Final version of the water-smartness assessment framework

Deliverable 6.3

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 869171. The publication reflects only the authors' views and the European Union is not liable for any use that may be made of the information contained therein.

Final version of the water-smartness assessment framework (V_2)

D6.3: Final version of the water-smartness assessment framework (V_2)

Summary

D6.3 completes the mission of WP6 of developing the B-WaterSmart assessment framework conceived as a holistic framework to support strategic planning and to assess gains in the process of achieving long-term objectives towards a water-smart(-er) society. It is designed as objective – driven with a tree-model composed of five strategic objective, fifteen assessment criteria and sixty metrics which can be selected by the users (e.g., local, regional strategic decision-makers, but also European and national authorities, or the research community) to develop tailored assessments. Furthermore, an iterative six-step process for continuously improving the transition process to a water - smart society, is proposed as deployment methodology of the framework. The framework has been developed in four steps by the three tasks of WP6: Task 6.1 has covered the groundwork, including an extensive literature review and the gathering of preliminary user-requirements for the intended framework; Task 6.2 has developed the framework up to version 1 (V_0 and V_1) and Task 6.3 has further refined it, as version 2 (V_2), after a period of testing performed by the Living Labs (LL) of the project. This deliverable presents the work fulfilled under Task 6.3. D6.3 is composed by an excel file and this supporting document organized in two parts: part I includes background information on the scope, the updated version of the elements forming the framework V_2, a description of the excel file and a guide for implementation; part II informs about the process performed by WP6 to develop the framework.

Deliverable number	Work package
D6.3	WP6
Lead beneficiary	**Deliverable author(s)**
LNEC	Catarina Silva, Maria Adriana Cardoso, Maria João Rosa, Helena Alegre (LNEC), Rita Ugarelli, Camillo Bosco, Gema Raspati, Kamal Azrague, Stian Bruaset, Sigrid Damman (SINTEF), Stef Koop, Stefania Munaretto (KWR), Marcella Melo Silva da Conceição, Carla Gomes (ICS), Laura Flores Rosell (CET), Alexandra Schmuck, Clemens Strehl (IWW), Prasanna Mohan Doss (NTNU).
Quality assurance	
Water Europe ICCS	Isabella Gervasio, Andrea Rubini Lucyna Lekawska-Andrinopoulou
Planned delivery date	**Actual delivery date**
28/02/2023	28/02/2023
Dissemination level	X PU = Public □ PP = Restricted to other programme participants □ RE = Restricted to a group specified by the consortium. Please specify: ______________________ □ CO = Confidential, only for members of the consortium

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List of Acronyms and Abbreviations

For abbreviations referring to the variables used to compute metrics, please see: Appendix B – List of variables adopted in BWS AF, V2

AC : Assessment Criteria

AF : Assessment Framework

BOD : Biological Oxygen Demand

BWS : B-WaterSmart

CE : Circular Economy

CICES : Common International Classification of Ecosystem Services

CSG : Coordination and Supporting Group

D : Deliverable

DMA : District Metered Area

DoW : Description of Work

DWD : Drinking Water Directives

EC : European Commission

EEA : European Economic Area

EFR : Environmental Flow Requirement

ES : Ecosystem Services

FAO : Food and Agriculture Organization

FAST : Framework ASsessment Tool

InAll : Innovation Alliance

IPCC : Intergovernmental Panel on Climate Change

IWA : International Water Association

JRC : Joint Research Centre

JSON : JavaScript Object Notation

LL : Living Labs

MS : Milestone

Mx : Month, *e.g.*, M30=month 30 of the project

OECD : Organization for Economic Co-operation and Development

SDG : Sustainable Development Goal

SO : Strategic Objective

SW : Stormwater

T : Task

TSS : Total suspended solids

WFD : Water Framework Directives

WP : Work Package

WR : Water Reclamation

WS : Water Supply

WW : Wastewater

Executive summary

The ultimate goal of the B-WaterSmart project is to accelerate the transformation to water-smart economies and societies. To achieve the goal, eight specific objectives have to be accomplished, as described in the description of action of the project:

- Objective 1: enable systemic innovation;
- Objective 2: create water-smart coastal regions;
- Objective 3: exploit the potential of smart resource allocation;
- Objective 4: foster resource recovery, circular economy, and ecosystem regeneration;
- Objective 5: facilitate a water-smart culture;
- Objective 6: demonstrate the gain in water-smartness as a novel and holistic concept;
- Objective 7: stimulate new business opportunities for European water solution providers;
- Objective 8: boost European and international accessibility and replication, exchange and uptake of innovations in water management.

WP6 has provided the means to achieve objective 6. Before WP6, although multiple descriptions and definitions of what a water-smart society should be and aim at (see extensive literature review in Ugarelli *et al.*, 2021), no harmonized and established approaches on how to assess the 'water-smartness' status or gains of a system, or society existed. Therefore, the mission of WP6 has been to fill this gap by first providing the definition of a water-smart society adopted by the project, and then by operationalizing it into an applicable evaluation framework. The framework will be then converted into an online dashboard (by Task 3.9) after being tested in Task 1.4 across the six Living Labs (LL) and the established Innovation Alliances (InAll) of the B-WaterSmart project.

This deliverable, D6.3, ends the work performed by WP6 structured into three consecutive tasks.

Task 6.1 has produced D6.1 which has achieved the two specific goals:

1) to provide the definition of "water-smart society";

2) to provide the preliminary theoretical concept and design of the B-WaterSmart framework, which reflects the formulated definition, and it supports the creation and implementation of strategic plans to achieve the water-smart society vision.

Task 6.2 has first achieved the MS16 (Ugarelli *et al.*, 2022a), consisting of the BWS AF version 0 (V_0) and then developed the framework up to version 1 (V_1) (described by D6.2).

V_1 built on the V_0, which provided the preliminary list of the elements forming the framework (strategic objectives, assessment criteria and metrics). MS16 built on the theoretical background given by D6.1. To deliver V_1, first the information provided by MS16 have been embedded into a web-application to facilitate a validation phase carried out by the project's Innovation Alliance (InAll) under the coordination of Task 1.4. The web-application can only be accessed with credentials provided by the developer to the InAll as users. This web-application was not originally planned in the project; however, SINTEF took initiative to provide this additional product to facilitate the InAll user-experience. The application was also supported by a detailed tutorial. It is worth to mention that the web-application has been conceived as a provisional solution which will be replaced by the dashboard (by Task 3.9) with an early release at M36.

Task 6.2 ended with D6.2 (Ugarelli *et al*. 2022b) composed of a supporting document and the web-application. The supporting document of D6.2 provides a detailed description of the framework as well as of the web-application, of the validation process established in collaboration with Task 1.4 and of the feedback and recommendations for improvement received.

Task 6.3 has then refined the framework based on the feedbacks documented in D6.2 and D1.3 (related to Task 1.4). A new process of iteration with the LLs and InAll was also established to further validate the framework.

This deliverable, D6.3, presents the work fulfilled under Task 6.3 and therefore consists of the (final) version 2 (V_2) of the B-WaterSmart Assessment Framework (BWS AF). The BWS AF V_2, consists of 5 strategic objectives, 15 assessment criteria and 60 related metrics.

This final deliverable of WP6 is composed of an excel file that provides the list of elements forming the framework and this document.

For completeness of the work performed, SINTEF has also updated and implemented the BWS AF V_2 of the web-application available at fast.b-watersmart.eu[1].

This document is organized in two parts: Part I includes background information about the BWS AF scope (Chapter 1), the updated version of the elements forming the framework V_2 (Chapter 2), the description of the structure of the BWS AF excel file (Chapter 3) and the guidance for the framework implementation (Chapter 4). Part II describes the process of the framework development with the description of the work performed by WP6 and of the co-creation process established with the InAll (Chapters 5-6), it also describes the method and main results of refining the standardized interview process (Chapter 7) and identifies the main differences between version V_0/V_1 and V_2 of the BWS AF (Chapter 8). In Chapter 9 the alignment of the work performed by WP6 with Description of Work (DoW) of each task is provided and the key conclusions ends the document in Chapter 10. Additional information is provided in the APPENDIX part, which

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[1] The web-application can only be accessed with credential provided by the developer, and, in this phase of the project, the users are limited to the InAll. This is to avoid confusion in the future with the dashboard developed in T3.9.

includes a glossary of the terminology applied, the full list of variables defining the metrics of the framework, the proposed reference values and the improved interview guide.

The deliverable D6.3 has been organized in two parts, since the plan is to extract Part I (containing the actual framework) as a separate document for distribution and download in the B-WaterSmart website together with the excel file, upon approval of the deliverable by the EC.

PART I – The B-WaterSmart Assessment Framework, V_2

1 The B-WaterSmart Assessment Framework (BWS AF)

1.1 Introduction

The B-WaterSmart project, and specifically through WP6, aims at providing an assessment framework to support multi-stakeholder and strategic decision-making towards the transition to a water-smart society that recognizes multiple values and facilitates the active participation of a varied set of actors.

B-WaterSmart has produced and adopted the following definition of a water-smart society: *"Societies are water-smart when they generate societal well-being via sustainable management of water resources. In water-smart societies, well-informed citizens and actors across sectors engage in continuous co-learning and innovation to develop an efficient, effective, equitable and safe circular use of water and the related resources. This is achieved by adopting a long-term perspective to ensure water for all relevant uses, safeguard ecosystems and their services to society, boost value creation around water, while anticipating change towards resilient infrastructure."* (D6.1 (Ugarelli et al., 2021))

Having a definition of what a water-smart society is does not help in assessing the performance of being water-smart, therefore the operationalization of the definition into an applicable assessment framework is needed to support the creation and implementation of strategic plans to achieve the water-smart society vision.

To this aim, Ugarelli et all. (2022a), based on the dialogue with the LLs and insights from literature review, has proposed an objective-driven assessment approach. The approach builds on the adopted definition to select the guiding strategic objectives towards a water-smart society: the three sentences in the definition were in fact transposed into a set of five strategic objectives (SO), listed below (Table 1).

Strategic objectives
A. Ensuring water for all relevant uses
B. Safeguarding ecosystems and their services to society
C. Boosting value creation around water
D. Promoting adaptive change towards resilient infrastructure
E. Engaging citizens and actors across sectors in continuous co-learning and innovation

Table 1 – Strategic objectives outlined from the definition.

The strategic objectives are the overarching goals that organizations, cities, or regions aim to realize towards their "water-smart" vision. Thus, they reflect the transformative features of the water-smart society.

Each objective should be evaluated against clear assessment criteria (AC), measured through metrics; specific, quantified targets should be set using such metrics. Elaborating on the meaning of each strategic objective provided the insights to identify the assessment criteria and then the related metrics.

Strategic objective A, related to Sustainable Development Goal (SDG) 6, aims to ensure that all sectors have access to enough water in terms of quantity, and safe water in terms of quality now and in the future. This links up with SDG 12, responsible consumption, and production, in providing water for both domestic and industrial uses, while ensuring health and safety; SDG 10, reduced inequalities, in terms of availability and accessibility; and SDG 11, on sustainable cities and communities.

Strategic objective B, safeguarding ecosystems and their services to society, links SDG 6 to SDG 14 and 15, protecting life below water and life on land, as well as SDG 11, on sustainable cities and societies. The objective describes the ability to prevent deterioration and ensure the protection of water-related ecosystems, enhance ecosystem services, strive towards carbon neutrality, and promote resource efficiency. This will also contribute towards SDG 12, responsible consumption and production, and SDG 13, on climate action.

Strategic objective C refers to generating economic value from synergies in the water-energy-resources-waste nexus through the implementation of circular economy policies and business models. This dimension is well aligned with Water Europe's vision, and specifically addresses SDG 12, responsible consumption, and production, ultimately linked to the need for sustainable food (SDG 2) and energy production (SDG 7), as well as SDG 11, sustainable cities and communities, and SDG 8, on decent work and economic growth.

Strategic objective D, promoting adaptive change towards resilient infrastructure, is about the establishment of planning procedures, their successful implementation, as well as financial and decision-making conditions promoting adaptive change towards resilient infrastructure. This relates directly to SDG 9, which aims to build resilient infrastructure, promote sustainable industrialization, and foster innovation, as well as SDG 3, good health and well-being, SDG 11 and SDG 13, on climate action.

Strategic objective E refers to the broad, iterative process of monitoring, evaluating, and learning water-smart practices amongst all relevant sectors by engaging citizens in planning, decision-making and implementation. This is linked to SDG 16, in striving for inclusiveness, as well as life-long learning (SDG 4) and sustainable cities and communities (SDG 11).

The features covered by each strategic objective as described above, are reflected by the assessment criteria and the metrics composing the B-WaterSmart framework. The full list of assessment criteria and metrics is provided in Section 1.5, while Chapter 2 offers the detailed definition for each element of the BWS AF, V_2. The BWS AF V_2 consists of 5 strategic objectives, 15 assessment criteria and 60 metrics (out of which 47 are considered to be core metrics).

In the following sections, the scope, the functionalities, the identified main users that guided the framework design (Ugarelli *et al.*, 2021) and the list of elements composing the BWS AF V_2 are provided.

1.2 Objective of the BWS AF

The objectives of the framework are to:

1. assist practitioners in strategic planning and to assess gains in the process of achieving long-term strategic objectives in a non-prescriptive, transparent, consistent, credible, stakeholder-based and easy-to-use way.
2. help policy-makers and decision-makers overcome existing barriers and implement their strategic agendas towards a water-smart society in support of development priorities in a sustainable way; and
3. enable benchmarking by providing a minimum set of metrics that can be used for comparisons in relation to own objectives, in time and with other organizations.

Using an integrated approach, the framework aspires to constitute an assessment tool to be applied at the strategic level of decision-making.

1.3 Frameworks' main functionality

The main functionalities of the proposed framework are to:

- provide a minimum set of metrics that can compare (i) the current state in relations to own objectives, (ii) developments over time and (iii) between cases.
- enhance adaptive management through yearly data-update of the framework to enhance flexibility, experimentation, and learning.
- enhance anticipatory capacity by allowing scenarios assessment to enable informed decision-making in adapting the current system to future challenges.

1.4 The Framework's main users

The envisaged users of the framework are:

1. **Living Labs' (LL) local[2], Innovation Alliance[3] and regional strategic decision-makers** - such as water utilities, municipalities, regional water managers – are envisioned to use the framework for the strategic decision-making and communication to various local stakeholders.
2. Through the local and regional strategic decision-makers the framework may also be a means of dialogue, cross-fertilization, and leverage with national and European

[2] LLs here refer to the B-WaterSmart six living labs, but users can be any LL beyond the project (definition of LL: real-life demonstration and implementation instrument that brings together public and private institutions, government, civil society, and academia to jointly build structured grounds to develop, validate, and scale-up innovations that embrace new technologies, governance, business models, and advancing innovative policies to achieve a Water-Smart Society (Water Europe).

[3] InAll are established in WP1 and consist on alliances between problem-owners; it builds on collaborative work with stakeholders, development of solutions for societal, regulatory and governance issues, supporting methodologies to enable a systematic and strategic planning towards systemic innovation for water-smartness, and capacity building (B-WaterSmart description of work).

policy-circles. Vice versa, **European and national authorities** may benefit from the ambitions, barriers and opportunities that the framework aims to exemplify.

3. **Consultants and researchers** that may use the framework to formulate advice or knowledge development to support water-smart and sustainable solutions at local, regional, national, or transnational level.

1.5 The BWS AF content

1.5.1 The structure of BWS AF

The BWS AF follows an objectives-criteria-metrics tree structure, and it is objective driven (Figure 1).

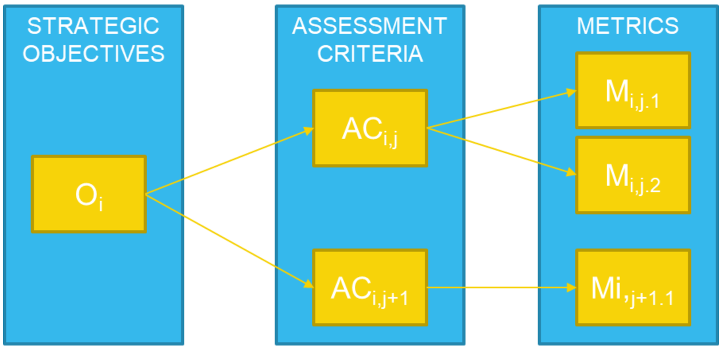

Figure 1 – The BWS AF tree structure

Its taxonomy (Table 2) consists of a list of selected strategic objectives. Each strategic objective can be associated with one or more of the five dimensions, reflecting the dimensions of sustainability transitions: *i.* social, *ii.* environmental, *iii.* economic, *iv.* technical and *v.* governance (Table 3). Each objective is specified by assessment criteria (Table 4) as points of view that allow for the assessment of the objectives. Each criterion in turn is described with a set of metrics (Table 4 with the number of the metrics per criterion) which will serve to assess the distance from a set target (as described in section 4.2). The full list of the metrics is provided by Table 5 in section 1.5.2 where more information about the characterization of the metrics is also provided. Strategic objectives, assessment criteria and metrics are described in full details in Chapter 2.

Strategic objectives	Dimensions	Assessment criteria	Metrics

Table 2 – The back-bone structure of the B-WaterSmart Framework, V_2

Strategic Objective (SO)	Soc	Env	Econ	Tech	Gov
A. Ensuring water for all relevant uses	++	+	+	+	+
B. Safeguarding ecosystems and their services to society		++		+	
C. Boosting value creation around water		+	++	+	+
D. Promoting adaptive change towards resilient infrastructure		+	+	++	+
E. Engaging citizens and actors across sectors in continuous co-learning and innovation	+				++

Table 3 – Relevance of the strategic objectives versus sustainability dimensions (score: '++' dominant dimension, '+' relevant, ' ' not relevant)

Strategic Objective (SO)	Assessment criteria (AC)	Number of metrics
A. Ensuring water for all relevant uses	A.1 Safe and secure fit-for-purpose water provision	4
	A.2 Accessibility and equity (for any user)	4
	A.3 Financial viability	4
B. Safeguarding ecosystems and their services to society	B.1 Safeguarded water ecosystems	3
	B.2 Enhanced ecosystem services to society	5
	B.3 Resource efficiency	4
C. Boosting value creation around water	C.1 Circular policy making	5
	C.2 Circular economy growth	3
	C.3 Resource recovery and use	5
D. Promoting adaptive change towards resilient infrastructure	D.1 Enabling planning to promote adaptive change towards circularity and resilience	1
	D.2 Implementing adaptive change towards resilient infrastructure	2
	D.3 Effectiveness of the adaptive change towards resilient infrastructure (Diagnosis)	8
E. Engaging citizens and actors across sectors in continuous co-learning and innovation	E.1 Awareness and knowledge	5
	E.2 Multi-sector network potential	3
	E.3 Stakeholder engagement processes	4
5 objectives	**15 criteria**	**60 metrics**

Table 4 – Strategic objectives, assessment criteria and the number of metrics of the BWS AF, V_2

1.5.2 The characterization of the metrics

The choice of metrics proposed has resulted from a 2-year process of co-creation and consultation with domain-specific experts, extensive literature review and interaction with the LLs and InAlls of the project. The selection of the metrics included in the framework complies with the requirements described in Ugarelli *et al.* (2021) listed below for completeness of the description.

Individually, each metric shall:

- be relevant for the strategic objectives of the LL;
- fit in the predefined assessment criteria;
- be clearly defined, with a concise meaning;
- be reasonably achievable (which mainly depends on the related variables);
- be auditable;
- be as universal as possible and provide a measure which is independent from the particular conditions of the LL;
- be simple and easy to understand;
- be quantifiable so as to provide an objective measurement of the service, avoiding any personal or subjective appraisal (best use of already collected data should be made);
- include information on the data quality of the variables.

Collectively, it shall be ensured that:

- every assessment metric provides information significantly different from the other metrics in the framework;
- definitions of the assessment metrics are unequivocal (this requirement is made extensive to its variables);
- only metrics which are deemed essential for effective performance evaluation are established.

The total number of metrics included in the V_2 is 60 (Table 5). The metrics composing the BWS AF V_2 are of different nature with different assessment methods required:

- **Performance Indicators (PIs):** 38 metrics are computed based on a proposed formula. For these metrics the user of the framework will have to enter quantitative values for the variables required as inputs. The resulting indicator is expressed by a specific unit (dimensionless (- or %) or intensive (e.g., kWh/m^3)). The list of variables used to assess the performance indicators-metrics as inputs have been categorized in (i) water volume data, (ii) physical assets data, (iii) operational data, (iv) demography and users' attributes data, (v) quality of service data and (vi) business and financial data. The variables are defined in Chapter 2 when describing the computation methods of the related metric and the full list of variables is included in the Appendix B.
- **Performance Indices – questionnaire based:** 3 metrics are assessed by answering a set of questions. For each question, the classification is made by associating each possible answer to a score. The overall level of the index will

result from the sum of all partial scores associated to the answers, weighted by category. The resulting index is expressed by a score.

- **Performance Indices – interview based:** 19 metrics, those related to social and governance dimensions, cannot be assessed through a quantitative approach by nature, but need to be assessed through interviews. The resulting index is expressed by a score in a Likert scale.

To facilitate the user in the selection of the metrics, depending on the scope and level of assessment, the metrics have been further clustered as:

- **Core metrics**: "core" metrics are relevant in view of the vision of a water-smart society, independently on the scale of impact of the user. To support benchmarking across cases, the core metrics should be selected and assessed by each involved case.
- **Additional metrics**: "additional" relates to metrics that depend on the scale of impact and specific challenges of the user. They are site-specific metrics.
- **Context metrics**: metrics that cannot be assessed by one specific user, but require a multi-stakeholder engagement; describe pure context and external factors to the management of the system or might not be modifiable by management decisions, even though they may condition decisions, but the management policies can influence them in the long term.
- **Service – specific metrics**: the water service to which the metrics are applicable has been provided to facilitate filtering the number of metrics to be applied in case the user of the framework focuses on service-specific assessments (see Table 5, where the code used refers to WS: Water Supply; WW: Wastewater; WR: Water Reclamation; SW: Stormwater).

Core metrics and service – specific metrics are visualized in Table 5 as well as a color code is used to highlight the different nature of the proposed metrics.

Criteria		Metric		Unit	Core metric	Service			
						WS	WW	WR	SW
A.1	Safe and secure fit-for-purpose water provision	A.1.1	Water exploitation index +	%	context	x		x	
		A.1.2	Safe drinking water	%	x	x			
		A.1.3	Compliant reclaimed water	%	x			x	
		A.1.4	Security and resilience index	Score (1-200)	x	x	x	x	x
A.2	Accessibility and equity (for any user)	A.2.1	Physical access to drinking water supply for households and small business	%	x	x			
		A.2.2	Physical access to drinking water supply in public spaces for quality of life	No./km^2		x			
		A.2.3	Physical access to water supply for industrial use	%	x	x		x	
		A.2.4	Physical access to water for irrigation	%	x	x		x	

Criteria	Metric	Unit	Core metric	Service			
				WS	WW	WR	SW
A.3 Financial viability	A.3.1 Consumer willingness to pay	5-point Likert scales	x	x	x	x	x
	A.3.2 Affordability	5-point Likert scales	x	x	x	x	x
	A.3.3 Financial continuation	5-point Likert scales		x	x	x	x
	A.3.4 Cost coverage ratio	-	x	x	x	x	x
B.1 Safeguarded water ecosystems	B.1.1 Environmental flow requirement compliance rate	%	x	x			x
	B.1.2 Effective stormwater treatment	%				x	x
	B.1.3 Effective wastewater treatment	%	x		x	x	
B.2 Enhanced ecosystem services to society	B.2.1 Water body self-purification	%		x	x		
	B.2.2 Maintaining nursery populations and habitats	%	x	x			
	B.2.3 Flood damage prevention	%	x		x		x
	B.2.4 Water provision by the ecosystem	%	x	x			
	B.2.5 People enjoying cultural ecosystem services	%	x	x	x	x	x
B.3 Resource efficiency	B.3.1 Water footprint	m^3/m^3	x	x	x	x	
	B.3.2 Carbon footprint	$kgCO_2eq/m^3$	x	x	x	x	
	B.3.3 Energy consumption	kWh/m^3	x	x	x	x	x
	B.3.4 Drinking water consumption	L/(capita. day)	x	x		x	
C.1 Circular policy making	C.1.1 Statutory compliance	5-point Likert scales	x	x	x	x	x
	C.1.2 Preparedness	5-point Likert scales		x	x	x	x
	C.1.3 Policy instruments	5-point Likert scales	x	x	x	x	x
	C.1.4 Green public procurement	%	context	x	x	x	x
	C.1.5 Level of ambition	5-point Likert scales		x	x	x	x
C.2 Circular economy growth	C.2.1 Resource recovery revenues	%	x	x	x	x	
	C.2.2 Green jobs	%		x	x	x	x
	C.2.3 Circular economy business models in practice	%		x	x	x	x

Criteria		Metric		Unit	Core metric	Service			
						WS	WW	WR	SW
C.3	Resource recovery and use	C.3.1	Water-related materials recovery	%	x	x	x	x	x
		C.3.2	Fertilizer production avoided	%	x		x	x	
		C.3.3	Reclaimed water in non-potable uses	%	x	x	x	x	
		C.3.4	Reclaimed water production	%	x		x	x	
		C.3.5	Energy production	%		x	x	x	
D.1	Enabling planning to promote adaptive change toward circularity and resilience	D.1.1	Infrastructure planning index for adaptive change	Score (1-100)	x	x	x	x	x
D.2	Implementing adaptive change towards resilient infrastructure	D.2.1	Infrastructure value index	-	x	x	x	x	x
		D.2.2	Infrastructure implementation index for adaptive change	Score (1-100)	x	x	x	x	x
D.3	Effectiveness of the adaptive change towards resilient infrastructure (Diagnosis)	D.3.1	Linear water losses	m^3/(year. km)	x	x		x	
		D.3.2	Water storage capacity	days	x	x	x		
		D.3.3	Incident occurrences	No./100 km/year	x	x	x	x	x
		D.3.4	Combined sewer overflows	No./device/ year	x		x		x
		D.3.5	Time for restoration	days	x	x	x	x	x
		D.3.6	Level of autonomy (of infrastructure)	%		x	x	x	
		D.3.7	Level of redundancy	%	x	x	x	x	
		D.3.8	Treatment capacity utilization	%		x	x	x	
E.1	Awareness and knowledge	E.1.1	Knowledge and education	5-point Likert scales	x	x	x	x	x
		E.1.2	Information availability and use	5-point Likert scales	x	x	x	x	x
		E.1.3	Local sense of urgency	5-point Likert scales	x	x	x	x	x
		E.1.4	Water smart culture	5-point Likert scales	x	x	x	x	x
		E.1.5	Smart monitoring	5-point Likert scales	x	x	x	x	x

Criteria		Metric		Unit	Core metric	Service			
						WS	WW	WR	SW
E.2	Multi-sector network potential	E.2.1	Clear division of responsibility	5-point Likert scales	x	x	x	x	x
		E.2.2	Authority	5-point Likert scales	x	x	x	x	x
		E.2.3	Room to maneuver	5-point Likert scales	x	x	x	x	x
E.3	Stakeholder engagement processes	E.3.1	Stakeholder inclusiveness	5-point Likert scales	x	x	x	x	x
		E.3.2	Metric "E.3.2" Protection of core values	5-point Likert scales	x	x	x	x	x
		E.3.3	Metric "E.3.3" Cross-stakeholders learning	5-point Likert scales	x	x	x	x	x
		E.3.4	Metric "E.3.4" Collaborative agents	5-point Likert scales	x	x	x	x	x
AC: 15		**Metrics: 58 + 2 context**			**47**	**53**	**47**	**50**	**36**

Metrics with green shadow: Performance Indices – questionnaire based
Metrics in orange shadow: Performance Indices – interview based
Metrics blank shadow: Performance Indicators (PIs)

Table 5 – Assessment criteria and metrics of the BWS AF, V_2 (WS: Water Supply; WW: Wastewater; WR: Water Reclamation; SW: Stormwater)

1.5.3 Reference values

The reference values are the judgement of what good, fair and poor is for each metric and for the stakeholders across the board. A reference value can be considered a joint performance ambition. The reference values are aimed to allow for comparisons between cases or alternative solutions and monitor evolution in becoming water-smart over time. For this reason, this judgement shall be established independently from the specific cases and be as stable as possible over time (Ugarelli et al., 2021). However, the reference values could be country specific dependent on legislation and strategic plans.

The metrics require reference values to judge the performance and identify the performance level.

Reference values may be established based on (depending on the metric):

1) National or European legislation (mandatory if existing);

2) Regulation or standardization;

3) Strategic goals – National, European and International strategic plans;

4) Theoretical concepts and technical requirements behind the metrics;

5) Literature reviews on best practices;

6) Statistical analysis of the metrics values associated to expert assessment of the cases (e.g., cluster analysis, percentiles distribution);

The reference values were established with an integrated analysis of these several sources (Figure 2). Figure 3 below demonstrates this rational and exemplifies for the metric energy production.

The reference values proposed for each metric are presented in Chapter 2, and the detailed information justifying the ranges proposed in the Appendix C.

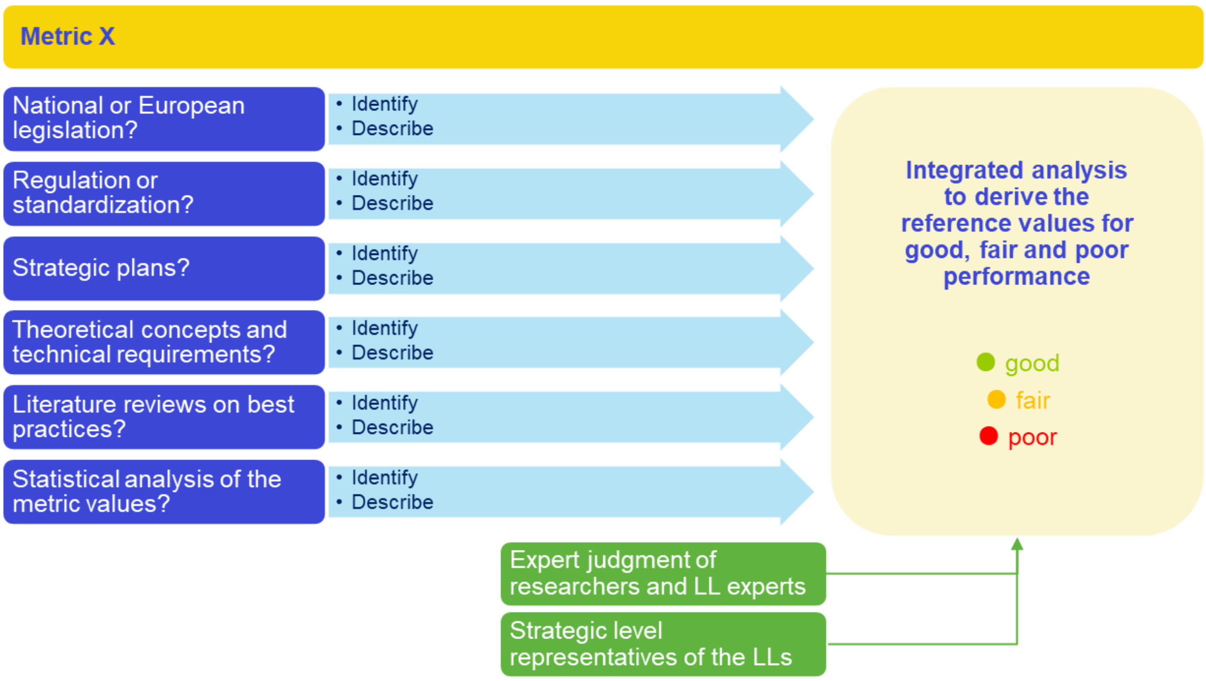

Figure 2 – Applied approach to derive reference values for a metric.

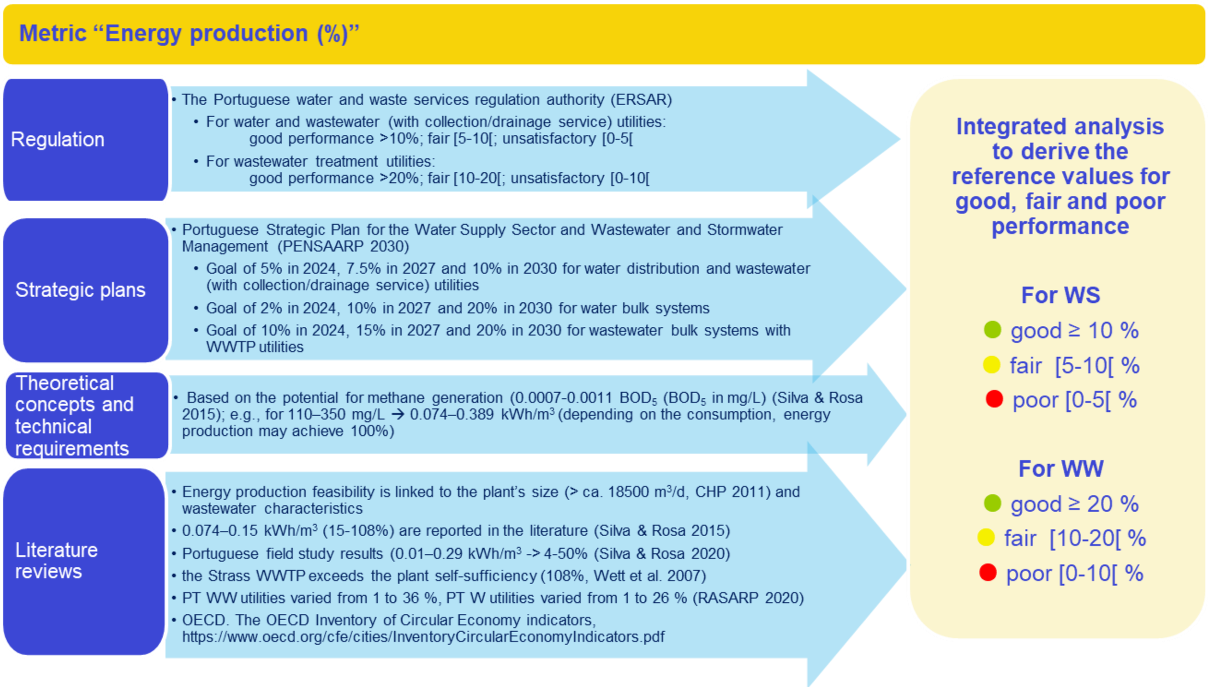

Figure 3 – Example of reference values formulation using the adopted approach.

2 Strategic Objectives, Assessment criteria and Metrics

2.1 Structure

Mirroring the BWS AF tree-structure (see section 1.5), the following sections provide the definition of each strategic objective, of the related assessment criteria and of the metrics proposed for each assessment criteria. The metrics are described according to the template presented in Table 6.

The full list of variables adopted in the V_2 of the BWS AF is provided in Appendix B – List of variables adopted in BWS AF, V2.

Field	Description
Metric Name	Name of the metric.
Definition and Rationale	a) definition, b) concepts, and c) rationale and interpretation for the metric.
Data Sources and Collection Method	Examples of possible data sources and collection method.
Method of Computation and Other Methodological Considerations	A formula or a computational method proposed, with explanation.
Unit	Expected unit for the metric (*e.g.,* score, %, m^3/year…).
Data Disaggregation	If relevant, a suggestion on whether the metric can be calculated for different levels of disaggregation, *e.g.,* the metric can be disaggregated by place of residence (urban/rural). This information will be relevant for the developers of the dashboard in T3.9, when designing required functionalities.
Reference Values	The judgement of what good, fair and poor is for each metric for the stakeholders across the board. This judgement shall be established independently from the specific cases and be as stable as possible over time.
Suggested Supplementary Metrics	Potential link to other metrics that can supplement the one under assessment in developing a strategic plan (it can help to guide the users to select multiple metrics that if combined can give a better overview of the challenges addressed).
References	References, when based on literature review.

