time or are likely to change in the foreseeable future?

Prevailing technologies and procedures	• What are the conventional solutions for the activities in focus of the assessment?
	  • Wastewater treatment
	  • Sludge treatment
	  • Irrigation (water sources, quality, equipment, etc.)
	  • Use of fertilisers (amounts, types, equipment, etc.)
	  • Production and use of other relevant resources or materials (such as biogas and biocomposite materials)
	  • Other
	  (Address the areas of relevance to the focus of your assessment)
	• To what extent are these compatible with the considered water-smart innovations?

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5.4 Specific context

<table>
<tr><th colspan="2">Specific context</th></tr>
<tr><td>Previous decisions</td><td>

What prompted the interest in innovative solutions for water reuse and resource recovery in the studied case?
Are there other previous decisions or critical events that may influence the scope for water-smart solutions significantly?
For instance, in terms of

Strategic priorities in the region
Management and organisation
Legal-administrative requirements

What are the current technologies and state of existing infrastructure for wastewater management, and the other activities considered in the specific case?
To what extent are existing systems and practices compatible with the considered water-smart solutions?
</td></tr>
<tr><td>Case-specific circumstances</td><td>
Geography and resource systems

Where are the different actors and their facilities located?
What are the amounts of wastewater and recovered resources in question?
Are there seasonal variations that may influence the supply and demand for resources?
How is the supply of water-based resources expected to develop in the future?

Innovation capacity

To what extent do the partners focus on learning, training, and continuous improvement?
Is there a demand for sustainable innovations, from owners, users, other local stakeholders?
Are the actors engaged in other entrepreneurial activities (technological or social)?
Do any of these involve symbiotic relations with other enterprises?
Do the actors have the financial resources to upscale the water-smart solutions in question?

Market environment

What is the capacity of the actors to communicate and deliver innovations to the market?
What is the level of engagement and capacity of targeted customers and competitors?
Are any of the resources or products already available in markets?
What is the expected demand for reused water and recovered materials?
</td></tr>
<tr><td>Process</td><td>

Who have been or are the potential drivers of the initiative (e.g., utility, technology provider, consultants, research institution, public agency)?
How is the communication and history of collaboration between the actors (degree, formal/informal, etc.)?
How is their current collaboration organized (type of agreements, contracts, form of interaction)?
To what extent do they have network relationships also outside of the case under study?
To what extent do they share a common vision?
To what extent and how are other stakeholders included/addressed?
Are any of the actors engaged in wider national or international collaboration related to circular economy?
</td></tr>
</table>

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6 Evaluative criteria

To gain a better overview of the contextual interactions influencing the scope for circular economy based on water-smart solutions, the descriptive questions are complemented by a set of qualitative evaluative criteria. The evaluation is structured according to the different context levels, as described in chapter 4, and operationalised in chapter 5. However, trends and developments at the different context levels also influence each other. Therefore, the final step is a summary scorecard, to provide an overview of the degree of alignment and possible contradicting tendencies between processes at the different levels.

6.1 For the initial case definition

The initial case definition sets the scope of assessment by identifying the resources, governance regimes, actors and focal interactions constituting the case. This delineation is supplemented by three evaluative criteria to characterize the case further with regards to the ambition and existing basis for developing water-smart collaboration. Beyond characterizing the case, the combined answers to these criteria provide information about the level of innovation and governance challenges involved. They are also useful to help determine stakeholders and angles for subsequent interviews.

We first classify the case in terms of so-called R-strategies, to limit resource use while generating value for society. The literature on circular economy includes various "R-ladders", where circularity strategies higher up on the ladder require fewer materials and those at the lower end use more materials, but solutions still aim to maximise sustainability and value creation from closing loops (see section A1.4 in Annex 1). Many of these classifications were developed for other sectors and cannot be directly applied to circular economy based on water resources.

For this assessment we adopt six categories from a recently developed CE model framework for the water and wastewater sector.[4] These are listed as R1-5 and R7 in the table below (Table 1). In addition, we include a strategy named R6 Repurpose, which is not included in the mentioned framework, but appears in WIDER UPTAKE and may become more important in future. This refers to use of wastewater resources or parts of them in alternative products with a different function (e.g., using calcite from drinking water treatment and cellulose from wastewater in biocomposite materials).

Table 1: : R-strategies to consider for initial case definition

Strategy	Definition
R1 Reduce	Prevent wastewater generation (e.g., reduce water usage and pollution at source)
R2 Remove	Application of effective strategies and technologies for the prevention of inclusion of hazardous pollutants into wastewater and removal of pollutants from water and wastewater
R3 Reuse	Reuse of wastewater after treatment, as an alternative source of water supply (non-potable usage, e.g., in agriculture or industry)
R4 Recycling	Recovery or reclamation of water from wastewater for potable usage
R5 Recovery	Recovery of resources as nutrients and energy from water-based waste
R6 Repurpose	Use of wastewater resources or parts of them in alternative products with different function (e.g., using calcite from drinking water treatment and cellulose from wastewater in biocomposite materials)
R7 Rethink	Rethinking how to use resources to create a sustainable economy, free of waste and emissions

[4] Smol et al. 2020, see further details and full reference in Annex 1.

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Several R-strategies may be used to characterise a given case, considering that the same compounds can be both products (e.g., treated water for reuse, biochar, recovered nutrients, energy, biocomposites, etc.) and resources, depending on the setting. The list does not imply a ranking in terms of value creation or resource use since this as well as the overall sustainability will be context-dependent and variable. What we aim for is a common and comparable way to understand the focal interactions in each case and get a picture of the level of complexity in terms of governance.

The second step is to check whether the case meets the criteria for industrial symbiosis. In other words, whether the case is a collaboration engaging traditionally separate industries in a collective approach to improve competitive advantage, involving physical exchange of water, energy, materials, and/or by-products. Here, we apply the common "3-2 heuristic": whether at least three different enterprises and two different resources are involved.

Lastly, we assess whether the case relates to an established network of actors, already in active collaboration or dialogue, whether relevant actors exist and are identified, or, as the case may be, if it requires establishment of entirely new actors or value networks.

The three steps can be summarised in the following evaluative questions:

1. What are the levels of circularity ('R-strategies') considered?
2. To what extent does the case (or cases) meet the criteria for industrial symbiosis?
3. To what extent does the case involve creation of new value chains or build on existing ones?

6.2 For the wider contexts

The Wider contexts refer to the broader social, economic, and political settings (e.g., international politics and markets, natural disasters, urbanisation, etc.) which are beyond the direct influence of specific actors. The Wider contexts do not determine but provide a social and material backdrop that makes some actions easier than others. As noted above, they include some factors that change only slowly; and some that change quickly or are associated with economic shocks, such as Covid-19. These events and developments may lead to pressures that require changes in the established systems. Such pressures may be characterised in terms of a) frequency (e.g., number of droughts or floods), b) magnitude of deviation from initial conditions, c) speed (e.g., rate of change in public awareness of climate change) and d) scope, or number of dimensions of society and e.g., water management that they affect.

To evaluate this in specific terms may be challenging and perhaps not necessary when assessing the governance context for circular economy based on water-smart solutions. It is highly relevant, however, to make general assessments as to whether the wider contexts are associated with drivers and barriers to the uptake of water-smart solutions , and whether they are increasing or decreasing over time. On this basis, each of the categories of wider contexts (demographical, environmental, political, economic, and socio-cultural contexts) are associated with the following evaluative questions:

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1. Are there any broader societal drivers influencing the uptake and potential for circular economy based on water-smart solutions?
2. Are any broader societal trends or developments associated with barriers?
3. How have these factors developed over the last 10-20 years, and how are they projected to develop over the next 10-20 years?