Table 6 – Metrics template

Navigation page across the Framework

To facilitate the reader to navigate through the different criteria and metrics described in this document, the fields of interest could be selected directly in the Table 5. The same labelling of the strategic objectives, assessment criteria and metrics adopted in the excel file is adopted in this section.

2.2 SO A – Ensuring water for all relevant uses

Description: all sectors (domestic, industrial, agriculture, environment) should have access to enough and sufficient water in terms of quantity, and safe water in terms of quality at the right time for the user, now and in the future. Ensuring water for all relevant uses describes the ability that now and in the future all sectors (domestic, industry, agriculture, environment) should be able to have secure and affordable access to sufficient water in terms of quantity and to safe water in terms of quality for the required multiple users and purposes.

2.2.1 AC A.1 "Safe and secure fit-for-purpose water provision"

Description: the AC deals with:

a. Guaranteed provision of water of reliable quantity and quality for multiple users and purposes, from fresh and reclaimed water sources, at an acceptable risk and
b. Ensuring water safety and water security.

2.2.1.1 Metric "A.1.1" Water exploitation index +

Metric Name

Water exploitation index, plus (WEI+)

Definition and Rationale

Definition: The Water Exploitation Index plus (WEI+) is a measure of total freshwater use as a percentage of the renewable freshwater resources (groundwater and surface water) at a given time and place. It quantifies how much water is monthly and seasonally abstracted and how much water is returned after use to the environment in basins, after having considered environmental flows requirements (EFR). The difference between water abstraction and return is regarded as water use and illustrates the pressure on renewable freshwater resources due to water demand.

Concepts: The WEI+ aims to illustrate the percentage used of the total renewable freshwater resources available in a defined territory (basin, sub-basin etc.) for a given time step (*e.g.,* seasonal, annual). WEI+ is a 'state' indicator (DPSIR). Its legislative reference is the Water Framework Directive. WEI+ is linked to the SDG 6, indicator 6.4.2 (level of water stress).

Rationale and Interpretation: WEI+ is part of the Eurostat EU SDG indicator set for which Eurostat produces regular monitoring reports on progress towards the SDGs in an EU context (EUROSTAT, n.d.). WEI+ is used to monitor progress towards SDG 6.4.2 "Level of water stress". SDG 6 is embedded in the European Commission's Priorities under the 'European Green Deal'.

In the absence of Europe-wide agreed formal targets, values above 20% are generally considered as an indication of water scarcity, while values equal or bigger than 40%

indicate situations of severe water scarcity, *i.e.,* the use of freshwater resources is clearly unsustainable.

Data Sources and Collection Method

Data sources: Data modelling based on data from the WISE SoE-Water quantity database (WISE 3) and other open sources (JRC, EUROSTAT, OECD, FAO) and including gap filling methods (EUROSTAT, 2021b).

Data provider: European Environmental Agency (EEA)

- https://www.eea.europa.eu/ims/use-of-freshwater-resources-in-europe-1
- https://www.eea.europa.eu/data-and-maps/explore-interactive-maps/water-exploitation-index-for-river-2
- https://ec.europa.eu/eurostat/databrowser/view/sdg_06_60/default/table?lang=en

National agencies could provide the WEI+ calculation with more reliable data for each basin.

NOTE: For each source of data should be verify the method of computation used.

Collection method: Data collection method is described in the Eurostat data collection manual (Eurostat, 2018). Figure 4 illustrates the conceptual model of WEI+ computation (https://www.eea.europa.eu/data-and-maps/indicators/use-of-freshwater-resources-2/data-and-methodology-specifications-wei/view).

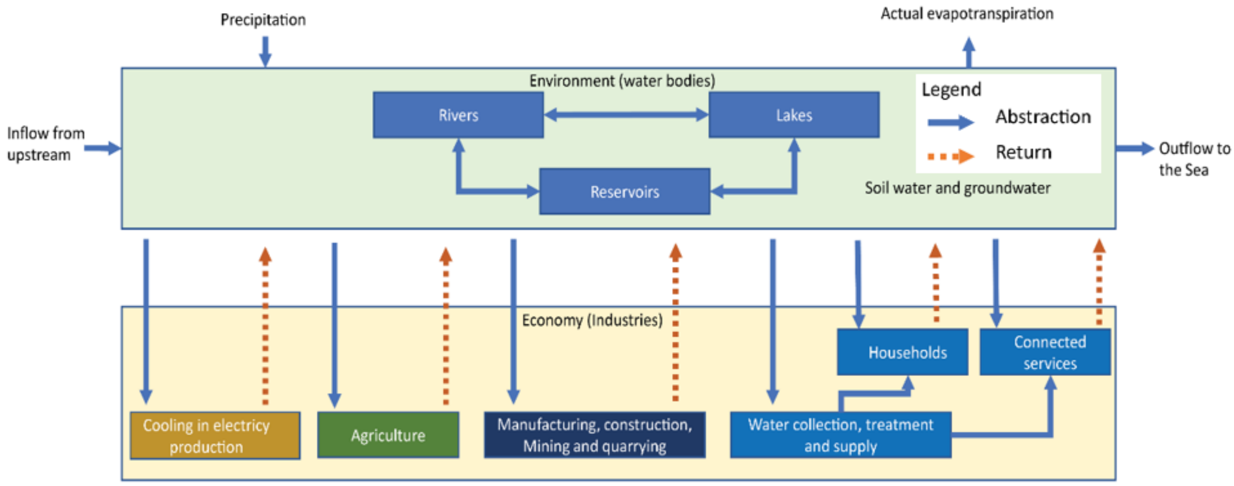

Figure 4 – Conceptual model of the WEI+ computation.

Note:

- Desalinated water, inter-basin water transfers via conveyance infrastructure and net water loses are not included into the calculation because of insufficient data coverage.
- Similarly, change in the groundwater aquifers is not included into the computation of the change in storage because no data available at the European level.

Method of Computation and Other Methodological Considerations

$$WEI+ = \frac{WU}{RWR - EFR} \times 100\%$$

where

- WU (km^3/year) = Water use = Abstraction – Return
- RWR (km^3/year) = Renewable water resources = Outflow + (Abstraction-Return) – change in storage
    - Change in storage = Water in (lakes + reservoirs) – water out (lakes + reservoirs)
- EFR (km^3/year) = Environmental flow; if no data are available, a value of 30% is commonly used as a reference in literature

Determination of the EFR can be done by application of various methods ranging from a simple hydrological approach to comprehensive holistic models. The approach should progressively take into account the variability of flow regime during time and space, leading to the most recent Hydraulic/Habitat models.

FAO published the guidelines that provide a minimum standard method, principally based on the Global Environmental Flows Information System (GEFIS), which is accessible via http://eflows.iwmi.org, and is the approach that will be used to generate the country EF data that will make up the global 6.4.2 report. The guidelines can be found at: https://www.fao.org/documents/card/en/c/ca3097en/ .

As a first level, the indicator can be populated with estimations based on national data aggregated to the country level. If needed, data can be retrieved from internationally available database on water availability and withdrawals by different sectors. Inclusion of estimation of environmental flows requirements based on literature values.

At the next level, the indicator can be populated with nationally produced data, which increasingly can be disaggregated to the sub-national basin unit level. Inclusion of estimation of environmental flows requirements based on literature values.

For more advanced levels, the nationally produced data have high spatial and temporal resolution (*e.g.,* geo-referenced and based on metered volumes) and can be fully disaggregated by source (surface water / groundwater) and use (economic activity). Literature values of environmental flows requirements are refined by national estimations.

Absolute water volumes are presented as millions of cubic meters (million m^3 or hm^3).

Note: Desalinated water, inter-basin water transfers via conveyance infrastructure and net water losses are not included into the calculation because of insufficient data coverage. Similarly, change in the groundwater aquifers is not included into the computation of the change in storage because no data available at the European level.

The WEI+ value could be used as aggregated metric instead of each variable as individual metrics.

Unit

[%]

Data Disaggregation

In order to disaggregate the indicator, the described components should be computed by aggregating the variables per subsector, as water abstraction for cooling in electricity production, agriculture, manufacturing/ construction/ mining/ quarrying, water collection/ treatment/ supply.

The disaggregation of the information at sub-national level should be done by basin units, collecting the data at the relevant level and considering the possible artificial transfer of water between basins.

Reference Values

- 🟢 Good [0; 20[
- 🟡 Fair [20; 40[
- 🔴 Poor [40; +∞[

Suggested Supplementary Metrics

B.1.1 Environmental flow requirement compliance rate

References

EEA (n.d.) Water exploitation index, plus (WEI+). Available under: Water exploitation index, plus (WEI+) (source: EEA) (sdg_06_60) (europa.eu)

EEA (2019) Indicator Assessment. Use of freshwater resources in Europe (last modified 22 Nov 2021) (Accessed: 02.03.2022) Available under: https://www.eea.europa.eu/data-and-maps/indicators/use-of-freshwater-resources-3/assessment-4

EUROSTAT (n.d.) Sustainable development goals. (Accessed: 02.03.2022) Available under: (Overview – Sustainable development indicators – Eurostat (europa.eu)

EUROSTAT (2018) Data collection manual for the OECD/Eurostat joint questionnaire on inland waters and Eurostat regional water questionnaire. Concepts, definitions, current practices, evaluations and recommendations. Version 4. Luxembourg: Publications Office of the European Union. Data Collection Manual for the JQ-IW and RWQ (europa.eu)

EUROSTAT (2021a) SDG 6 – Clean water and sanitation. Ensure availability and sustainable management of water and sanitation for all. (online, accessed:02.03.2022). Available under: SDG 6 – Clean water and sanitation – Statistics Explained (europa.eu)

EUROSTAT (2021b) Sustainable Development in the European Union. Monitoring Report on progress towards the SDGs in an EU context. 2021 edition. Luxembourg: Publications Office of the European Union. https://ec.europa.eu/eurostat/documents/3217494/12878705/KS-03-21-096-EN-N.pdf/8f9812e6-1aaa-7823-928f-03d8dd74df4f?t=1623741433852

FAO. 2019. Incorporating environmental flows into "water stress" indicator 6.4.2 – Guidelines for a minimum standard method for global reporting: http://www.fao.org/3/CA3097EN/ca3097en.pdf

IWMI. Global Environmental Flows Information System (GEFIS): http://eflows.iwmi.org,

IWMI. IWMI Research Report 168 – Global Environmental Flow Information for the Sustainable Development Goals http://www.iwmi.cgiar.org/Publications/IWMI_Research_Reports/PDF/pub168/rr168.pdf

IWMI. Environmental Flow Calculators: https://www.iwmi.cgiar.org/resources/data-and-tools/models-and-software/environmental-flow-calculators/

2.2.1.2 Metric "A.1.2" Safe drinking water

Metric Name

Safe drinking water ($C_{totalDW}$)

Definition and Rationale

Definition: This metrics is defined as the percentage of compliance with drinking water quality standards.

Concepts: 'Non-compliance with water quality standards' as described by the monitoring report under the Drinking Water Directives (DWD) (or associated national legislation): *"The percentage of compliance reflects the ratio of the number of samples analyzed and the number of exceedances observed. If at least 99 % of all analyses done in a given year meet the given standard, the Member State is considered to be compliant with the Directive for the parameter concerned. Exceedances of indicator parameters do not necessarily mean a non-compliance with the Directive because of the above-mentioned reasons (if there is no direct threat to human health)."* (untitled (europa.eu))

Rationale and Interpretation: The DWD and associated national legislations set standards for the most common potentially harmful organisms and substances that can be found in drinking water. Three types of parameters are distinguished: microbiological, chemical, and indicator. A total of 48 parameters must be monitored and tested regularly under the DWD. Indicator parameters give evidence of an indirect relevance to the quality of water; they indicate a change in the source of water, the treatment, or the distribution (EC, 2016).

Data Sources and Collection Method

- Water supplier; for large suppliers (obliged to report under DWD) data sources may also be National health organizations or the respective entity in charge for reporting of water quality under the DWD; triennial report to the EC.
- Health authorities.
- Administrative data collected by government or non-government entities involved in the delivery or oversight of services. Examples include water and sanitation inventories and databases, and reports of regulators.
- Other datasets may be available such as compilations by international or regional initiatives (*e.g.,* Eurostat), studies conducted by research institutes, or technical advice received during country consultations.

Method of Computation and Other Methodological Considerations

$$C_{totalDW} = \left(1 - \frac{n_{e_{totalDW}}}{n_{totalDW}}\right) \times 100$$

where

- $C_{totalDW}$ (%) = Percentage of total compliance for safe drinking water
- $n_{etotalDW}$ (No./year) = Total number of samples of drinking water with exceedance, *i.e.,* sum of samples with microbial, chemical and indicator parameter exceedance
  - $n_{e_{totalDW}} = \sum ne_i$, with
  - ne_i = number of samples with indicator parameter for indicator group 'i', with 'i' = microbial, chemical, (indicator) parameter exceedance
- $n_{totalDW}$ (No./year) = Total number of drinking water samples analyzed in assessment period

Unit

[%]

Data Disaggregation

Disaggregation according to compliance per monitored indicator group, *i.e.,* microbiological, chemical, and indicator parameters. Disaggregation may be performed also based on different water utilities, service area, local or regional level, or alternative water resources and sectors.

Reference Values

🟢	Good	[98.5; 100]
🟡	Fair	[94.5; 98.5[
🔴	Poor	[0; 94.5[

Suggested Supplementary Metrics

A.1.4 Security and Resilience Index

References

COUNCIL DIRECTIVE 98/83/EC of 3 November 1998 on the quality of water intended for human consumption. Official Journal L 330, 05/12/1998, p0032-0054. EUR-Lex – 31998L0083 – EN- EUR-Lex (europa.eu)

EC (2016) Report from the Commission: Synthesis report on the quality of drinking water in the Union examining Member states reports for the 2011-2013 period, foreseen under Article 13(5) of Directive 98/83/EC. EC: Brüssels. Available under: untitled (europa.eu)

JMP (WHO/Unicef Joint Monitoring Programme, JMP) (2021) SDG indicator metadata. SDG 6.1.1. (last updated 20.12.2021). Available under: jmp-2021-metadata-sdg-611.pdf (washdata.org))

2.2.1.3 Metric "A.1.3" Compliant reclaimed water

Metric Name

Compliant reclaimed water ($C_{totalRW}$)

Definition and Rationale

Definition: This metrics is defined as the percentage of compliance with reclaimed water quality standards at the point of compliance.

Concepts: 'Reclaimed water' means urban wastewater that has been treated in compliance with the requirements set out in Directive 91/271/EEC (Urban Wastewater Treatment Directive), and which results from further treatment in a reclamation facility; in accordance with Section 2 of Annex I to this Regulation:

'Point of compliance' means the point where a reclamation facility operator or alternative water supplier delivers reclaimed and/or non-potable water to the next actor in the chain.

'Non-compliance with reclaimed water quality standards per type of use' is defined in accordance with the agreements under EU or national legislation, such as Regulation (EU) 2020/741 of the European Parliament and of the Council on minimum requirements for water reuse.

Rationale and Interpretation: The percentage of compliance reflects the ratio of the number of samples analyzed and the number of exceedances observed. If at least 90% of all analyses done in a given year meet the given standard, none of the values of samples exceed the maximum deviation limit of 1 log unit from the indicated value for E. coli and Legionella spp., or the 100% of the indicated value for intestinal nematodes and for BOD_5, TSS and turbidity in Class A, the Member State is considered to be compliant with regulation EU 2020/741 for the parameter concerned.

Data Sources and Collection Method

- Reclaimed/alternative water supplier; data sources may also be National health organizations or the respective entity in charge for reporting of reclaimed water quality under EU regulation 2020/741.
- Other entities within the reclaimed water supply chain, *e.g.,* storage provider, reclaimed water user.
- Health authorities.
- Administrative data, which may consist of information collected by government or non-government entities involved in the delivery or oversight of services. Examples include water and sanitation inventories and databases, and reports of regulators.
- Other datasets may be available such as compilations by international or regional initiatives (*e.g.,* Eurostat), studies conducted by research institutes, or technical advice received during country consultations.

Method of Computation and Other Methodological Considerations

$$C_{totalRW} = \left(1 - \frac{n_{e_{totalRW}}}{n_{totalRW}}\right) \times 100$$

where

- $C_{totalRW}$ (%) = Percentage of total compliance for safe reclaimed water
- $n_{etotalRW}$ (No./year) = Total number of samples of reclaimed water with exceedance, *i.e.,* sum of samples with microbial, chemical or indicator parameter exceedance
    - $n_{e_{totalRW}} = \sum_{i=A}^{D} \left(n_{M_i} + n_{C_i} + n_{I_i}\right)$, with
        - n_M = number of samples with microbial exceedance
        - n_C= number of samples with chemical exceedance
        - n_I= number of samples with indicator exceedance
        - i = Class A, B, C, D
- $n_{totalRW}$ (No./year) = Total number of reclaimed water samples analyzed in assessment period

Unit

[%]

Data Disaggregation

Disaggregation to compliance per indicator parameter and reclaimed water intended use (*e.g.,* 4 quality classes for reclaimed water for agricultural irrigation).

Reference Values

🟢	Good	[95; 100]
🟡	Fair	[90; 95[
🔴	Poor	[0; 90[

Suggested Supplementary Metrics

A.1.4 Security and Resilience Index

References

EU regulation 2020/741 of the European Parliament and of the Council of 25 May 2020 on minimum requirements for water reuse. Official Journal of the European Union L 177, 05/06/2020, pp. 32 – 655, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32020R0741&from=EN

2.2.1.4 Metric "A.1.4" Security and resilience index

Metric Name

Security and resilience index (SRI)

Definition and Rationale

Definition: The SRI is an index providing a level of development regarding the management of safety, security, cybersecurity, contingency, emergency/crisis, with respect to governance and operationalization, risk management, communication and plan for security and resilience implemented and effective.

Concepts: The SRI aims to assess the aspects considered essential for a resilient water service (drinking or reclaimed water supply service, wastewater or stormwater service), considering 4 classes (Governance and safety operationalization, Risk management, Communication and Existence of a plan), and 5 categories related to safety, security of facilities (infrastructure and product), cybersecurity, contingency, and emergency and crisis management.

Rationale and Interpretation: the index considers a set of requirements, to ensure that the aspects considered essential for a resilient water service are addressed. SRI provides a level of development regarding the requirements, allowing identifying the main opportunities for improvement.

Data Sources and Collection Method

The drinking water supply and wastewater utility's responsible teams.

Method of Computation and Other Methodological Considerations

SRI is defined by a set of questions (Table 7 and Table 8) applicable to 5 categories, each category having a defined weight in a total of 200. The set of questions is structured in 4 classes. For each question, the classification is made by associating each possible answer to a score, corresponding to a development level, and the maximum overall score for the index is 200. The overall level of the index will result from the sum of all partial scores associated to the answers, weighted by category. In case of a missing answer, the score will be zero.

The questions are made available at: https://nextcloud.b-watersmart.eu/index.php/f/130599 [4]

[4] The repository can be accessed only by the project's partners. The file and related questions will be embedded in the Dashbord in further developments of the project.

SECURITY AND RESILIENCE INDEX FOR WATER SERVICE

ERSAR – Portuguese Authority for for Water and Waste regulation

http://www.ersar.pt/pt/site-comunicacao/site-noticias/Documents/Guia_Tecnico27.pdf (in Portuguese)

A1.5

Scoring by classes

Sub-classes A.1 to A.10:
0 points - No
10 points - Yes

Sub-class A.11:
0 points - No
20 points - Yes

Sub-class B.1:
0 points - No
10 points - Yes

Sub-classes B.2 and B.3:
0 points - No
15 points - Yes

Sub-class C.1 and C.2:
0 points - No
10 points - Yes

Sub-class D.1:
0 points - No
20 points - Yes

Sub-class		Score	Category				
			Water safety	Security (facilities, infrastructure and product)	Cybersecurity	Contingency to drought	Emergency/crisis management
Weight		-	60	40	40	30	30
Class A – Governance and safety operationalization							
Sub-class A.1	Existence of a responsible person for governance e safety operationalization	10					
Sub-class A.2	Existence of a team with allocated responsibilities	10					
Sub-class A.3	Existence of a permanent contact point	10					
Sub-classe A.4	Existence of an inventory/register with identification of main infrastructures' components	10					
Sub-class A.5	Existence of register of operation and conditions modes and respective changes	10					
Sub-class A.6	Existence of a register with identification of incidents/accidents and stakeholders	10					
Sub-class A.7	Existence of a process to manage safety/security incidents	10					
Sub-class A.8	Existence of a registry of contacts carried out with authorities (in case of incidents)	10					
Sub-class A.9	Procedures are in place for management of exceptional conditions	10					
Sub-class A.10	Existence of a management process for documented information	10					
Sub-class A.11	A report is made with the due frequency and content for monitoring and reviewing the plan	20					
Maximum Score		120					
Class B – Risk management							
Sub-class B.1	Identification of hazards and control measures is carried out	10					
Sub-class B.2	Risk assessment is carried out	15					
Sub-class B.3	Risk treatment is carried out	15					
Maximum Score		40					
Class C – Communication							
Sub-class C.1	Existence of a process for notification of incidents (number of users affected, duration, geographic distribution)	10					
Sub-class C.2	Existence of programs and protocols for internal and external communication	10					
Maximum Score		20					
Class D – Existence of a plan and planning							
Sub-class D.1	A security and resilience plan is in place and up-to-date	20					
Maximum Score		20					
Total maximum Score		200					

Table 7 – Screenshot of the questionnaire – Screenshot of the questionnaire supporting the assessment of the A1.4 (security and resilience) index for water drinking service

SECURITY AND RESILIENCE INDEX FOR WASTEWATER SERVICE

ERSAR – Portuguese Authority for for Water and Waste regulation
http://www.ersar.pt/pt/site-comunicacao/site-noticias/Documents/Guia_Tecnico27.pdf (in Portuguese)

A1.5

Scoring by classes

Sub-classes A.1 to A.10:
0 points - No
10 points - Yes

Sub-class A.11:
0 points - No
20 points - Yes

Sub-class B.1:
0 points - No
10 points - Yes

Sub-classes B.2 and B.3:
0 points - No
15 points - Yes

Sub-class C.1 and C.2:
0 points - No
10 points - Yes

Sub-class D.1:
0 points - No
20 points - Yes

Sub-class		Score	Category				
			Wastewater safety	Security (facilities, infrastructure and product)	Cybersecurity	Contingency to floods	Emergency/crisis management
	Weight	-	40	40	30	50	40
Class A – Governance and safety operationalization							
Sub-class A.1	Existence of a responsible person for governance e safety operationalization	10					
Sub-class A.2	Existence of a team with allocated responsibilities	10					
Sub-class A.3	Existence of a permanent contact point	10					
Sub-classe A.4	Existence of an inventory/register with identification of main infrastructures' components	10					
Sub-class A.5	Existence of register of operation and conditions modes and respective changes	10					
Sub-class A.6	Existence of a register with identification of incidents/accidents and stakeholders	10					
Sub-class A.7	Existence of a process to manage safety/security incidents	10					
Sub-class A.8	Existence of a registry of contacts carried out with authorities (in case of incidents)	10					
Sub-class A.9	Procedures are in place for management of exceptional conditions	10					
Sub-class A.10	Existence of a management process for documented information	10					
Sub-class A.11	A report is made with the due frequency and content for monitoring and reviewing the plan	20					
Maximum Score		120					
Class B – Risk management							
Sub-class B.1	Identification of hazards and control measures is carried out	10					
Sub-class B.2	Risk assessment is carried out	15					
Sub-class B.3	Risk treatment is carried out	15					
Maximum Score		40					
Class C – Communication							
Sub-class C.1	Existence of a process for notification of incidents (number of users affected, duration, geographic distribution)	10					
Sub-class C.2	Existence of programs and protocols for internal and external communication	10					
Maximum Score		20					
Class D – Existence of a plan and planning							
Sub-class D.1	A security and resilience plan is in place and up-to-date	20					
Maximum Score		20					
Total maximum Score		200					

Table 8 – Screenshot of the questionnaire – Screenshot of the questionnaire supporting the assessment of the A1.4 (security and resilience) index for wastewater service

Unit

[-]

Data Disaggregation

Disaggregated by different sectors of the drinking water and of the wastewater domain.

Reference Values

- 🟢 Good [140; 200]
- 🟡 Fair [75; 140[
- 🔴 Poor [0; 75[

Suggested Supplementary Metrics

-

References

ERSAR; LNEC. Guide for the Assessment of the Quality of Service in Water and Wastewater Services, 4rd ed.; Technical guide 27; Entidade Reguladora dos Serviços de Águas e Resíduos, Laboratório Nacional de Engenharia Civil: Lisbon, Portugal, 2021; Available online: https://www.ersar.pt/pt/publicacoes/publicacoes-tecnicas/guias

2.2.2 AC A.2 "Accessibility and equity (for any user)"

Description: the AC assesses the accessibility to water services for different users including physical accessibility, *e.g.,* in public spaces for consumption and leisure, and social equity.

2.2.2.1 Metric "A.2.1" Physical access to drinking water supply for households and small business

Metric Name

Physical access to drinking water supply for households and small businesses ($P_{Hconnect}$)

Definition and Rationale

Definition: The physical access to drinking water is expressed as the percentage of households and small businesses connected to the waterworks system to the total households and small businesses in the area.

Concept: The physical access to drinking water supply reflects the accessibility in terms of the water supply network and a physical connection to the system as required by customers. The metric can be extended to sewers connection, as indicated under data disaggregation.

Rationale and Interpretation: It is related with the level of physical accessibility.

Data Sources and Collection Method

The data sources are represented by the internal registers of the water utility regarding the customers connected, and the data should refer to a reference date.

Method of Computation and Other Methodological Considerations

The metric reflects the proportion of households and small business connected to service ($P_{Hconnect}$). It is assessed as the percentage of households and small business connected to the waterworks over the total x 100; it also includes mixed/commercial properties and multiple household properties, *e.g.,* blocks or flats.

This indicator must refer to a reference date. This indicator is the most recommended indicator to assess service coverage, particularly in areas with floating population.

$$P_{HConnect} = \frac{NH_{Connect}}{NH_{Total}} \times 100$$

where

- $NH_{Connect}$ (No.) = Number of households (and / or small business) that are connected to the service
- NH_{Total} (No.) = Total number of households (and / or small business) in the area (area to be specified by the user)

Unit

[%]

Data Disaggregation

Data disaggregation can be performed depending on type of service (drinking water supply or sewers connection) and on the level of urbanization of the considered areas (predominantly urban area, intermediately urban area, rural area).

Reference Values

- Predominantly urban area:

🟢	Good	[95; 100]
🟡	Fair	[80; 95[
🔴	Poor	[0; 80[

- Intermediately urban area:

🟢	Good	[90; 100]
🟡	Fair	[80; 90[
🔴	Poor	[0; 80[

- Predominantly rural area:

🟢	Good	[80; 100]
🟡	Fair	[70; 80[
🔴	Poor	[0; 70[

Suggested Supplementary Metrics

-

References

Adapted from indicator QS1 in IWA (2016) and AA07b in ERSAR – Technical guides.

Alegre, H., Baptista, J.M., Cabrera, E., Cubillo, F., Duarte, Hirner, W., Parena, R. (2016). Performance Indicators for Water Supply Services: Third Edition. IWA Publishing, Volume 15. DOI: https://doi.org/10.2166/9781780406336.

ERSAR; LNEC. Guide for the Assessment of the Quality of Service in Water and Wastewater Services, 4rd ed.; Technical guide 27; Entidade Reguladora dos Serviços de Águas e Resíduos, Laboratório Nacional de Engenharia Civil: Lisbon, Portugal, 2021; Available online: https://www.ersar.pt/pt/publicacoes/publicacoes-tecnicas/guias

2.2.2.2 Metric "A.2.2" Physical access to drinking water supply in public spaces for quality of life

Metric Name

Physical access to drinking water supply in public spaces for quality of life (PWA)

Definition and Rationale

Definition: The physical access to drinking water (Physical Water Access, PWA) in public spaces is expressed as the ratio of the number of available and operational access points of drinking water supply in public space over the public space total area.

Concepts: This is a density index defined as the total number of operational physical access points to water supply in public spaces (public drinking water fountains, cooling fountains, etc.) of a given area. A fountain or other point of public consumption must be considered "non-operational" when it is not possible to provide water to consumers due to physical deficiencies (*e.g.,* broken taps, broken pump).

Rationale and Interpretation: The density expresses the average spatial distribution of water access points in public areas, reflecting the level of physical accessibility in "public access" and addressing "quality of life" in public areas.

Data Sources and Collection Method

G.I.S. can be used to create a geodatabase with survey areas and existing physical access points to water supply in public spaces locations. The indicator must refer to a reference date.

Method of Computation and Other Methodological Considerations

$$PWA = \frac{N_{WAP}}{Area}$$

where

- N_{WAP} (No.) = Number of operational fountains and other points of public consumption in public spaces
- $Area$ (km^2) = Total area served by the fountains or other points of public consumption in public spaces (area to be specified by the user)

Unit

[No./km^2]

Data Disaggregation

It might be more relevant to normalize the indicator per total population in different areas.

Reference Values

- 🟢 Good [1; +∞[
- 🟡 Fair [0.2; 1[
- 🔴 Poor [0; 0.2[

Suggested Supplementary Metrics

-

References

Adapted from the indicator QS6 in IWA (2016)

2.2.2.3 Metric "A.2.3" Physical access to water supply for industrial use

Metric Name

Physical access to water supply for industrial use ($PI_{Connect}$)

Definition and Rationale

Definition: The physical access to industrial water is expressed as the percentage of industries connected to a waterworks system supplying water compatible with their needs in terms of quality and quantity to the total number of industries requiring the service in an area.

Concepts: The physical access to water supply rate reflects the accessibility in terms of water supply network and a physical connection to the system as required by industries.

Rationale and Interpretation: It is related with the level of physical accessibility.

Data Sources and Collection Method

The data sources are represented by the internal registers of the water utility regarding the customers connected, and the data should refer to a reference date.

Method of Computation and Other Methodological Considerations

The metric is assessed as the percentage of industries connected to the service ($PI_{Connect}$) over the total. It can be set that it relates to industry and other billed water consumption to distinguish it from A.2.1.

$$PI_{Connect} = \frac{NI_{Connect}}{NI_{Total}} \times 100$$

where

- $NI_{Connect}$ (No.) = Number of industries that are connected to the service
- NI_{Total} (No.) = Total number of industries requiring the service in an area (area to be specified by the user)

Unit

[%]

Data Disaggregation

It requires to define different scales and water demands of industries. It is suggested to disaggregate industries based on their water demand intensity in two categories, namely large intensity, with water consumption higher or equal than 10.000 m^3/year – and small intensity, with water consumption smaller than 10.000 m^3/year.

Reference Values

🟢	Good	[95; 100]
🟡	Fair	[80; 95[
🔴	Poor	[0; 80[

Suggested Supplementary Metrics

-

References

-

2.2.2.4 Metric "A.2.4" Physical access to water for irrigation

Metric Name

Physical access to water for irrigation ($PA_{Connect}$)

Definition and Rationale

Definition: Area of a land irrigated with freshwater, reclaimed water and/or rainwater as a proportion of total irrigated area.

Concepts: The access to water for agriculture or garden reflects the level of sustainable practice adopted for irrigation.

Rationale and interpretation: The rationale is to assess water stress for agriculture use disaggregated for different types of crops and/or water sources.

Data Sources and Collection Method

The available GIS, master plans, project documents to identify relevant areas to be considered as well as detailed information on water sources for the considered area should be collected.

Method of Computation and Other Methodological Considerations

The metric is assessed as the percentage of area of land irrigated with freshwater, reclaimed water and rainwater over the total considered area.

$$PA_{Connect} = \frac{A_{Connect}}{A_{ir\ Total}} \times 100$$

where

- $A_{Connect}$ (ha) = Area of land irrigated with freshwater, reclaimed water and/or rainwater (hectares)
- $A_{ir\ Total}$ (ha) = Total irrigated area (area to be specified by the user) (hectares)

Unit

[%]

Data Disaggregation

The user can disaggregate this metric for different agricultural uses or for gardens at the household level. The user may define disaggregation based on the type of agriculture/crops or also based on different water sources.

Reference Values

🟢	Good	[85; 100]
🟡	Fair	[50; 85[
🔴	Poor	[0; 50[

Suggested Supplementary Metrics

Note: more complex metrics are available for eventual consultation in : Water Debt Indicator Reveals Where Agricultural Water Use Exceeds Sustainable Levels – Tuninetti – 2019 – Water Resources Research – Wiley Online Library

References

-

2.2.3 AC A.3 “Financial viability”

Description: the AC deals with the establishment of financial tariffs according to the average income/affordability, water saving measures and the consumer willingness to pay.

2.2.3.1 Metric “A.3.1” Consumer willingness to pay

Metric Name

Consumer willingness to pay (CWP)

Definition and Rationale

Definition: Answer the following question: How is expenditure regarding the water-smart services* perceived by all relevant stakeholders (*i.e.,* is there trust that the money is well-spent)?

Concepts: The extent that expenditures for water-smart services are perceived money being well spent and trust that money is well spend.

Rationale and Interpretation: Willingness to pay for water-smart services is a key enabling factor in transforming to a water-smart society.

Data Sources and Collection Method

See Appendix D on the interview method applied.

Method of Computation and Other Methodological Considerations

Select a Likert category by answering the following question: How is expenditure regarding the water-smart services perceived by all relevant stakeholders (*i.e.,* is there trust that the money is well-spent)?

Careful substantiation with references to written documentation as well as anonymous interviewees is required to justify the score.

*The score justification has to define which water-smart services are considered and which findings relate to which service.

++	**Willingness to pay for present and future risk reductions**	Water smartness is fully comprehended by decision-makers. There is political and public support to allocate substantial financial resources. Also, expenditure for non-economic benefits is perceived as important. There is clear agreement on the use of financial principles, such as polluter-pays- and user-pays- or solidarity principle.

+	**Willingness to pay for provisional adaptation**	Due to growing worries about water challenges, there are windows of opportunity to increase funding. However, the perception of risk does not necessarily coincide with actual risk. Financial principles, such as polluter-pays principle, may be introduced. Due to inexperience, implementation is often flawed. Focus groups decide on priority aspects regarding water challenges, but there is confusion regarding the extent and magnitude of the water challenges.
0	**Willingness to pay for business as usual**	There is support for the allocation of resources for conventional tasks. There is limited awareness or worries regarding water smartness. Most actors are unwilling to financially support novel policies beyond the status quo. Generally, there is sufficient trust in local authorities.
-	**Fragmented willingness to pay**	Willingness to pay for measures addressing the water challenges are fragmented and insufficient. The importance and risks are perceived differently by each stakeholder. Generally, their estimates of the cost are substantially lower than the actual costs.
--	**Mistrust and resistance to financial decisions**	There is a high level of mistrust in decision making of resource allocation. At this level financial decisions are based on prestige projects, projects that benefit small groups or specific interests. As expenditures often do not address the actual water challenges, there is a high degree of resistance regarding resource allocation.

Unit

Ordinal scale. Likert style scoring with five categories ranging from very limiting (--) to very encouraging (++) water-smartness.

Data Disaggregation

none

Reference Values

🟢	Good	+ or ++
🟡	Fair	0
🔴	Poor	- or --

Suggested Supplementary Metrics

-

References

-

2.2.3.2 Metric "A.3.2" Affordability

Metric Name

Affordability (AFF_{WSW})

Definition and Rationale

Definition: Answer the following question: To what extent are water-smart services* and adaptation measures** available and affordable for all citizens, including the poorest?

Concepts: The extent that water-smart services and measures are available and affordable for all citizens, including the poorest.

Rationale and Interpretation: The affordability, of water-smart services and measures, is critical to have broad support for these measures and service provision.

Data Sources and Collection Method

See Appendix D on the interview method applied.