6.3 For the structural context

The Structural context refers to the prevailing governance systems, technologies and practices that frame the action situations under study. As such, it goes beyond the specific case setting, and is only partly under the influence of specific actors. The structural context tends to stabilise existing systems and favour incremental development, via lock-ins linked to sunk investments in machines, infrastructures, and competencies; already existing regulations and standards; the cognitive routines that e.g., blind engineers to developments outside their focus; and adaptation of lifestyles to technical systems. The established "rules" in sectors can thus constrain the uptake of water-smart solutions but may also enable them. For instance, already established trust between actors, or challenges pertaining to existing treatment processes may be conducive for implementation of new solutions.

The structural context may also include various tensions, e.g., between regulatory and policy frameworks relating to different sectors and administrative levels, different institutional logics (e.g., a hydraulic, market-based, or water-sensitive approach) regional interests, diverging goals and perspectives among actors, short-term and long-term orientation, efficiency versus resilience, and isomorphism versus structural and technological change.

Considering such interactions, the evaluative questions for the structural context, related to each of its dimensions, as described in chapter 4[5] are:

1. Are there specific lock-ins or tensions that are seen as conducive, creating "windows of opportunities" for circular economy based on water-smart solutions?
2. Are there specific lock-ins or tensions that may hinder circular economy based on water-smart solutions?
3. Have there been any significant changes in these factors over the past 10-20 years, and are relevant changes foreseen to take place during the next 10-20 years?

6.4 For the specific context

The specific context is a smaller and less stable configuration than the structural context. Both levels are seen to share certain rules that coordinate action, but for the specific context of emerging innovations these are more "in the making". In the specific case, they are influenced by contextual interaction with the local resource base and institutional setting, as well as existing facilities and their proximity.

[5] 1) Levels and scales, 2) strategies and instruments, 3) actor networks, 4) perspectives and goal ambitions, 5) responsibilities and resources, and 6) prevailing technologies and procedures.

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Following the descriptive questions concerning previous decisions, case-specific circumstances, and process to assess, develop or promote water-smart solutions, we therefore evaluate the specific context according to the following questions:

1. To what extent are there synergies and strategic fit between local/regional agendas and circular economy based on water-smart solutions?
2. To what extent are the geographical features, including existing facilities and infrastructure, conducive for circular economy based on water-smart solutions?
3. To what extent are the capabilities and practices of actors adequate for implementation and circular economy based on water-smart solutions?
4. To what extent are user acceptance and market conditions conducive?
5. Have there been important developments in these factors over the last 10-20 years, and are there any foreseen changes in the coming 10-20 years?

6.5 Summary scorecard

As the final step of the evaluative assessment, it is recommended that the conducive and unconducive factors identified are summarised in a simple scorecard, as illustrated below (Table 2).

Since some dimensions may harbour both drivers and barriers, or conducive and unconducive factors, the scorecard has one column for each. The analyst may rank the strength of each identified factor according to a nominal scale, as either highly conducive/unconducive (3), conducive/unconducive (2), mildly conducive/unconducive (1), or neutral (0). The final column is to show the identified trend in development over time, that is if there is a tendency that conditions are becoming more conducive (arrow pointing upwards), less conducive (arrow pointing down), or there are no clear such tendencies (horizontal arrow).

The scorecard can be used as a basis for further discussion, of the level of alignment across dimensions and context levels and state of system change.

Furthermore, it may facilitate comparison across cases and countries where GOCIWA is applied, and ease the communication of key findings, in dialogue with different categories of stakeholders.

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Table 2: Summary scorecard template

Context level	Dimension	Conducive factors	Nom. rank	Unconducive factors	Nom. rank	Development trend
Wider contexts	Demographic					
	Environmental					↑
	Political					
	Economic					↓
	Socio-cultural					↔
Structural context	Levels and scales					
	Strategies and instruments					
	Actors and networks					
	Perspectives and goal ambitions					
	Responsibilities and resources					
	Prevailing technologies					
Specific context	Synergies, strategic fit					
	Location and facilities					
	Capabilities and practices					
	User acceptance					
	Entrepreneurial initiative					

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7 Manual for application

In this section, you will find a detailed manual for application of the Governance assessment for circular economy based on water resources (GOCIWA). The manual has been developed through applying and testing the tool in the contexts of the demonstration cases in WIDER UPTAKE, in Norway, the Netherlands, Italy, the Czech Republic and Ghana.

The assessment has twelve steps. Before starting the assessment, it is strongly recommended to read through the theoretical background in Annex 1.

1. Starting from the-water smart solution/s in question, identify the resources, key actors and governance systems involved. This should be done by outlining the implicated network of action situations (as explained in 4.2.1), which will delineate the case, as well as the categories of stakeholders which should be consulted or in other ways considered in the assessment. This can be done by entering the relevant information into the Excel file provided as Annex 3, provided to help sort, and maintain an overview of the data and results from the assessment.

2. Conduct a desk study to assess the wider contexts (see section 4.2.2). This entails collection of updated information on political, socio-economic, and cultural factors that may have an influence of the potential uptake of the water smart solution/s. Use the assessment chart in section 5.2 as a guide. Annex 3 has a separate sheet for this step, which also contains examples of good sources for this work.

3. Go through the assessment charts for the structural (see section 5.3) and specific context (see section 5.4) carefully. These are also laid out in a separate sheet in Annex 3, where you first may note down the information you already have concerning the different dimensions. Conduct an initial desk study, using official web resources to get an initial overview of relevant governance structures, legislation, and policy documents, including sector policies. You may also use web items and/or printed reports from the national environment agency, sector associations and/or annual reports of key actors to gain information about present and projected amounts of resources, prevailing technologies, and procedures.

   For analysts who already are closely involved, this will require limited time but still be a fruitful exercise, to get a systematic overview and identify information gaps. For analysts who are less familiar with the contexts of water-smart solutions, the initial desk study could require up to 4-5 working days. Besides providing a basis of information related to the topics in the assessment charts, this step will help identify a wider set of stakeholders related to the case in question and shed light on how the different topics in the assessment charts best may be broached in dialogue with them.

4. Draft an interview guide that can provide information about the structural and case-specific contexts. The interview guide should be used to get deeper knowledge on the particular contexts and should complement the desk studies conducted in the steps above. It should therefore be developed and applied as a guide for semi-structured interviews not a fixed and firm set of questions, but a set of topics where the order, exact formulations and follow-up questions are tailored to the role and activities of the respective interviewees. Annex 2 provides an example of an interview guide, but the set of questions must be tailored to each case.

5. Conduct an initial interview with the utility or main contact for the case to be assessed. This initial interview should be used to test the draft interview guide, via the interviewer's own experience and feedback from the interviewee (e.g., the case owner) on how the interview guide works. Additionally, the interview can be used to discuss and identify a final sample of other actors and stakeholders, to be consulted via interviews.

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6. Based on the outcome of step 5, identify, and recruit potential informants. Keep in mind that you should cover the different focal action situations identified for your assessment, and recruit informants that can represent different groups of stakeholders, e.g., policy makers, producers, users, and NGOs. Depending on the action situations in each case, +/- 10 interviews can suffice. For some stakeholder categories who may lack formal representation, such as urban farmers, and organizations where employees from different departments are relevant, group interviews may be suitable. Otherwise, individual interviews with ample time for discussion and reflection are preferable. To allow for this, around 1,5 hours should be set aside for each interview.

7. Conduct interviews with stakeholders. The interviewees must be informed about their rights and data management according to the requirements of the EU General Data Protection Regulation (GDPR). Use voice/video recording if the informants agree, or make detailed notes regarding all statements, not just those you find most relevant in the moment. During subsequent interviews new topics and perspectives may come up and make details that seemed less interesting before quite relevant, as supporting, contradictive or alternative points of view.

8. Write summaries or transcribe the interviews if the assessment is intended for research. If it is mainly for practical purposes and time is limited, it is possible to move directly to the next step.

9. Analyse the data referring back to the assessment charts (as presented in chapter 5). This can be done via the Excel sheet for the structural and specific context provided as Annex 3. Here, you enter key messages from each interview plus desk studies into the rows and columns designated for each topic and action situation.