Method of Computation and Other Methodological Considerations

Select a Likert category by answering the following question: To what extent are water-smart services and adaptation measures available and affordable for all citizens, including the poorest?

Careful substantiation with references to written documentation as well as anonymous interviewees is required to justify the score.

*The score justification has to define which water-smart services are considered and which findings relate to which service.

** If applicable explain what is being considered as a water-smart adaptation in the justification of a very encouraging score (++).

++	**Water-smart adaptation affordable for all**	Programs and policies ensure water-smart adaptation measures for everyone. This includes public infrastructure and private property protection. The solidarity principle is clearly percolated in policy and regulation.
+	**Limited affordability of water-smart adaptation services**	Serious efforts are made to support water-smart adaptation for everyone, including vulnerable groups. There is often recognition that poor and marginalized groups are disproportionately affected by water challenges. This is increasingly addressed in policy and regulation.
0	**Unaffordable water-smart adaptation**	Basic water services are affordable for the vast majority of the populations, however poor people and marginalized communities have much difficulty to afford water-smart adaptation measures to protect themselves against impacts such as extreme heat, flooding or water scarcity.

-	**Limited affordability of basic water services**	A share of the population has serious difficulty to pay for basic water services such as neighborhoods with low-income or marginalized groups. There is hardly any social safety net regarding water services, let alone for water-smart adaptation measures.
--	**Unaffordable basic water services**	Basic water services are not affordable or even available for a substantial part of the population. This may be due to inefficient or obsolete infrastructure, mismanagement, or extreme poverty.

Unit

Ordinal scale. Likert style scoring with five categories ranging from very limiting (--) to very encouraging (++) water-smartness.

Data Disaggregation

Reference Values

- 🟢 Good + or ++
- 🟡 Fair 0
- 🔴 Poor - or --

Suggested Supplementary Metrics

-

References

-

2.2.3.3 Metric "A.3.3" Financial continuation

Metric Name

Financial continuation (FC)

Definition and Rationale

Definition: Answer the following question: To what extent do financial arrangements secure long-term, robust policy implementation, continuation, and risk reduction?

Concepts: The extent that financial arrangements secure long-term, robust policy implementation, continuation, and risk reduction.

Rationale and Interpretation: Long-term financial support is critical to ensure long-term water-smart solutions that can continuously be improved.

Data Sources and Collection Method

See Appendix D on the interview method applied.

Method of Computation and Other Methodological Considerations

Select a Likert category by answering the following question: To what extent do financial arrangements secure long-term, robust policy implementation, continuation, and risk reduction?

Careful substantiation with references to written documentation as well as anonymous interviewees is required to justify the score.

++	**Long-term financial continuation**	There is secured continuous financial support for long-term policy, measures, and research regarding water challenges. These costs are included into baseline funding. Generally, both economic and non-economic benefits are considered and explicitly mentioned.
+	**Abundant financial support with limited continuation**	Abundant financial resources are made available for project-based endeavors that are often exploring new solutions but lack long-term resource allocation or institutionalized financial continuation. Hence, long-term implementation is uncertain.
0	**Financial continuation for basic services**	Financial resources are available for singular projects regarding basic services. The allocation of financial resources is based on past trends, current costs of maintenance and incremental path-dependent developments. Costs to deal with future water challenges are often not incorporated. Limited resources are assigned for unforeseen situations or calculated risks.

-	**Inequitable financial resource allocation**	There are potential resources available to perform basic management tasks, but they are difficult to access, are distributed rather randomly and lack continuity. No clear criteria can be found on the resource allocation. Resources allocation is ad hoc and considers only short-time horizons.
--	**Lack of financial resources**	There are insufficient financial resources available to perform basic management tasks.

Unit

Ordinal scale. Likert style scoring with five categories ranging from very limiting (--) to very encouraging (++) water-smartness.

Data Disaggregation

Reference Values

- 🟢 Good + or ++
- 🟡 Fair 0
- 🔴 Poor - or --

Suggested Supplementary Metrics

-

References

-

2.2.3.4 Metric “A.3.4” Cost coverage ratio

Metric Name

Cost coverage ratio (CCR)

Definition and Rationale

Definition: Cost coverage ratio is the ratio between the revenues obtained due to water reuse, and from by-products recovered from treatment process of water or wastewater and the total costs excluding the investment subsidized.

Concepts: **By-product** is considered a secondary product made in the manufacture, treatment or synthesis of something else. **Revenue** is the income that a business or government receives regularly, or an amount representing such income. Treatment process or activity is considered the main infrastructure or technology where the organization is having its main activities. It can be considered a wastewater treatment plant, an industry, etc. Total **costs** during the assessment period, including capital (excluding the investment subsidized) and running costs, regarding the service.

Rationale and Interpretation: Potential revenues around water due to water reuse (avoided consumption, water selling) and from by-products recovered from wastewater treatment (salt, fertilizer, energy selling or avoided consumption, etc.) related to total costs in the scope of the organization (utility, industry(ies), etc.).

Data Sources and Collection Method

Data will be provided by the organization, based on real data from its treatment process or activity. Other needed data will also be obtained through desk study.

Method of Computation and Other Methodological Considerations

$$CCR = \frac{R_{BP}}{C_{tot}}$$

where:

- R_{BP} (€/year) = Yearly revenue generated from by-products recovery, around water due to water reuse (avoided consumption, water selling) and from by-products recovered from wastewater treatment (salt, fertilizer, energy selling or avoided consumption, etc.)
- C_{tot} (€/year) = Yearly total costs excluding the investment subsidized

Unit

[-]

Data Disaggregation

This metric can be calculated for different by-products, considering an individual or a group of byproducts. Disaggregation can also be based on *e.g.,* infrastructure component (or at least WWTP, DWTP), resources targeted (effluent, nitrogen, and sludge), or utility level.

Reference Values

🟢	Good	[100; 110]
🟡	Fair	[90; 100[or]110; 120]
🔴	Poor	[0; 90[or]120; +∞[

Suggested Supplementary Metrics

C.2.1 Resource recovery revenues

References

-

2.3 SO B – Safeguarding ecosystems and their services to society

Description: Water-related ecosystems provide multiple benefits and services to society and are essential for reaching several Sustainable Development Goals (SDGs). Water-related ecosystems have significant economic, cultural, aesthetic, recreational and educational value. They help to sustain the global hydrological cycle, carbon cycle and nutrient cycles. They support water security, they provide natural freshwater, regulate flows and extreme conditions, purify water and replenish groundwaters. Safeguarding ecosystems and their services to society describes the ability to prevent deterioration and ensure protection of water-related ecosystems, to enhance ecosystem services in urban and rural areas and to take carbon neutrality actions and promote resource efficiency in view of environmental protection.

2.3.1 AC B.1 "Safeguarded water ecosystems"

Description: the AC deals with the protection of receiving water bodies from pollution (*e.g.,* inland surface waters, coastal waters, groundwater, etc.) in order to (a) prevent further deterioration and protect and enhance the status of aquatic ecosystems, (b) promote sustainable water use based on a long-term protection of available water resources; (c) enhance protection and improvement of the aquatic environment, etc.

2.3.1.1 Metric "B.1.1" Environmental flow requirement compliance rate

Metric Name

Environmental flow requirement compliance rate (EFR_{CR})

Definition and Rationale

Definition: Minimum water flow is the environmental lower limit for water flow in a stream or river and is defined by the EFR (Environmental Flow Requirement).

Concepts: Upholding minimum waterflow of rivers and streams is a central aspect to the protection of water ecosystems. Going below this limit would affect life in the water and thus the biodiversity.

Rationale and Interpretation: The EFR and its limits are set so that the biodiversity and the ecosystems can flourish, since they are dependent on a certain level of water flow in order to accomplish this. A minimum water flow is therefore used to safeguard water ecosystems in rivers and streams.

Data Sources and Collection Method

Data on water flow will have to be collected directly from the stream/river, and it will have to be continuously monitored. Flow measurements will give the user available data to compare it to the EFR which is defined by the regulatory body.

Data collection should follow these steps:

1. Identify significant water bodies (main water bodies)
2. Quantify the EFR for each water body
3. Collect the hourly flowrates of the water body
4. Calculate a weighted average to have a single value in regions where there are many water bodies.

Method of Computation and Other Methodological Considerations

$$EFR_{CR} = (1 - \frac{H_{<EFR}}{H_{annual}}) \times 100$$

where

- $H_{<EFR}$ (h/year) = Amount of time (hours) during a year in which EFR is not achieved
- H_{annual} (h/year) = Total number of hours per year (8760 or 8784)

Unit

[%]

Data Disaggregation

Not relevant

Reference Values

- Northern Europe

🟢	Good	[60; 100]
🟡	Fair	[40; 60[
🔴	Poor	[0; 40[

- Southern Europe

🟢	Good	[40; 100]
🟡	Fair	[20; 40[
🔴	Poor	[0; 20[

Suggested Supplementary Metrics

A1.1 Water exploitation index, plus (WEI+)

References

Liu, j., Liu, Q. and Yang, H. 2016. Assessing water scarcity by simultaneously considering environmental flow requirements, water quantity, and water quality in *Ecological Indicators,* volume 60, pages 434-441.

UN Water: https://www.unescap.org/sites/default/files/Session7_Environmental_flow_requirements_Water_use_Central_Asia_8-10Oct2019_ENG.pdf

2.3.1.2 Metric “B.1.2” Effective stormwater treatment

Metric Name

Effective stormwater treatment (SWT_{eff})

Definition and Rationale

Definition: Share of treated stormwater generated from stormwater treatment facilities complying with legal requirements.

Concepts: Stormwater treatment coverage. The concept is based on measuring or having an overview of the total amount of stormwater that is effectively produced in a city that is being treated before it is sent to a recipient (lake, river, sea, groundwater).

Rationale and Interpretation: The metric is used to have an overview of how much of the produced polluted stormwater in an area that is sent directly to a recipient without being treated. Polluted stormwater should be defined according to the existing regulation of the considered area. Untreated polluted stormwater will have a negative impact on ecosystems in all kinds of water bodies, and the share of polluted stormwater that is treated is therefore a measure of the level of protection of water bodies.

Data Sources and Collection Method

In order to have data on this metric it is necessary to have three categories of data:

1. It is necessary to have an overview of all the installed and built local stormwater treatment systems.

2. In case of combined wastewater systems (where both stormwater and sewer are sent to treatment plant for treatment), it is necessary to have an overview of areas where stormwater is not effectively connected to the combined system, and where the stormwater instead is sent (untreated) to a recipient.

3. Geographic information system (GIS) data on area use. It is necessary to know the areas where solutions described under point 1 and/or 2 are implemented. GIS can be used to assess the size of these areas and thus also the size of the areas not having in place a system for stormwater treatment. This way the share of area of a city/municipality that have treatment systems in place can be estimated.

Method of Computation and Other Methodological Considerations

$$SWT_{eff} = \frac{A_{Treatment}}{A_{Total}} \times 100$$

where:

- $A_{Treatment}$ (m^2 or ha) = Area of identified potential stormwater pollution areas where suitable treatment is implemented
- A_{Total} (m^2 or ha) = Total potential stormwater pollution area identified

Unit

[%]

Data Disaggregation

The metric can be disaggregated by different city areas/sub-areas, thus also being able to identify which areas of a city contributes most and least to the metric.

Reference Values

🟢	Good	[95; 100]
🟡	Fair	[90; 95[
🔴	Poor	[0; 90[

Suggested Supplementary Metrics

-

References

-

2.3.1.3 Metric "B.1.3" Effective wastewater treatment

Metric Name

Effective wastewater treatment (WWT_{eff})

Definition and Rationale

Definition: Share of generated wastewater that is treated in wastewater treatment facilities complying with legal requirements.

Concepts: Wastewater treatment coverage and volumetric efficiency. The concept is based on having an overview of the share of customers that is connected to the public wastewater system or is having a local legal treatment system in place. Based on population data, the share of total generated wastewater that is being treated can then be estimated.

Rationale and Interpretation: The metric is used to have an overview of how much of the generated wastewater in an area that is sent directly to a recipient or into the ground without being treated. Untreated wastewater will have a negative impact on ecosystems in all kinds of water bodies, and the share of wastewater that is treated is therefore a measure of the level of protection of water bodies.

Data Sources and Collection Method

The following data is necessary:

1. Measure the total amount/volume of wastewater that is being treated through all treatment plant systems.

2. Have an overview of the total number of population that generates wastewater, and multiply that with the expected daily (or other) amount of generated wastewater per person.

Method of Computation and Other Methodological Considerations

$$WWT_{eff} = \frac{V_{Treatment}}{TWW} \times 100$$

where

- $V_{Treatment}$ (m^3/year) = Volume of treated wastewater complying with legal requirements
- TWW (m^3/year) = Volume of treated wastewater

Unit

[%]

Data Disaggregation

The metric can be disaggregated by wastewater treatment facilities/plants and the areas for which they provide Service.

Reference Values

🟢	Good	100
🟡	Fair	[95; 100[
🔴	Poor	[0; 95[

Suggested Supplementary Metrics

-

References

-

2.3.2 AC B.2 "Enhanced ecosystem services to society"

Description: this AC deals with Ecosystem Services (ES). ES are the benefits to human society that are directly attributable to the ecological functioning of ecosystems. The metrics identified to assess the criteria cover services enhanced in urban and rural areas to cover all interested organizations. An exhaustive list of metrics should reflect the ecosystem services of interest in the organization.

2.3.2.1 Metric "B.2.1" Water body self-purification

Metric Name

Water body self-purification (SP_{NPC})

Definition and Rationale

Definition: Measures the self-purification of nutrients in a water body in relation to the total load by nutrient entry to the water body on an annual time frame.

Concepts: The metric is based on the ecosystem service theory and based on the common classification of ecosystem services from the European Environment Agency. In the calculation, only the most critical substance for the analyzed area can be considered.

Rationale and Interpretation: The metric shows the ability of a water body for self-purification of water. This can be used to measure improvements in the ecosystem, enhancing this capacity, which is beneficial for human demand, if water is abstracted for instance.

Data Sources and Collection Method

- Use of literature values for retention capacity of water bodies in combination with GIS-Data of the water body to determine e.g., water surface (Gerner, 2018).
- Measurements from the water body for nutrient-entry from literature or field-measurements

Method of Computation and Other Methodological Considerations

Calculate the nutrients self-purification (SP_{NPC}):

$$SP_{NPC} = \frac{NPC_{retention}}{NPC_{\text{entry}}} \times 100$$

where

- $NPC_{retention}$ (ton/year) = Sum of N, P and C retention capacity
- NPC_{entry} (ton/year) = Sum of N, P and C entry to the water body

Unit

[%]

Data Disaggregation

The self-purification percentage can be quantified for different spatial frames, depending on the water body type and for the different nutrients.

Reference Values

🟢	Good	[40; 100]
🟡	Fair	[10; 40[
🔴	Poor	[0; 10[

Suggested Supplementary Metrics

-

References

EEA (2018): CICES V5.1, 18/03/2018. https://cices.eu/resources/.

Gerner N. V., Nafo I., Winking C., Wencki K., Strehl C., Wortberg T., Niemann A., Anzaldua G., Lago M., Birk S. (2018): Large-scale river restoration pays off: A case study of ecosystem service valuation for the Emscher restoration generation project. Ecosystem Services, 30, 327-338.

2.3.2.2 Metric "B.2.2" Maintaining nursery populations and habitats

Metric Name

Maintaining nursery populations and habitats (W_E)

Definition and Rationale

Definition: The metric assesses the ability of a water ecosystem (W_E) to maintain nursery populations and habitats using the WFD assessment of water bodies within the catchment. The metric is defined as the water area of the catchment with a good ecological status or better in relation to the whole catchment area.

Concepts: The metric is based on a proxy to measure the state of an ecosystem to maintain nursery populations and habitats of the catchment, ensuring biodiversity. Therefore, the metric is based on the WFD (2000) and the 5-step-scale (EC, 2005) to assess the ecological status of a water body.

The underlying concept is the ecosystem service theory manifested in specific ecosystem services selectable from CICES (EEA, 2018). Here, so called regulating ecosystem services are beneficial for human well-being. For water related regulating ecosystem services especially the ecosystem service for maintaining nursery populations and habitats is important. This is, because water bodies with a good ecological status do also maintain nursery populations and habitats for a variety of species enabling for instance a functioning ecosystem which regulates water quality beneficial for water abstraction, provides fish stocks beneficial for recreational fishing and alike.

Rationale and Interpretation: The metric is a proxy to highlight the ability of a water ecosystem to maintain nursery populations and habitats for a variety of species, ensuring biodiversity. This is an important so-called intermediate ecosystem which needs to be ensured for a "water-smart society" in order to enable final ecosystem services like the provision of a good water quality which is abstract-able and useable for potable or non-potable final use. It is also the basis for many water-related cultural ecosystem services.

Data Sources and Collection Method

Data sources:

- WFD-reporting
- Water data statistics

Method of Computation and Other Methodological Considerations

$$W_E = \frac{WA_{\geq good}}{WA} \times 100$$

where

- $WA_{\geq good}$ (km²) = Water area with a good ecological status or better
- WA (km²) = Overall water area of the whole catchment

Unit

[%]

Data Disaggregation

The data can be disaggregated for smaller parts of a water catchment area. Also, a disaggregation can be conducted by type of water, *e.g.,* assess lakes in the catchment area separately from river sections or alike.

Reference Values

🟢	Good	[40; 100]
🟡	Fair	[10; 40[
🔴	Poor	[0; 10[

Suggested Supplementary Metrics

-

References

EEA (2018): CICES V5.1, 18/03/2018. https://cices.eu/resources/

EC (2005): Common Implementation Strategy for the Water Framework Directive (2000/60/EC), Guidance document n.o 13 Overall approach to the classification of ecological status and ecological potential.

WFD (2000): DIRECTIVE 2000/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2000 establishing a framework for Community action in the field of water policy.

2.3.2.3 Metric "B.2.3" Flood damage prevention

Metric Name

Flood damage prevention (FDP)

Definition and Rationale

Definition: The metric measures the flood damage prevention (FDP) due to flood control and coastal protection by ecosystems using a proxy indicator. It shows the amount of protected people by the ecosystem (which can be any type of any flood protection by the ecosystem).

Concepts: The metric is based on a proxy to measure the endangered human health dimension by extreme events. It is based on the indicator "amount of people affected by floods". The underlying concept is the ecosystem service theory, manifested in specific ecosystem services selectable from CICES (EEA, 2018). Here, so called regulating ecosystem services are beneficial for human well-being. For water related regulating ecosystem services especially the ecosystem service from flood control and coastal protection are important.

Rationale and Interpretation: Apart from economic damage potential due to floods, the risk for the society in terms of human health, affected population and thus social vulnerability is of growing concern and trigger for scientific studies (Sortino Barrionuevo et al., 2022; Tascón-González et al., 2020). A straightforward indicator to use is the "amount of people affected by floods over the considered area" using GIS data combined with flood risk maps. The rationale of this metric is to give a possibility to calculate the enhanced use of ecosystems for regulation of extreme events, namely for flood protection, without a too detailed methodology, but still based in state-of-the-art ecosystem service theory and flood risk management standards.

The baseline is the flood damage potential (here defined as amount of people affected by floods). This can shrink over time, e.g. because of any ecosystem-based measure, such as a restored flood plain or similar, which retains the water up to a certain threshold, thus protecting people behind this nature-based protection measure, *e.g.,* a city zone close to a river with a flood plain. But the detailed modelling of any ecosystem-based measure is not necessary, since the metric tracks the plan amount of people affected by floods from year to year. A shrinking metric thus indicates the improvement.

Data Sources and Collection Method

Data sources:

- Local GIS-data for inhabitants in the area (mostly available in digital formats from census)
- Flood risk maps in accordance with the European Flood-Risk-Management-Directive (2007)

Estimations / Simulations with relation to ecosystem related protection (*e.g.,* flood plains, enhanced retention area for a river etc.) with a recommended return period of 100 years, but other return periods may be considered within different data disaggregation.

Method of Computation and Other Methodological Considerations

$$FDP = (1 - \frac{AP_{today}}{AP_{in\ reference\ year}}) \times 100$$

where

- $AP_{in\ reference\ year}$ (No.) = Affected people by a flood event in the reference period (a specific year needs to be defined)
- AP_{today} (No.) = Affected people by a flood event according to today's GIS-data and flood risk maps

Unit

[%]

Data Disaggregation

The calculation can be done at different spatial levels. Also, more return periods for flood events could be covered, depending on data availability improving the accuracy of the estimation / simulation.

Reference Values

- 🟢 Good 90; 100]
- 🟡 Fair [60; 90[
- 🔴 Poor [0; 60[[

Suggested Supplementary Metrics

-

References

EEA (2018): CICES V5.1, 18/03/2018. https://cices.eu/resources/.

Flood-Risk-Management-Directive (2007): DIRECTIVE 2007/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2007 on the assessment and management of flood risks.

Sortino Barrionuevo J. F., Castro Noblejas H., Cantarero Prados F. J. (2022): Vulnerability to Flood Risk: A Methodological Proposal for Assessing the Isolation of the Population. Land, 11(2), 277.

Tascón-González L., Ferrer-Julià M., Ruiz M., García-Meléndez E. (2020): Social Vulnerability Assessment for Flood Risk Analysis. Water, 12(2), 558.

2.3.2.4 Metric "B.2.4" Water provision by the ecosystem

Metric Name

Water provision by the ecosystem ($W_{available}$)

Definition and Rationale

Definition: Measures the available water by the ecosystem ($W_{available}$) in relation to last year's availability.

Concepts: The metric measures the development of water provision by the ecosystem. The underlying concept is the ecosystem service theory, manifested in specific ecosystem services selectable from CICES (EEA, 2018). Here, so called provisioning ecosystem services are beneficial for human well-being. For water related regulating ecosystem services especially the ecosystem service from water provisioning for several usages is important (water for potable and non-potable use, water for hydroelectricity etc.).

Rationale and Interpretation: Different innovations may lead to an improvement of the ecosystem in a way that it can provide more water to be used. For instance, managed aquifer recharge may lead to enhance the capacity of groundwater, enabling an increase in water abstraction. Surface water is considered as well.

Data Sources and Collection Method

- Water availability estimations / measurements
- Data on water use and water abstraction per year

Data sources:

- Local GIS-data for inhabitants in the area (mostly available in digital formats from census)
- Flood risk maps in accordance with the European Flood-Risk-Management-Directive (2007)

Estimations / Simulations with relation to ecosystem related protection (e.g. flood plains, enhanced retention area for a river etc.)

Method of Computation and Other Methodological Considerations

Calculation of the metric:

$$W_{Available} = \frac{W_t}{W_{t-1}} \times 100$$

where

- W_t (million m^3/year) = Water available for abstraction from the ecosystem in year t
- W_{t-1} (million m^3/year) = Water available for abstraction from the ecosystem in the previous year t-1

Unit

[%]

Data Disaggregation

Disaggregation may be conducted by type of water use from the ecosystem and/or by ground water body.

Reference Values

- 🟢 Good [40; 100]
- 🟡 Fair [10; 40[
- 🔴 Poor [0; 10[

Suggested Supplementary Metrics

-

References

EEA (2018): CICES V5.1, 18/03/2018. https://cices.eu/resources/

2.3.2.5 Metric "B.2.5" People enjoying cultural ecosystem services

Metric Name

People enjoying cultural ecosystem services (CES)

Definition and Rationale

Definition: The metric measures the relation of "people enjoying cultural ecosystem services" (CES) provided by the water system under study in relation to the overall people living in reach of the water system (e.g., in the area of the hydrological catchment area of the water body or in coastal zones close by). Additionally, also indirect links can be accounted for this metric. For instance, if reclaimed water is reducing the pressure on conventional water sources, enabling urban green irrigation, cultural services attached to than can be accounted for here. Some examples are listed in the table below (Table 9).

CICES definition by Group of services (EEA, 2018)	Example	Indicator to account for (sum of this per anno equals the variable AC as defined below)
Physical and experiential interactions with natural abiotic components of the environment	People swimming in the lake, sea-side etc.	Amount of people doing that activity per anno
	People using a water side for kayaking, boating, sailing	Amount of people doing that activity per anno
	People using a public urban park for recreation only maintainable by reclaimed water	Visitors per anno
Intellectual and representative interactions with natural environment	Students, school groups and alike interacting with a water system for educational reasons (*e.g.,* studying healthy flora and fauna of the water system)	Amount of people visiting the water system for that activity per anno

Table 9 – Examples for cultural ecosystem services are (not limited to, but exemplarily stated here, based on EEA, 2018)

Concepts: The metric is used to measure the "people enjoying cultural ecosystem services". The underlying concept is the ecosystem service theory, manifested in specific ecosystem services selectable from CICES (EEA, 2018). Here, so called cultural ecosystem services are beneficial for human well-being. For water related cultural ecosystem services especially the amount of people enjoying recreational activities aligned with the water system or enabled by water used for *e.g.,* urban ecosystems like urban green spaces under study are of interest.

Rationale and Interpretation: A central figure to estimate the enhanced use of cultural ecosystem services is the amount of people enjoying these. Ecosystem service evaluations often use the amount of people visiting an ecosystem (*e.g.,* pedestrians or bikers enjoying the water side view), using it for recreational activities (*e.g.,* swimming in the water, sailing on the water, fishing etc.) and alike to derive a monetary value with a complex methodology, as for instance conducted in Gerner et al. (2018). Additionally cultural services, like using an irrigated urban green for recreation, can be accounted for under this metric. For B-WaterSmart metrics of the Section B.2 it is not envisioned to fulfil a comprehensive ecosystem service evaluation. The approach is rather to define and use straightforward, easy to use indications of an enhanced ecosystem service use beneficial for society. Thus, the amount of people benefiting from water related ecosystems is the plain and key indication used for this metric.

Data Sources and Collection Method

Calculate or estimate these variables:

- Amount of people from the catchment area using the water system for cultural activities each year (or using *e.g.,* urban ecosystems only maintained by water); for touristic sides also people from outside the catchment area can be accounted for in this variable.
- Inhabitants living in the catchment area.

Date sources:

- Regional statistics
- Census data
- Literature values

Method of Computation and Other Methodological Considerations

On an annual basis, calculate this metric:

$$CES = \frac{AP}{I} \times 100$$

where

- AP (No.) = Amount of people from the catchment area using the water system for recreational activities each year (for all possible type of recreational cultural activities valid, as long as they would not take place without the water system) per year; in touristic regions also people from outside the catchment area can be accounted for in this variable Inhabitants living in the catchment area
- I (No.) = Inhabitants living in the catchment area

Unit

[%]

Data Disaggregation

It can be disaggregated by parts of the catchment area of the water system under study. It may be also disaggregated by city / municipal postal codes or alike Additionally, for some areas it may also be possible and essential to disaggregate by the type of recreational activity and thus different types of cultural ecosystem services the number of people is relating to.

Reference Values

● (green)	Good	[40; 100]
● (yellow)	Fair	[10; 40[
● (red)	Poor	[0; 10[

Suggested Supplementary Metrics:

-

References

EEA (2018): CICES V5.1, 18/03/2018. https://cices.eu/resources/.

Gerner N. V., Nafo I., Winking C., Wencki K., Strehl C., Wortberg T., Niemann A., Anzaldua G., Lago M., Birk S. (2018): Large-scale River restoration pays off: A case study of ecosystem service valuation for the Emscher restoration generation project. Ecosystem Services, 30, 327-338.

2.3.3 AC B.3 "Resource efficiency"

Description: the AC reflects the effort in carbon neutrality actions, focusing on the use of resources and energy, and on the emission of CO_2 caused by the use of resources and energy and all other processes in a utility.

2.3.3.1 Metric "B.3.1" Water footprint

Metric Name

Water footprint (WFP)

Definition and Rationale

Definition: This metric is defined as the water footprint associated to direct and indirect use of water for the consumption of 1 m^3 of drinking water and/or the treatment of 1 m^3 of wastewater. Water footprint (WF) is an indicator of direct and indirect freshwater resources appropriation. Directly used water is the amount used in the production/treatment, while indirect is the amount used in producing products, processes, systems etc. that is used in the production/treatment of the product.

Concepts: The water footprint of a product is defined as the total volume of freshwater that is used directly or indirectly to produce/treat the product. It is estimated by considering water consumption and pollution in all steps of the production/treatment chain. The water footprint of a product breaks down into a green, blue, and grey component.

WF has a geographical and temporal dimension, for which great importance is given to the point of collection, consumption and return to the environment. WF can be calculated for a process, a product, a group, an individual or an area. In this case, WF is calculated for a product (which is water). WF footprint is normally made up of the following three components:

- Green WF: Rainwater used
- Blue WF: Surface & groundwater used
- Grey WF: Water to dilute pollution

Drinking water consumption corresponds to the authorized consumption (see International Water Association (IWA) water balance in metric D.3.1) defined in IWA (2016) which is the volume of metered and/or non-metered water taken by registered customers, the water supplier and others who are implicitly or explicitly authorized to do so by the water supplier, for residential, commercial, and industrial purposes, during the assessment period. It includes water exported.

Note (1): Authorized consumption may include items such as firefighting and training, flushing of mains and sewers, street cleaning, watering of municipal gardens, public fountains, frost protection, building water, etc. These may be billed or unbilled, metered or unmetered, according to local practice.

Note (2): Authorized consumption includes leakage and waste by registered customers that are unmetered.

Rationale and Interpretation: WF gives information about the impacts of the activities and identifies the main water consumption or pollution hotspots. It will help to reduce water consumption and to make a more efficient use of resources.

Data Sources and Collection Method

The following data should be collected for water footprint:

1. The total amount of water which is used directly by the utility for producing 1 m^3 of drinking water and/or treating 1 m^3 of wastewater. This includes water used in the whole of the treatment plant, water used for operation of the network, and water which is lost through leakages in the networks. This is water that is contributing to the production of water, but which is not part of the product itself.

2. The amount of water which is used in the production process of resources and products that the utility is using to produce 1 m^3 of drinking water to customers or is using to treat 1 m^3 of wastewater. Such information must be gathered from the producers of such products/resources. Such resources and products can be, but are not limited to:

- Electrical power/ energy that is used in the treatment and in the distribution network (pumping)
- Chemicals used in the treatment
- Equipment used in the treatment and in the distribution system (new equipment). Examples of such equipment are pipes, pumps, valves, treatment facility products etc.
- Etc.

For the drinking water consumption, the data is collected by the organization (*e.g.,* metering systems) and the data could be collected annually or more frequently.

Method of Computation and Other Methodological Considerations

The method suggested is a simplified approach which is suitable when only an approximation is needed, or when limited resources are available for analysis, or when limited data is available and consists in applying literature values for all the existing types of components, instead of customized values of each actual component. When possible, a full LCA analysis (with a suitable tool) should be performed where all negative and positive contributions are considered. An example on how to perform this type of analysis is available at https://doi.org/10.1016/j.resconrec.2019.104458.

$$WFPdw = \frac{WF_{dw}}{DWP} \quad \text{or} \quad WFPww = \frac{WF_{ww}}{TWW}$$

where

- WF_{dw} (m^3/year) = Water footprint in the drinking water system and WF_{WW} (m^3/year) = Water footprint in the wastewater system; should be collected for every process and product that is being used in the system (this includes water used in the whole of the treatment plant, water used for operation of the network, and water which is lost through leakages in the drinking water network) through a period of time (e.g., year)

- DWP (m^3/year) = Annual drinking water production; used for drinking water systems
- TWW (m^3/year) = Volume of wastewater treated; used for wastewater systems

Unit

[m^3/m^3]

Data Disaggregation

Data for WF can be disaggregated down on each component of the water/wastewater system, treatment stages, pumps, pipes etc. Or by type of use (accounting for the share of WF_{dw} due to, for instance, industrial, residential or public use).

Reference Values

- For water supply:

🟢	Good	[0.0; 1.0]
🟡	Fair	]1.0; 1.5]
🔴	Poor	]1.5; +∞[

- For wastewater system:

🟢	Good	[0.0; 1.0]
🟡	Fair	]1.0; 2.0]
🔴	Poor	]2.0; +∞[

Suggested Supplementary Metrics

B.3.4 Drinking water consumption

References

Alegre, H., Baptista, J.M., Cabrera, E., Cubillo, F., Duarte, Hirner, W., Parena, R. (2016). Performance Indicators for Water Supply Services: Third Edition. IWA Publishing, Volume 15. DOI: https://doi.org/10.2166/9781780406336.

Romeiko, X. X. (2019). Comprehensive water footprint assessment of conventional and four alternative resource recovery based wastewater service options. Resources, Conservation and Recycling, 151, 104458. DOI: https://doi.org/10.1016/j.resconrec.2019.104458

Hoekstra, A.Y., Chapagain, A.K., Aldaya, M.M. & Mekonnen, M.M. (2011) The water footprint assessment manual: Setting the global standard, Earthscan, London, UK. https://waterfootprint.org/en/resources/publications/water-footprint-assessment-manual/

2.3.3.2 Metric "B.3.2" Carbon footprint

Metric Name

Carbon footprint (CFP)

Definition and Rationale

Definition: This metric is defined as the carbon footprint that is emitted directly and indirectly for the consumption of 1 m^3 of drinking water and/or treatment of 1 m^3 of wastewater. Carbon footprint (CFP) is an indicator of direct and indirect Greenhouse Gas (GHG) emissions produced by the organization activities.

Concepts: CFP gives information about the impacts of the activities and identifies the emission hotspots. It will help to reduce emissions and to make a more efficient use of resources. CFP results are in kg CO_2 equivalent. The CO_2 equivalent is calculated from Global warming potential over100 years. This is an IPCC indicator for calculating the carbon footprint.

Carbon footprint is a product of direct emissions and indirect emissions. These are defined as follows: DIRECT EMISSIONS: Emissions from sources owned or controlled by the organization (Scope 1); INDIRECT EMISSIONS: Emissions derived from activities that occur in sources that are not owned or controlled by the organization, related to the energy consumption (Scope 2) or to other resources consumption or production (Scope 3). As a minimum requirement for computing this metric, only the direct emissions related to the operational activities of the utility should be considered.

Rationale and Interpretation: The metric should be measured in order for an organization to have an overview of the impact it may have on climate change, and in order to review how to reduce the impact over time. It will also help to identify areas of its operation that are central to the production of greenhouse gas emissions, and thus will be able to review how and where measures should be directed in order to reduce such emissions.

Data Sources and Collection Method

Data should be gathered from international databases on the emission of CO2 related to specific processes. There are many databases available for this purpose. Eco-invent is an example of an international database that can be used to get information related to emission of a wide range of processes and products. These databases are normally updated with the latest data on CO2 equivalents. If data is not possible to find in databases, there is a chance that the producer has this kind of data for the relevant product. Electricity bills and diesel/gasoline consumption can be considered as the basis for the calculations. These amounts should be coupled with data on CO_2 equivalents for the different processes.

Method of Computation and Other Methodological Considerations

The method suggested is a simplified approach which is suitable when only an approximation is needed, or when limited resources are available for analysis, or when limited data is available, and consists in applying literature values for all the existing types of components, instead of customized values of each actual component. When possible, a full LCA analysis (with a suitable tool) should be performed where all negative and positive CO_2 emissions are considered. An example on how to perform this type of analysis is available at https://doi.org/10.1016/j.jenvman.2022.115715

$$CFP_{dw} = \frac{CF_{dw}}{DWP} \quad or \quad CFP_{WW} = \frac{CF_{WW}}{TWW}$$

where

- CF_{dw} (kg CO_2 equivalents/year) = Carbon footprint in the drinking water system and CF_{WW} (kg CO_2 equivalents/year) = Carbon footprint in the wastewater system; should be collected for every process and product (this includes carbon emissions in the whole of the treatment plant and in the network) that is being used in the system through a period of time, for example a year
- DWP (m^3/year) = Annual drinking water production; used for drinking water systems
- TWW (m^3/year) = Volume of wastewater treated; used for wastewater systems

Unit

[kg CO_2 eq/m^3]

Data Disaggregation

Data can be disaggregated in each product and process that is part of the system, as already stated above. This gives the user a possibility to review which process and/or product in the systems that contributes the most to CO_2 emissions. Disaggregation is possible also by type of use (accounting for the share of CF due to, for instance, industrial, residential or public water use, or industrial, residential or public produced wastewater).