10. Write up the final case assessment according to the structure of the assessment charts. Assess each context level and its dimensions according to the evaluative criteria described in section 6.

11. Summarise the findings in the summary scorecard, depicted and explained in section 6.5 (Table 2). The scorecard is also included in Annex 3. The scorecard provides an overview of the alignment across context and dimensions, and provides a starting point for stakeholder dialogue and, if relevant, comparison between cases.

12. Where resources allow, a small validation workshop with the interviewed stakeholders is recommended. This could be virtual or face-to-face, depending on the circumstances.

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8 Conclusion

This document has presented the Governance assessment for circular economy based on water resources (GOCIWA), developed as the first output from work package 4 in WIDER UPTAKE, on governance and business models.

GOCIWA provides a tool for systematic assessment of the conditions, drivers and barriers to circular economy based on water-smart solutions in different governance contexts. It builds on previous tools for water governance assessment, but applies a broader system perspective, where multi-sector interactions and the interplay between social and material factors is taken into account.

The tool is intended for practitioners as well as researchers, and is largely qualitative, based on desk study and stakeholder interviews. It consists of five steps, which are carefully explained and accompanied by schematic assessment charts. The evaluation is summarised in a simple scorecard, which provides an overview of conducive and unconducive factors at different context levels, as well as their degree of alignment. A detailed manual for application and support material, in form of an exemplary interview guide and an Excel sheet for data collection and analysis, are provided.

GOCIWA can be useful for investigation as part of public planning processes, as well as for comparative studies and actors wanting a systematic, independent assessment of institutional drivers and barriers before starting or proceeding with a more specific initiative to implement and upscale water-smart solutions. In WIDER UPTAKE, the results from the Initial case assessments will be used as input for further work to address barriers and facilitate circular economy based on water-smart solutions.

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Annex 1: Theoretical background

A1.1 Introduction

The initial basis for the development of the Governance assessment for circular economy based on water resources (GOCIWA) is the contextual interaction theory (CIT) (Bressers et al. 2013), as operationalised in the DROP tool for governance assessment related to integrated water resource management (Bressers et al. 2016) and further developed to address factors enabling innovation uptake in the DESSIN project (Rouillard et al. 2016). To address governance factors influencing the scope for circular economy based on water resources, we saw the need for further tool development, bringing in additional theoretical perspectives. Task 4.1 in WIDER UPTAKE therefore included an exploratory literature study with this objective. Research articles from the last five years,[6] were included in the survey, and the following strings were used:

- Water AND governance OR socio-technical OR circular economy
- Water AND governance OR socio-technical OR industrial symbiosis

Articles from the most relevant journals (Environmental Science and Policy; Environmental Innovation and Societal Transitions; Water Resources Management; Water; Ecology and Society; Water Science and Technology; Environmental Policy and Governance; Journal of Cleaner Production; Technological Forecasting and Social Change; Sustainability; Resources, Conservation and Recycling; Ecological Economics; Water Policy; Water Economics and Policy; Journal of Environmental Policy and Planning; Local Environment; Global Environmental Change) were screened by title, and we ended up with 198 articles that were screened by abstract.

76 articles were read in detail, to identify perspectives and factors that should be considered for the tool development. Based on our existing knowledge on these topics, we supplemented this body of articles with other relevant literature not caught by the search strings. In addition to an initial introduction to CIT, this annex presents a brief summary of the strands of research and key insights collected.

A1.2 Contextual Interaction Theory (CIT)

CIT was originally developed in order to separate between the analysis of 'policy formation' and 'policy implementation' (Bressers, 2004, p. 288). To understand the latter, Bressers (2004) saw the need to take actors and their characteristics into account, to a greater extent than what has been the case in mainstream research on policy and governance.

The theory sees policy processes as multi-actor interaction processes. Both individuals and organisations can be considered as actors. Many factors may have an influence, but only if they change the motivation, cognitions and/or resources of the actors, which provide them with capacity and power. The characteristics of the actors shape the process but are in turn also influenced by the course and experiences in the process. Deliberate strategies of actors can try to promote such changes both in other actors and within their own group or organisation (Bressers et al. 2016).

Their motivations, cognitions and resources are not only intrinsic to actors, and influenced by their social interaction, but also influenced by many external factors from a multi-layered context, as illustrated in Figure 2 (Bressers and de Boer, 2013).

[6] Listed in WOS, BIOSIS, CABI, FSTA, KJD, MEDLINE, RSCI, SCIELO, or ZOOREC.

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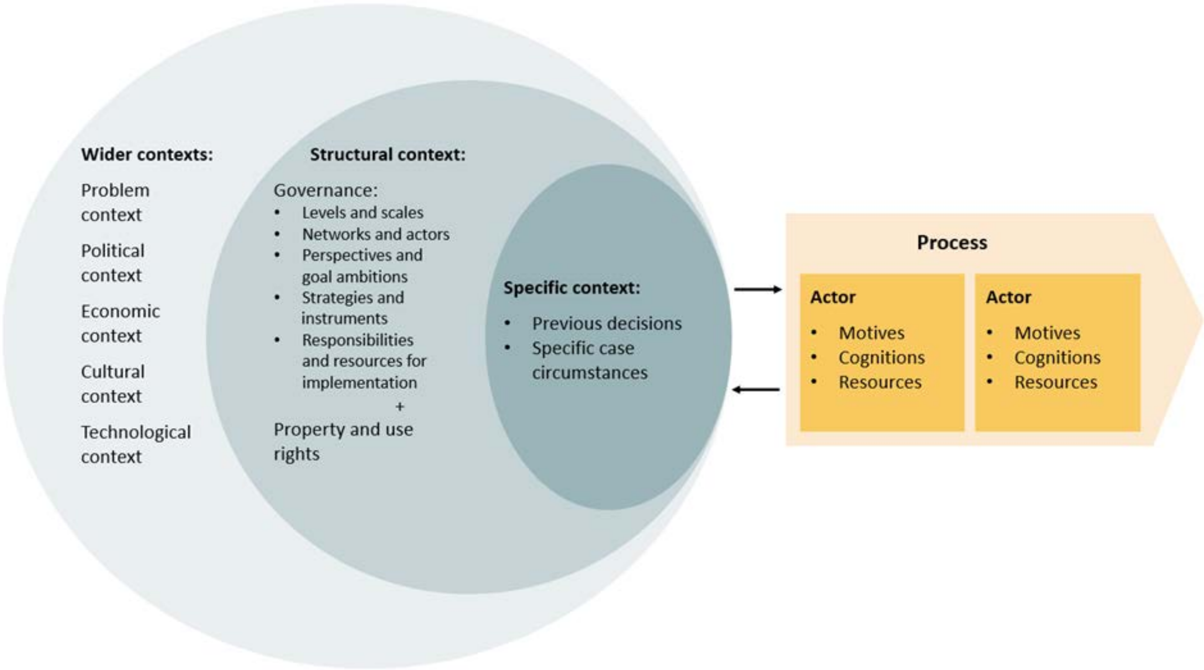

Figure 2: The different contexts defined in CIT (adapted from Bressers and de Boer 2013)

The specific context involves factors like the characteristics of the geographical place of the case or intervention in focus and its case history, consisting of previous decision-making and framing. This layer is encompassed by a structural context, which includes both governance and the relevant property and use rights. The structural context is much more stable than the specific context, which applies to individual cases. Also, the goals of governance may differ between levels: e.g., the national-level governance may focus on safe and cost-efficient water management, while city-level governance may also consider factors such as urban liveability (Jensen et al. 2015). The structural context will to a lesser degree be influenced by individual cases. Lastly, there is a less specified layer of wider contexts, where socio-cultural, and economic and technological developments and political system are included.

CIT considers five 'multiplicity aspects of governance' as central to the structural context. These are as follows:

1. Scales and levels: seeing governance as multilevel in all scales (jurisdictional, spatial, temporal etc.)
2. Actors and networks: governance assumes the multi-actor character of the relevant network(s)
3. Perceptions of the issue and goal ambitions (not just the objectives): assuming the multifaceted character of the problems and ambitions
4. Strategies and instruments: governance assumes the multi-instrumental character of the strategies of the actors involved
5. Resources and responsibilities for implementation: recognizing the complex multi-resource basis for implementation

The structural context is seen to influence multi-actor interaction processes not only through its contents, but also through its extent and coherence. The extent is a quality of the regime that refers to its completeness, to which degree it covers all relevant actions and aspects. Coherence is the degree to which the various elements of the regime are strengthening rather than weakening each other. Flexibility is seen as *"the degree to which the regime elements support and facilitate adaptive actions and strategies in as far as the integrated (among others multi-sectoral) ambitions are served by this adaptiveness,"* (de Boer and Bressers 2011:92). This, as well as intensity, or the degree to which the regime elements urge changes in the status quo or in current developments, influences its adaptiveness.

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In the DROP tool, the above-mentioned dimensions are associated with sets of open questions, with the aim to systematically describe the governance regime in a certain area concerning a certain issue. In particular, the model draws attention to the governance conditions that can hinder water resource management projects or policies under complex and dynamic conditions. Furthermore, the questions proposed for each dimension include consideration of how conditions have developed over time, drawing attention to different trajectories and patterns of change. The results are summarised visually in simple scorecards.

In the DESSIN project, the DROP tool was adapted for assessment of conducive and unconducive factors influencing innovation uptake in urban water management (Rouillard et al., 2016). The same dimensions and criteria were used, but operationalised differently, in a three-step process to characterize innovation cases, assess governance factors of influence, and finally develop coherent storylines of innovation uptake and governance regime influence.

GOCIWA builds extensively on these works. We have adopted and adapted the basic structure of the DROP assessment framework and take a broad, multi-level perspective on governance, while placing actors and their motivations, cognitions, and resources centrally in the assessment. However, we pay more attention to developments and processes at the Wider contexts and Specific context levels, and as noted in the main document, we aim to take multi-sector interactions and material dimensions, in form of resource systems and technologies, into account. On this background, the set of evaluative criteria is also different and broader. The following sections present some of the insights from previous research that we have drawn upon to address these aspects.

A1.3 Industrial symbiosis

Industrial symbiosis (IS) has been defined as engaging *'traditionally separate industries in a collective approach to competitive advantage involving physical exchange of materials, energy, water, and by-products.'* (Chertow 2000, p. 313). The keys to industrial symbiosis are collaboration and the synergistic possibilities offered by geographic proximity. Chertow (2007) provides a '3-2 heuristic' as a minimum criterion: There must be at least three different actors involved in exchanging at least two different resources for the collaboration to be defined as a basic industrial symbiosis.

Essentially, IS entails a win-win interaction among members of a value chain (typically a network of organisations spanning different sectors), where actors endeavour to share materials as well as industry knowledge critical to improving technology and business activities (Fraccascia & Giannoccaro 2020). Historically, the most successful examples of IS have developed on their own as businesses have chased comparative advantages (Chertow, 2007). Their IS relationships have later been 'uncovered' by e.g., researchers. Some of the learnings from IS have been that past experiences from IS may help to overcome the presumption that IS is costly, and that previous IS projects may offer actors the opportunity to cooperate, and thus contribute to developing a cooperative culture in the region.

Chertow (2007) and Schlüter et al. (2019) have described the process of IS emergence which can be summarized in three phases:

1. Pre-emergence: This includes the initial contextual conditions, such as the availability of infrastructure, physical proximity, mutual trust, and culture, and the available (unused) resources that support the emergence of IS.
2. Emergence: This is a process with three sub-phases. The actors first become aware of IS benefits and develop a symbiotic idea based on business interest. Then, they reach out to possible partners and explore the possibilities for symbiotic connections, and finally they prepare for establishment of IS in an organizing phase.

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3. Post-emergence, where the industrial symbiosis is physically established. The IS network develops from various IS emergence processes that lead to an accumulation of IS linkages.

The EU INTERREG project SYMBI (Industrial Symbiosis for Regional Sustainable Growth and a Resource Efficient Circular Economy) described industrial symbiosis based on 48 cases in the EU (Chamber of Commerce of Molise, 2017). 83% of the successful IS cases were concerned with the exchange of energy, by-products, and secondary raw material. They also found that the key actors who need to be involved are large industrial enterprises, SMEs, and local authorities. Similar results were reached by Vanhamäki and colleagues (2020) who also argued for the importance of universities, and generally underscored the importance of planning, stakeholder interaction and collaboration, business strategies and sustainability in IS. Indeed, active participation and commitment of actors was found a success criterion in 75% of SYMBI's cases.

The rationales for developing industrial symbioses were: improving resource efficiency (67%), promoting use of bio-energy resources (56%), and reducing CO2 emissions (50%). Economic factors are therefore important drivers for IS. For instance, the demand for extractable elements from IS can provide an incentive for investment (Rosiek 2020). According to the SYMBI project, key economic factors were: reduction in production costs (52%), increased profits and revenues (44%), and opening of new markets for secondary raw materials (38%). Additional drivers for IS are policy and regulations, both nationally and e.g., in EU level (Rosiek 2020). Especially financing opportunities can be important (Neves et al. 2019).

Some of the success criteria for IS are for instance the diversity of industries, as it results in a range of different wastes that can be used in different processes. This was found as a success factor in 50% of IS projects (Chamber of Commerce of Molise 2017). Furthermore, geographical proximity is often a facilitator (in 60% of the cases that SYMBI mapped), both in that it can increase trust and due to the fact that waste is mostly of low economic value, so that transportation and environmental costs may work against symbiosis connections over long distances. Neves et al. (2019) note that the predominance of certain industries, that are of key importance for economic development, such as steel and iron in China and agro-food in Italy, can act as a driver for the establishment of IS networks as they ensure stable supply of waste that can be valorised. Additionally, the authors find that industrially mature areas can be conducive for the establishment of IS networks, as industrial relations and networks already exist.

Neves et al (2019) also studied the barriers for IS and concluded with the following issues: low taxes on landfill disposal, lack of policies that encourage and regulate industrial symbiosis, lack of funding to promote it, and deficient regulatory frameworks. In addition, existing legislation may limit the implementation of synergy relationships, especially if it is too rigid, unclear, or inconsistent. Of non-regulatory barriers they highlighted the following:

- Lack of knowledge of other companies' potential to receive or provide waste
- Lack of trust (resistance to provide data on processes and waste)
- Reduction of waste also a barrier, as the waste stream cannot be guaranteed
- Uncertainties related to profitability and associated costs and risks

Many of the factors discussed in this strand of literature are already covered in the dimensions of the DROP tool. However, some additional insights that we gain and have wanted to incorporate in GOCIWA concern the role of geographical proximity, the kind of networks that are implicated (number, size and type of actors, their maturity and position in the economy, complementarity/diversity, etc.), and their previous engagement in IS networks. What phase of IS emergence a particular network is in, is also an important aspect.

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A1.4 Circular Economy (CE)

The CE concept broadly refers to closing material loops, transforming the economy from a linear to a circular one, where materials and products are fed back into the loop and used as long as possible. The end goal is to move away from the economic model where finite resources are excessively consumed and products and materials reach an end-of-life state and become waste. For such a shift to happen, technical and/or social innovations tend to be required (de Jesus et al. 2018).