Reference Values

🟢	Good	[0; 0.3]
🟡	Fair	]0.3; 0.7]
🔴	Poor	]0.7; +∞[

Suggested Supplementary Metrics

B.3.3 Energy consumption

References

Faragò, M., Damgaard, A., Rebsdorf, M., Nielsen, P. H., & Rygaard, M. (2022). Challenges in carbon footprint evaluations of state-of-the-art municipal wastewater resource recovery facilities. Journal of Environmental Management, 320, 115715. DOI: https://doi.org/10.1016/j.jenvman.2022.115715.

2.3.3.3 Metric "B.3.3" Energy consumption

Metric Name

Energy consumption (E_{eff})

Definition and Rationale

Definition: This metric is defined as the ratio of the energy consumption for abstraction/treatment of water/wastewater per cubic meter of water produced/treated.

Concepts: This metric aims assess the total energy used across the whole system (drinking water or wastewater system or both systems aggregated), for heating, all processes and installations (treatment processes, pumps etc.) over a set period of time, per total water produced/treated (given in m^3) for the same time period. It therefore reflects the efficiency in use of energy.

Rationale and Interpretation: Calculating and getting an overview of the energy used for producing drinking water or treating wastewater is important because energy use is the use of natural resources and will have an impact on the water ecosystem. Reducing the energy use can therefore have a positive impact on the water ecosystem.

Data Sources and Collection Method

The electric bill from the electrical supplier company gives an overview of the total energy used by the utility. The total over a year should be accumulated in order to get an average for the whole year (energy demand varies by month). Drinking water produced or wastewater treated over the same 12 months is something the utility should have available.

Method of Computation and Other Methodological Considerations

The metric is assessed as a ratio between total energy used per cubic meter of water produced/treated per year and therefore the indicator is labelled as Energy efficiency (E_{eff}).

$$E_{\mathrm{eff\,dw}} = \frac{E_{dw}}{DWP} \quad or \quad E_{\mathrm{eff\,ww}} = \frac{E_{ww}}{TWW}$$

where

- E_{dw} (kWh/year) = Total energy used in the drinking water system (all processes)
- E_{ww} (kWh/year) = Total energy used in the wastewater system (all processes)
- DWP (m^3/year) = Annual drinking water production; used for drinking water systems
- TWW (m^3/year) = Volume of wastewater treated; used for wastewater systems

Unit

[kWh/m^3]

Data Disaggregation

Data can be disaggregated down to individual components and processes, in order to have a detailed overview of what processes and components use most energy. To this purpose, it is required the installation of energy meters on all the components to be assessed. Having this data could however help a utility in identifying the energy hungry components, and possibly work to reduce the energy on these components, or alternatively install new more energy efficient components. Moreover, disaggregation can be based on sectors (water supply, wastewater collection, wastewater treatment), alternative water resources and resources targeted (*e.g.,* effluent, nitrogen, sludge)

Reference Values

- For water supply

🟢	Good	[0; 0.5]
🟡	Fair	]0.5; 0.8]
🔴	Poor	]0.8; +∞[

- For wastewater

🟢	Good	[0; 0.6]
🟡	Fair	]0.6; 0.9]
🔴	Poor	]0.9; +∞[

Suggested Supplementary Metrics

B.3.2 Carbon footprint

References

Performance of water utilities beyond compliance — Sharing knowledge bases to support environmental and resource-efficiency policies and technical improvements, EEA Technical report No 5/2014 http://www.eea.europa.eu/publications/performance-of-water-utilities-beyond-compliance

2.3.3.4 Metric "B.3.4" Drinking water consumption

Metric Name

Drinking water consumption (DWC_{PC})

Definition and Rationale

Definition: This metric is defined as the drinking water consumption per capita.

Concepts: The drinking water consumption per capita is a measure on how effectively water is used by the inhabitants served. Thus, it is also an indirect measure of the amount of water-saving products and installations that are installed and used by inhabitants. Its assessment requires the value of the annual drinking water production and consumption which includes water used for industry, public use, leakages and other unaccounted for water use.

Rationale and Interpretation: The drinking water consumption per capita is a measure of the effectiveness of water use by inhabitants, *e.g.,* by the individual end users. Drinking water demand represents a significant share of the total demand in a city which often impacts remarkably the surrounding water ecosystems. Therefore, limiting the drinking water demand can notably mitigate the impact on water ecosystems. Measuring this metric supports benchmarking analysis and informs on the need for investing more in water management campaigns (towards the public), and for installing more (on a city-wide level) water-saving products and installations.

Data Sources and Collection Method

Data is collected by the organization (*e.g.,* metering systems) and could be collected annually or more frequently.

Method of Computation and Other Methodological Considerations

The metric is assessed as a ratio between water consumption and the related population.

$$DWC_{PC} = \frac{(DWP - V_{Loss} - V_{OU})\, x\, 1000}{365\, x\, P_{Total}}$$

where

- DWC_{PC} (l/capita/day) = Drinking water consumption per capita
- DWP (m^3/year) = Annual drinking water production
- V_{Loss} (m^3/year) = Annual water losses
- V_{OU} (m^3/year) = Annual water consumption for other use than domestic use (public, industrial, etc.)
- P_{total} (No.) = Number of total residents

Note: If water meters are installed in most of the private residences, it is possible to calculate the average water consumption based on the measurement data from the meters. This will give the most accurate estimation of water consumption since it is based on specific individual data.

Unit

[l/capita/day]

Data Disaggregation

Disaggregation can be based on different categories of users and waterworks.

Reference Values

🟢	Good	[80; 150]
🟡	Fair	]150; 175] or [50; 80[
🔴	Poor	[0; 50[or]175; +∞[

Suggested Supplementary Metrics:

C.3.3 Reclaimed water in non-potable uses, D.3.1 Linear water losses

References

-

2.4 SO C – Boosting value creation around water

Description: Value creation from synergies in the water-energy-resources-waste nexus through the implementation of circular economy policies and business models.

2.4.1 AC C.1 "Circular policy making"

Description: the AC deals with the design and implementation of a realistic cohesive set of short-term and long-term CE policies through innovation and complying statutory regulations.

2.4.1.1 Metric "C.1.1" Statutory compliance

Metric Name

Statutory compliance (SC)

Definition and Rationale

Definition: Answer the following question: To what extent is legislation and compliance, well-coordinated, clear and transparent and do stakeholders respect agreements, objectives, and legislation related to water-smartness?

Concepts: The extent that organizations and their stakeholders comply with existing legislation in a well-coordinated, clear and transparent manner.

Rationale and Interpretation: Compliance with regulation is critical for the implementation of water-smart solutions. As such, good coordinated, transparent agreements, objectives and legislation that is respected by stakeholders supports the transformation towards a water-smart society.

Data Sources and Collection Method

See Appendix D on the interview method applied.

Method of Computation and Other Methodological Considerations

Select a Likert category by answering the following question: To what extent is legislation and compliance, well-coordinated, clear and transparent and do stakeholders respect agreements, objectives, and legislation?

Careful substantiation with references to written documentation as well as anonymous interviewees is required to justify the score.

* The score justification has to state which policies are considered and which findings relate to which policy or group of policies.

++	**Good compliance to effective sustainable legislation**	Legislation is ambitious and its compliance is effective as there is much experience with developing and implementing sustainable policy. Short-term targets and long-term goals are well integrated. There is a good relationship among local authorities and stakeholders based on dialogues.
+	**Flexible compliance to ambitious explorations**	New ambitious policies, agreements and legislations are being explored in a "learning-by-doing" fashion. Most actors are willing to comply. Some targets may be unrealistic and requires flexibility
0	**Strict compliance to fragmentized legislation**	Legal regulations regarding water challenge are fragmented. However, there is strict compliance to well-defined fragmentized policies, regulations and agreements. Flexibility, innovations and realization of ambitious goals is limited. Activity may be penalized multiple times by different regulations due to poor overall coordination
-	**Moderate compliance to incomplete legislation**	The division of responsibilities of executive and controlling tasks is unclear. Legislation is incomplete meaning that certain gaps can be misused. There is little trust in local authorities due to inconsistent enforcement typically signaled by unions or NGO's
--	**Poor compliance due to unclear legislation**	Legislation and responsibilities are unclear, incomplete, or inaccessible leading to poor legal compliance by most actors. If legislation is present, it enjoys poor legitimacy. Actors operate independently in small groups. Fraudulent activities may take place

Unit

Ordinal scale. Likert style scoring with five categories ranging from very limiting (--) to very encouraging (++) water-smartness.

Data Disaggregation

-

Reference Values

- 🟢 Good + or ++
- 🟡 Fair 0
- 🔴 Poor - or --

Suggested Supplementary Metrics

-

References

-

2.4.1.2 Metric "C.1.2" Preparedness

Metric Name

Preparedness (PREP)

Definition and Rationale

Definition: Answer the following question: To what extent is the LL/organization prepared for uncertain changes and events in circular policy-making*?

Concepts: The level of preparedness to sudden changes and uncertainties in the formulation of circular policies and emergency planning (PREP).

Rationale and Interpretation: Policy-making and action plans are classified into five levels from no action to proactive plans considering all risks, impacts and worst-case scenarios.

Data Sources and Collection Method

See Appendix D on the interview method applied

Method of Computation and Other Methodological Considerations

Select a Likert category by answering the following question: To what extent is the LL/organization prepared for uncertain changes and events in circular policy making?

Careful substantiation with references to written documentation as well as anonymous interviewees is required to justify the score.

* The score justification has to state which policies are considered and which findings relate to which policy or group of policies.

++	**Comprehensive preparedness**	Long-term plans and policies are flexible and bundle different risks, impacts and worst-case scenarios. They are clearly communicated, co-created and regularly rehearsed by all relevant stakeholders. The required materials and staff are available on short-term notice in order to be able to respond adequately. Evaluations on the rehearsals or reviews on dealing with calamities are available.
+	**Fragmented preparedness**	A wide range of threats is considered in action plans and policies. Sometimes over-abundantly as plans are proactive and follow the precautionary principle. Awareness of risks is high, but measures are scattered and non-cohesive. They may be independent or made independently by various actors. Allocation of resources, staff and training may therefore be ambiguous.

0	**Low awareness of preparation strategies**	Based on past experiences, there are action plans and policies related to water-smart principles. Actions and policies are clear but actual risks are often underestimated and the division of tasks is unclear. They are not sufficient to deal with all imminent calamities or gradually increasing pressures. Damage is almost always greater than is expected or prepared for.
-	**Limited preparedness**	Action plans are responsive to recent calamities and ad hoc. Actual probabilities and impacts of risks are not well understood and incorporated into actions or policies. Reports can be found on how the water sector deals with recent calamities.
--	**Poor preparedness**	There are hardly any action plans or policies for dealing with (future) calamities, uncertainties and existing risks. The city is highly vulnerable.

Unit

Ordinal scale. Likert style scoring with five categories ranging from very limiting (--) to very encouraging (++) water-smartness.

Data Disaggregation

-

Reference Values

🟢	Good	+ or ++
🟡	Fair	0
🔴	Poor	- or --

Suggested Supplementary Metrics

-

References

Koop SHA (2021) Indicators of the Governance Capacity Framework (GCF) (Version June 2021). https://library.kwrwater.nl/publication/61397218/

2.4.1.3 Metric "C.1.3" Policy instruments

Metric Name

Policy instruments (PI)

Definition and Rationale

Definition: Answer the following question: To what extent are circular economy policy instruments* effectively used (and evaluated), in order to stimulate desired behavior and discourage undesired activities and choices?

Concepts: The effective use of policy instruments that promote the circular economy and enable behavioral changes for a water-smart society.

Rationale and Interpretation: Existence of specific policy instruments (plans, strategies, legislation, regulations) that aim to implement circular economy and sustainable principles (*e.g.,* water-energy-waste nexus)

Data Sources and Collection Method

See Appendix D on the interview method applied.

Method of Computation and Other Methodological Considerations

Select a Likert category by answering the following question: To what extent are circular economy policy instruments effectively used (and evaluated), in order to stimulate desired behavior and discourage undesired activities and choices?

Careful substantiation with references to written documentation as well as anonymous interviewees is required to justify the score.

* The score justification has to state which policy instruments are considered and which findings relate to which policy instrument or group of policy instruments.

++	**Effective instruments enhance sustainable transformations**	There is much experience with the use of policy instruments. Monitoring results show that the current use of instruments proves to be effective in achieving sustainable behaviour. Continuous evaluation ensures flexibility, adaptive capacity, and fit-for-purpose use of policy instruments.
+	**Profound exploration of sustainability instruments**	Instruments to implement principles such as full cost-recovery and polluter-pays principle, serve as an incentive to internalize sustainable behavior. The use of various instruments is explorative and therefore not yet optimized and efficient. The use of instruments is dynamic. There are a lot of simultaneous or successive changes and insights.

0	**Fragmented instrumental use**	Policy fields or sectors often have similar goals, but instruments are not coherent and may even contradict. Overall instrumental effectiveness is low and temporary. There is sufficient monitoring and evaluation leading to knowledge and insights in how instruments work and actors are getting a more open attitude towards improvements.
-	**Unknown impacts of policy instruments**	Instruments are being used without knowing or properly investigating their impacts on forehand. The set of instruments leads to imbalanced development and inefficiencies that are hardly addressed.
--	**Instruments enhance unsustainable behaviour**	Policy instruments may enhance unwanted or even damaging behavior that opposes sustainability principles, *e.g.,* discount for higher water use stimulates spilling and inefficiency. There is hardly any monitoring that can be used to evaluate the counterproductive effects of these policy instruments.

Unit

Ordinal scale. Likert style scoring with five categories ranging from very limiting (--) to very encouraging (++) water-smartness.

Data Disaggregation

-

Reference Values

🟢	Good	+ or ++
🟡	Fair	0
🔴	Poor	- or --

Suggested Supplementary Metrics

-

References

Koop SHA (2021) Indicators of the Governance Capacity Framework (GCF) (Version June 2021). https://library.kwrwater.nl/publication/61397218/

2.4.1.4 Metric "C.1.4" Green public procurement

Metric Name

Green public procurement (GPP_C)

Definition and Rationale

Definition: This indicator gives the percentage of the number of green public procurement contracts, compared to the total number of public procurement contracts. Total # of public procurement contracts includes # of non-green contracts+ # of green contracts + # of comprehensive green contracts.

Rationale and Interpretation: The use of Green Public Procurement (GPP) criteria as a 'proxy' indicator for market creation for circular economy products and services implies assessing whether there exist sustainability criteria that are being applied in public contracts (such as for wastewater management infrastructure), and what criteria are being applied in evaluating and approving these contracts (such as energy consumption, waste production, nutrient recovery). GPP can give more context information and complement other policy making metrics.

Data Sources and Collection Method

Method of Computation and Other Methodological Considerations

$$GPP_C = \frac{PP_{GC}}{PP_{tot-C}} \times 100$$

where:

- PP_{GC} (No.) = Number of green public procurement contracts
- $PP_{tot\text{-}C}$ (No.) = Total number of public procurement contracts, including non-green contracts, green contracts, and comprehensive green contracts

Unit

[%]

Data Disaggregation

Disaggregation can be performed based on different involved actors (utility, city council, regional administration, etc.).

Reference Values

- 🟢 Good [50; 100]
- 🟡 Fair [10; 50[
- 🔴 Poor [0; 10[

Suggested Supplementary Metrics

-

References

Green Public Procurement criteria (EU criteria – GPP – Environment – European Commission (europa.eu))

B-WaterSmart

2.4.1.5 Metric "C.1.5" Level of ambition

Metric Name

Level of ambition (LA)

Definition and Rationale

Definition: Answer the following question: To what extent are goals* ambitious (*i.e.,* identification of challenges, period of action considered, and comprehensiveness of strategy) and yet realistic (*i.e.,* cohesion of long-term goals and supporting flexible intermittent targets, and the inclusion of uncertainty in policy)?

Concepts: The level of ambition of the strategies from a realistic point of view, considering the long-term achievements, flexibility of goals and uncertainties.

Rationale and Interpretation: Action strategies to achieve water-smart society require ambitious goals that are also attainable and sufficiently flexible to fit the time frame, account for inherent uncertainties and align with other goals.

Data Sources and Collection Method

See Appendix D on the interview method applied.

Method of Computation and Other Methodological Considerations

Select a Likert category by answering the following question: To what extent are goals ambitious (*i.e.,* identification of challenges, period of action considered, and comprehensiveness of strategy) and yet realistic (*i.e.,* cohesion of long-term goals and supporting flexible intermittent targets, and the inclusion of uncertainty in policy)?

Careful substantiation with references to written documentation as well as anonymous interviewees is required to justify the score.

* The score justification has to state which goals are considered and which findings relate to which goals.

++	**Realistic and ambitious strategy**	Policy is based on modern and innovative assessment tools and policy objectives are ambitious. Support is provided by a comprehensive set of intermittent targets, which provide clear and flexible pathways. Assessment tools and scenarios analyses identify tipping points that may be found in policy documents.
+	**Long-term ambitious goals**	There is a long-term vision that incorporates uncertainty. However, it is not supported by a comprehensive set of short-term targets. Hence, achievements and realistic targets are difficult to measure or estimate. Visions are often found online as an organization's strategy. They often entail a description of water challenges and need for action.

0	**Confined realistic goals**	There is a confined vision of water challenges. Ambitions are mostly focused on improving the current situation where unchanging conditions are assumed and risk and scenarios analyses are lacking.
-	**Short-term goals**	Actions and goals mention sustainability objectives. Actions and goals are "quick fixes" mainly not adhering to a long-term vision or sustainable solutions. Uncertainties and risks are largely unknown.
--	**Short-term, conflicting goals**	Goals consider only contemporary water challenges, are short-sighted and lack sustainability objectives. Goals are arbitrary and sometimes conflicting, and the character of policy is predominantly reactive.

Unit

Ordinal scale. Likert style scoring with five categories ranging from very limiting (--) to very encouraging (++) water-smartness.

Data Disaggregation

-

Reference Values

🟢	Good	+ or ++
🟡	Fair	0
🔴	Poor	- or --

Suggested Supplementary Metrics

-

References

Koop SHA (2021) Indicators of the Governance Capacity Framework (GCF) (Version June 2021). https://library.kwrwater.nl/publication/61397218/

2.4.2 AC C.2 "Circular economy growth"

Description: the AC deals with value creation, revenue generation and green employment opportunities through new circular business models around water-energy-resources-waste nexus.

2.4.2.1 Metric "C.2.1" Resource recovery revenues

Metric Name

Resource recovery revenues (RRR)

Definition and Rationale

Definition: By-product recovery revenue is the percentage of return that is obtained due to water reuse, and from by-products recovered from treatment process of water or wastewater.

Concepts: **By-product** is considered a secondary product made in the manufacture, treatment or synthesis of something else. **Revenue** is the income that a business or government receives regularly, or an amount representing such income. Treatment process or activity is considered the main infrastructure or technology where the organization is having its main activities. It can be considered a wastewater treatment plant, an industry, etc.

Rationale and Interpretation: Potential revenues around water due to water reuse (avoided consumption, water selling) and from by-products recovered from wastewater treatment (salt, fertilizer, energy selling or avoided consumption, etc.) related to total revenues in the scope of the organization (utility, industry(ies), etc.).

Data Sources and Collection Method

Data will be provided by the organization, based on real data from its treatment process or activity. Other needed data will also be obtained through desk study.

Method of Computation and Other Methodological Considerations

$$RRR = \frac{R_{BP}}{R_{tot}} \times 100$$

where:

- R_{BP} (€/year) = Yearly revenue generated from by-products recovery, around water due to water reuse (avoided consumption, water selling) and from by-products recovered from wastewater treatment (salt, fertilizer, energy selling or avoided consumption, etc.)
- R_{tot} (€/year) = Yearly total revenue generated within the organization

Unit

[%]

Data Disaggregation

This metric can be calculated for different by-products, considering an individual or a group of byproducts. Disaggregation can also be based on *e.g.,* infrastructure component (or at least WWTP, DWTP), resources targeted (effluent, nitrogen, and sludge), or utility level.

Reference Values

- 🟢 Good > interest rate+0.5
- 🟡 Fair [interest rate; interest rate+0.5]
- 🔴 Poor < interest rate*

*Based on the reference interest rates of the European Central Bank

Suggested Supplementary Metrics

C.3.1 Water-related materials recovery

References

International Energy Agency (https://web.archive.org/web/20110726171133/http://www.ieabioenergy-task38.org/systemdefining/biomitre_technical_manual.pdf#), Cambridge (https://dictionary.cambridge.org/dictionary/)

2.4.2.2 Metric "C.2.2" Green jobs

Metric Name

Green jobs (GJ)

Definition and Rationale

Definition: This indicator is defined as the percentage of new jobs created in a circular economy context over the total amount of jobs.

Concepts: Green jobs are those jobs considered to contribute to preserve or restore the environment. They minimize waste and pollution, protect, and restore ecosystems and support adaptation to the effects of climate change.

Rationale and Interpretation: Number of green jobs created, converted or maintained in the circular economy context in comparison with total jobs created, converted and maintained.

Data Sources and Collection Method

Data will be provided by the organizations, based on real data from its treatment process or activity.

Method of Computation and Other Methodological Considerations

$$GJ = \frac{N_{GJ}}{N_J} \times 100$$

where

- N_{GJ} (No./year) = Number of new created, converted, maintained green jobs on a yearly basis
- N_J (No./year) = Total number of created, converted, maintained jobs on a yearly basis

Unit

[%]

Data Disaggregation

The data can be disaggregated between economic sectors, communities, and on local or regional level.

Reference Values

🟢	Good	[6; 100]
🟡	Fair	[3; 6[
🔴	Poor	[0; 3[

Suggested Supplementary Metrics

-

References

International Labour Organization (ILO), What is a green job?
https://www.ilo.org/global/topics/green-jobs/news/WCMS_220248/lang--en/index.htm

2.4.2.3 Metric "C.2.3" Circular economy business models in practice

Metric Name

Circular economy business models in practice (BM_{CE})

Definition and Rationale

Definition: New and modified business models related to circular economy in the water-energy-waste nexus that have already been put into practice related to the new and existing models.

Concepts: **Circular economy**: refers to an economy that is restorative, aims to maintain the utility of products, components and materials and retain their value. **Business model**: company's plan for making a profit. It identifies the products or services the business plans to sell, its identified target market, and any anticipated expenses.

Rationale and Interpretation: Circular business models are those that combine the creation of economic value with the narrowing, slowing, or closing of resource loops. By doing this, circular business models aim to preserve the embedded value and functionality of products, and the materials within them, at their highest possible level. By closing resource loops and by slowing and narrowing resource flows, it can reduce the environmental footprint of economic production and consumption. By business it can be understood the organization scope (wastewater treatment plant, industry(ies), municipality, city, or region).

Data Sources and Collection Method

The collection method can be facilitated through questionnaires. Other needed data can also be obtained through desk study.

Method of Computation and Other Methodological Considerations

$$BM_{CE} = \frac{BM_c}{BM_{tot}} \times 100$$

where

- BM_c (No.) = Number of new and modified circular economy business models put into practice during a period of time (yearly frequency is suggested)
- BM_{tot} (No.) = Number of total business models (new and existing) during the same period of time considered for the BM_c

Unit

[%]

Data Disaggregation

The data can be disaggregated by country or city and between number of inhabitants in the city. Disaggregation can be performed also based on local or regional level.

Reference Values

- 🟢 Good [50; 100]
- 🟡 Fair]1; 50[
- 🔴 Poor [0; 1[

Suggested Supplementary Metrics

C.2.1 By-products recovery revenues (by-products involved in the business model).

References

European Environment Agency (https://www.eea.europa.eu/publications/a-framework-for-enabling-circular/a-framework-for-enabling-circular) Investopedia (https://www.investopedia.com/terms/b/businessmodel.asp)

OECD, Circular Economy: What We Want to Know and Can Measure (2018)

2.4.3 AC C.3 “Resource recovery and use”

Description: the AC deals with resource production and recovery from synergies in the water-energy-resources-waste nexus and use.

2.4.3.1 Metric “C.3.1” Water-related materials recovery

Metric Name

Water-related materials recovery (WR)

Definition and Rationale

Definition: This indicator is defined as the percentage of a by-product material or waste that is recovered and is suitable for its reuse after a treatment process or activity to enhance other activities within the site of interest and the organization scope.

Concepts: By-product is considered a secondary product made in the manufacture, treatment or synthesis of something else. Treatment process or activity is considered the main infrastructure or technology where the organization is having its main activities. An organization can be considered a drinking water plant, wastewater treatment plant, an industry, etc.

Rationale and Interpretation: This indicator gives an overview of the mass balance (inputs-outputs) of a by-product material or waste flow of the same type. It considers a recovered by-product material or waste over total (of the same type) entering the treatment process or activity within the organization scope (wastewater treatment plant, industry(ies), municipality, city or region). By-products that could be considered are sludge, nutrients, chemical compounds, etc. If more than one waste flow is recovered, a weighting factor will be applied to obtain a unique total indicator.

Data Sources and Collection Method

Data will be provided by the organization, based on real data. Data sources are represented by the internal registers of the organization regarding the waste entering to the treatment process or activity and the waste and by-products recovered, and the data could be collected annually or more frequently.

Method of Computation and Other Methodological Considerations

$$WR = \frac{W_{i,re}}{W_{i,in}} \times 100$$

where:

- $W_{i,re}$ (kg/year) = Material recovered
- $W_{i,in}$ (kg/year) = Total potential recoverable material entering the treatment process or activity (including materials that are added and recovered during the process, *e.g.,* catalysts)

Unit

[%]

Data Disaggregation

This indicator can be disaggregated by type of utility (wastewater/drinking water) and by resources targeted (*e.g.,* sludge, phosphorus (P) and/or nitrogen (N)), sodium chloride (NaCl), etc. An example could be mass of P recovered over total mass of P entering the wastewater treatment plant.

Reference Values

- 🟢 Good [15; 100]
- 🟡 Fair [10; 15[
- 🔴 Poor [0; 10[

Suggested Supplementary Metrics

B 3.1 Water footprint, B 3.2 Carbon footprint and C.2.1 By-products recovery revenues.

References

OECD. The OECD Inventory of Circular Economy indicators, https://www.oecd.org/cfe/cities/InventoryCircularEconomyIndicators.pdf

https://finance.ec.europa.eu/system/files/2022-03/220330-sustainable-finance-platform-finance-report-remaining-environmental-objectives-taxonomy-annex_en.pdf

2.4.3.2 Metric "C.3.2" Fertilizer production avoided

Metric Name

Fertilizer production avoided (FPA)

Definition and Rationale

Definition: This indicator is defined as the percentage of nutrient recovered used as a fertilizer in relation to the total nutrient used as fertilizer.

Concepts: Nutrient recovered is the nutrients obtained by a recovery process from a source such as wastewater, waste, or sludge.

Rationale and Interpretation: This indicator gives an overview of the nutrients (nitrogen (N)/phosphorus (P)) recovered as a fertilizer (*e.g.,* sludge application, fertirrigation) over the total N/P used for fertilization purposes (recovered and added) in the organization scope (industry(ies), municipality, city, or region). From this indicator it can be obtained: avoided production costs, avoided production, and avoided emissions to produce commercial fertilizers (*i.e.,* only a part of the total commercial fertilizer needed). The recovered nutrient should be intended as the useful nutrient, so the use of a correction factor is recommended in quantifying the recovered nutrients.

Data Sources and Collection Method

Data will be provided by the organization, based on real data from treatment process or activity, and the data could be collected annually or more frequently.

Method of Computation and Other Methodological Considerations

$$FPA = \frac{N_{i,re}}{N_{i,tot}} \times 100$$

where

- $N_{i,re}$ (kg/year) = Nutrient recovered used as a fertilizer
- $N_{i,tot}$ (kg/year) = Total nutrient used as a fertilizer

Unit

[%]

Data Disaggregation

This indicator can be disaggregated with respect to the type of fertilizers or nutrients (*e.g.,* phosphorous (P) and/or nitrogen (N)) utilized within the organization scope (industry(ies), municipality, city or region). An example could be mass of N recovered over total mass of N used as fertilizer.

Reference Values

- Good [30; 100]
- Fair [5; 30[
- Poor [0; 5[

Suggested Supplementary Metrics

B.3.2 Carbon footprint and C.3.1 Water-related materials recovery

References

OECD adaptation. The OECD Inventory of Circular Economy indicators, https://www.oecd.org/cfe/cities/InventoryCircularEconomyIndicators.pdf

2.4.3.3 Metric "C.3.3" Reclaimed water in non-potable uses

Metric Name

Reclaimed water in non-potable uses (RWnpU)

Definition and Rationale

Definition: This metric is defined as the volume of reclaimed water used over the total water used for non-potable uses.

Concepts: This metric aims to assess the level of environmental sustainability of the service in terms of circularity and the resources recovery, regarding the reclaimed water used for non-potable uses (*e.g.,* for irrigation and street cleaning). Reclaimed water means urban wastewater that has been treated in compliance with the requirements set out in Directive 91/271/EEC and which results from further treatment in a reclamation facility (EU Regulation 2020/741).

Rationale and Interpretation: The reclaimed water use is an important measure to assess the use of water. The higher the reclaimed water used the lower the freshwater consumption for non-potable uses.

Data Sources and Collection Method

The data sources are represented by the internal registers of the reclaimed water users regarding the volumes of reclaimed water used and of the water utilities regarding the water consumptions for non-potable uses, and the data could be collected annually or more frequently.

Method of Computation and Other Methodological Considerations

$$RWnpU = \frac{RW}{npW} \times 100$$

where:

- RW (m^3/year) = Volume of reclaimed water used for different scopes (*e.g.,* irrigation, street cleaning)
- npW (m^3/year) = Total volume of water used for non-potable uses, from all sources, including reclaimed water
- "Used" may be "supplied" or "consumed", but must be consistent in RW and npW

Unit

[%]

Data Disaggregation

Disaggregated for the different uses and users' categories.

Reference Values

🟢	Good	1/3 of C.3.4 reference values
🟡	Fair	1/3 of C.3.4 reference values
🔴	Poor	1/3 of C.3.4 reference values

1/3 ratio should be adjusted to reflect potables and non-potables uses

Suggested Supplementary Metrics

C.3.4 Reclaimed water production

References

-

2.4.3.4 Metric "C.3.4" Reclaimed water production

Metric Name

Reclaimed water production (RWP)

Definition and Rationale

Definition: This metric is defined as the volume of reclaimed water produced (for own use or transfer to third parties) over the volume of treated wastewater.

Concepts: This metric aims to assess the level of environmental sustainability of the service in terms of circularity and the resources recovery, regarding the production of reclaimed water, obtained from the wastewater treatment. Reclaimed water means urban wastewater that has been treated in compliance with the requirements set out in Directive 91/271/EEC and which results from further treatment in a reclamation facility (EU Regulation 2020/741).

Rationale and Interpretation: The reclaimed water production is an important measure to assess the use of wastewater.

Data Sources and Collection Method

The data sources are represented by the internal registers of the wastewater utility regarding the volumes of wastewater and reclaimed water produced, and the data could be collected annually or more frequently.

Method of Computation and Other Methodological Considerations

$$RWP = \frac{V_{reclaimed}}{TWW} \times 100$$

where

- $V_{reclaimed}$ (m^3/year) = Volume of reclaimed water produced in a reclamation facility under the responsibility of the utility, and which is transferred to other entities for use or for its own uses (exclude the recirculation or recycling of water, when it occurs in a closed circuit within one or more processes)
- TWW (m^3/year) = Volume of wastewater treated; used for wastewater systems

Unit

[%]

Data Disaggregation

Disaggregated for the different water quality uses, for different plants and for rain harvesting and other sources for reclaimed water.

Reference Values

- WEI+ < 10

- 🟢 Good [5; 100]
- 🟡 Fair [0.5; 5[
- 🔴 Poor [0; 0.5[

- 10 ≤ WEI+ < 30

- 🟢 Good [10; 100]
- 🟡 Fair [5; 10[
- 🔴 Poor [0; 5[

- 30 ≤ WEI+ < 70

- 🟢 Good [20; 100]
- 🟡 Fair [10; 20[
- 🔴 Poor [0; 10[

- WEI+ ≥ 70

- 🟢 Good [30; 100]
- 🟡 Fair [15; 30[
- 🔴 Poor [0; 15[

Suggested Supplementary Metrics

B 3.1 Water footprint and C.3.3 Reclaimed water in non-potable uses

References

ERSAR; LNEC. Guide for the Assessment of the Quality of Service in Water and Wastewater Services, 4rd ed.; Technical guide 27; Entidade Reguladora dos Serviços de Águas e Resíduos, Laboratório Nacional de Engenharia Civil: Lisbon, Portugal, 2021; Available online: https://www.ersar.pt/pt/publicacoes/publicacoes-tecnicas/guias

2.4.3.5 Metric "C.3.5" Energy production

Metric Name

Energy production (EP)

Definition and Rationale

Definition: This indicator is defined as the percentage of energy produced from water treatment or distribution processes or waste recovery activities in relation to the total energy consumed.

Concepts:

Water treatment: water treatment is any process that improves the quality of water to make it appropriate for a specific end-use.

Waste recovery: it is any process where some kind of waste (*e.g.,* sludge, ice cream, food waste, etc.) is used to get a by-product or energy.

Treatment process or activity: it is considered the main infrastructure or technology where the organization is having its main activities. It can be considered a wastewater treatment plant, an industry, etc.

Rationale and Interpretation: This indicator gives an overview of the energy consumed that it is produced from water treatment and waste recovered (*e.g.,* anaerobic digestion, sludge, ice cream, food waste, etc.) over total energy consumption.

Data Sources and Collection Method

Data will be provided by the organization, based on real data from the amount of water required for its different activities and the data could be collected annually or more frequently.

Method of Computation and Other Methodological Considerations

$$EP = \frac{E_{re}}{E_{dw} + E_{ww}} \times 100$$

where

- E_{re} (kWh/year) = Energy produced from water treatment or waste recovery processes
- E_{dw} (kWh/year) = Total energy used in the drinking water system (all processes)
- E_{ww} (kWh/year) = Total energy used in the wastewater system (all processes)

Unit

[%]

Data Disaggregation

The data can be disaggregated by plant, type of processes or recovery activities (water treatment/sludge recovery, etc.) within the scope of the organization.

This indicator can be disaggregated according to the source of energy. For example, a distinction can be made between energy coming from water treatment or from waste recovered.

Reference Values

- For water supply

🟢	Good	[10; +∞[
🟡	Fair	[5; 10[
🔴	Poor	[0; 5[

- For wastewater

🟢	Good	[20; +∞[
🟡	Fair	[10; 20[
🔴	Poor	[0; 10[

- For waste

🟢	Good	[100; +∞[
🟡	Fair	[50; 100[
🔴	Poor	[0; 50[

Suggested Supplementary Metrics

B 3.2 Carbon footprint, B 3.3 Energy consumption

References

International Committees About Circular Economy

OECD. The OECD Inventory of Circular Economy indicators, https://www.oecd.org/cfe/cities/InventoryCircularEconomyIndicators.pdf

2.5 SO D - Promoting adaptive change towards resilient infrastructure

Description: Existence of governance, financial and decision-making conditions promoting adaptive change towards resilient infrastructure enabling robust planning and its implementation while assessing the effectiveness in terms of resilience.