Kirchherr et al. (2017) distinguish between two types of core perspectives on CE: those relating to the strategies and e.g., variety of R frameworks, and those that take a systems perspective. In terms of the former, Corona et al (2019) provide an overview of the different strategies that have been proposed to achieve this change. These concepts include (but are not limited to): sustainable and eco-design, energy and material efficiency measures, strategies defined within the three-R's waste hierarchy (reduce-reuse-recycle, sometimes expanded to 11 different R-strategies), business model innovation, industrial symbiosis, etc.. 9 R, as one of the most influential concepts, is illustrated below (Figure 3):

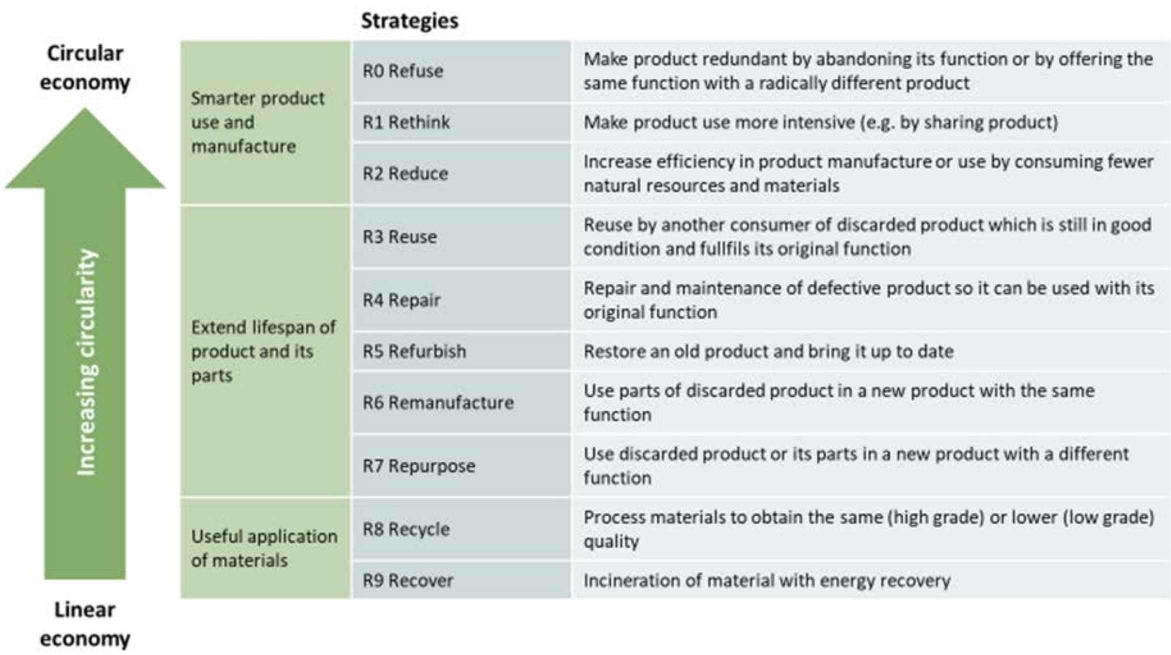

Figure 3: The 9 R-strategies (adapted from Kirchherr et al. 2017)

As noted in chapter 5, a circular economy model framework, comprising a distinct set of R-strategies, has recently been developed for the European water and wastewater sector (Smol et al. 2020). Aside from relating specifically to this sector, this framework emphasizes not only technological but also organizational and societal changes, by defining Rethink as "holistic changes in the value chains of water and wastewater" and considering it as the most important strategy for transforming towards CE (Smol et al. 2020:693).

In terms of systemic perspectives, Baldassarre et al. (2019) argue for a perspective combining circular economy and industrial ecology (IE) perspectives on industrial symbiosis. The IE perspective on IS regards it as a socio-technical process, which enables an analysis of the dynamic interaction and collaboration between multiple stakeholders. However, the IE perspective is theoretical and complex, making it difficult for practitioners to act upon. The CE perspective contributes with business language and thinking to IS studies, perhaps making it more accessible to practitioners. However, this perspective may remain too firm centric, thus unable to capture the systemic perspectives involved. The combination of the two will provide greater analytical purchase, while

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remaining accessible to practitioners. Also, Konietzko et al. (2020) consider CE as a systemic concept, pointing to previous research showing that CE requires higher degrees of collaboration among actors, whole-systems design, a transformation of production and consumption systems, reverse/cascading skills, cross cycle and cross sector collaboration, a shift from supply chains to value networks, life cycle thinking, and sustainable supply chain network designs.

The impacts generated by CE are often measured through circularity metrics. Ideally, circularity metrics should provide an indication of how well the principle of CE is applied to a product or service. However, most of the published metrics have been criticized for not representing the systemic and multidisciplinary nature of CE (Saidani et al. 2017) and focusing solely on to what extent material cycles are closed. According to Corona et al. (2019), these approaches frequently overlook the characteristics of circular loops (e.g., shorter, or longer) and multi-dimensional sustainability performance, i.e., environmental, economic, and social. Corona et al. (2019) also point out that circularity metrics based only on material recirculation are not suitable to measure the absolute decrease in resources use, which should be a priority in CE.

The success in closing loops and achieving effective circularity depends on a change in the paradigm of wastewater management. It demands a new perspective on wastewater, as a stream of resources with significant economic impact and value (Guerra-Rodríguez 2020), and that such a perspective informs national legislation and policy designs.

To summarize, the CE literature draws attention to the complex interaction between actors, resources, and products. It also underscores that circular value chains require cross sector collaboration and whole system design. These aspects are therefore addressed in GOCIWA. We also consider the level of interest and degree of focus on different 'R' strategies, and what CE metrics (if any) that are applied at different context levels.

A1.5 IAD and socio-ecological perspectives

Pahl-Wostl et al. (2020) developed a framework for context-sensitive assessment of multi-level water governance – a "transdisciplinary diagnostic approach" – to help address the coordination challenges involved in integrated water resource management. That is, specifically for challenges and actions that involve actors and governance regimes linked to different sectors. To achieve transformation across multiple sectors and levels, the assessment is combined with a participatory change management process. Their framework focuses on implementation processes at regional and local scales and their embedding in a multi-level water governance system, as well as an environmental and societal context. The ambition to consider interactions between social and ecological systems is also found in many other studies and approaches within water governance, which to a lesser or larger degree draw on Institutional Analysis and Development (IAD) and subsequent research on socio-ecological systems (SES).

The conceptual framework of Pahl-Wostl et al. (2020), named STEER, makes a distinction between a) context, b) the 'water governance and management system' (including institutions, actors, and their interactions), and c) its 'functional performance' measured by outcomes and impacts. Three main categories of processes are considered; planning, implementation, and ecosystem services interactions, referring to operational activities that are based on contributions from ecosystems and/or result in tangible changes in ecosystem services and/or physical objects (e.g., building technical or green infrastructure, livestock production, drinking water supply).

Following Ostrom (2005), different governance functions are associated with different action situations (AS). Defined as *"a structured context of social interactions that lead to identifiable products"* (Pahl-Wostl et al. 2020:25) each AS may be influenced by different kinds of inputs and produce different kinds of outputs. As depicted in Figure 4, these comprise institutions, knowledge, operational factors (e.g., infrastructure, processing, change in public opinion) and impacts on ecosystem services. An output from one AS (e.g., knowledge) may serve as input to another AS.

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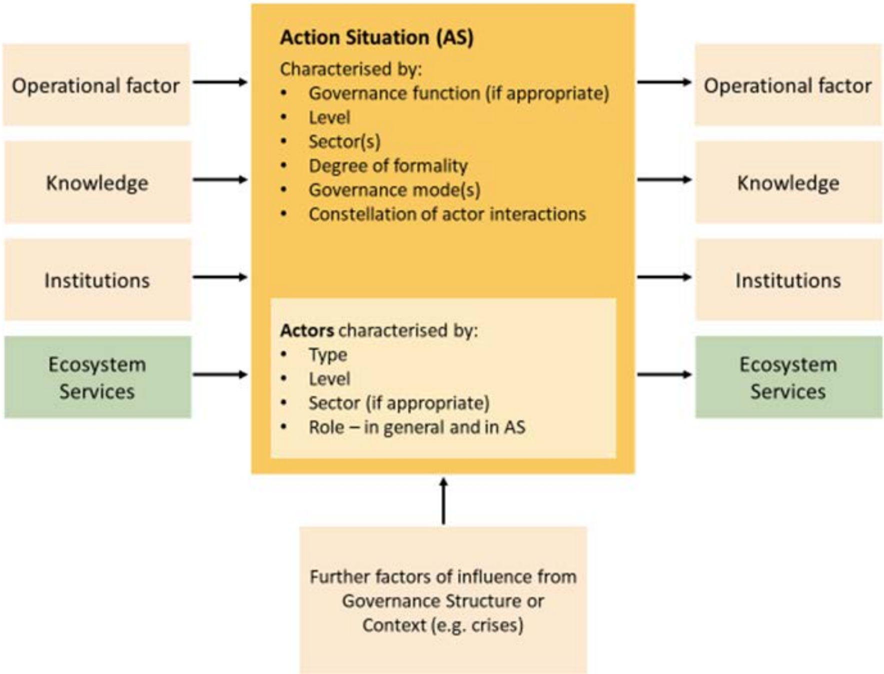

Figure 4: Generic visualisation of action situations (adapted from Pahl-Wostl et al. 2020)

The core concept of the STEER framework is operationalized by sets of 2nd and 3rd tier variables, linked to context, governance structure, processes, and performance/outcomes.

The framework reflects a set of hypotheses:

- Centralised vs. decentralised - polycentric governance systems may be particularly suited for dealing with complex water resource governance challenges
- Redundancy and gaps in governance functions constitute coordination challenges
- Governance modes (i.e., hierarchies, markets, networks) matter - the absence of clear dominance of one governance mode supports synergistic interplay & effective coordination
- Ecosystem Services (ES) – emphasis has been given to provisioning services, whereas regulating and supporting services have been largely ignored. Interdependencies between different ES, at different scales/levels may be associated with governance challenges

The insights generated by Pahl-Wostl and colleagues (2020) suggest that when policy implementation and integrated water management is concerned, it is important to map and assess the contextual interactions linked to specific action situations. We therefore apply the concept of action situations for the Initial case definition in GOCIWA. Pahl-Wostl et al. (2020) also emphasize the interaction between governance and material dimensions, including both operational factors and ecosystem services. While those under governance structure to a larger extent are covered in CIT, some of the 2nd and 3rd order variables on Processes and Performance may be useful to address synergies and trade-offs and are also drawn upon in our framework.

A1.6 The Water-Energy-Food nexus approach

The Water-Energy-Food (WEF) nexus approach begins by identifying two or more resources within a particular geographic or socio-political boundary and continues by quantifying resource use and the ways in which the use of one resource affects the other to affect the sustainability of the interconnected social-ecological system. The

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approach sheds light on governance through concepts of trade-offs, synergies, and thresholds in the management of water, energy, and food resources (Mohtar and Daher 2016).

The nexus is seen as a product of a) the interaction of environmental resources, b) the intersection of interests and c) the distribution of risks, both environmental and institutional (Kurian et al., 2016a). *Nexus nodes*, as the points of interaction between material fluxes, public financing, and heterogeneity of bio-physical and institutional systems, is a central concept (Kurian 2017). The *critical mass*, of interests based on interactions involving decisions on financing, technology choice and leadership, that would support effective implementation, is another core element. Finally, *nexus thresholds* to action are determined by distribution of environmental risks, institutional capacity, and externalities.

Villamayor-Tomas (2015) approaches the WEF nexus with a combination of value chain and IAD perspective. Here, food, energy and water value chains are studied specifically as networks of action situations (NAS) where actors' decisions depend not only on the institutional structure of a particular situation, but also on the decisions made in related situations. He sees a value chain as *"the full range of activities which are required to bring a product or service from conception, through to the different phases of production, delivery to final consumers, and final disposal after use"* (Villamayor-Tomas 2015:738). Production is only one of a number of value links, there are a range of activities within each link and these 'intra-chain linkages' are mostly bidirectional. Activities in a particular link may be affected both by the outputs of upstream activities, and by constraints in downstream links. Whereas a value chain perspective alone may provide knowledge of organisational relations (contracting practice; governance structures) and their links with the form of transactions, the combined framework draws attention to the multi-level institutions that shape decisions both within and across action situations. Villamayor-Tomas provides a stylised flowchart to illustrate how the framework may be used as basis for discussing the role of different actors, interactions, synergies, and trade-offs, as illustrated below (Figure 5):

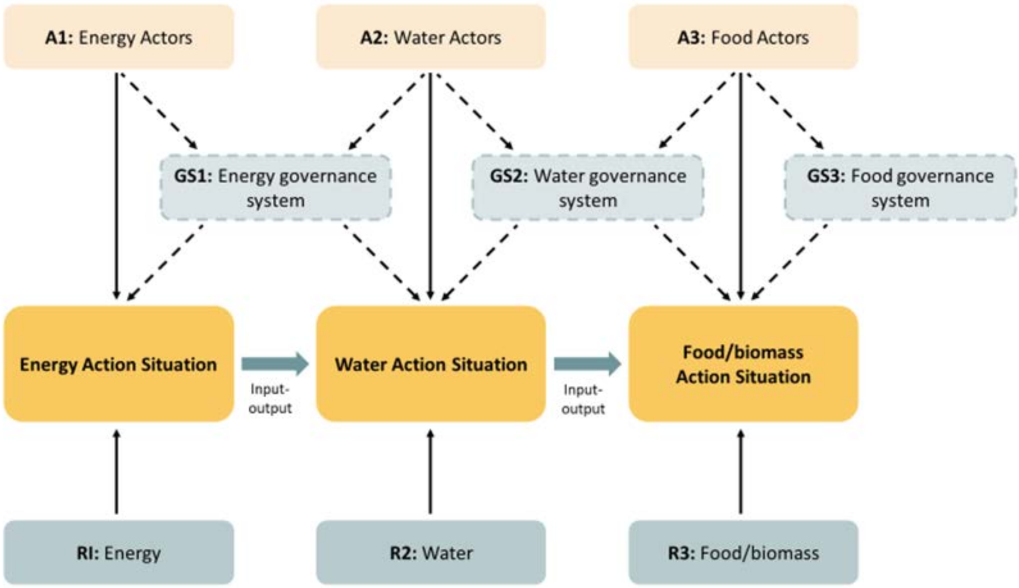

Figure 5: Stylised flowchart of action situations (adapted from Villamayor-Tomas et al. 2015)

Once the focal action situation/s are defined, one can begin to analyse a) how the situations are linked (e.g., via shared resources or institutions) and b) the direction of those linkages.

Pahl-Wostl et al. (2020) underscore the long-established claim that paradigm shifts are needed in water management, towards:

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- Participatory management and collaborative decision making
- Increased integration of issues and sectors
- Management of problem sources, not effects
- Decentralized and more flexible management approaches
- More attention to management of human behaviour through 'soft' measures
- Explicit inclusion of the environment in management goals
- Open and shared information sources
- Incorporation of iterative learning cycles into management processes

They argue that the WEF nexus may facilitate a shift from a sector-centric towards a more systemic view with special focus on relationships and feedback between sectors, thus breaking "silos". To achieve this, more attention must be paid to multilevel and multi-loop social learning, as well as the identification of barriers to transformative change, such as institutional inertia, power constellations, and entrenched beliefs and practices.

As noted above, we analyse the considered processes and value chains as a set of connected AS. This is to address how different governance systems (water, agriculture, energy, industrial production, as relevant in each particular demo case) interact and may create drivers and barriers in different parts of the value chain. GOCIWA considers the interaction across different resource and governance systems, and addresses information sharing, learning as well as other aspects with a view to wider system transition.