2.5.1 AC D.1 “Enabling planning to promote adaptive change towards circularity and resilience”

Description: a robust plan is in place. It is transparent and consistent with the developed strategic agenda regarding circularity and resilient infrastructures, with informed decision-making on the solutions, taking into account the diagnosis, risk scenarios, evaluation of benefits and identification of the needs for planning and design of resilient infrastructures, including resources needed. It is adaptive, flexible, and agile, promoting adaptive responses and management (enables the identification of different suites of options for the actions required for the organizations to navigate towards circularity and resilience, in the process of addressing challenges, *e.g.,* climate change, demographic change, etc.), and it establishes a process for periodical monitoring and for critical review of actions, ensuring it remains relevant and is properly operational.

Regulations, guidelines, codes, and standards exist and are used to promote development of innovative and resilient solutions.

2.5.1.1 Metric “D.1.1” Infrastructure planning index for adaptive change

Metric Name

Infrastructure planning index for adaptive change (IPI_{AC})

Definition and Rationale

Definition: The infrastructure planning index for adaptive change assesses the level of development in terms of existence of a robust plan that promotes adaptive change towards resilient infrastructures.

Concepts: The infrastructure planning index for adaptive change intends to assess, on the one hand, the existence of a robust plan for infrastructure adaptive change; on the other hand, its features regarding the ability to be adapted, flexible and agile, promoting adaptive responses and management of infrastructures in order to be resilient considering circularity. Resilient assessed in terms of robustness, autonomy, and redundancy.

A robust plan means that a plan exists and is approved; it is transparent and consistent with the developed strategic agenda regarding circularity and resilient infrastructures (in terms of robustness, autonomy, and redundancy); it was developed engaging all relevant stakeholders, with informed decision-making on the solutions, *i.e.,* taking into account long term and context analysis, an assessment and diagnosis, risk scenarios, evaluation of impacts and benefits, and identification of the needs for planning and design resilient infrastructures, including allocation of resources needed and responsibilities; it is aligned with the financial plan.

A plan adaptive, flexible and agile promoting adaptive responses and management means that it enables the identification of different suites of options for the actions required by the organizations towards circularity and resilience, in the process of addressing the challenges (*e.g.,* climate change, demographic change); it defines priorities of action according to different timeframes, and establishes a process for periodical monitoring and for critical review of the actions, ensuring it remains relevant and is adequate for infrastructure adaptive change.

Rationale and Interpretation: a plan for adaptive change constitutes a planning instrument that establishes, in an organized way, the guidelines for the user to implement adaptive change towards resilient infrastructures under its responsibility. The plan needs to address a set of requirements, in order to ensure that the solutions are the most adequate in each time frame, and implementation will be effective, efficient and sustainable. IPI_{AC} provides a level of development regarding the requirements, allowing to identify the main opportunities for improvement.

Data Sources and Collection Method

The organizations' planning and management responsible teams.

Method of Computation and Other Methodological Consideration

IPI_{AC} is defined by a set of questions structured in two categories A) and B) (Figure 5), each one corresponding to a score of 50. This means that the maximum overall score for the index is 100. If category A is not scored the overall value of the index is zero. For each question, the classification is made by associating each possible answer to a score corresponding to a development level. The overall level of the index will result from the sum of all partial scores associated to the answers. In case of a missing answer, the score will be zero.

The questions are made available at: https://nextcloud.b-watersmart.eu/index.php/f/130599[5]

[5] The repository can be accessed only by the project's partners. The file and related questions will be embedded in the Dashboard in further developments of the project.

IPI$_{AC}$ - Infrastructure Planning Index for Adaptive Change [**100**]

A) Robust plan for infrastructure adaptive change [**50**]

1. There is a plan for infrastructure management that addresses circularity and resilient infrastructures (in terms of robustness, autonomy and redundancy) (Yes/No) [5/0]
2. The plan is formally approved (Yes/Partially/No) [5/2.5/0]
3. It is transparent and consistent with the developed strategic agenda regarding circularity and resilient infrastructures (in terms of robustness, autonomy and redundancy) (Yes/Partially/No) [5/2.5/0]
4. It has been developed within a consultative process by engaging all relevant stakeholders (Yes/Partially/No) [5/2.5/0]
5. The actions are selected based on an informed decision-making, i.e. taking into account: [**28**]
   a. short, mid and long-term analysis (Yes/Partially/No) [2/1/0]
   b. analysis of the context (Yes/Partially/No) [2/1/0]
   c. a structured assessment and diagnosis (Yes/Partially/No) [3/1.5/0]
   d. definition of risk scenarios and analysis of impacts (Yes/Partially/No) [6/3/0]
   e. evaluation of benefits and drawbacks (Yes/Partially/No) [2/1/0]
   f. identification of the needs for planning and design resilient infrastructures (in terms of robustness, autonomy, redundancy, time for restoration) (Yes/Partially/No) [4/2/0]
   g. identification of the appropriate human, financial and technological resources needed (Yes/Partially/No) [2/1/0]
   h. allocation of responsibilities (Yes/Partially/No) [3/1.5/0]
   i. alignment of the financial needs with the financial plan (Yes/Partially/No) [3/1.5/0]
6. There is a single reference document that reflects the points addressed in A)3, A)5 and B) with relevance to circularity and resilient infrastructures (Yes/Partially/No) [2/1/0]

B) The plan is adaptive, flexible and agile, promoting adaptive responses and management [**50**]

1. Enables the identification of different suites of options for the actions required for the LL to navigate towards circularity and resilience, in the process of addressing challenges, e.g., climate change, demographic change,... (Yes/Partially/No) [5/2.5/0]
2. Defines priorities of action according to different timeframes (short, mid and long-term) (Yes/Partially/No) [15/7.5/0]
3. Establishes a process for periodical monitoring that includes [**15**]
   a. definition of the monitoring period (Yes/No) [3/0]
   b. definition of responsibilities for the different tasks (Yes/Partially/No) [3/1.5/0]
   c. assessment of effectiveness of actions according to defined goals (Yes/Partially/No) [3/1.5/0]
   d. definition of an approach to calculate level of execution of the actions (Yes/No) [3/0]
   e. reporting of the monitoring results (Yes/Partially/No) [3/1.5/0]
4. Establishes a **process for critical review** of the plan, ensuring it remains relevant and adequate for infrastructure adaptive change, that includes [**15**]
   a. definition of the reviewing period (Yes/No) [2/0]
   b. definition of responsibilities for the different tasks (Yes/Partially/No) [2/1/0]
   c. review of the context (Yes/ No) [2/1/0]
   d. analysis of the monitoring results (Yes/Partially/No) [2/1/0]
   e. review of the approach to assess effectiveness (Yes/No) [2/0]
   f. review of the goals and actions (Yes/Partially/ No) [3/1.5/0]
   g. reporting of the reviewing results (e.g. reviewed plan) (Yes/Partially/No) [2/1/0]

Figure 5 – Screenshot of the questionnaire to assess metric D1.1

Unit

[-]

Data Disaggregation

This metric can be disaggregated by different type of infrastructure (*e.g.,* water supply system, wastewater system, storm water system, etc.).

Reference Values

- Good [70; 100]
- Fair [40; 70[
- Poor [0; 40[

Suggested Supplementary Metrics

D.2.1 Infrastructure value index

D.2.2 Infrastructure implementation index for adaptive change

References

Monte, M., Freixial, P., Rodrigues, R., Cardoso, M. A. (2017). Assessment of the quality of service provided to users by the water utilities in Portugal: revision of the Infrastructure Asset Knowledge and Management Index. Leading Edge Sustainable Asset Management of Water and Wastewater Infrastructure Conference, LESAM Conference 2017, 20-22 June 2017, Trondheim, Norway.

Cardoso, M.A., Brito, R.S, Pereira, C., David, L., Almeida, M.C. (2019). Resilience Assessment Framework RAF. Description and implementation. D6.4, Deliverable of the H2020 Project RESCCUE, Grant Agree. 700174.

2.5.2 AC D.2 “Implementing adaptive change towards resilient infrastructure”

Description: the plan is being implemented and the monitoring and reviewing process is in place, assessing the degree of actual realization of the plan regarding implementation of solutions to achieve resilient infrastructures, reflecting if adaptive change is implemented or considered, namely regarding flexibility and innovative solutions.

2.5.2.1 Metric “D.2.1” Infrastructure value index

Metric Name

Infrastructure value index (IVI)

Definition and Rationale

Definition: The infrastructure value index is the ratio between the current value of an infrastructure and the replacement cost on modern equivalent asset basis.

Concepts: The infrastructure current value would be, in a competitive market activity, its market value. In a monopolistic activity, as in urban water services, alternative valuation approaches must be adopted. Dividing this current value by the replacement cost on modern equivalent asset basis provides a measurement of the current value of the infrastructure.

Rationale and Interpretation: If all assets of a given infrastructure had the same replacement cost and the same useful life, IVI would represent the residual life (%), (*i.e.,* [1- (average age/useful life)] %). In a real-life infrastructure, IVI can be seen as a weighted average of the residual lives (%) of the infrastructure components, where the weights are the component replacement costs. IVI is always referred to a date (year), as a snapshot.

Data Sources and Collection Method

The water utility’s GIS could represent an important data source, while a market analysis about the current prices of the infrastructural components could be adopted as collection method.

Method of Computation and Other Methodological Consideration

$$IVI = \frac{ICV}{IRC}$$

where

- ICV (€) = Infrastructure current (fair) value
- IRC (€) = Infrastructure replacement cost

Both horizontal and vertical assets should be included for the computation of the metric (see reference for details).

Unit

[-]

Data Disaggregation

This metric can be disaggregated by different type of infrastructure (*e.g.,* water supply system, wastewater system, storm water system, etc.).

Reference Values

- 🟢 Good [0.4; 0.6]
- 🟡 Fair [0.2; 0.4[or]0.6; 0.8]
- 🔴 Poor [0.0; 0.2[or]0.8; 1.0]

Suggested Supplementary Metrics

D.2.2 Infrastructure Implementation Index for Adaptive Change

References

Alegre, H., Vitorino, D., & Coelho, S. (2014). Infrastructure value index: a powerful modelling tool for combined long-term planning of linear and vertical assets. *Procedia Engineering*, *89*, 1428-1436.

2.5.2.2 Metric "D.2.2" Infrastructure implementation index for adaptive change

Metric Name

Infrastructure implementation index for adaptive change (III_{AC})

Definition and Rationale

Definition: The infrastructure implementation index for adaptive change provides a level of implementation of the plan and of promotion of adaptive change towards resilient infrastructures.

Concepts: The infrastructure implementation index for adaptive change intends to assess the level of implementation of the plan and of promotion infrastructure adaptive change.

An implemented plan means that it is in place and the investment is being executed. A plan that promotes adaptive change means that it is being adequately monitored and reviewed, considering critical review of actions, ensuring it remains relevant and is adequate for infrastructure adaptive change.

Rationale and Interpretation: the implementation of the plan for adaptive change needs to address a set of requirements, in order to ensure that it is being properly implemented, monitored and a critical review of actions is considered ensuring it remains relevant and is adequate for infrastructure adaptive change. III_{AC} provides a level of development regarding the requirements, allowing identifying the main opportunities for improvement.

Data Sources and Collection Method

The water utility's planning and management responsible teams, management plans, investment reports, execution projects.

Method of Computation and Other Methodological Consideration

III_{AC} is defined by a set of questions with a maximum overall score for the index of 100 (Figure 6). For each question, the classification is made by associating each possible answer to a score corresponding to a development level. The overall level of the index will result from the sum of all partial scores associated to the answers. In case of a missing answer, the score will be zero.

The questions are made available at: https://nextcloud.b-watersmart.eu/index.php/f/130599 [6]

[6] The repository can be accessed only by the project's partners. The file and related questions will be embedded in the Dashbord in further developments of the project.

III_{AC} - Infrastructure Implementation Index for Adaptive Change [**100**]

The plan for infrastructure adaptive change is being implemented promoting adaptive responses and management

1. The plan is in place (Yes/No) [**25/0**]
2. The implementation is being monitored according to the plan regarding: [**30**]
   a. the monitoring period (Yes/No) [2/0]
   b. responsible persons for the different tasks (Yes/Partially/No) [3/1.5/0]
   c. assessment of effectiveness of actions according to defined goals (Yes/Partially/No) [10/5/0]
   d. calculation of the level of execution of the actions (Yes/Partially/No) [10/5/0]
   e. reporting of the monitoring results (Yes/Partially/No) [5/2.5/0]
3. The **revision of the plan is being carried out** according to the plan, ensuring it remains relevant and is properly operational for infrastructure adaptive change, regarding [**25**]
   a. the reviewing period (Yes/No) [2/0]
   b. responsible persons for the different tasks (Yes/Partially/No) [2/1/0]
   c. review of the context (Yes/Partially/No) [2/1/0]
   d. analysis of the monitoring results (Yes/Partially/No) [5/2.5/0]
   e. the approach to assess effectiveness (Yes/Partially/No) [2/1/0]
   f. review of the goals (Yes/Partially/No) [5/2.5/0]
   g. review of the actions (Yes/Partially/No) [5/2.5/0]
   h. reporting of the reviewing results (e.g. reviewed plan) (Yes/Partially/No) [2/1/0]
4. The investment is being executed according to the plan (Yes /Partially (linear proportion with absolute value of the deviation)/No) [**20/10/0**]

Figure 6 – Screenshot of the questionnaire to assess metric D2.2

Unit

[-]

Data Disaggregation

This metric can be disaggregated by different type of infrastructure (*e.g.,* water supply system, wastewater systems, storm water system, etc.).

Reference Values

● (green)	Good	[70; 100]
● (yellow)	Fair	[40; 70[
● (red)	Poor	[0; 40[

Suggested Supplementary Metrics

D.1.1 Infrastructure planning index for adaptive change

D.2.1 infrastructure value index

References

Monte, M., Freixial, P., Rodrigues, R., Cardoso, M. A. (2017). Assessment of the quality of service provided to users by the water utilities in Portugal: revision of the Infrastructure Asset Knowledge and Management Index. Leading Edge Sustainable Asset Management of Water and Wastewater Infrastructure Conference, LESAM Conference 2017, 20-22 June 2017, Trondheim, Norway.

Cardoso, M.A., Brito, R.S, Pereira, C., David, L., Almeida, M.C. (2019). Resilience Assessment Framework RAF. Description and implementation. D6.4, Deliverable of the H2020 Project RESCCUE, Grant Agree. 700174.

2.5.3 AC D.3 “Effectiveness of the adaptive change towards resilient infrastructure (Diagnosis)”

Description: the implementation of the planned actions is effective (degree of effectiveness of actions) in terms of resilience ensuring that the infrastructure is safe (component importance is known, low exposure, protected, robust – well maintained, reliable, expenditure is covered, low time of restoration, low losses, efficient, pollution prevention), autonomous (autonomy from other services, importance to other services, level of autonomy), flexible (with redundancy).

2.5.3.1 Metric “D.3.1” Linear water losses

Metric Name

Linear water losses (LWL)

Definition and Rationale

Definition: Linear water losses are defined as the ratio of the volume of yearly water losses and the total length of the supply and/or distribution pipes of the utility for the assessment year.

Concepts: The water loss per pipelines length provides an insightful information about the level of conditions of water pipes, but it does not take directly into account the relationship between water losses and pressure, and it is mostly suited for system with a low density of connections.

Rationale and Interpretation: The reason of selecting this metric rather than other metrics (such as the largely adopted percentage of water losses over the total inflow) is due to its reliability and stability given by the fact that the selected metric’s denominator is not affected by the variations of consumption as it happens for other related metrics. This metric is well suited for water distribution network, but the water losses might be derived also for wastewater systems and reclaimed water systems as better described under the section “data disaggregation”.

Data Sources and Collection Method

The water utility’s SCADA (supervisory control and data acquisition) and GIS could represent an important data source, while the collection method related to the volume of leakage should be driven by the definition of water losses in the IWA water balance, as shown in Figure 7.

System Input Volume	Authorised Consumption	Billed Authorised Consumption	Billed Metered Consumption	Revenue Water
			Billed Unmetered Consumption	
		Unbilled Authorised Consumption	Unbilled Metered Consumption	Non Revenue Water
			Unbilled Unmetered Consumption	
	Water Losses	Apparent Losses	Unauthorised Consumption	
			Customer Meter Inaccuracies	
		Real Losses	Leakage on Transmission and Distribution Mains	
			Leakage and Overflows at Storage Tanks	
			Leakage on Service Connections up to point of Customer Meter	

Figure 7 – IWA Water Balance (Alegre H., *et al*, 2006)

Method of Computation and Other Methodological Considerations

$$LWL = \frac{V_{loss}}{L_{net}}$$

where

- V_{Loss} (m^3/year) = Annual water losses, defined as shown in Figure 7
- L_{net} (km) = Total length of the supply and distribution pipelines, excluding the user branches (or connection pipelines), at the assessment date of the assessment year

Unit

[m^3/year/km]

Data Disaggregation

This metric can be disaggregated for service areas and for the following categories:

- for drinking water: per system pipes, transport pipes, and distribution pipes.
- for wastewater pipes: only volumes during dry weather periods must be considered (in this case the yearly water loss should be extrapolated from the available data during dry weather periods).
- for reclaimed water: per final usage (*e.g.,* irrigation, cleaning, urban use).
- for other non-conventional sources (*e.g.,* rainwater distribution).

Reference Values

- for distribution

🟢	Good	[0; 1100]
🟡	Fair	]1100; 1800]
🔴	Poor	]1800; +∞[

- for bulk systems

🟢	Good	[0; 1800]
🟡	Fair	]1800; 2700]
🔴	Poor	]2700; +∞[

Suggested Supplementary Metrics

-

References

Alegre H., et al. (2006) Performance Indicators for Water Supply Services. IWA Manual of Best Practice, 2nd Edition. ISBN 1843390515

Alegre H., Hirnir W., Baptista J.M., and Parena R., Performance Indicators for Water Supply Services, IWA Manual Best Practice, first edition, IWA Publishing, London, 2000
(14) (PDF) Infrastructure Leakage Index (ILI) as Water Losses Indicator. Available from: https://www.researchgate.net/publication/26872179_Infrastructure_Leakage_Index_ILI_as_Water_Losses_Indicator [accessed Mar 30 2022].

Matos, M. R., Cardoso, M. A., Ashley, R., Duarte, P., Molinari, A., Shulz, A. (2003). Performance Indicators for Wastewaters Services. Manual of Best Practice. IWA Publishing, London, ISBN 1900222906.

2.5.3.2 Metric “D.3.2” Water storage capacity

Metric Name

Water storage capacity (WSC)

Definition and Rationale

Definition: Water Storage Capacity (WSC) is defined as the ratio between the total volume of storage (e.g., tanks for water supply, including rain harvesting systems, or at the entrance of a wastewater treatment plant) and the average flow provided or demanded to the considered system (demands associated to distribution systems, rain harvesting systems, or treatment plants).

Concepts: The water storage capacity provides an insightful information about the number of days that the system can handle relying on the potential stored volume of water, not on the actual volume of stored water.

Rationale and Interpretation: the reason for selecting this metric expressed as a time rather than other volumetric unit is due to the aim of reflecting more explicitly the effectiveness of the infrastructural availability, regarding the potential volume for storage with respect to the average inflow to the considered system. Nature-based solutions are herein addressed as infrastructure components.

Data Sources and Collection Method

The water utility GIS, master plans, projects documents.

The operational part of the storage capacities (preferably on the 1st of January of the considered year) and the yearly average flow entering or being demanded to the considered system.

Method of Computation and Other Methodological Considerations

$$WSC = \frac{V_t}{Q_s}$$

where

- V_t (m^3) = Total operational volume of storage capacity
- Q_s (m^3/day) = Yearly average flow entering or being demanded to the system

Unit

[days]

Data Disaggregation

This metric can be disaggregated for instance:

- for drinking water systems
- for rain harvesting systems

- for wastewater treatment plants

Reference Values

- for drinking water systems and wastewater treatment plants

🟢	Good	[1; 2]
🟡	Fair	[0.5; 1[or]2; +∞[
🔴	Poor	[0; 0.5[

- for rain harvesting systems

🟢	Good	[4; +∞[
🟡	Fair	[1; 4[
🔴	Poor	[0; 1[

Suggested Supplementary Metrics

-

References

Carollo, M., Butera, I., & Revelli, R. Water savings and urban storm water management: Evaluation of the potentiality of rainwater harvesting systems from the building to the city scale. PLOS ONE, 17(11), e0278107. https://doi.org/10.1371/journal.pone.0278107

Donatello S., Dodd N. & Cordella M., 2021. Level(s) indicator 3.1: Use stage water consumption user manual: introductory briefing, instructions and guidance (Publication version 1.1). JRC, European Commission.

2.5.3.3 Metric "D.3.3" Incident occurrences

Metric Name

Incident occurrences (IO)

Definition and Rationale

Definition: This metric is defined as the number of incident occurrences in the system per pipe length, for each type of incident, which have been recorded by the utility in the assessment year.

Concepts: This metric provides the frequency of the respective type of incidents in the assessment year per length unit.

Rationale and Interpretation: Frequency of yearly incidents along time provides information on the performance progress of the system toward change.

Data Sources and Collection Method

The data sources are internal registers of the water utility, while the collection method should ensure that the recorded incidents are associated to year of occurrence and the type of incident is adequately labeled (*e.g.,* burst, collapse, and flooding).

Method of Computation and Other Methodological Considerations

$$IO = \frac{R_i}{L_{net}} \times 100$$

where

- R_i (No./year) = Number of registered incidents per year
- L_{net} (km) = Total pipeline length for the considered system excluding the user branches (or connection pipelines), at the assessment date of the assessment year

For the computation of this metric is extremely important to well define the data disaggregation, in order to distinguish the yearly incidents for different types of events.

Unit

[No./100 km/year]

Data Disaggregation

The metric can be disaggregated for different water sectors, distinguishing per type of incidents:

- Flooding
- Contamination
- Burst
- Collapse
- etc.

Reference Values

For water supply systems

- Bursts in distribution

🟢	Good	[0; 30]
🟡	Fair	]30; 60]
🔴	Poor	]60; +∞[

For wastewater systems

- Floods

🟢	Good	[0; 0.5]
🟡	Fair	]0.5; 2.0]
🔴	Poor	]2.0; +∞[

- Collapses

🟢	Good	[0; 1.0]
🟡	Fair	]1.0; 2.0]
🔴	Poor	]2.0; +∞[

Suggested Supplementary Metrics

A.1.4 Security and Resilience Index

References

-

2.5.3.4 Metric "D.3.4" Combined sewer overflows

Metric Name

Combined sewer overflows (CSO)

Definition and Rationale

Definition: This metric is defined as the ratio between the number of yearly CSOs occurrences which have been registered by the utility and the number of CSO devices of the system, at the assessment date of the assessment year.

Concepts: This metric provides insight on the average CSOs occurrences per CSO device in an assessment year.

Rationale and Interpretation: Average frequency of yearly CSOs (registered) occurrences per device along time provides information on the performance of the combined or stormwater system towards change.

Data Sources and Collection Method

The data sources are represented by the internal registers of the water utility regarding CSO occurrences, while the collection method should ensure that the recorded occurrences are associated to year of occurrence.

Method of Computation and Other Methodological Considerations

$$CSO = \frac{CSO_r}{N_{CSO}}$$

where

- CSO_r (No./year) = Yearly total number of registered CSOs of the considered organization
- N_{CSO} (No.) = Number of active CSO devices in the assessment year

Unit

[No./device/year]

Data Disaggregation

-

Reference Values

- Non sensitive water bodies

🟢	Good	[0; 30]
🟡	Fair	]30; 60]
🔴	Poor	]60; +∞[

- Non sensitive water bodies and recreational use

🟢	Good	[0; 5]
🟡	Fair	]5; 10]
🔴	Poor	]10; +∞[

- Sensitive water bodies

🟢	Good	[0; 6]
🟡	Fair	]6; 12]
🔴	Poor	]12; +∞[

- Bathing waters

🟢	Good	[0; 2]
🟡	Fair	]2; 3]
🔴	Poor	]3; +∞[

Suggested Supplementary Metrics

-

References

Matos, M. R., Cardoso, M. A., Ashley, R., Duarte, P., Molinari, A., Shulz, A. (2003). Performance Indicators for Wastewaters Services. Manual of Best Practice. IWA Publishing, London, ISBN 1900222906.

2.5.3.5 Metric “D.3.5” Time for restoration

Metric Name

Time for restoration (TR_{max})

Definition and Rationale

Definition: Maximum assets out-of-service duration over all structural failures occurred in the infrastructure, including recovery time, during a set assessment period.

Concepts: The metric addresses resilience of the water infrastructure with regards to infrastructure assets robustness. It also reflects the level of preparedness of the operator in restoring the system.

Rationale and Interpretation: It refers to structural failures on the assets (collapses, bursts, etc.), whether originating or not a service interruption as a consequence. The time of restoration (TR) does not refer to assets that have been decommissioned. A low value of the max TR means that if a structural failure occurs in the system, it can be quickly restored, while a high value means the system is less robust.

Data Sources and Collection Method

The data sources are internal records (work orders) of the water utility regarding structural failure occurrences, while the collection method should ensure that the considered failure corresponds to the assessment period.

The assessment period has to be defined. It can be “last year” and therefore the metric can be defined as the “maximum assets out-of-service period considering all recorded structural failures, including recovery time, occurred last year”. Another example could be a reference to a set “period of time”, *e.g.,* last five years, in that case the TR would be assessed as the maximum assets out-of-service time, recorded during the last five years, for restoring a structural failure in the system over all the recorded failures for the five-year time period.

Method of Computation and Other Methodological Considerations

$$TR_{max} = [MAX(TR_{i,j})]_t$$

where

- $[MAX(TR_{i,j})]_t$ (days) = Maximum recorded time of restoration (out-of-service duration + recovery time) considering all structural failures (*j*) occurred in all assets (*i*) in the considered assessment period *t*

Unit

[days]

Data Disaggregation

TR can be disaggregated by different type of assets (*i*) (*e.g.,* water supply system, storm water system, wastewater system, etc.) and for type of structural failure.

Reference Values

🟢	Good	[0.0; 0.25]
🟡	Fair	]0.25; 1.0]
🔴	Poor	]1.0; +∞[

Suggested Supplementary Metrics

D.3.2 Water storage capacity

References

Cardoso MA, Brito RS, Pereira C, Gonzalez A, Stevens J, Telhado MJ (2020°). RAF resilience assessment framework – a tool to support cities' action planning. Special issue *Integrated assessment of climate change impacts and urban resilience: from climate and hydrological hazards to risk analysis and measures*. Sustainability 2020, 12:2349. https://doi.org/10.3390/su12062349.

Cardoso, M.A., Brito, R.S., Pereira, C., David, L., Almeida, M.C. (2020). Resilience Assessment Framework RAF. Description and implementation. D6.4. RESCCUE project.

2.5.3.6 Metric "D.3.6" Level of autonomy (of infrastructure)

Metric Name

Level of autonomy (LoA)

Definition and Rationale

Definition: Percentage of customers covered by water infrastructure dependent on other services but supported by alternative autonomy solutions on need.

Concepts: The metric addresses resilience of the water infrastructure considering infrastructure assets autonomy.

Rationale and Interpretation: Autonomy relates to dependence from other services. It refers to the part of the infrastructure that is dependent to other services (*e.g.,* energy) where autonomy solutions (back-up solutions) are implemented (*e.g.,* electrical generators). A low value means that if a failure occurs in the other service (*e.g.,* energy) there is a high percentage of water customers served by the dependent water infrastructure that will be affected, while a high value means that even if a failure occurs in the other service, the water infrastructure maintains operational, and a low number of water customers will be affected.

Data Sources and Collection Method

The water utility infrastructure inventory, GIS and customer and billing systems.

Method of Computation and Other Methodological Considerations

$$LoA = \frac{C_{AS}}{C_{OS}} \times 100$$

where

- C_{AS} (No.) = Number of customers covered by infrastructure dependent on other services with autonomy (back-up) solutions
- C_{OS} (No.) = Number of customers covered by infrastructure dependent on other services

Unit

[%]

Data Disaggregation

This metric can be disaggregated by different type of infrastructure (*e.g.,* water supply system, storm water system, wastewater system, treatment plants, etc.).

Reference Values

- 🟢 Good [80; 100]
- 🟡 Fair [70; 80[
- 🔴 Poor [0; 70[

Suggested Supplementary Metrics

D.3.5 Time for restoration

References

Cardoso MA, Brito RS, Pereira C, Gonzalez A, Stevens J, Telhado MJ (2020). RAF resilience assessment framework – a tool to support cities' action planning. Special issue *Integrated assessment of climate change impacts and urban resilience: from climate and hydrological hazards to risk analysis and measures*. Sustainability 2020, 12:2349. https://doi.org/10.3390/su12062349.

Cardoso, M.A., Brito, R.S., Pereira, C., David, L., Almeida, M.C. (2020). Resilience Assessment Framework RAF. Description and implementation. D6.4. RESCCUE project.

2.5.3.7 Metric "D.3.7" Level of redundancy

Metric Name

Level of redundancy (LoR)

Definition and Rationale

Definition: Percentage of customers covered by redundant infrastructure *i.e.,* with alternative infrastructure able to provide the service in the case of malfunction.

Concepts: The metric addresses resilience of the water infrastructure considering infrastructure assets redundancy.

Rationale and Interpretation: Redundancy relates alternative solutions in the service. It refers to the part of the infrastructure where solutions increasing redundancy are implemented (*e.g.,* DMA (district metered areas), valves, gates). A low value means that if a failure occurs in the water service there is a high percentage of water customers that will be affected, while a high value means that even if a failure occurs in the water service the water infrastructure maintains operational with an alternative solution and a low number of water customers will be affected.

Data Sources and Collection Method

The water utility infrastructure inventory, GIS and customer and billing systems.

Method of Computation and Other Methodological Considerations

$$LoR = \frac{C_{RS}}{C_{TOT}} \times 100$$

where

- C_{RS} (No.) = Number of customers covered by infrastructure with redundant solutions
- C_{TOT} (No.) = Total number of customers served by infrastructure

Unit

[%]

Data Disaggregation

This metric can be disaggregated by different type of infrastructure (*e.g.,* water supply system, storm water system, wastewater system, etc.).

Reference Values

🟢	Good	[90; 100]
🟡	Fair	[80; 90[
🔴	Poor	[0; 80[

Suggested Supplementary Metrics

-

References

Cardoso MA, Brito RS, Pereira C, Gonzalez A, Stevens J, Telhado MJ (2020). RAF resilience assessment framework – a tool to support cities' action planning. Special issue *Integrated assessment of climate change impacts and urban resilience: from climate and hydrological hazards to risk analysis and measures*. Sustainability 2020, 12:2349. https://doi.org/10.3390/su12062349.

Cardoso, M.A., Brito, R.S., Pereira, C., David, L., Almeida, M.C. (2020). Resilience Assessment Framework RAF. Description and implementation. D6.4. RESCCUE project.

2.5.3.8 Metric "D.3.8" Treatment capacity utilization

Metric Name

Treatment capacity utilization (TCU)

Definition and Rationale

Definition: This metric is defined as the percentage of treatment capacity used in the period of highest production and is computed as the ratio between the daily average wastewater flow of the 30 consecutive days with highest inflows and the daily treatment capacity.

Concepts: This metric aims to assess the level of sustainability of the service management in terms of infrastructure, regarding the use of water treatment infrastructure.

Rationale and Interpretation: the treatment capacity utilization is an important measure to assess the under or over utilization of the infrastructure which impact the process efficiency.

Data Sources and Collection Method

The data sources are represented by the internal registers of the water and wastewater utility regarding water flows, and the data should be collected daily.

Method of Computation and Other Methodological Considerations

$$TCU_{dw} = \frac{Q_{30\,\max dw}}{Q_{TC\ dw}} \times 100 \ \ or \ \ TCU_{ww} = \frac{Q_{30\,\max ww}}{Q_{TC\ ww}} \times 100$$

where

- $Q_{30max\ dw}$ (m^3/day) = Daily average water flow of the 30 consecutive days with highest production
- $Q_{TC\ dw}$ (m^3/day) is the daily treatment capacity of water treatment
- $Q_{30max\ ww}$ (m^3/day) = Daily average wastewater flow of the 30 consecutive days with highest inflows
- $Q_{TC\ ww}$ (m^3/day) is the daily treatment capacity of wastewater treatment

Unit

[%]

Data Disaggregation

Disaggregated to different systems (water treatment/production plant, wastewater treatment plant, etc.).

Reference Values

- For water supply

🟢	Good	[70; 90]
🟡	Fair	[60; 70[or]90; 110]
🔴	Poor	[0; 60[or]110; +∞[

- For wastewater

🟢	Good	[70; 95]
🟡	Fair	[60; 70[or]95; 120]
🔴	Poor	[0; 60[or]120; +∞[

Suggested Supplementary Metrics

-

References

ERSAR; LNEC. Guide for the Assessment of the Quality of Service in Water and Wastewater Services, 4rd ed.; Technical guide 27; Entidade Reguladora dos Serviços de Águas e Resíduos, Laboratório Nacional de Engenharia Civil: Lisbon, Portugal, 2021; Available online: https://www.ersar.pt/pt/publicacoes/publicacoes-tecnicas/guias

2.6 SO E – Engaging citizens and actors across sectors in continuous co-learning and innovation

Description: Perpetuated process of monitoring, evaluation and learning of water-smart practices amongst all relevant sectors (industry, agriculture, environment) by deliberately engaging citizens in planning, decision-making and implementation. Such an integrated, knowledge-based, and inclusive approach can ensure the awareness and capacity required to transform towards a water-smart society.

2.6.1 AC E.1 "Awareness and knowledge"

Description: Awareness refers to the understanding of causes, impact, scale and urgency of the water-related challenge and need for water-smart solutions. This assessment criterion also describes the qualities of information and knowledge with which actors have to engage in water-smart decision-making.

2.6.1.1 Metric "E.1.1" Knowledge and education

Metric Name

Knowledge and education (K-E)

Definition and Rationale

Definition: Answer the following question: To what extent are knowledge and education available regarding the current and future risks, impacts, and uncertainties of water-smartness?

Concepts: The metric assesses the knowledge and level of education of involved stakeholders of current and future risks, impacts and uncertainties of water-smart solutions and challenges.

Rationale and Interpretation: Level of knowledge and education of stakeholders and competent authority about water-smart solutions and key risks, impacts and uncertainties now and in the future is key for the adoption and successful implementation of any water-smart solution.

Data Sources and Collection Method

See Appendix D on the interview method applied.

For this indicator a general survey may provide additional information that enhances the accuracy during the periodic monitoring.

Method of Computation and Other Methodological Considerations

Select a Likert category by answering the following question: To what extent are knowledge and education available regarding the current and future risks, impacts, and uncertainties of water-smartness?

Careful substantiation with references to written documentation as well as anonymous interviewees is required to justify the score.

++	**Balanced awareness**	Nearly all members of the community are aware of and understand the actual risks, impacts and uncertainties. Water challenges are addressed at the local level. Local communities and stakeholders are familiar with or are involved in the implementation of adaptation measures.
+	**Overestimation**	The community is knowledgeable and recognize the many existing uncertainties. Consequently, they often overestimate the impact and probability of incidents or calamities. Water-smart solutions have been raised at the local political level and policy plan may be co-developed together with local communities.
0	**Underestimation**	Most communities have a basic understanding of water smartness principles. However, the current risks, impacts and frequencies are often not fully known and underestimated. Future risks, impacts and frequencies are often unknown. Some awareness has been raised amongst or is created by local stakeholders and communities.
-	**Fragmented knowledge**	Only a small part of the community recognizes the risks related to water challenges. The most relevant stakeholders have a limited understanding of water challenges. As a result, the issue is hardly or not addressed at the local governmental level.
--	**Ignorance**	The community, local stakeholders and decision-makers are unaware or ignore water smartness challenges. This is demonstrated by the absence of articles on the issue in newspapers, on websites or action groups addressing the issue.

Unit

Ordinal scale. Likert style scoring with five categories ranging from very limiting (--) to very encouraging (++) water-smartness.

Data Disaggregation

-

Reference Values

- Good + or ++
- Fair 0
- Poor - or --

Suggested Supplementary Metrics

-

References

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2.6.1.2 Metric "E.1.2" Information availability and use

Metric Name

Information availability and use (IAU)

Definition and Rationale

Definition: Answer the following question: To what extent is information on water challenges available, reliable, and based on multiple sources and methods, and being used to meet current and future demands to reveal information gaps and enhance well-informed decision-making?

Concepts: The extent that information on water smartness related aspects are available, reliable, and based on multiple sources and methods. How this information is used to meet current and future demands to reveal information gaps and enhance well-informed decision-making.

Rationale and Interpretation: Information availability and use is precondition for selecting and implementing water-smart solutions or develop new water-smart concepts.

Data Sources and Collection Method

See Appendix D on the interview method applied.

Method of Computation and Other Methodological Considerations

Select a Likert category by answering the following question: To what extent is information on water challenges available, reliable, and based on multiple sources and methods, and being used to meet current and future demands to reveal information gaps and enhance well-informed decision-making?

Careful substantiation with references to written documentation as well as anonymous interviewees is required to justify the score.

++	**Comprehensive information use enabling long- term integrated policy**	A comprehensive and integrated documentation of the issue can be found on local websites and policy papers. It is characterized with adequate information, an integrated description of social, ecological, and economic processes regarding water challenges, as well as goals and policies. The available information is being used by all relevant stakeholders.
+	**Information use enhancing integrated long-term thinking**	Strong effort is put in providing integrated information from various fragmented sources. Information gaps are identified and attempted to be bridged. This may be clear from extensive documentation on the long-term process. Also, citizen knowledge may be considered.

0	**Information used fits demand, limited exploratory research**	Information on water challenges is available. Knowledge on understanding or tackling the water challenges is progressing and is produced and used in a structural way. Knowledge gaps are hardly identified due to lock-in into existing disciplines and policy. This is apparent from the quantity of factual information, but the causes, risks and impacts of long-term processes are lacking behind.
-	**Information scarcity and limited quality and use**	Limited information is available which does not grasp the full extent of water challenges. In some cases, not all information that is used is of sufficient quality to generate a comprehensive overview.
--	**Lack of information**	No information on many water challenges can be found. Or the scarce available information is of poor quality.

Unit

Ordinal scale. Likert style scoring with five categories ranging from very limiting (--) to very encouraging (++) water-smartness.

Data Disaggregation

-

Reference Values

- Good + or ++
- Fair 0
- Poor - or --

Suggested Supplementary Metrics

-

References

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2.6.1.3 Metric "E.1.3" Local sense of urgency

Metric Name

Local sense of urgency (LSU)

Definition and Rationale

Definition: Answer the following question: To what extent do actors (i.e., citizens, stakeholders, and decision-makers)* have a sense of urgency, resulting in widely supported awareness, actions, and policies that address water challenges?

Concepts: The metric assesses the sense of urgency for endorsing water-smart solutions that stakeholders experience which supports awareness, action and water-smart policy.

Rationale and Interpretation: A sense of urgency to endorse water-smart solutions can be considered critical for actually applying water-smart solutions and is an important metric for assessing water smartness.

Data Sources and Collection Method

See Appendix D on the interview method applied.

Method of Computation and Other Methodological Considerations

Select a Likert category by answering the following question: To what extent do actors (i.e., citizens, stakeholders, and decision-makers) have a sense of urgency, resulting in widely supported awareness, actions, and policies that address water challenges?

Careful substantiation with references to written documentation as well as anonymous interviewees is required to justify the score.

* The score justification need to specify the sense of urgency per actor.

++	**Strong demand for action**	There is a general sense of importance regarding water challenges. There is continuous, active, public support and demand to undertake action and invest in innovative, ground-breaking solutions. This is evident, since the issue receives much media attention and action plans are implemented.
+	**General sense of urgency of long-term sustainability goals**	There is increasing understanding of the causes, impacts, scale and urgency of water challenges. It leads to general sense of urgency of the need for long-term sustainable approaches. However, measures requiring considerable efforts, budget, or substantial change with sometimes uncertain results are often receiving only temporal support.
0	**Moderate willingness for small changes**	There is growing public awareness and increasing worries regarding water challenges. However, the causes, impact, scale and urgency are not widely known or acknowledged leading to the support for only incremental changes.

-	**Raising of awareness by small groups**	A marginalized group (e.g., the most vulnerable, environmentalists, NGOs) express their concerns, but these are not widely recognized by the general public. Adaptation measures are not an item.
--	**Resistance**	There is generally no sense of urgency and sometimes resistance to spend resources to address water challenges.

Unit

Ordinal scale. Likert style scoring with five categories ranging from very limiting (--) to very encouraging (++) water-smartness.

Data Disaggregation

-

Reference Values

🟢	Good	+ or ++
🟡	Fair	0
🔴	Poor	- or --

Suggested Supplementary Metrics

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References

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2.6.1.4 Metric "E.1.4" Water smart culture

Metric Name

Water-smart culture (WSC)

Definition and Rationale

Definition: Answer the following question: How fully are water challenges internalized by the community and decision-makers (at historical, cultural, normative, and political level), making room for a more sustainable and adaptive water culture?

Concepts: The extent that water-smartness is interwoven in sustainable policy, in the historical, cultural and political context, expressed in high levels of hydrocitizenship across multiple governance levels. The metric assesses the levels of social engagement and commitment towards a water-smart culture, based on awareness of water-related challenges and their implications for the well-being of the community.

Rationale and Interpretation: Similarities and differences between water smartness and the existing discourse is essential to understand in terms of characteristics and level of difference. Hence, this metric is indispensable to understand the level of water smartness prevalent in society.

Data Sources and Collection Method

See Appendix D on the interview method applied.

Method of Computation and Other Methodological Considerations

Select a Likert category by answering the following question: How fully are water challenges internalized by the community and decision-makers (at historical, cultural, normative, and political level), making room for a more sustainable and adaptive water culture?

Careful substantiation with references to written documentation as well as anonymous interviewees is required to justify the score.

++	**Full discourse embedding and commitment towards a smart-water culture, expressed in a high level of hydrocitizenship**	The local community – stakeholders, civil society and decision-makers – is fully aware of the water challenges, their causes, impacts, scale, and urgency, which is fully embedded into policy for water management. The community is directly engaged in long-term policy making and implementation through multiple, fair and regular participatory initiatives that involve all groups of citizens, including those most vulnerable to water-related risks. At this mature stage of hydrocitizenship, water is widely regarded as a central resource for human and environmental well-being, and as such is fully integrated into everyday practices and policies.

+	**Consensus for sustainable actions, but moderate commitment towards a water-smart culture**	There is a consensus that water-smartness is required, but there is still limited experience in implementing water-smart solutions in a long-term integrated approach. Furthermore, the decision-making processes are long and trust relations with less represented actors need to be built. Some groups are engaged in addressing water challenges and there are incentives for participation and sustainable water practices, yet hydrocitizenship is not yet fully internalized across multiple levels of governance. Water is important but not necessarily considered a key concern for the local community.
0	**Low sense of urgency and commitment for a water-smart culture**	Water challenges are increasingly identified, framed, and interwoven into local discourse. Some citizen groups and organizations of the local community are engaged in addressing water challenges, yet uncertainty and a low sense of urgency limit the reach of current water-smart policy and practices. Decision-making often results in very compromised small short-term policy changes, and water issues are often disregarded in face of other economic and political concerns.
-	**Persistent reluctance and poor embedding raising conflicts around water management**	Actors feel reluctant to execute current policy as it conflicts with their norms and values. Policy hardly takes the local context and existing discourses into account, disregarding many societal demands, leading to water management plans and strategies that do not respond well to local needs and instead raise conflicts and distrust between actors. The result is a widely inefficient use of resources and ineffective overall implementation. Water related challenges are partly recognized, but mostly due to external pressure, instead of intrinsic motivations.
--	**Policy mismatch and inefficient water management**	The cultural, historical, and political context is largely ignored in policy making, leading to arduous implementation. Actors – including water managers, local and sectoral organizations – often do not fully understand the scope, moral or to whom water policy applies or how to implement it (total confusion). Citizens and stakeholders are not aware of current water challenges, or of how current practices impact the city and future generations.

Unit

Ordinal scale. Likert style scoring with five categories ranging from very limiting (--) to very encouraging (++) water-smartness.

Data Disaggregation

-

Reference Values

🟢	Good	+ or ++
🟡	Fair	0
🔴	Poor	- or --

Suggested Supplementary Metrics

-

References

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2.6.1.5 Metric “E.1.5” Smart monitoring

Metric Name

Smart monitoring (SM)

Definition and Rationale

Definition: Answer the following question: To what extent is the monitoring of process, progress, and policies able to improve the level of learning (i.e., to enable rapid recognition of alarming situations, identification, or clarification of underlying trends)?* Or can it even have predictive value?

Concepts: The extent that monitoring of process, progress and policies enable learning. This learning in its basic level is rapidly recognizing alarming situations in order to act on them timely. However, learning is more advanced if monitoring data can enable the recognition of underlying trends or even have predictive value.

Rationale and Interpretation: Monitoring forms the basis of any form of evaluation or learning that is critical for the progress towards a water-smart society.

Data Sources and Collection Method

See Appendix D on the interview method applied.

Method of Computation and Other Methodological Considerations

Select a Likert category by answering the following question: To what extent is the monitoring of process, progress, and policies able to improve the level of learning (i.e., to enable rapid recognition of alarming situations, identification, or clarification of underlying trends)? Or can it even have predictive value?

Careful substantiation with references to written documentation as well as anonymous interviewees is required to justify the score.

* Specify the critical situations that require monitoring and which the responsibility of whom. This then form the basis for the scope of this metric.

++	**Useful to predict future developments**	Monitoring system is adequate in recognizing alarming situations, identifying underlying processes and provides useful information for identifying future developments. Reports of monitoring will display discrepancies between fundamental beliefs and practices. The monitoring is changed to act upon these findings by altering the fundamental beliefs. Often regulatory frameworks are changed, new actors are introduced, new risk management approach are used.

+	**Useful to recognize underlying processes**	The abundant monitoring provides sufficient base for recognizing underlying trends, processes, and relationships. Reports of monitoring will display discrepancies between assumptions and real process dynamics. Acting upon these findings by altering the underlying assumptions characterizes this level of smart monitoring. Often also system boundaries are re-defined, new analysis approach introduced, priorities are adjusted, and new aspects are being examined.
0	**Quick recognition of alarming situations**	Monitoring system covers most relevant aspects. Alarming situations are identified and reported. This leads to improvement of current practices regarding the technical measures. There is only minor notification of societal and ecological effects.
-	**Reliable data but limited coverage**	Monitoring occurs; however, the monitoring system does not cover all facets of water challenges, with sometimes incomplete description of the progress and processes of technical and policy measures. Monitoring is limited to singular effectiveness or efficiency criteria and cannot identify alarming situations.
--	**Irregular, poor quality or absent**	There is no system to monitor water challenges or monitoring is irregular.

Unit

Ordinal scale. Likert style scoring with five categories ranging from very limiting (--) to very encouraging (++) water-smartness.

Data Disaggregation

-

Reference Values

🟢	Good	+ or ++
🟡	Fair	0
🔴	Poor	- or --

Suggested Supplementary Metrics

-

References

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2.6.3 AC E.2 “Multi-sector network potential”

Description: developing and implementing water-smart solutions involves a plethora of actors and interests from all levels of government, organizations and (private) stakeholders. For sustainable solutions, working in networks is an essential determinant for enabling water-smart solutions.

2.6.3.1 Metric “E.2.1” Clear division of responsibility

Metric Name

Clear division of responsibility (CDR)

Definition and Rationale

Definition: Answer the following question: To what extent are responsibilities clearly formulated and allocated, in order to effectively adopt and implement water-smart solutions?

Concepts: The extent that responsibilities are clearly divided and that all stakeholders and competent authorities accurately know who is responsible to do what in order to pursue water-smart solutions.

Rationale and Interpretation: A clear division of responsibilities is crucial for the successful transformation towards water-smart societies because management processes change and typically combine various components of the old sectorial distinctions made in policy and practice.

Data Sources and Collection Method

See Appendix D on the interview method applied.

Method of Computation and Other Methodological Considerations

Select a Likert category by answering the following question: To what extent are responsibilities clearly formulated and allocated, in order to effectively adopt and implement water-smart solutions?

Careful substantiation with references to written documentation as well as anonymous interviewees is required to justify the score.

++	**Dynamic, fit-for-purpose cooperation**	There is much synergetic cooperation that can provide water-smart solutions. The roles and responsibilities are clearly divided amongst actors. These cooperations are dynamic and result in fit-for-purpose problem solving necessary to solve complex, multi-level and unknown challenges.

+	**Innovative cooperative strategies**	Actors recognize that knowledge and experience are scattered within the local network. Therefore, extra effort is made to bundle the scattered expertise and to reach fit-for-purpose division of clear roles and responsibilities. New cooperation compositions are explored.
0	**Inflexible division of responsibilities**	Responsibilities are divided over a limited set of conventional actors. Opportunities for new cooperation and more effective division of responsibilities are not seized or even recognized. Sometimes conventional actors get more tasks to deal with new water challenges.
-	**Barriers for effective cooperation**	Authorities are fragmentized or they lack interest. Moreover, miscommunication and lack of trust are causes that block effective water governance.
--	**Unclear division of responsibilities**	There is an unclear division of responsibilities and often the relationships are over-hierarchical. Everybody expects someone else to make required effort and trust is hardly found.

Unit

Ordinal scale. Likert style scoring with five categories ranging from very limiting (--) to very encouraging (++) water-smartness.

Data Disaggregation

-

Reference Values

🟢	Good	+ or ++
🟡	Fair	0
🔴	Poor	- or --

Suggested Supplementary Metrics

-

References

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2.6.3.2 Metric "E.2.2" Authority

Metric Name

Authority (AU)

Definition and Rationale

Definition: Answer the following question: To what extent are legitimate forms of power and authority present that enable long-term, integrated, and sustainable solutions for achieving a water-smart society?

Concepts: Legitimate forms of power that can enable water-smart solutions and contribute to a water-smart society.

Rationale and Interpretation: The level that legitimates forms of power contribute to implementing a water-smart society is an important characteristic of understanding the level of water smartness.

Data Sources and Collection Method

See Appendix D on the interview method applied.

Method of Computation and Other Methodological Considerations

Select a Likert category by answering the following question: To what extent are legitimate forms of power and authority present that enable long-term, integrated, and sustainable solutions for achieving a water-smart society?

Careful substantiation with references to written documentation as well as anonymous interviewees is required to justify the score.

++	**Strong well-embedded authority**	Long-term, integrated approaches regarding water challenges are well embedded in policy and regulatory authorities. Authoritative figures receive much support both politically and by society. Their opinions and statements also receive much media attention.
+	**Stirring authority**	There is recognition of the need for long-term and integrated approaches by both the public and the political arena. Sustainability water-smart approaches are now implemented as declarations of intent and sustainability principles in policy and regulation. Legitimate authorities are assigned to coordinate long-term integrated policy and implementation.
0	**Restricted authority**	Water challenges are addressed if the status quo is not questioned. Long-term policy visions are limited, and new policy mainly needs to fit into existing fragmentized structure. This means small (technical) changes are occurring.

-	**Unfruitful attempts**	Water challenges are put forward by individuals or a group of actors, but there is only little interest which is also fragile due to poor embedding of sustainability principles in current policy mechanisms, interests, and budget allocation. The challenge may have been mentioned in reviews or reports but left unaddressed.
--	**Powerlessness**	The addressing of Water challenges is regularly overruled with contradicting and competing interests and so it is hardly included in policy, regulation or administrative principles.

Unit

Ordinal scale. Likert style scoring with five categories ranging from very limiting (--) to very encouraging (++) water-smartness.

Data Disaggregation

-

Reference Values

- Good + or ++
- Fair 0
- Poor - or --

Suggested Supplementary Metrics

-

References

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2.6.3.3 Metric "E.2.3" Room to maneuver

Metric Name

Room to maneuver (RM)

Definition and Rationale

Definition: Answer the following question: To what extent do actors have the freedom and opportunity to develop a variety of alternatives and approaches (this includes the possibility of forming *ad hoc*, fit-for-purpose partnerships that can adequately address existing or emerging issues regarding the water challenge)?

Concepts: The level of freedom and opportunity to develop a variety of alternatives and approaches to experiment and find out what works and what does not work and, in this way, becoming water-smart.

Rationale and Interpretation: The room to maneuver and experiment has been emphasized in many studies as a key factor for achieving more sustainable and climate adaptive solution pathways.

Data Sources and Collection Method

See Appendix D on the interview method applied.

Method of Computation and Other Methodological Considerations

Select a Likert category by answering the following question: To what extent do actors have the freedom and opportunity to develop a variety of alternatives and approaches (this includes the possibility of forming *ad hoc*, fit-for-purpose partnerships that can adequately address existing or emerging issues regarding the water challenge)?

Careful substantiation with references to written documentation as well as anonymous interviewees is required to justify the score.

++	**Freedom to develop innovative solutions**	There is a common and accepted long-term vision for dealing sustainably with water challenges. Within the boundaries of this vision, actors are given the freedom to develop novel and diverse approaches and partnerships, resulting in continuous improvements and exploration. These partnerships are most likely institutionalized.
+	**Redundancy to address uncertainty**	There is recognition that a high degree of freedom is necessary to deal with complex situations in the form of experiments and looking for new unconventional collaborations. There is a dynamic mix of cooperative partnerships and a redundant set of diverging alternative solutions. A clear overall vision to steer research is however lacking.

0	**Limited room for innovation and collaboration**	Actors are given the means to perform predefined tasks for dealing with problems that are framed with a narrow, short-term, and technical-oriented scope. There is limited room to deviate. Solutions are sought in own sectoral field and expertise.
-	**Limited autonomy**	Only a few actors receive some degree of freedom, there are limited opportunities to develop alternatives, and there is hardly any opportunity to form partnerships with unconventional actors.
--	**Strictly imposed obligations**	The actions of stakeholders are strictly controlled and there are rigid short-term targets. Freedom to form new partnerships is strongly limited as actor network composition is fixed and small. There are no resources made available for exploring alternatives that might be more effective or efficient whereas many actors that are affected by water challenges do not have a voice.

Unit

Ordinal scale. Likert style scoring with five categories ranging from very limiting (--) to very encouraging (++) water-smartness.

Data Disaggregation

-

Reference Values

- 🟢 Good + or ++
- 🟡 Fair 0
- 🔴 Poor - or --

Suggested Supplementary Metrics

-

References

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2.6.4 AC E.3 “Stakeholder engagement processes”

Description: stakeholder engagement is required for common problem framing, gaining access to a wide variety of resources and creating general support that is essential for effective policy implementation. In order to further drive this inclusive change process, agents of change are required to show direction, motivate others to follow and mobilize the resources required.

2.6.4.1 Metric “E.3.1” Stakeholder inclusiveness

Metric Name

Stakeholder inclusiveness (SI)

Definition and Rationale

Definition: Answer the following question: To what extent are stakeholders* interacting in the decision-making process interaction (i.e., are merely informed, are consulted or are actively involved)? Are their engagement processes clear and transparent? Are stakeholders able to speak on behalf of a group and decide on that group’s behalf?

Concepts: The extent that all relevant stakeholders are included in a legitimate and meaningful way is essential for decision-making about adopting and implementing water-smart solutions. It can be considered as a key component of achieving water smartness.

Rationale and Interpretation: Inclusive stakeholder engagement in decision-making is part of and critical condition of becoming water smart.

Data Sources and Collection Method

See Appendix D on the interview method applied.

Method of Computation and Other Methodological Considerations

Select a Likert category by answering the following question: To what extent are stakeholders interacting in the decision-making process interaction (i.e., are merely informed, are consulted or are actively involved)? Are their engagement processes clear and transparent? Are stakeholders able to speak on behalf of a group and decide on that group’s behalf?

Careful substantiation with references to written documentation as well as anonymous interviewees is required to justify the score.

* The score justification need to specify the level of inclusion per stakeholders if there are substantial differences in stakeholder inclusion.

++	Transparent involvement of committed partners	All relevant stakeholders are actively involved. The decision-making process and the opportunities for stakeholder engagement are clear. It is characterized by local initiatives specifically focusing on water such as local water associations, contractual arrangements, regular meetings, workshops, focus groups, citizen committees, surveys.
+	Timely, over-inclusive and active involvement	Stakeholders are actively involved. It is still unclear how decisions are made and who should be involved at each stage of the process. Often too many stakeholders are involved. Some attendants do not have the mandate to make arrangements. Stakeholder engagement is abundantly done for often overlapping issues.
0	Untimely consultation and low influence	Stakeholders are mostly consulted or informed. Decisions are largely made before engaging stakeholders. Frequency and time-period of stakeholder engagement is limited. Engagements are mainly ad hoc consultations where stakeholders have low influence on the end-result.
-	Non-inclusive involvement	Not all relevant stakeholders are informed and only sometimes consulted. Procedures for stakeholder participation are unclear. If involved, stakeholders have but little influence.
--	Limited supply of information	No stakeholders are included, or their engagement is discouraged. Information cannot be found on the extant decision-making process.

Unit

Ordinal scale. Likert style scoring with five categories ranging from very limiting (--) to very encouraging (++) water-smartness.

Data Disaggregation

-

Reference Values

🟢	Good	+ or ++
🟡	Fair	0
🔴	Poor	- or --

Suggested Supplementary Metrics

-

References

-

2.6.4.2 Metric "E.3.2" Protection of core values

Metric Name

Protection of core values (PCV)

Definition and Rationale

Definition: Answer the following question: To what extent 1) is commitment focused on the process instead of on early end-results? 2) do stakeholders could be actively involved? 3) are the exit procedures clear and transparent? (All three ensure that stakeholders feel confident that their core values will not be harmed.)

Concepts: Level of commitment during stakeholder engagement is focused on the process instead of on early end-result. Level that stakeholders are given the opportunity to be actively involved. The presence of clear and transparent exit procedures prior and during the stakeholder engagement process.

Rationale and Interpretation: Stakeholder engagement is not sufficient in itself and should not be considered as a 'ticking the box exercise'. The level that stakeholder's core values such as their key interests, values and livelihood are respected and properly accounted for during their engagement process is critical for the establishment and successful implementation of water-smart solutions.

Data Sources and Collection Method

See Appendix D on the interview method applied.

Method of Computation and Other Methodological Considerations

Select a Likert category by answering the following question: To what extent 1) is commitment focused on the process instead of on early end-results? 2) do stakeholders could be actively involved? 3) are the exit procedures clear and transparent? (All three ensure that stakeholders feel confident that their core values will not be harmed.)

Careful substantiation with references to written documentation as well as anonymous interviewees is required to justify the score.

++	**Maximal protection of core values**	Stakeholders are actively involved and have large influence on the end-result. There are clear exit possibilities and leading to more stakeholders more committed to the process. The participation opportunities and procedure of implementation are clear.
+	**Requisite for early commitment to output**	Stakeholders are actively involved and expected to commit themselves to early outcomes in the process. Hence relevant stakeholders may be missing in contractual arrangements as they do not want to commit themselves to decisions to which they have not yet contributed. At this point involved stakeholders have influence on the end-result and therefore the output serves multiple interests.

0	**Suboptimal protection of core values**	As stakeholders are consulted or actively engaged for only short periods, alternatives are insufficiently considered. Influence on end-result is limited. Decisions comply with the interests of the initiating party primarily. There are no clear exits in the engagement process.
-	**Non-inclusive and low influence on results**	The majority of stakeholders is engaged, but the level of engagement is low (informative or sometimes consultative). There is a low influence on the result which invokes resistance, for example on internet platforms and newspapers.
--	**Insufficient protection of core values**	Because stakeholders are hardly engaged or informed, core values are being harmed. Implementation and actions may be contested in the form of boycotts, legal implementation obstructions and the invoking of anti-decision support. There may be distrust and an absence of participation.

Unit

Ordinal scale. Likert style scoring with five categories ranging from very limiting (--) to very encouraging (++) water-smartness.

Data Disaggregation

-

Reference Values

- 🟢 Good + or ++
- 🟡 Fair 0
- 🔴 Poor - or --

Suggested Supplementary Metrics

-

References

-

2.6.4.3 Metric "E.3.3" Cross-stakeholders learning

Metric Name

Cross-stakeholders learning (C-SL)

Definition and Rationale

Definition: Answer the following question: To what extent are stakeholders open to and could interact with other stakeholders and deliberately choose to learn from each other through relational, cognitive and strategic learning?

Concepts: The extent that stakeholder are open to and able to interact with other stakeholders and deliberately choose to learn from each other through relational (1), cognitive (2) and strategic (3) learning.

1) Relational learning refers to the extent that stakeholders understand traditional beliefs in relation to the water-smartness challenges.
2) Cognitive learning refers to the understanding of dynamics, causes and solutions related to water-smartness challenges.
3) Strategic learning refers to the extent that stakeholders have changed the way they operate in their everyday practice in relation to resources, priorities and strategic cooperation.

Rationale and Interpretation: Learning across stakeholders is critical for endorsing and successfully implementing water-smart concepts and solutions.

Data Sources and Collection Method

See Appendix D on the interview method applied.

Method of Computation and Other Methodological Considerations

Select a Likert category by answering the following question: To what extent are stakeholders open to and could interact with other stakeholders and deliberately choose to learn from each other through relational, cognitive and strategic learning?

Careful substantiation with references to written documentation as well as anonymous interviewees is required to justify the score.

++	**Putting cross-stakeholder learning into practice**	Stakeholders have a very good understanding of cultural values, problems, solutions and associated risks and uncertainties. This knowledge allows them to find the best shared solutions and the most appropriate approach to manage risk and uncertainty. Stakeholders receive sound information in a clear and understandable format that they can easily absorb and utilize to address problems, develop solutions, and manage risk and uncertainty. This is evidenced by broad support for policy measures and implementation. Moreover, continuous cross- stakeholder learning programs are in place or may be institutionalized.
+	**Open for cross-stakeholder learning**	Stakeholders have a good understanding of cultural values, problems, solutions but not a full picture of the associated risks and uncertainties. Their interaction is considered valuable and useful for improving policy and implementation. Various initiatives for cross-stakeholder learning have been deployed, yet the translation into practice appears difficult. The programs may not be structural, and the learning experience may not be registered and shared.
0	**Open for stakeholder interaction**	Stakeholders have an acceptable understanding of cultural values problems, solutions and of the associated risks and uncertainties. They are open to interaction, though not much learning is going on due to the informative character of the interaction. Often, several stakeholders, that do not necessarily share interests or opinions, are involved in the decision-making process.
-	**Small coalitions of stakeholders with shared interest**	Stakeholders have a poor understanding of cultural values, problems, solutions and associated risks and uncertainties. Interaction occurs in small coalitions based on common interests. Opinions of those outside the coalition are generally withheld. Only information for the shared point of view is sought. This is evidenced by the finding of only one perspective regarding water challenges or few perspectives that are supported by means of circle-referencing.
--	**Closed attitude towards cross-stakeholder learning**	Stakeholders have a very poor understanding of cultural values, problems, solutions and associated risks and uncertainties. There is no contact with other parties, contact may even be discouraged. This is apparent from limited sharing of experience, knowledge, and skills. No information is shared outside organization and sector, nor is external information used.

Unit

Ordinal scale. Likert style scoring with five categories ranging from very limiting (--) to very encouraging (++) water-smartness.

Data Disaggregation

-

Reference Values

🟢	Good	+ or ++
🟡	Fair	0
🔴	Poor	- or --

Suggested Supplementary Metrics

-

References

-

2.6.4.4 Metric "E.3.4" Collaborative agents

Metric Name

Collaborative agents (CA)

Definition and Rationale

Definition: Answer the following question: To what extent are actors enabled to engage, build trust-collaboration, and connect business, government, and sectors, to address water challenges in an unconventional* and comprehensive way?

Concepts: The extent that practitioners, policy-makers, researchers etc. are enabled to engage, build trust-collaboration, and connect business, government, and sectors to enable water-smart solutions in an unconventional and comprehensive way.

Rationale and Interpretation: The extent that individuals collaborate to establish water-smart solutions across business, government and sectorial silo is essential considering the integrative nature of water-smartness.

Data Sources and Collection Method

See Appendix D on the interview method applied.

Method of Computation and Other Methodological Considerations

Select a Likert category by answering the following question: To what extent are actors enabled to engage, build trust-collaboration, and connect business, government, and sectors, to address water challenges in an unconventional and comprehensive way?

Careful substantiation with references to written documentation as well as anonymous interviewees is required to justify the score.

* (If applicable) explain what unconventional collaborations are being considered for justifying the score of this metric.

++	**Agents of change enhances wide-spread synergetic collaboration**	There is on-going build-up of productive and synergetic collaborations. Facilitators may even be administered to coordinate this through mediation and authority. There is a conception of the ideal collaboration composition.
+	**Agents of change can push for collaboration between new stakeholders**	There is an understanding that water challenges require long-term and integrated solutions. Hence, wide-spread collaborations between a variety of stakeholders and sectors are being established. New collaborations with unconventional actors, result, more and more, in valuable new insights and effective networks.

0	**Agent are enabled to enhance conventional collaboration**	Traditional coalitions are preserved to maintain status quo. There is trust within these coalitions. There is limited space to create new collaborations. If new collaboration occurs solutions are still mostly sectoral and short- to mid-term.
-	**Insufficient opportunities for collaborative agents**	There is insufficient opportunity for agents of change to go beyond conventional collaboration. The current collaborations are deemed sufficient to deal with water challenges whereas the vision is limited to ad hoc command and control approaches.
--	**Lack of collaborative agents**	Collaboration is discouraged, because of a strong hierarchical structure. There is distrust between stakeholders and the willingness and thereby opportunities for collaborative agents are largely lacking.

Unit

Ordinal scale. Likert style scoring with five categories ranging from very limiting (--) to very encouraging (++) water-smartness.

Data Disaggregation

-

Reference Values

🟢	Good	+ or ++
🟡	Fair	0
🔴	Poor	- or --

Suggested Supplementary Metrics

-

References

-

3 The excel file of BWS AF

3.1 Structure

The BWS-AF is implemented in a Microsoft Excel file and consists of multiple data sheets. While the major information is given in the sheet “BWS AF V2” with the metrics description, formulation and reference values, the other sheets contain supporting information, i.e., a front-page introducing the BWS AF structure, a sheet for each assessment criterion containing information to support the calculation of the metrics proposed under the specific assessment criterion and a sheet with the variables list per category. The structure of the BWS AF-V_2 file is given in Table 10.

Sheet number	Sheet name	Description
1	Description	Front page
2	BWS AF V_2	Complete list of the strategic objectives, assessment criteria and metrics with a short description, the computation method, the unit and the reference values
3-15	CharacterNumber (i.e., A1-E3)	One sheet for each Assessment criterion containing information to support the calculation of the related metrics
16	Categories of input variables	The spreadsheet provides the full list of variables defined in the BWS AF, V_2, sorted by category. The same list is also provided in the Appendix B of this document

Table 10 – The structure of the BWS AF-V_2 file

The BWS AF V_2 excel file will be made available for download at the project website under “Results”[7]- https://b-watersmart.eu/results-downloads/water-smartness-assessment-framework/

3.2 The BWS AF V_2 sheet

The BWS AF V_2 is composed of the fields described in the Table 11.

Field	Description
Strategic Objective (SO)	String providing the name of the strategic objective (refer to section 2 of this document for the definition of each objective)
Soc	It indicates if the objective embraces the social dimension (score: ‘++’ dominant dimension, ‘+’ relevant, ‘ ‘ not relevant)
Env	It indicates if the objective embraces the environmental dimension (score: ‘++’ dominant dimension, ‘+’ relevant, ‘ ‘ not relevant)

[7] Note: the D6.3 will be made available as public deliverable in the project website after it will be reviewed and approved by the EC.

Field	Description
Econ	It indicates if the objective embraces the economic dimension (score: '++' dominant dimension, '+' relevant, ' ' not relevant)
Tech	It indicates if the objective embraces the technical dimension (score: '++' dominant dimension, '+' relevant, ' ' not relevant)
Gov	It indicates if the objective embraces the governance dimension (score: '++' dominant dimension, '+' relevant, ' ' not relevant)
Assessment criteria (AC)	String providing the Assessment Criteria title (refer to section 2 of this document for the definition of each criterion)
Metric title	String providing the name of the metric
Metric description	Text describing the metric (refer to section 2 of this document for the full description of each metric)
Metric type	Text describing the nature of the metric: equation-based, questionnaire-based or interview based (for more information refer to section 1.5.2 of this document)
Method of computation	The equation for metric computation (refer to section 2 of this document for the method of computation)
Unit	Unit proposed for the metric
Reference values	The reference values of good, fair and poor performance established for each metric (refer to section 2 of this document for the reference values which the justification is described in the Appendix C)

Table 11 – List of attributes and descriptions of the BWS AF V_2 sheet

3.3 The "Assessment Criteria" sheets

Each sheet of a specific assessment criterion gathers all the related metrics which are described as variables or metrics (input/output), name, range, numerical example (containing the computational formula of the metric), and unit. In the Table 12 the descriptions of the fields for each sheet going from AC A1 to AC E3 are shown. These sheets are meant to support the calculation of each metric.

Sheet	Field	Description
A1-E3	Input/output	Input/output field for each metric of the Assessment Criteria
	Name	List of variable names required for the metric calculation
	Description	A short description of the metric – description to be used in the web-application
	Range	The expected numerical interval of each specific variable
	Numerical example	An example, in which users can enter input values for the variables and compute the corresponding metric
	Unit	Unit proposed for the metric

Table 12 – List of attributes and descriptions of the "Assessment Criteria" sheets

3.4 The “Categories of input variables” sheet

The last sheet provides the list of the variables to be used to assess performance indicators-type of metrics and it is composed of the fields described in the Table 13.

Field	Description
Related Metrics	The list of metrics in which a given variable is applied
Variable	The name of the variable (the code adopted)
Definition	A text describing the variable
Unit	Unit proposed for the variable
Categories	The list of categories used to characterize the variables (6 columns)

Table 13 – List of attributes and description of the “Categories of input variables” sheet.

4 Guidance for implementation

4.1 Approach for implementation

As already referred, the BWS AF provides an objective-driven comprehensive framework aiming at supporting a coherent assessment of multi-stakeholder activities for strategic decision-making towards the transition to a water-smart society. This assessment may be carried out at regional (e.g., LL), city or utility level (users defined in 1.4). Through the BWS AF implementation, a tailored assessment may be carried out for a region or a utility, allowing identification of the aspects that are more developed and those presenting higher room for improvement. It constitutes an assessment tool, key to establish a diagnosis and, subsequently, to define a plan for improvement. . Therefore, it supports the strategic planning process, whether to develop strategic agendas for a water-smart society for regions or organizations, or to develop strategic plans for organizations towards a water-smart society.

Taking into account the components of the framework and the stakeholders involved, the implementation at the regional level requires the involvement of multiple parties, in a collaborative process to define an effective and robust tailored assessment system for the region, as well as incorporating the best available information. An inherent aspect in these collaborative processes is the recognition of the role of each stakeholder, both the specific role as well as its contribution to the region or the city as a whole. Generally, the objectives and perceptions of stakeholders differ according to their specific duties and aims. Assembling a multi-stakeholder team allows to consider different points of view and to improve individual perceptions of a water-smart society. Consequently, decision-making processes are better supported, and opportunities arise for using information and resources more efficiently (Cardoso et al., 2019).

Additionally, the BWS AF provides the classification of core and additional metrics. Based on this feature, the insight assessment may firstly be carried out for the core metrics, and in a later stage, extended to a deeper assessment including additional metrics.