A1.7 Socio-technical perspectives

Literature on sustainability transitions has argued that the large-scale sustainability challenges of our time require systemic changes in the production and consumption patterns of the sectors of the world, including energy, mobility, food, and water (Markard et al. 2012). Such systemic changes are often impeded by path dependency and linked to established technologies, practices, and institutions. Hence, to foster a fundamental change towards CE in e.g., the water sector, change needs to happen in the social as well as technological dimensions. Seeing sustainability transitions as interactions between technology, power, politics, markets, institutions etc. means that we need to interrogate their multi-dimensional nature, as well as the underlying dynamics of structural change (Geels 2011). *"Many systems that are deemed unsustainable remain in (a seeming state of) stability due to lock-in mechanisms, which make it difficult to dislodge existing systems"* (Geels 2011:25). Amongst other, lock-ins may be associated with:

- Scale economies
- Sunk investments in machines, infrastructures, and competencies
- Institutional commitments
- Shared beliefs and discourses
- Power relations
- Political lobbying by incumbents to stabilize existing systems
- Consumer lifestyles and preferences fitted to existing technical systems

The Multi-Level Perspective, as one of the schools in socio-technical transitions research, conceptualizes sustainability transitions as non-linear processes that result from the interplay between the development of niche innovations (such as CE solutions in the water sector), developments and stability in the established production and consumption patterns (i.e. the regime) in the sector, and external developments (such as public pressure for more sustainable water systems or economic recessions). The existing regime is stabilized by rules, norms, beliefs, and expectations. However, external (i.e., landscape) developments may put pressure on these patterns, opening a window of opportunity for radical innovations. Transitions may then unfold, if novel innovations are able to mature, the sectoral regime becomes destabilized, and the niche innovations are able to change some of the existing regime configurations (Geels 2011). Figure 6 illustrates this transition pattern.

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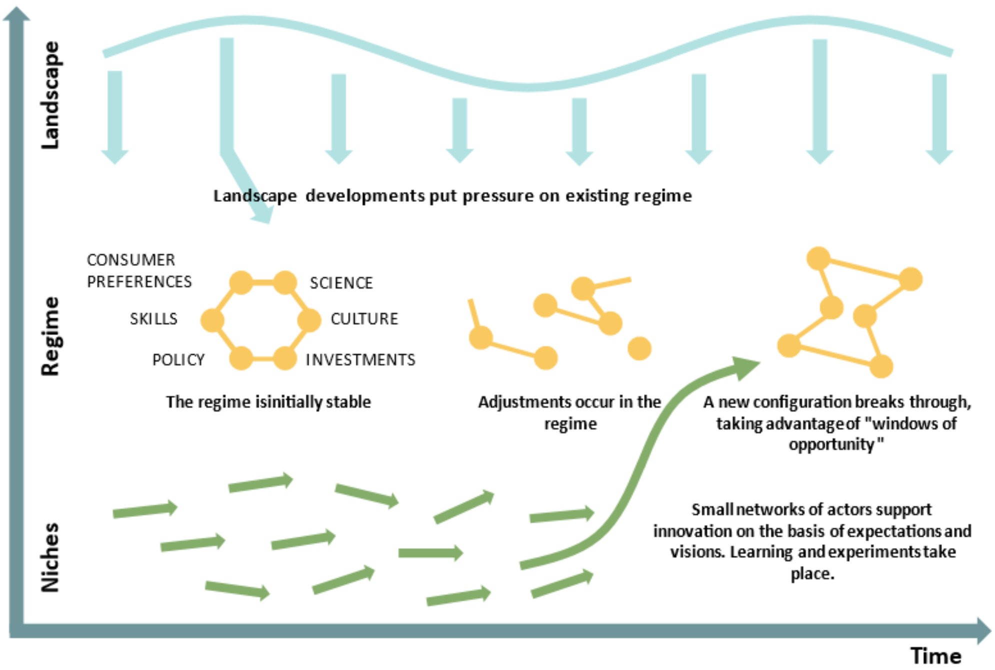

Figure 6: Multi-level perspective on sustainability transitions (adapted from EEA 2016, Geels 2002)'

This perspective helps to understand why water system transitions may not take place at all (at least without policy intervention), or why they may take a long time, often decades. The high sunk costs and long lifetimes of water infrastructure (similarly to other infrastructural systems), strengthened by numerous institutions, typically present a barrier to fast and fundamental change. However, as described above, regimes may come under pressure. For instance, by increasing knowledge and awareness, or by specific events. For example, in Roskilde, Denmark, a heavy flooding event demonstrated the inability of the existing stormwater system to deal with such situations, creating an opening for alternative water management systems (Jensen et al. 2015).

The existing regimes may also guide the choice among the alternative technologies. In a study from Australia, Fuenfschilling and Truffer (2016) found that different institutional logics, a traditional hydraulic perspective versus a more market-oriented and a water sensitive logic, compete within the water sector. In their case study, on how new water supply technologies were explored to respond to a drought, desalinization technologies gained an upper hand against recycling, as their advocates managed to frame this technology as a seemingly better fit with the existing regime, in terms of the hydraulic logic and related system values, such as safety and quality in water supply (Fuenfschilling and Truffer 2016). The study draws attention to various forms of institutional work (i.e., advocacy, defining, vesting, mimicry, constructing networks and identities) used by actors to protect existing regimes or promote sustainable innovation.

Cramer (2020) shows how the specific geographic context of the Amsterdam Metropolitan Area enabled the design, implementation and scaling up of a circular economy project. Van Welie et al. (2018) found that the sanitation system in Nairobi consisted of multiple sub-sectoral service-regimes, such as public sanitation, domestic sewer regime, etc., which had their own regime-like characteristics and were tightly aligned, making the sanitation system more resistant to change. In a more recent publication (van Welie et al. 2019), the Technological Innovation System (TIS) framework is applied to Nairobi's sanitation value chain. This perspective draws attention to the core processes that drive the development of a TIS, such as gaining technology legitimation, mobilizing resources, forming markets, guiding search activities, entrepreneurial experimentation, and knowledge development (Hekkert et al. 2007). Analysing these functions over time and comparing them across cases may help identify system weaknesses in the form of coordination, capability, and institutional failures.

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Also, within the field of socio-technical transition studies, the strategic niche management perspective highlights the need of policymakers to stimulate both supply and demand for the new water technology, aiming to make the "rules of the game" more favourable for the novel technology, and create room for experimentation and technological variation. (Kemp et al. 1998, Schot and Geels 2008). Key objectives are to:

- Articulate the changes in technological and institutional framework needed for economic success
- Learn about the technical and economic feasibility and environmental gains
- Stimulate further technological development, achieve cost-efficiencies, promote complementary technologies and skills, and stimulate changes in social organizations
- Build a semi-coordinated network of actors committed to the transition

It is important to ensure that the process is not dominated by certain actors (e.g., powerful incumbents with vested interests in the existing water technologies) and keep the transition in a desirable direction. Other processes that may have to be stimulated are e.g., attracting more actors to the niche, stimulation of experimentations, creation of early markets and the mobilization of sufficient financial and human resources (Bergek et al. 2008).

While local projects form test beds for new technologies, niches often also develop on a more global level, as the emerging community around a new technology shares cognitive, formal, and normative rules. In such communities, diversity of ideas is productive, but too much diversity may lead to uncertainty and fragment resources, hampering the emergence of a stable set of rules. Niches are more likely to diffuse widely if they link with ongoing processes at regime and landscape levels (Fuenfschilling and Truffer 2016). Such co-evolution may have multiple forms. For instance, niches may be adopted to solve problems in the regime.