At any level, for the successful implementation of the BWS AF the coordination of the whole process is key, as for subsequent steps in strategic planning, particularly ensuring its development, monitoring and revision. Therefore, the implementation of the proposed framework incorporates a stepwise approach (adapted from Cardoso et al., 2019):

1. Establishment of the scope of the assessment, namely, level of application (regional, city or utility/organization), which water services are included and the geographical limits.
2. Stakeholder identification, commitment, assemblement of teams and responsibilities, and establishment of leading principles of collaboration, including setup of a coordination and supporting group (CSG).
3. Definition of the context of application including assessment period, and analysis level (core or additional).

4. Setting of a program for implementation of the assessment, including the definition of the BWS assessment system tailored for the region, city or the utility by establishing the strategic objectives e defining the assessment criteria and metrics, from the BWS AF. The tasks included in the program must provide opportunities for debating sessions and supporting actions by CSG.
5. Identification of data requirements, data sources (e.g., data repositories, reporting or information systems) and selection of analysis tools for supporting application of the assessment.
6. Evaluation of preliminary assessment from results by CSG and feedback to parties.
7. Production of final version of the assessment.

Feedback loops should be considered whenever applicable or identified as necessary by team members.

4.2 Application to the strategic planning process

This section presents the proposed methodology for application of the framework in the strategic planning process, as well as an example of application. The definitions of the terms applied ("reference value", "target", "scenario" and "alternative") are provided in Appendix A – Key definitions adopted in the B-WaterSmart Assessment Framework. Furthermore, guidance on how to define an assessment system based on the framework and how to set reference values and targets is provided. A methodology for strategic planning, aiming to ensure a continuous improvement for the transition process to a water-smart society is proposed in Figure 8, and it comprises an iterative six-step process (Ugarelli et al., 2021).

STEP1 – Selection of strategic objectives, assessment criteria, metrics and reference values

Step 1 is a crucial stage to know where the organization stands, set up clear directions of action, as well as accountability of results through timely review. It consists of the definition, by the strategic management decision level, of (i) clear objectives, (ii) assessment criteria that translate the objectives into the relevant points of view, (iii) metrics to assess them, and (iv) reference values for every metric.

The BWS AF consists of a full assessment system, i.e., it proposes five strategic objectives grounded on the water-smart society vision and provides a portfolio of assessment criteria and metrics with reference values. The organization should select the strategic objectives according to its mission and vision, and this selection requires a proficient knowledge of the context. Then, the organization should select the assessment criteria, in alignment with the strategic objectives and, similarly, should select the metrics in alignment with the assessment criteria. The metrics selection requires parsimony, i.e., their number should be as limited as possible at a strategic level, but all metrics that are deemed essential for effective performance evaluation need to be considered.

Additionally, reference values for each metric are needed in order to allow establishing a judgement of what is good, fair and poor performance for each metric (the performance level). These values are aimed to allow for comparisons between cases or alternative solutions and to monitor evolution over time. For this reason, this judgement shall be established independently from the specific cases and be as stable as possible over time. The BWS AF proposes reference values for each metric. In certain cases that are context dependent, when building the tailored assessment system, the reference values may need to be adjusted. The recommendations to derive reference values are described in section 1.5.3.

Once the metrics have been selected, it is important to check their measurement details, such as definitions, measurement units, and data needed for their calculation, and to identify who collects the data and the frequency of data collection. It is important to check for metrics that are already being monitored for other purposes and, if deemed needed, to include these in the metrics sets.

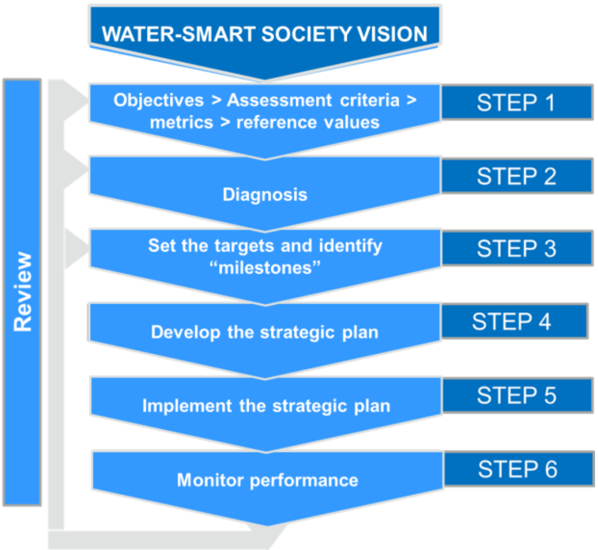

Figure 8 – The iterative six-step process for strategic planning to meet the water-smart vision developed within the B-WaterSmart (Ugarelli et al., 2021).

STEP 2 - Diagnosis

In order to decide how to act, it is essential to carry out a sound diagnosis to assess the reference situation using the established assessment system through metrics calculation, and the corresponding performance level through the reference values. This step usually includes the collection and evaluation of relevant information (on the internal context and on the external context, global and stakeholder-specific) and the assessment of the performance against the selected objectives. Assessing the reference situation allows to check progress over time by comparison with the results of earlier assessments, e.g., performed on a regular yearly basis, or to assess the effectiveness of alternative solutions (see step 4). The diagnosis should also include the definition of scenarios (see Appendix A for further explanation about the scenarios) to enhance anticipatory capacity. Scenarios are due to external factors (isolated and/or combined) that may influence the analysis, such as demographic trends, regulatory changes, climate change effects.

STEP 3 - Set the targets

The diagnosis allows identifying the performance against the set objectives; therefore, the user is now ready to set targets for each metric selected at STEP 1 to express the desired level of performance to be achieved on the short, medium and long terms. To achieve the targets for each metric, a list of intermediate actions, "milestones", might need to be accomplished at a given time. At this step, the milestones have to be defined as well as the time at which the action has to be completed.

Table 14 presents an example to illustrate: i) the alignment between objectives, assessment criteria and metrics, in a water utility assessment system; ii) the diagnosis regarding that objective, through metrics calculation and assessment of the current performance level (in 2022); and iii) the definition of targets for the metrics on the short (in 2025), medium (in 2030) and long (in 2035) runs, considering the scenario analysis (in Table 15).

Step 1						**Step 2**		**Step 3** (after scenario analysis, Table 15)		
Objectives	Assessment criteria	Metrics	Reference values			Results (t0) (2022)		Targets		
			Poor 🔴	Fair 🟡	Good 🟢			t1 (2025)	t… (2030)	tN (2035)
Objective A [Ensuring water for all relevant uses]	Criterion A.1 [Safe and secure fit-for-purpose water provision]	A.1.1 Water exploitation index, plus (WEI+) (%)	[0; 20[	[20; 40[	[40; +∞[	25 🟡	Context metric	25	40	50
		A.1.4 Compliant reclaimed water (%)	[0; 90[	[90; 95[	[95; 100]	100 🟢		100 🟢	100 🟢	100 🟢
	…									
Objective B [Safeguarding ecosystems and their services to society]	Criterion B.1 [Safeguarded water ecosystems]	B.1.3 Effective wastewater treatment (%)	[0; 95[	[95; 100[	100	100 🟢		100 🟢	100 🟢	100 🟢
Objective C [Boosting value creation around water]	Criterion C.3 [Resource recovery and efficient use]	C.3.5 Reclaimed water in non-potable uses (%)	[0; 1.7[	[1.7; 3.3[	[3.3; 100]	2 🟡	WEI+ [10; 30[	2 🟡	-	-
			[0; 3.3[	[3.3; 6.7[	[6.7; 100]	-	WEI+ [30; 70[	-	8 🟢	10 🟢
		C.3.6 Reclaimed water production (%)	[0; 5[	[5; 10[	[10; 100]	6 🟡	WEI+ [10; 30[	6 🟡	-	-
			[0; 10[	[10; 20[	[20; 100]	-	WEI+ [30; 70[	-	24 🟢	30 🟢
…	…									

Table 14 – Example of an extract of an assessment system established by a water utility, the metrics' results and targets

Table 15 presents an example to illustrate the prospective evaluation of the performance of the current system considering an increased water scarcity due to decreased rainfall (a climate change effect scenario). The scenario considered translates a typical climate change effect, i.e., decreased rainfall and increased temperature, which results in an increased water exploitation index, WEI+, driven by a decreased volume of renewable water and an increased water demand for irrigation – in this example, a change from 25% in 2022 to 50% in 2035 was considered. Furthermore, with no new investments, most likely the more stringent treated wastewater requirements foreseen based on the currently proposed revision of the EU urban wastewater treatment directive (UWWTD) cannot be met, and the performance level relative to effective wastewater treatment decreases. Moreover, water reuse is an effective measure to minimize water scarcity; therefore, the current reclaimed water production and non-potable reuse would be insufficient, corresponding to poor performance. Accordingly, the targets considered in Table 14 are defined to achieve a good performance level in 2030. This prospective analysis highlights the need to plan the investments for achieving the targets set for reclaimed water production and use.

Scenario 1: Increased water scarcity due to decreased rainfall (STEP 2)						
Objectives	Assessment criteria	Metrics	Results (t0) (2022)	External context changes expected	Expected trend	Expected performance level (with no investments)
Objective A [Ensuring water for all relevant uses]	Criterion A.1 [Safe and secure fit-for-purpose water provision]	A.1.1 Water exploitation index, plus (WEI+) (%)	25 🟡	✓ Increased water scarcity	↗ WEI+ change to 50%	🔴
		A.1.4 Compliant reclaimed water (%)	100 🟢	×	→	🟢
Objective B [Safeguarding ecosystems and their services to society]	Criterion B.1 [Safeguarded water ecosystems]	B.1.3 Effective wastewater treatment (%)	100 🟢	✓ New UWWTD	↘	🟡
Objective C [Boosting value creation around water]	Criterion C.3 [Resource recovery and efficient use]	C.3.5 Reclaimed water in non-potable uses (%)	2 🟡	✓ Increased water scarcity	→	🔴 Due to WEI+ change to 50%
		C.3.6 Reclaimed water production (%)	6 🟡	✓ Increased water scarcity	→	🔴 Due to WEI+ change to 50%
...	...	...	...	...	...	...

Table 15 – Example of a prospective evaluation for the scenario considered

STEP 4 – Develop the strategic plan

Following the diagnosis, alternative solutions (i.e., strategies, interventions, or actions) can be identified, assessed based on the same metrics, targets and scenarios previously considered, and compared between each other and with the reference situation, to select those resulting in a higher global value for the organization/entity/city/region. The results should be expressed in a document, the strategic plan, that should be synthetic, clear, and effectively disseminated to all relevant internal and external stakeholders. The plan includes a summary of the diagnosis and of the selected alternative solutions. As the BWS assessment system supports these developments, it constitutes a means to facilitate visualization and communication in a transparent way.

Following the previous example, which considers the scenario of "Increased water scarcity due to decreased rainfall", besides the alternative status-quo, another alternative considered is to increase the overall treatment level to comply with the new UWWTD requirements and to increase the tertiary treatment capacity to produce wastewater compatible with the use, and therefore to increase the reclaimed water production and non-potable reuse.

For comparative analysis of alternatives, the metrics should be selected and computed for the year analyzed (2022 in the example presented) and for a longer time horizon (in 2035), which is particularly important for analyzing the impact of infrastructural alternatives and considering the scenarios impact (Table 16). To compare the results of each metric with different units, a normalization value should be computed using a performance function defined by the reference values, as illustrated in Figure 9 for the effective wastewater treatment and reclaimed water production, whose reference values are WEI+ dependent, therefore requiring 4 functions. Based on the normalized values, a global score (arithmetic average of the normalized values) for each alternative in 2022 and in a longer time horizon (in 2035) is computed (also different weights for each metric could be use in relation to their importance for the organization), and alternatives can be compared.

For each alternative, the economic analysis in the long-term, taking into account costs in the analysis horizon period, should be carried out and the alternative selected for implementation depends on the balance between the financial capacity of the organization to meet these expenses and the expected improvement in performance.

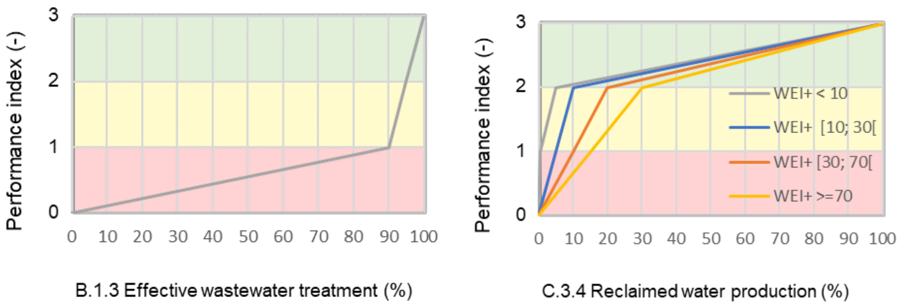

Figure 9 – Normalization of the metrics B.1.3 Effective wastewater treatment and C.3.3 Reclaimed water production (%)

Alternatives/Metrics	A.1.3 Compliant reclaimed water (%)	B.1.3 Effective wastewater treatment (%)	C.3.3 Reclaimed water in non potable uses (%)	C.3.4 Reclaimed water production (%)	Global score (arithmetic average of the normalized values)
A0. Status-quo 2022	100 % ● 3	100 % ● 3	2 % ● 1.2	6 % ● 1.2	● 2.1
A0. Status-quo Prospective evaluation	● 3	● 1.5	● 0.6	● 0.6	● 1.4
A1. Increase the treatment capacity 2022	100 % ● 3	100 % ● 3	10 % ● 2.2	30 % ● 2.2	● 2.6
A1. Increase the treatment capacity Prospective evaluation	● 3	● 3	● 2.1	● 2.1	● 2.5
…					
Legend	Metric value ● / ● / ● (normalized value)				

Table 16 – Example of alternatives comparison

STEP 5 - Implement the strategic plan

This step consists on the effective plan implementation. Therefore, the selected alternatives should be executed according to the plan and within the work plan established. Monitoring the plan implementation is essential to ensure an adequate execution and the achievement of the expected results. The latter consists of step 6.

STEP 6 - Monitor performance

Monitoring performance consists of periodically gathering the necessary data, systematically calculating the metrics for all strategic objectives of the plan and comparing these values with the targets defined. This allows to identify the need for changes in the plan, thus leading to a plan revision.

PART II – The process of the framework development

5 The process of co-creation of the BWS AF

The development of the BWS-AF is structured according to four phases (Figure 10). The conceptualization, described in deliverable D6.1 submitted at M9, the prototype V_0, as the milestone MS16 achieved at M19, followed by the prototype V_1 at M26, described in the deliverable D6.2, and the prototype V_2 at M30 described in this deliverable D6.3. In the following, the work performed at each phase is described.

By M9 (D6.1):

Deliverable D6.1 defines the methodology followed during the framework design and conception, it includes the key features of the B-WaterSmart framework and its high-level architecture. The main design driving factors presented in the deliverable have been identified based on feedbacks gathered from the LL owners. The document also provides the definition of a “water-smart society” which also has driven the framework conceptualization.

By M19 (Prototype V_0, MS16):

During the period M10-M19, the Task 6.2 has focused on the following activities:

- Finalization of the strategic objectives list through interaction with the LL owners.
- Finalization of the list of the assessment criteria, as viewpoints that overall express the intent behind the objective, defined through interaction with the LL owners.
- Review, gaps identification and selection of the list of metrics, relevant for the strategic level of application of the framework, proposed by the WP2, 4 and 5 teams at M15.
- Finalization of the list of metrics to be made available to the InAll (Task 1.4) for validation and feedback during the validation phase (M20-M24).
- Preparation of MS16.
- Development of a detailed action plan for collaboration with Task 1.4 (as process to receive feedback from the InAll) and Task 3.9 (to define how WP6 can support the preliminary design for the dashboard) during the validation phase.
- Started the development of a web-application, named FAST, embedding the content of MS16 as additional contribution, not planned as for the description of work (DoW), to facilitate the validation phase and provide structured feedback to WP6 towards the development of the Framework V_1. The web-application is described in Chapter 5 of D6.2. The FAST application has been created as a temporal solution and as such it has provided only the following basic features:
    - it allowed a hands-on experience for the InAll
    - it facilitated the feedback process
    - it included simple features for visualization of the assessments
    - it provided only basic features to navigate through the different parts of the framework
    - it allowed the creation of an automatic ‘pdf’ report at the end of each assessment exercise.

By M26 (Prototype V_1, D6.2):

Thanks to the FAST application, the InAll had the opportunity to analyze and evaluate the BWS AF V_0 and finally provide guided feedback (through specific feedback forms embedded in FAST) to Task 6.2. Task 6.2 analyzed all the valuable recommendations provided by the InAll during September 2022 (since the validation phase, originally planned to end in mid-July, was extended until end of August to provide the InAll with more time across the summer break) and grouped them in comments to be addressed in V_1, comments to be addressed in V_2 (by Task 6.3) and comments considered valuable for the development of the dashboard (Task 3.9). The processed feedbacks have been shared also with Task 1.4 for further analysis presented in D1.3.

Through the feedback received and further interaction with Task 3.9, Task 6.2 has produced the BWS AF V_1, which:

- Includes the improved definition of the metrics up to a mature level to be finalized by M30 (prototype V_2) through iteration with the InAll (Chapter 7 of D6.2).
- Proposes for each metric reference values to be intended as "the judgement of what good, fair, and poor is for each metric for the stakeholders across the board. This judgement shall be established independently from the specific cases and be as stable as possible over time". The reference values are the result of in-depth study of available literature, National and EU directives and guidelines (provided in Appendix C – Reference values of D6.2).
- Presents in a structured way the feedback obtained by the InAll, with an overview of the requirements already embedded in V_1 or as requirements to be embedded in V_2, by Task 6.3 (Chapters 6 and 8 of D6.2);
- Provides a preliminary list of lessons learnt in developing the web-application to be shared with Task 3.9 as insights into the phase of designing the dashboard (Chapter 9 of D6.2).

Therefore, D6.2 as the second deliverable of WP6 has achieved the following three specific goals:

1) to provide the V_1 of the B-WaterSmart Assessment Framework (BWS AF);
2) to inform Task 6.3 on improvements to be covered towards the BWS AF V_2;
3) to share with Task 3.9 useful requirements to start the design of the dashboard which will embed the BWS AF.

By M30 (Prototype V_2, D6.3):

Based on deliverable D1.3 (by Task 1.4 at M26) and deliverable D6.2, the process of refinement of the framework (Task 6.3) has continued from M27 until M30 (Prototype V_2). The activities performed are described in the following section 6 and 7. An overview of the differences between V_0/V_1 and V_2 is presented in section 8.

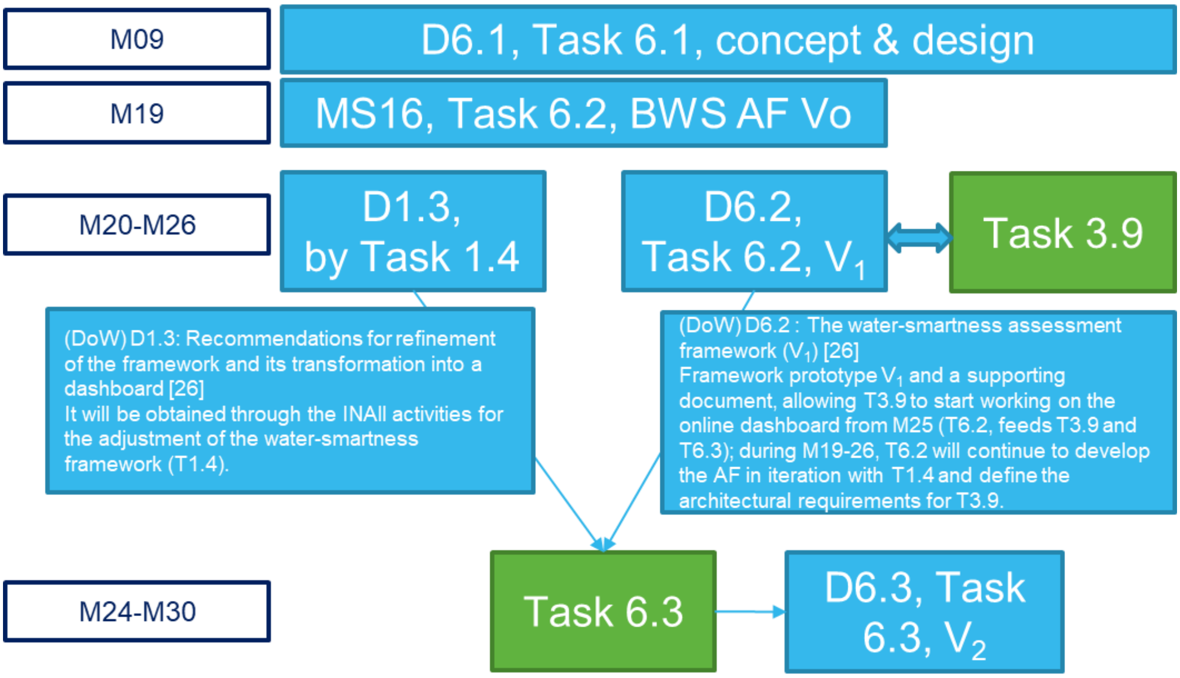

Figure 10 – The four phases of co-development of the BWS-AF

6 The activities performed towards the Prototype V_2

The activities performed by Task 6.3 towards the Prototype V_2 have been performed by creating sub-groups within the WP6 team appointed to address the requirements stated in D6.2. In the following, the requirements are copied from the conclusions of D6.2 and followed by the description of the process established to address them.

1. **Metrics**: reduce the number of metrics, by establishing a new iterative process with the InAll (and LLs). A substantial share of the metrics is applied in all LLs as a way to ensure learning between them. Which metric and how many metrics is to be determined. As a suggestion, the LL can be asked to prioritize the metrics for each AC, the priority numbers of the LLs can be added up. The metrics that are prioritized most will apply to all LLs. A cap on the total number of metrics needs to be set prior to this exercise. The total number of metrics can be equally split across each SO.
   The work performed: a new iterative process with the InAll was initiated (through one workshop held on 4th November 2022 and performed under the umbrella of T1.4). During the workshop, the consolidated feedback provided during the validation phase was presented and discussed in plenary with all the InAll in order to ensure alignment and confidence on the analysis performed.

   Next, the WP6 sub-groups have further processed the recommendations included in D1.3 and D6.2 starting from a dedicated meeting on 9th November. The task for each sub-group has included:
   - To implement the recommendations (e.g., by removing or adapting metrics, renumbering them, improving their description, including the option for the scope (context information, etc)). In performing the review of the metrics, the WP6 groups have analysed the feedbacks of the InAll towards the selection of metrics that are:
     - **Simple:** easily communicated.
     - **Measurable:** capable of being quantified.
     - **Feasible:** able to be collected. This is a slightly different requirement than being measurable, since something can technically be measured, but collection would require time and resources beyond the capacity of the organizations or individuals involved.
   - To revise the list of variables used to compute the indicator-type of metrics and to categorize the variables in classes, instead of presenting them in alphabetic order as done in V_0 and V_1, to facilitate their search.
   - To revise the reference values and their justifications, based on the InAll feedbacks.
   - To highlight core metrics among those proposed in V_1. The aim of the exercise here was to select «which metrics should be considered as core in view of the vision of a water-smart society», meaning to support long term strategic planning towards the achievement of the strategic objectives driving the framework. The guiding target for the WP6 experts

was to select as core 75% of the metrics included per each strategic objective under their responsibility and ensuring a fair distribution of core metrics among the AC. In January 2023 a new round of interaction with the InAll and LL owners started to finalize the process of co-creation. Bilateral meetings have been organized to obtain their selection of core metrics, intended, as above, as metrics that must be included to meet the scope of the framework, even if not specifically relevant for the local challenges of each individual InAll or LL.

The results of the parallel analysis performed by WP6 and T1.4 have then been compared to come up with the final list of 60 metrics of which 47 are “core”. It was decided to consider as “core” the metrics selected as such by at least 4 teams (among the InAll and WP6 expert groups) (see Figure 11 for illustration purposes).

Finally, an overall assessment of the selections has been performed to ensure coherence, consistency, and completeness of the resulting list of core metrics to meet the scope of the framework as described in D6.1 and in the B-WaterSmart description of work.

				Core metrics (provided in InAll bilateral meetings)					
	Assessment Criteria (AC)	Metrics	Core metrics (WP6 options)	LL_1	LL_2	LL_3	LL_4	LL_5	LL_6
A. Ensuring water for all relevant uses	A.1 Safe and secure fit-for-purpose water provision	A.1.1 Water resource exploitation index, plus (WEI+)		x		x			
		~~A.1.2 Alternative water resource exploitation index (AWEI)~~							
		A.1.3 Safe drinking water	x	x	x		x	x	x
		A.1.4 Compliant reclaimed water	x		x	x			x
		A.1.5 Security and resilience index ~~– drinking water (DW)~~	x				x		x
		~~A.1.6 Security and resilience index – wastewater (WW)~~							
	A.2 Accessibility and equity	A.2.1 Physical access to drinking water supply for households and small	x	x		x	x	x	x
		A.2.2 Physical access to drinking water supply in public spaces for quality of life	-	x			x		x
		A.2.3 Physical access to water supply for industrial use	x	x		x	x		x
		A.2.4 ~~Agriculture Irrigated Area with~~ Physical access to water for irrigation	x	x		x	x		x
		~~A.2.5 Number of points with potential conflicts of water use~~							
	A.3 Financial viability	A.3.1 Consumer willingness to pay	-	x	x	x			x
		A.3.2 Affordability	x	x	x	x	x		
		A.3.3 Financial continuation	-			x			
B. Safeguarding ecosystems and their services to society	B.1 Safeguarded water ecosystems	B.1.1 EFR compliance rate	x			x	x		
		B.1.2 Effective stormwater treatment	-			x	x		x
		B.1.3 Effective wastewater treatment	x	x		x	x	x	
	B.2 Enhanced ecosystem services to society	B.2.1 Benefits from regulating services (water quality)	-						
		B.2.2 Maintaining nursery populations and habitats	x			x	x		
		B.2.3 Regulation of extreme events	x			x	x		x
		B.2.4 Water provision by ecosystem	-	x		x	x		
		B.2.5 People enjoying cultural ecosystem services	x		x	x			x
	B.3 Resource efficiency	B.3.1 Water footprint ~~for drinking water~~	x			x	x		
		~~B.3.2 Water footprint for wastewater~~							
		B.3.3 Carbon footprint ~~for drinking water~~	x		x	x	x	x	x
		~~B.3.4 Carbon footprint for wastewater~~							
		B.3.5 Energy consumption	x	x	x	x	x		x
		B.3.6 Drinking water consumption	x	x		x	x	x	x

Figure 11 – Screenshot of the working file circulated and used to select the final list of metrics (included here only for illustration purposes).

2. **Scope of the framework**: ensure that, also in collaboration with Task 1.4, the use of the framework depending on the user is clearly stated, either as part of D6.3 or as part of D1.3. This is a need expressed by the LLs and InAlls during the validation phase and it requires some attention, since the different roles of the LLs and the InAll in the creation and in the validation phases, as for the description of work, might be the source of the confusion. The framework in the project is co-created with the LLs owners; during the validation phase (see D1.3 for more details on the process) some partners validated the framework thinking at the entire LL and others as InAll (single organizations), but, beyond the project, the framework should be flexible for different decision levels at different scale (local and regional). This can be possibly solved by categorizing the metrics differently, *e.g.,* clustering the metrics in "core" and "additional", where "core" is a cluster of metrics relevant independently on the scale of impact of the user, and "additional" relates to metrics that depend on the scale of impact and specific challenges of the user. Possibly, addressing first this topic, might also solve the need to aggregate the metrics (bullet 1).
   The work performed: based on the recommendation above and in alignment with the design criteria agreed with the LLs and proposed in D6.1 (section 6.5.3), stating that "75% of the metrics should be considered as generic and 25% site-specific", 75% of the total number was set as "core" metrics. Furthermore, to refine the use of the framework depending on the user, which was not clear for the users during the validation phase, mainly due to a mismatch between the co-creation performed with the LLs in WP6 and the validation performed by the InAll in T1.4, the guidance for the implementation has been included in D6.3 as chapter 4. Last, the relevance of clarifying the scope of the use of the framework, when covering the interview-based indexes, has also been further stressed in the revised guide for conducting the interviews included in D6.3 as Appendix D.

3. **Revise the interview process based on the lessons learnt**: Task 6.3 should complement D6.3 with a guide for conducting interviews that takes into account the improvements proposed, describe how the procedure is envisioned to function in the long run (and within the dashboard), as well as perform a second round of interviews to test the approach.
   The work performed: the guide for conducting interviews has been created and made available in D6.3 as Appendix D. The new guide considers the improvements proposed during the validation phase, but also the outcomes of a dedicated workshop organized to gather advice and lessons learnt both from the InAll partners that have been interviewed and the social scientists that performed the interviews during the validation phase. The workshop has replaced the suggestion of performing a new round of interviews, as a more focused and efficient approach towards the scope of improving the methodology. More details about the main points of improvement are provided in section 7.4.

7 The activities performed in relation to the interview process and the revision of the interview-based metrics

7.1 Introduction

A substantial number of metrics (19) of the B-WaterSmart framework are being assessed through an interview-based process supplemented with desk study. These metrics essentially assess components that are not easily quantifiable but are essential to support strategic decision-making towards a water-smart society. The metrics and data gathering process that is primarily intended to be through interviews with living lab owners and key stakeholder representatives, each bringing in specific expertise and knowledge for specific metrics. This chapter builds on the first testing phase reported in Deliverable 6.2 and focusses on two aspects. Firstly, section 7.2 elaborates on the reduction of the number of interview-based metrics that has been implemented as part of an overall reduction of the number of metrics of the B-WaterSmart framework as advised by the InAll team (Cardoso et al. 2022). Secondly, sections 7.3 and 7.4 respectively describe the method and main results of refining the standardized interview process that has been proposed in Deliverable 6.2 and tested in a learning-by-doing approach. More specifically, the experiences of both interviewers and interviewees form the basis for refining and validating the standardized interview procedure that ensures future application.

7.2 Adjust of set of interview-based metrics

For the second testing phase of the B-WaterSmart assessment framework, we have incorporated the proposals evidenced in the Deliverable 6.2. It took place with a redesign of the interview-based set of metrics in order to decrease the overlaps between them. This is part of a broader effort to make the assessment more cohesive and concise and to simplify the framework and its data-gathering procedures.

The interview-based metrics that are revised in this section are included in three Strategic Objectives (SO): A Ensuring water for all relevant uses, C Boosting value creation around water and E Engaging citizens and actors across sectors in continuous co-learning and innovation. In the SO A and C, metrics were kept the same as presented in D6.2 since there was a consensus of the living labs and researchers on their complementarity and relevance for evaluation of the established Assessment Criteria (AC). Regarding the number of AC, SO E had more AC than the other SOs and therefore was somewhat imbalanced. Hence, the number of AC has been reduced from five to three. With this new configuration the strategic objective consists of the following ACs: E.1 Awareness and knowledge, E.2 Multi-sector network potential and E.3 Stakeholder engagement processes. Some metrics were reallocated in these three ACs and others were removed from the framework based on considerations of interviewer and interviewees' feedbacks and InAll' recommendations (D6.2, Ugarelli *et al*. 2022b), always with the perspective that the cohesion and applicability of the framework were preserved.

Section 8 also provides the overview of the interview-based metrics proposed in D6.2 and revised in this deliverable. The AC E.1, previously composed of metrics E.1.1 Knowledge and education, E.1.2 Local sense of urgency, E.1.3 Hydrocitizenship and E.1.4 Discourse embedding, has been revised. Metrics E.1.1 Knowledge and education and E.1.2 Local sense of urgency were kept (the E.1.2 is now E.1.3). Two metrics from AC E.5 Information and knowledge sharing have been added to this first AC. These metrics are E.5.1 Information availability and use, and E.5.2 Information transparency and sharing. Metrics E.5.3 knowledge cohesion has been removed as being redundant since the very scope and essence of all the B-WaterSmart metrics is to produce cohesive knowledge.

The previous metrics E.1.3 Hydrocitizenship and E.1.4 Discourse embedding have merged into a new and reformulated one called E.1.4 Water smart culture because both metrics were overlapping substantially. And to complete this AC 1 on awareness, the metric E.4.1 smart monitoring, was moved to E.1.5.

The changes in AC E.2 Multi-sector network potential are that the metric E.2.2 Network Cohesion was removed from the framework for similar as for knowledge cohesion. The combined profile of the B-WaterSmart metrics already implies networks cohesion. In other words, a high score of the remaining metrics implies a higher network cohesion. Hence, for reasons of parsimony, this particular metric was considered redundant.

For the last AC E.3 Stakeholder engagement processes, metric E.3.3 Progress and variety of options was removed because several Living Labs considered the metrics as ambiguous. The metrics under AC E.4 Capacity building were moved to E.1 and E.3.

Table 5 (section 1.5.1) provides the resulting revised arrangement of interview-based metrics (in orange shadow) and ACs within the B-WaterSmart framework.

The previous framework had 28 metrics under the interview-based methodology. Eight metrics were removed or merged. In total, 19 metrics are now part of the interview-based metrics.

Table 5 shows the proposed core metrics. Core metrics are considered essential to ensure that the AC meaning is sufficiently assessed. Hence, the number of core metrics are balanced to reflect the set of ACs.

7.2.1 Coherence in the current setting of Interview - based group of metrics

The main changes to maintain the consistency of the interview-based metrics happened on SO E. This is because some of the ACs were incorporated with the others and metrics were removed to reduce not only the redundancy but to make the framework more dynamic too. Related to engaging citizens and actors, main goal of SO E, the AC E.1 focus on the idea of awareness to address the understanding of the causes and impacts of the challenges related to water management. The first metric refers to the level of knowledge and education regarding current and future water-related risks. Metric E.1.2

addresses the need to identify available information on water-related challenges. The third one, local sense of urgency, brings a very relevant concept for the acceptance of water-smart solutions, which is the urgency that some challenges may bring, such as wastewater reuse, which is already developed in some countries precisely because of the greater scarcity of the territory, appearing as a notion of urgency among stakeholders and the community. Metric E.1.4, assesses the level of social engagement and commitment towards a water-smart culture. E.1.5 Smart monitoring, measures the extent of monitoring the process, progress and policies to enable learning to act in emergency situations and generate important information about the systems. They complement each other since they aim to measure the level of knowledge in society regarding water challenges, promote the identification of available information, assess the level of urgency people perceive, understand social engagement, and assess monitoring to get information to feed the learning process.

For AC E.2, what is essential is the cooperation among the various sectors, articulating themselves in networks that can promote developments. Metric E.2.1 Clear division of responsibility will assess to what extent responsibilities among the various stakeholders involved in water management and governance are clear to advance smart solutions. The second metric to join the group is E.2.2 Authority which assesses whether there are forms of power capable of ensuring long-term, integrated, and sustainable solutions for achieving a water-smart society. Metric E.2.3 Room to maneuver, closes this block, aiming assesses the level of freedom to develop alternatives to address the necessary solutions for each context.

Finally, AC E.3 also experienced substantial changes, from the perspective of representing the group where engagement among stakeholders is essential. In this sense, this assessment criteria were marked with metrics that represent the level of engagement of key actors (metric E.3.1), the level of preservation of the main objectives, the level of learning among them and how well they articulate to collaborate for the development and maintenance of efficient solutions.

7.3 Improving interview-based data collection

The assessment of the interview-based metrics follows a standardized procedure including three overarching steps: desk study, interviews and feedback (see chapter 5 Deliverable 6.2 for a full description). This procedure is intended to ensure a standardized and reproducible data collection enabling to minimize bias from the interviewer and interviewees. In this way, legitimate results can be produced that enable strategic decision-making. In order to optimize the data-gathering procedure, a learning-by-doing approach has been applied to the testing of this procedure in each of the six living labs. Researchers connected to the respective living labs have been identified as the interviewees. The main reason to apply this approach is that these individuals have more intimate knowledge of the regional context, speak the language and typically already work with the living lab owners. In addition, interviewers have been selected that preferably have professional experience in conducting interviews. The choice to select different individuals for each living lab is also to test if the interview guide that was provided to them (see Appendix D) was sufficiently clear and to eliminate individual perceptions. Together with this guide, the interviewers have had a joint preparatory seminar to get fully acquainted with the procedure and way of conducting interviews. From each living lab three interviewees have been selected for three separate interviews during the testing phase. In accordance with the procedure, the interviewers translated the comprehensive questions of the metric in tailored and shorter questions related to the background and expertise of the interviewee. Next, they made a tentative metric score and a small justification that has been sent to the interviewees for validation and possible contributions by them.