The above insights highlight that water-smart innovations are affected by the existing regimes, creating inertia for change which may affect their wider uptake. The understanding of socio-technical lock-ins and enabling conditions for transitions is therefore of crucial importance also for governance. TIS draws attention to system functions such as gaining technology legitimation, mobilizing resources, forming markets, guiding search activities, entrepreneurial experimentation, and knowledge development. Strategic niche management highlights the role of learning and experiments and provides a particular focus on how to overcome barriers and stimulate the uptake of new sustainable technologies. These are all elements incorporated in GOCIWA, and main reasons why we take a system perspective, considering developments and pressures for change at the Wider contexts level, as well as the Structural context, and pay close attention to processes in the specific case context.

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Annex 2: Exemplary interview guide

The interview has three parts. After a brief introduction of yourself and your organization we first ask for your perspectives on the general and broader context for circular economy based on water-smart solutions. With this we mean for instance how the regulations and policies affect the upscaling of circular water management, who are the main actors (both public and private) in the relevant sectors, and what kind of strategies do they have which may affect the upscaling of circular water management. In this way we seek to shed light on the overarching drivers and barriers for further upscaling of circular water management. Here we thus focus on the conditions that go beyond the specific local conditions of the demo case.

In the second part we then focus on the specific conditions in the demo case in question. The questions concern previous decisions and events that influence the scope for circular economy based on water resources, case-specific circumstances, such as resource system and geographical distances, other entrepreneurial activities, etc., and the key actors and their form of collaboration. This way we seek to identify specific and local factors that have characterized, driven and hindered the case study in question.

Finally, we ask you to summarize the discussed topics into main drivers and barriers for wider uptake of circular water management.

1. Please briefly introduce yourself and your organization.

(Name, position, relevant experience, organization, and its objectives).

Then we start with the broader conditions for circular economy based on water-smart solutions.

Authorities and their responsibilities across levels and scales

2. Who are the most relevant authorities for your activities and for the other parts of the considered value chain for circular economy based on water resources?
   a. At the local/regional level?
   b. At the national level?
   c. At the international level?

3. What are the main responsibilities of these authorities? Their geographical extent and time/planning horizons?

4. How would you describe their coordination and collaboration when it comes to circular economy based on water resources?
   a. How do they collaborate at the local, national, and international levels?
   b. How about across these levels?

5. Are all roles and responsibilities clearly assigned, or are there any areas of governance that no authority has a clear responsibility for? If so, please explain.

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Strategies and instruments

6. What are the most important regulations affecting the scope for circular economy based on water resources? Are some of these particularly conducive or unconducive? Please explain.

7. Among ongoing regulatory developments to facilitate circular economy, do you foresee any changes that will influence the scope for water-smart solutions in your country? If so, please explain.

8. Are there any other action plans or policies stimulating circulating circular economy based on water resources? E.g., national green transition strategies, green public procurement, R&D funding? If so, please explain.

9. Are any particular incentives, additional funding sources available for key actors?

10. Are there any sector strategies or industry roadmaps promoting circular economy based on water resources? If so, please explain.

11. Are there any efforts to develop new guidelines or standards for water-smart solutions or use of water-based resources? If so, please explain.

Actor networks, resources, technologies

12. How would you describe the main categories of actors and their relation to the solutions in question?

13. Please describe the capacity and competences of the key (categories of) actors.
    a. Size and financial resources
    b. Degree of knowledge and competences, R&D capacity
    c. Culture in the organization

14. How would you describe their interaction and collaboration concerning water-smart solutions? To what extent and how do they interact?

15. Are there networks (such as industry associations) engaged in water-smart solutions and/or facilitating collaboration around such solutions? If yes, please describe their activities.

16. Are there any conflicts of interests?

17. Are there any actors with a mediating or facilitating role?

18. What are the conventional solutions (technologies and practices) in the different parts of the value chain (or those parts you are familiar with)?

19. To what extent are they compatible or at odds with circular economy based on water resources?

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Perspectives and goal ambitions

20. What are your main motivations for engaging in innovation linked to water reuse and resource recovery?

21. How do you see the perspectives and motivations of other stakeholders? Who have been the strongest advocates and who have been more resistant? Please explain.

22. To what extent is circular economy based on water resources a priority among the relevant authorities?
    a. Has is it been promoted in policy white papers and political statements?
    b. Are any clear goals or targets expressed?

23. Which various angles does the public discourse on sustainable water management take?
    a. Has the public opinion changed over time? How?

We now move to the second part focusing on the specific context of the demo case.

Previous decisions and priorities

24. What prompted or is currently generating interest in innovative solutions for water reuse and resource recovery in the studied case? E.g., critical events, strategic priorities, technology development, investment decisions, management changes, political pressure, something else?

25. Are any previous decisions in the specific context associated with significant barriers to innovation uptake?

26. What are the relevant pre-existing technological solutions in place?

27. To what extent is the current infrastructure, equipment, and practices compatible with the new circular water management solutions? Please describe.

Case-specific circumstances

28. Who are the key actors in the specific case under study, and where are their facilities located?

29. Can you provide information or indications/estimates on the amounts of resources (or services) involved?

30. Are there seasonal fluctuations (e.g., more, or less phosphorous, temperature variations) that influence the performance of water-smart solutions and the generated resources?

31. Are the actors and/or public stakeholders engaged in other entrepreneurial activities technological or social), or industrial symbiosis? If so, please mention.

32. Are any of the circular water management products (e.g., treated wastewater, bio-products, fertilizers, energy products, etc.) already used? Please elaborate.

33. How do you see the expected long-term demand for these products? Why do you think so?

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Process of collaboration

34. Who have been or may be the main driver of the studied initiative (e.g., utility, their owners, technology provider, consultants, research institution, public agency)?

35. How is the history of collaboration between the actors (degree, formal/informal, etc.)?

36. How is the current collaboration organized (type of agreements, contracts, degree, and form of interaction)?

37. Would you say the actors have a common vision regarding the circular water management case? Please explain.

38. To what extent and how do they engage with relevant stakeholder groups? Please explain.

Finally, to sum up

39. What, in your opinion, are the most important drivers and barriers to wider uptake of the case innovations?

40. Is there anything you would like to add?

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Annex 3: Excel sheets for data collection and analysis

The following pages exhibit different parts on an Excel file provided for data collection and analysis.

The Excel file contains four sheets:

1. Case Definition
2. Wider Contexts
3. Structural and Specific Context
4. Summary Scorecard

The first one, for Case Definition, provides a structure for identifying the action situations in focus of the assessment and their key, constitutive elements.

The second, on Wider Contexts, provides space for sorting and collecting information regarding the different Wider Context dimensions considered and relating this to the respective references/data sources that have been used. The template contains a few examples of relevant data sources. However, these will vary across countries. For users who do not intend to write a separate assessment report, a column for evaluation of the different dimensions has been added on the far right. This has reference to the evaluative criteria for the initial case definition. Evaluation is made easy, in that the rows in the Excel sheet provide an overview of the resources, actors, focal interactions and governance systems, across action situations.

The third sheet addresses both the Structural and Specific Context, with a column for general interview responses and information from documents, as well as columns for statements relating to the different action situations in focus. With all information filled, this will become a huge sheet. However, by putting the Structural and Specific context together, all the descriptive interview data can be collected in one place. We can also assess all the drivers and barriers related to each action situation, by looking at the respective columns. Thereby it is easy to make comparisons and find out where, in what part of the value chain, main challenges and opportunities reside. It is also possible to compare results for specific action situations across different assessments, for example drivers and barriers to water reuse across different countries and cases in WIDER UPTAKE.

The same way as for the Wider Contexts, a column for evaluation of the different dimensions has been added on the far right, for users who do not intend to write a separate assessment report. By using these columns, the evaluative assessment is related to descriptive data in a systematic and transparent way. The table format helps ensure that the evaluation takes all relevant dimensions and information sources into account, and that the evaluative assessments for each context level easily can be transferred to the summary scorecard.

For visibility in PDF format, the Excel sheet for the Structural and Specific Context is distributed across three pages in this Annex.

The fourth sheet of the Excel file, finally, provides the Summary Scorecard presented in section 6.5.

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