In order to assess how the detailed procedures could be implemented in this testing phase an interactive workshop has been organized. This workshop was attended by both the interviewers and the interviewees of each living lab. The key question to find joint answers within this session was as follows: *What tips, advice and instruction are helpful in enabling LLs to update the interview-based metrics?*

In order to ensure a balanced input from all attendees the following approach was applied to answer the key question. To set the scene, first two multiple-choice questions have been posed to all participants. Each of them could answer anonymously through an interactive software tool (Mentimeter). First all living lab practitioners that have been interviewed where invited to share their experience of being interviewed, provide suggestions to improve the process as well as reflect on the ability within their living lab to apply this approach in the project and afterwards. Next, it was the turn of the interviewers to reflect on their experience of conducting the interviews, suggest improvements in the procedure and build on the input of the living lab representatives. Finally, in the concluding section all participants were invited to formulate main concluding points based on what they have heard. The meeting has been recorded (with permission of participants) to ensure full accuracy of the participants' input.

7.4 Main point of improvement for interview-based data collection

As a result of the feedback during the interactive session with both Living Lab representatives and scientists conducting the interviews during the testing phase various suggestions have been proposed to improve the interview-based guidelines. Based on their joint experiences the following improvement suggestions have been endorsed to overcome challenges related to perceived ambiguity and unclarity of the purpose and scope of the interview-based process of scoring the metrics. These suggestions have been incorporated or more explicitly incorporated in the interview guidelines in the Appendix D.

Suggestion 1: Preparatory meeting to explain the scope and purpose

The majority of interviewers and interviewees indicated that it took time to ensure to set the scope of the interview and ensure that, during the interview, this scope was consistently being applied. The interview-based metrics are designed to be generic and require tailored questioning in relation to the interviewee but also in relation to the context of each Living Lab. For instance, one of the metrics assesses policy instruments. To properly score such a metric, it should be clarified which policy areas or specific policies are relevant within the context of the activities in a living lab. Accordingly, it is relevant to explain, the overall objective of the B-WaterSmart framework and the frequency of monitoring prior to the interview. One specific point of attention is that the metrics assess the current state of affairs and not future plans or ambitions. In fact, the metrics are designed to monitor progress on the realization of such plans and ambitions. These aspects can be clarified in a preparatory meeting. In addition, the type and nature of the questions can already be briefly shared in order to help to interviewee to prepare answers and provide specific examples.

- Improvement 1: The guideline now includes a mandatory preparatory meeting and topics to discuss in this meeting prior to each interview.

Suggestion 2: Selection of interviewees

During the testing phase only a small group consisting of two or three Living Lab representatives have been interviewed. The total number of metrics has been divided amongst them to fit the profile and expertise of each interviewee. Consequently, there was little opportunity to cross-check statements with different interviews or with desk study and policy analysis. Let alone, that the information and perspectives of various stakeholders could be taken into account during this testing phase. The interviewers and interviewees noted these limitations and at times interviewees considered themselves not eligible to answer each question and they also raised points of the danger of getting biased information. Put differently, the answer you get depend largely on who you ask at what time. The interview guide in the Appendix D provides a detailed description of a standardized stakeholder analysis and interview selection. However, the point of who to interview within an organization remains challenging and deciding who is eligible to be interviewed with respect to which metric various from on organization to another. Advice that is to make the interview selection a group decision.

- Improvement 2: Advice included to make the interview selection in the organization(s) of the living lab owners based on a group decision.

Suggestion 3: Selection of interviewer

Many interviewees and interviewers emphasized the need for a well-qualified interviewer with sufficient experiences and skills in conducting interviews and who is well-acquainted with the questions and content. Figure 12 also reflects this point. The availability of qualified staff to conduct interviews on a regular basis (i.e., yearly) is considered the main challenge in collecting data within and beyond the project. During the testing phase, a group of scientists each with different expertise have conducted the interviews. This variety of interviewees was intentionally, because for the metrics to be broadly applicable during and beyond the testing phase, the instructions provided need to be sufficient to enable a broad group of professionals affiliated to the living labs. During the interactive session it was commonly agreed that the interviewer is preferably independent (outside the organization of the living lab owner) or, alternatively, the scores are decided by a group of about five people with varying expertise and roles within the organization of the living lab owner. There was also the suggestion to provide a description of qualifications of an interviewer to support the selection of the most capable interviewers in the future.

- Improvement 3: Suggestion on selection on qualifications for the selection of the most capable interviewer is incorporated in the guideline (see box 1).
- Improvement 4: In the guideline, two options are provided to determine the overall metric score.
    - Option 1: at least 10 interviews by an independent interviewer outside the organization of the living lab owner(s) who is responsible for the scoring and justification of the scoring.
    - Option 2: with less than 10 interviews a group of about five people with various expertise and roles in the organization(s) of the living lab owners are jointly responsible for the scoring and justification of the scoring.

In this way, the legitimacy and reliability of the scores are ensured within the context of limited resources to conduct interviews.

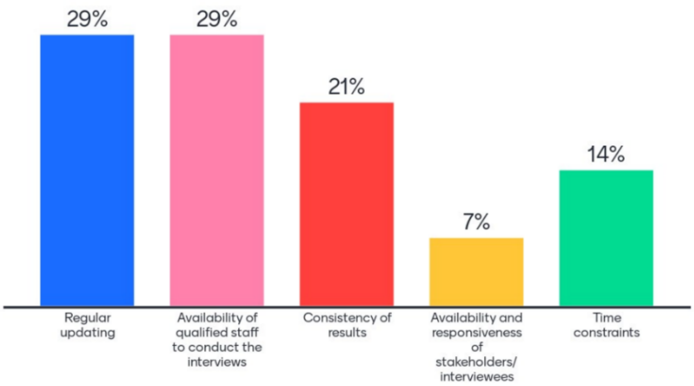

Figure 12 – Ranking of the six living lab representatives with respect to the main challenges in collecting data for the interview-based metrics. Data acquired using anonymous software (Mentimeter) during an online session at 01-02-2023

Text box 1 Generic description of the qualifications of an interviewer or members of a group of interviewers responsible for conducting interviews and determining the metric score and justification in the most unbiased way possible.

Interview qualifications
An interviewer has preferably the following set of skills an experience: She or he has professional experience with conducting interviews. Has at least five years of experience in the water sector and adjacent fields such as circular systems or climate adaptation, as a scientist of practitioner. Is reasonably acquainted with the process and activities within the Living Lab. Is able to have a broad overview by having a generic understanding of technical knowledge, practical processes and scientific data collection and validation processes. Able to critically reflect and communicate from a broader societal perspective beyond a specific organisation or interest. The interviewer is a particular good listener with adequate reporting skills and is knowledgeable of privacy regulation and how to deal with request for anonymity by interviewers (if applicable). Interviewer is being recognised by the management team of the organisation providing the interviewer as being well-qualified for the task and is aware of political sensitivities or potential reputational damage.

Suggestion 4: Ensuring accuracy

It was noted that the set of metrics enables living labs to identify data gaps and support actions to better account for this. Hence, it was suggested to add an accuracy label for each metrics indicating how confident the independent researcher or group of experts is about the scoring accuracy. This label can be according to a traffic light model and is visible of everyone viewing the results.

- Improvement 5: Add accuracy label for each metric according to traffic light model:
    - Green: Confident of validity and legitimacy of score. Multiple interviews and stakeholders provide similar information. Statements are further supported by policy documents, plans or other written information.
    - Grey: sufficiently confident of the validity and legitimacy of score. Most interviews and stakeholders provide similar information. No strong discrepancies. Limited number of interviews (<3 interviews for a single metric) or limited number of policy documents plans or other written information that can support interview statements.
    - Red: More information, monitoring or discussion (with stakeholder) is necessary to improve the score accuracy of this metrics.

One living lab specifically emphasized that getting reliable data - also throughout the monitoring phase – requires a well standardized data-gathering procedure. Appendix D now provides a detailed standardized procedure for the interview process if it is performed by an individual or duo of independent researchers as well as some general guidelines if the scores are determined by a group people with different expertise and roles within the organization(s) of the living lab owner.

- Improvement 6: Detailed standardized procedure for conducting interviews is provided in the Appendix D.

Suggestion 5: Provide generic instructions for conducting interviews

When considering the continued application of the interview-based process as a way of monitoring process towards water smartness in the living labs, providing generic interview instructions was identified by all the sessions' participants as crucial. Hence, beyond the overall qualifications of the interviewer(s) provided in box 1 an additional 10-point guideline for conducting the interviews is provided (see pages 328 and 329 in the Appendix D).

8 BWS V_2 versus V_0 and V_1

The modifications of the metric between V_0/V_1 and V_2 are shown in Table 17. The changes are the results of the process described in sections 6 and 7.

Metric V0 or V1		Keep the metric	Remove the metric	Adapt the metric	For context information	Metric V2	
A.1.1	Water resource exploitation index, plus (WEI+)				x	A.1.1	Water exploitation index, plus (WEI+)
A.1.2	Alternative water resource exploitation index (AWEI)		x			-	-
A.1.3	Safe drinking water	x				A.1.2	Safe drinking water
A.1.4	Compliant reclaimed water	x				A.1.3	Compliant reclaimed water
A.1.5	Security and resilience index – drinking water (DW)			x (merged in one)		A.1.4	Security and resilience index
A.1.6	Security and resilience index – wastewater (WW)		x (merged in one)			-	-
A.2.1	Physical access to water supply (households and small businesses)	x				A.2.1	Physical access to drinking water supply for households and small businesses
A.2.2	Physical access to water supply in public spaces for quality of life	x				A.2.2	Physical access to drinking water supply in public spaces for quality of life
A.2.3	Physical access to water supply (industrial use)	x				A.2.3	Physical access to water supply for industrial use
A.2.4	Agriculture area with access to water for irrigation			x (to include gardens, ref. values)		A.2.4	Physical access to water for irrigation
A.2.5	Number of points with potential conflicts of water use		x			-	-
A.3.1	Consumer willingness to pay	x				A.3.1	Consumer willingness to pay
A.3.2	Affordability	x				A.3.2	Affordability

Metric V0 or V1		Keep the metric	Remove the metric	Adapt the metric	For context information	Metric V2	
A.3.3	Financial continuation	x				A.3.3	Financial continuation
-	-	New				A.3.4	Cost coverage ratio
B.1.1	EFR compliance rate			x (equation and ref. values)		B.1.1	Environmental flow requirement compliance rate
B.1.2	Effective stormwater treatment	x				B.1.2	Effective stormwater treatment
B.1.3	Effective wastewater treatment	x				B.1.3	Effective wastewater treatment
B.2.1	Benefits from regulating services (water quality)			x (the name)		B.2.1	Water body self-purification
B.2.2	Maintaining nursery populations and habitats	x				B.2.2	Maintaining nursery populations and habitats
B.2.3	Regulation of extreme events	x		x (the name, equation and ref. values)		B.2.3	Flood damage prevention
B.2.4	Water provision by ecosystem	x				B.2.4	Water provision by the ecosystem
B.2.5	People enjoying cultural ecosystem services	x				B.2.5	People enjoying cultural ecosystem services
B.3.1	Water Footprint for drinking water			x (merged in one)		B.3.1	Water footprint
B.3.2	Water Footprint for wastewater		x (merged in one)			-	-
B.3.3	Carbon Footprint for drinking water			x (merged in one)		B.3.2	Carbon footprint
B.3.4	Carbon Footprint for wastewater		x (merged in one)			-	-
B.3.5	Energy consumption	x				B.3.3	Energy consumption
B.3.6	Drinking water consumption			x (the ref. values)		B.3.4	Drinking water consumption

Metric V0 or V1		Keep the metric	Remove the metric	Adapt the metric	For context information	Metric V2	
C.1.1	Statutory compliance	x				C.1.1	Statutory compliance
C.1.2	Preparedness	x				C.1.2	Preparedness
C.1.3	Policy instruments	x				C.1.3	Policy instruments
C.1.4	Green public procurement				x	C.1.4	Green public procurement
C.1.5	Level of ambition	x				C.1.5	Level of ambition
C.2.1	By-products recovery revenues	x				C.2.1	Resource recovery revenues
C.2.2	Green jobs	x				C.2.2	Green jobs
C.2.3	Circular economy business models in practice	x				C.2.3	Circular economy business models in practice
C.3.1	Water-related materials recovery	x				C.3.1	Water-related materials recovery
C.3.2	Fertilizer production avoided	x				C.3.2	Fertilizer production avoided
C.3.3	Sludge beneficial use		x			-	-
C.3.4	Water consumption from other sources		x			-	-
C.3.5	Reclaimed water use			x (the name, equation and ref. values)		C.3.3	Reclaimed water in non-potable uses
C.3.6	Reclaimed water production	x				C.3.4	Reclaimed water production
C.3.7	Energy production	x				C.3.5	Energy production
D.1.1	Infrastructure Planning Index for Adaptive Change	x				D.1.1	Infrastructure planning index for adaptive change
D.2.1	Infrastructure Value Index	x				D.2.1	Infrastructure value index
D.2.2	Infrastructure Implementation Index for Adaptive Change	x				D.2.2	Infrastructure implementation index for adaptive change
D.3.1	Linear water losses	x		x (the ref. values)		D.3.1	Linear water losses
D.3.2	Water storage capacity			x (to include rainwater, the ref. values)		D.3.2	Water storage capacity
D.3.3	Water retention		x			-	-

Metric V0 or V1		Keep the metric	Remove the metric	Adapt the metric	For context information	Metric V2	
D.3.3	Incident occurrences	x				D.3.3	Incident occurrences
D.3.4	Combined Sewer Overflows	x				D.3.4	Combined sewer overflows
D.3.5	Time for restoration	x				D.3.5	Time for restoration
D.3.6	Level of autonomy (of infrastructure)	x				D.3.6	Level of autonomy (of infrastructure)
D.3.7	Level of redundancy	x				D.3.7	Level of redundancy
D.3.8	Treatment capacity utilization	x				D.3.8	Treatment capacity utilization
E.1.1	Knowledge and education	x				E.1.1	Knowledge and education
E.5.1	Information availability and use			x		E.1.2	Information availability and use
E.1.2	Local sense of urgency	x				E.1.3	Local sense of urgency
E.1.3 E.1.4	Hydrocitizenship Discourse embedding			x		E.1.4	Water smart culture
E.4.1	Smart monitoring			x		E.1.5	Smart monitoring
E.2.1	Clear division of responsibility					E.2.1	Clear division of responsibility
E.2.2	Network Cohesion		x			-	-
E.2.3	Authority					E.2.2	Authority
E.2.4	Room to maneuver					E.2.3	Room to maneuver
E.3.1	Stakeholder inclusiveness	x				E.3.1	Stakeholder inclusiveness
E.3.2	Protection of core values	x				E.3.2	Protection of core values
E.3.3	Progress and variety of options		x			-	-
E.4.3	Cross-stakeholder learning			x		E.3.3	Cross-stakeholder learning
E.3.4	Collaborative agents	x				E.3.4	Collaborative agents
E.4.2	Evaluation		x			-	-
E.5.2	Information transparency and sharing		x			-	-
E.5.3	Knowledge cohesion		x			-	-

Table 17 – Metric changes between V_0/V_1 and V_2

9 Assessing the results and outcomes of WP6 versus the contractual mandate

D6.3 ends the work performed by WP6 in B-WaterSmart. In the following table, the level of alignment of the work performed by WP6 with the Description of Work (DoW) of each task is provided, as a final overview of the results achieved.

T6.1 in DoW	**How we have addressed it**
The task will provide a B-WaterSmart definition of "watersmartness" not yet available in the literature, as well as set the theoretical foundation of the water-smartness assessment framework.	D6.1, first deliverable of WP6, has achieved the two specific goals: 1) to provide the definition of "water-smart society" (contributing to KPI7); 2) to provide the preliminary theoretical concept and design of the B-WaterSmart framework, which reflects the formulated definition, and it supports the creation and implementation of strategic plans to achieve the water-smart society vision.
The framework will be created by setting requirements defined by the six LLs. Therefore, the task includes an end-user consultation with the LL problem-owners (facilitated by T1.5) to provide the preliminary requirements.	To achieve the two goals of the deliverable and task, the same methodological approach was followed: the literature review findings have been combined with LL owners' inputs and feedback collected through a series of interviews and workshops. The methodological approach is detailed in D6.1.
D6.1 will also include guiding information to be used by WP2, 4 and 5 on how to select and define the indicators to be provided to T6.2 by M15 (MS13).	This requirement is covered by section 6 of D6.1 and specifically by 6.7 which provides guidance on how to define metrics addressing specifically WP2, 4 and 5. Furthermore, the first action of the following T6.2 has been to organize a training workshop, under WP1 umbrella, to guide WP2, 4 and 5 towards the creation of MS13.
T6.2 in DoW	**How we have addressed it**
We will develop a holistic framework to assess water-smartness at different scales of operational environments (local, city, metropolitan, regional, or national).	The objective – driven framework is built with a tree-model: strategic objective-assessment criteria – metrics. D6.1 sets the scope of the framework which is to support the strategic decision level. Meaning supporting decisions to reach the vision of a water-smart society in the long term. The framework supports strategic decisions at different scales of operational environment. The user can select and assess the metrics, criteria and objectives depending on the spatial scale of interest.

Based on T6.1, we will develop the evaluation framework that links qualitative and quantitative indicators to assess water-smartness, including technical (WP2), circular economy (WP4) and governance and social aspects (WP5).	The metrics composing the BWS AF are of different nature (quantitative and qualitative) with different assessment methods required: Performance Indicators, Performance Indexes-questionnaire based and Performance Indexes – interview based. The metrics build on the inputs from WP2, 4 and 5 (from MS 13), but extensive work has been performed by WP6 to aggregate, polish and filter them to avoid overlaps. Each strategic objective covers different aspects, e.g., technical, circular economy, and governance, depending on the related assessment criteria and corresponding metrics (see D6.2, D6.3, Table 3).
The framework will support the steps of diagnosis (baseline), priority setting, assessment of alternatives scenarios, and monitoring of performances through the list of selected indicators.	An iterative six-step process, covering the steps mentioned in the DoW for continuously improving the transition process to a water - smart society is proposed as deployment methodology of the Framework. In D6.1 and D6.2, the description of how to use the framework in performing the steps is provided and further defined in D6.3 as chapter 4. Within the B-WaterSmart project, the steps are performed, up to the preparation of a strategic plan, by the InAll under Task 1.4, as methodology to test the ability of the framework in supporting strategic planning. To facilitate the water smartness assessments, WP6 has developed the so called FAST tool, to provide the InAll with an easier way to navigate through the objectives, criteria and metrics, enter data and make preliminary assessments and to provide feedback to T6.2, through embedded feedback forms, after a “test-drive” of the objectives-criteria and metrics proposed. The work performed to design the FAST tool, and the lessons learnt from a technical point of view are shared with T3.9 (in chapter 9 of D6.2, but also through bilateral meetings). It has to be noted that T1.4 is strongly related to T6.2, T6.3 and T3.9. The InAlls tested the framework and provided feedback for its improvement from version V_0 to version V_1 and V_2. T6.2 and T6.3 provide the content of the framework, explain the six-step deployment approach and provide recommendations and

	lessons learnt from the developers of FAST and the users (the InAll) to T3.9. The actual use of the assessment framework as management support tool is planned to be achieved with the use of the dashboard as software tool (see task 1.4 description in the DoW), therefore FAST has been conceived only as a temporal tool.
It will help to identify measures and solutions towards water-smart economies and societies, by estimation and comparison of metrics covering the technical (level of performance), economic (e.g., affordability of a solution within a CE context), social (e.g. equity, governance, participation, social maturity, job creation), environmental impact (e.g. GHG emissions, life cycle assessment) and risk (e.g. related to impact of potential threats induced by water reuse) dimensions.	The framework with the list of objectives, criteria and metrics proposed has been built to support decisions to meet the vision of a water-smart society. In FAST, the possibility to run comparisons is provided to facilitate the testing of the framework instead of doing it manually with multiple excel files (as originally planned for WP6). This is done by the user by selecting objectives, related criteria, and metrics for each assessment. Assessment's management happens at the user level: each user can create as many assessments as wished. Each assessment reflects defined scenarios and alternatives or just the baseline (i.e., how are we performing today?). When editing an assessment, the different sections are split into tabs. The first tab presents the framework used and allows the user to select which metrics to use (they can be individually selected). When filling in an assessment, results can be visualized live: as soon as all the required fields are filled, the metric's value will be calculated, and the "score" will be updated. The FAST application adopts the traffic light approach for visualizing the calculated values for the metrics against reference values. Aggregated results are also calculated (at assessment criteria and strategic objective level) and can be visualized on the assessment main page. At the end of each assessment the user can create a final report. The FAST application also has a way to export the results as a PDF report or downloaded as JSON to further process the data. Comparisons across assessments have to be done "manually" using the data from each assessment (JSON files).

	In FAST is possible to work with individual assessments only, but the dashboard will allow directly comparing the results of different assessments. [Most of the text above comes from section 9.1.2 of D6.2].
A key feature will be to assess short- to mid-term gains in water-smartness achieved by technology and management, as well as to provide a roadmap for water-smartness in the context of the UN SDGs (2030 and onwards).	The DoW presents here examples of application of the framework. However, a clarification might be required. The framework does not assess the “water smartness level” of a single technology or of a single management decision since it is designed as to support only the strategic level (this is set as starting point of designing the framework in D6.1). Still, the aggregated impact of alternatives actions, that can be set by the users as part of a strategic plan, can be tested. For instance, the strategic planning can identify the need to create new circularities, switch to new processes, promote water reuse and the effect those changes can have should be reflected at aggregated level for the assessment of the corresponding relevant metrics of the framework. This is what can be done with the BWS assessment framework, as strategic tool. The gains can be assessed (in aggregated level) possibly also for short and medium term as long as the user can measure the variables affected for the assessment of the selected metrics for the set time horizon (although, it is proposed that one assessment should have the same time horizon for all the metrics). In the same way, the roadmap in the context of SDGs is an example of possible use of the framework. SDGs are reflected by multiple metrics, criteria and objectives of the framework.
Task 6.2 will be developed in collaboration with WP3, for the architecture requirements and the development of the dashboard version (T3.9), as well as WPs 2, 4 and 5 for the definition of indicators. By M15, WP2, WP4 and WP5 will deliver the indicators (MS13), based on the requirements set in D6.1.	About T3.9: as said above, the work performed to design the FAST tool and the lessons learnt from a technical point of view are shared with T3.9 (in chapter 9 of D6.2 but also through bilateral meetings). About WP2, 4 and 5: WP6 received MS13 and revised towards improvement and alignment the inputs on metrics received. Also, further refinement of metrics under WP6 is done by dedicated sub-groups of experts: metrics have been clustered, and responsibilities distributed based on members’ expertise and including WP2, 4 and 5 leaders.

At M19, T6.2 will provide T1.4 with the preliminary version of the framework (Prototype V0) (MS16) to be tested by M24; during M19-24, T6.2 will continue to develop the Prototype in iteration with T1.4 and set the architectural requirements for T3.9.	This is implemented according to DoW, but T6.2 continued until M26 (instead of M24). Also, it has to be clarified that as prototype we do not intend a software. The software is created in T3.9, based on the work described above and the requirements provided by WP6 and T1.4.
T6.2 ends with the Prototype version V1, (D6.2) which will be refined in T6.3 and converted into the dashboard by T3.9.	V_1 has been submitted at M26, as D6.2 (contributing to KPI7).
T6.3 in DoW	**How we have addressed it**
The feedback from T1.4 will be provided by M24 and used in T6.3 for refining the framework (V1), specifically on the type and definition of the indicators in relation to the technologies applied by the different LLs; the outcome of T6.3 will be the final version of the prototype (V2) (D6.3, M30), to be developed into the dashboard module in WP3 (T3.9) and therefore applied as a management support tool.	The work performed in T6.3 to deliver the last version of the framework is described in this D6.3. Main activities have been to: - revise the metrics, related variables, and reference values, based on set criteria and the feedbacks of the InAll. - cluster the metrics in “core” metrics and “additional ones” including interaction with the InAll, based on their specific challenges and vision of a water-smart society. - provide a guidance on the use of the framework including lessons learnt from T1.4. - provide a final guide on how to run interviews (beyond the project) based on the lessons learnt during the process. Ideally, it would have been useful to include in D6.3 examples of applications of the framework from the InAll as different use cases, but the task was premature considering the InAll had to work with a framework under development. Possibly, use cases can be performed to support the development of the dashboard (T3.9) under the testing activities planned in T1.4.

10 Key conclusions and outlook

With D6.3 ends the work of WP6 in the B-WaterSmart project.

D6.3 presents the results of Task 6.3 and the work performed to refine the B-WaterSmart assessment framework based on the feedbacks documented in D6.2 and D1.3 (related to Task 1.4).

D6.3 is composed of an excel file, embedding all the elements of the final version (V2) of the Framework, and this document is structured in two parts. Part I presents the framework and guidance for its use, while Part II gathers all the information related to the activities performed and the adopted development process. The structure of the document has been designed with the intention to extract Part I, upon approval of the deliverable by the EC after review, as a separate module for wide distribution via the project website together with the excel file to maximize the dissemination and impact of the knowledge created.

The final version of the BWS AF consists of 5 strategic objectives, 15 assessment criteria and 60 metrics (47 core metrics) providing a framework for the establishment of tailored assessment system.

The result is grounded on the adopted definition of water-smart society (Figure 13) and the design requirements provided by Task 6.1 through extensive literature review and collaboration with the six LLs of the project.

The definition invites to consider that to be transformative, the concept of "water-smart society" should include societal well-being and co-development including citizens and actors across different disciplines and sectors. Moreover, it emphasizes the need for a long-term perspective, conserving ecosystems and maximizing their services to society, while anticipating change and adapting existing infrastructure.

The conceptualization of a water-smart society can guide utility policy, and its implications for capacity building, collaboration, and strategic management.

By transposing the definition into five strategic objectives, WP 6 (Task 6.2) has therefore made a first step towards operationalising it into an objective-driven assessment framework able to assist decision makers and practitioners in their strategic planning process towards the realization of their water-smart society vision. Through an intense process of co-creation established in different directions (with the LLs, the InAll, and among the interdisciplinary expertise within WP6) and across WPs (mainly with WP1, 2, 4 and 5), three versions of the prototype have been produced until this final version.

The next steps, within the project, will be to transfer the knowledge created to T3.9 which will embed the content of the framework into a dashboard that will be a management support tool providing more advanced functionalities to guide the user in developing strategic plans; the design of the dashboard will also benefit from the lessons learnt shared by the developers (SINTEF) of the provisional web-application (FAST) created to facilitate the validation process under T1.4.

From an innovation point of view, the WP6 team will pursue opportunities to test the framework for multiple use cases, even beyond the project, in order to create a library of examples of possible ways to adopt the framework for different user needs. In fact, we believe that different users can further inform our work besides the already envisaged scope and adoption methodology we have proposed. Good examples will be retrieved to support the development of the dashboard (T3.9) under the testing activities planned in T1.4. Furthermore, through collaboration with WP4, it is planned to further link the BWS AF with the study, under WP4, on the EU Taxonomy. The interest is to identify new opportunities to use selected metrics proposed by WP6 to also document taxonomic compliance and gather eventual valuable outcomes of the study as recommendations in a policy brief by the end of the project.

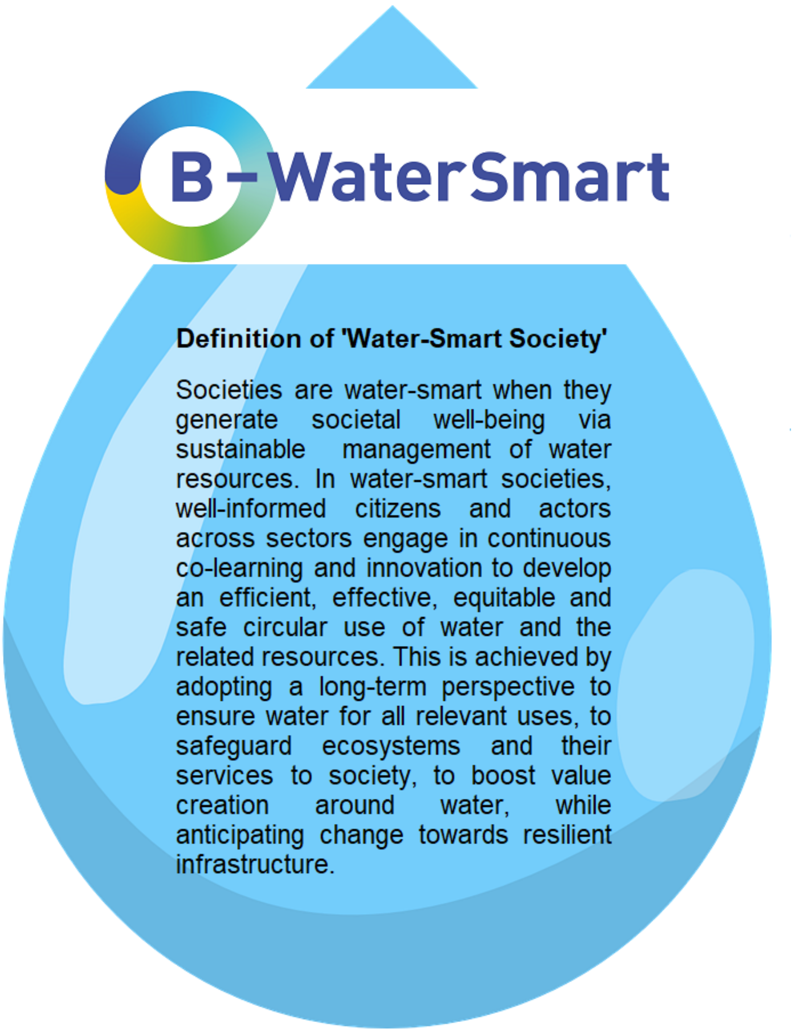

Figure 13 – WaterSmart society as defined by task 6.1 (Ugarelli et al., 2021)

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Appendix A – Key definitions adopted in the B-WaterSmart Assessment Framework

A.1 Definitions related to the content of the Framework

Strategic Objectives are the goals that the organization aims to achieve. Objectives have to be clear and concise, as well as ambitious, feasible and compatible, and take into account the ultimate goal for the utility of achieving the "water-smart" vision. The strategic objectives must reflect the transition features of how becoming a water-smart society. For each objective, it is recommended that key assessment criteria are specified.

Criteria are points of view that allow for the assessment of the objectives. For each criterion, metrics must be selected in order for targets to be set, and for further monitoring of the results.

Metrics are the specific parameters or functions used to assess criteria quantitatively or qualitatively; metrics can be indicators, indices or levels:

Performance indicators are metrics of efficiency or effectiveness and consist of a value expressed in specific units. Performance Indicators are typically expressed as ratios between variables; these may be commensurate (*e.g.,* %) or non-commensurate (*e.g.,* $/m^3). Performance indicators should be characterized with a confidence grade which indicates the quality of the data represented by the indicator.

Performance indices are quantitative, commensurate metrics incorporating an intrinsic judgment of performance in their formulation. They may result for instance from the combination of more disaggregated performance measures (*e.g.,* weighted average of performance indicators), from analysis tools (*e.g.,* simulation models, statistical tools, cost efficiency methods) or from scoring systems.

Performance levels, which are performance metrics of a qualitative nature, expressed in discrete categories (*e.g.,* good, fair, poor).

A.1.1 Complementary definitions

A performance assessment system comprises a set of performance assessment metrics and related data elements that represent real instances of the undertaking context. The classification of these data elements depends on the active role they play:

Variables: A variable is a data element from the system that can be combined into processing rules in order to define the performance assessment metric. The complete variable consists of a value (resulting from a measurement or a record) expressed in a specific unit, and its reliability level that indicates the quality of the data represented by the variable.

Context information: Context information are data elements that provide information on the inherent characteristics of an undertaking and account for differences between systems. There are two possible types of context information:

Information describing pure context and external factors to the management of the system. These data elements remain relatively constant through time (demographics, geography, *etc*.) and in any case are not affected by management decisions.

Some data elements on the other hand are not modifiable by management decisions in the short or medium term, but the management policies can influence them in the long term (for instance the state of the infrastructure of the utility).

Context information is especially useful when comparing indicators from different systems.

A.2 Key definitions related to the six-steps adoption methodology of the B-WaterSmart Framework

Reference values are the judgement of what good, fair and poor is for each metric for the stakeholders across the board. This judgement shall be established independently from the specific cases and be as stable as possible over time.

Targets are the actual proposed values to be achieved for each metric and specific case within a given time frame (short, medium or long term).

Scenarios are defined by factors (isolated and/or combined) not controlled by the decision maker, but which may influence the analysis and should therefore be considered (*e.g.,* demographic trends, regulatory changes, climate projections). It is not recommended to select more than two scenarios to avoid increasing the decision problem complexity. The scenarios are used to deal with uncertainties about the future; although they do not represent a complete description of the future, they can help to highlight central factors to be considered in the decision-making process. The factors come into the decision process since the "Water Domain" is not “standalone”, but it interacts with other domains (government, regulators, users and communities, environment,…) that can impose factors influencing the water domain performances; this implies that decisions made in and about the other domains will also have impacts on the water domain and should be taken into consideration, *e.g.,* decision taken in other domains can impact the achievement of the LL strategic objectives.

Alternatives relate to the candidate decisions the organization/decision maker may take to achieve the strategic objectives and of which it has control upon. Alternatives can refer to alternative technological solutions, but also management practices, awareness campaigns, communication, policies influence, *etc*.

Appendix B – List of variables adopted in BWS AF, V_2

Variable	Definition	Units	For Metrics
Category: "Water volume data"			
WU	Water use = Abstraction - Return	km^3/year	A.1.1
RWR	Renewable water resources = Outflow + (Abstraction-Return) - change in storage	km^3/year	A.1.1
EFR	Environmental flow	km^3/year	A.1.1
W_t	Water available for abstraction from the ecosystem in year t	million m^3/year	B.2.4
W_{t-1}	Water available for abstraction from the ecosystem in the previous year t-1	million m^3/year	B.2.4
Q_s	Yearly average inflow entering the supplied system	m^3/day	D.3.2
DWP	Annual drinking water production	m^3/year	B.3.1, B.3.2, B.3.3, B.3.4
V_{OU}	Annual water consumption for other use than domestic use (public, industrial, etc.)	m^3/year	B.3.4
V_{loss}	Annual water losses	m^3/year	B.3.4, D.3.1
$Q_{max-30dw}$	Daily average water flow of the 30 consecutive days with highest production	m^3/day	D.3.8
$Q_{max-30ww}$	Daily average wastewater flow of the 30 consecutive days with highest inflows	m^3/day	D.3.8
TWW	Volume of wastewater treated	m^3/year	B.1.3, B.3.1, B.3.2, B.3.3, C.3.4
$V_{Treatment}$	Volume of treated wastewater complying with legal requirements	m^3/year	B.1.3
$V_{reclaimed}$	Volume of reclaimed water produced in a reclamation facility under the responsibility of the utility, and which is transferred to other entities for use or for its own uses (exclude the recirculation or recycling of water, when it occurs in a closed circuit within one or more processes)	m^3/year	C.3.4
RW	Volume of reclaimed water used for different scopes (e.g., irrigation, street cleaning)	m^3/year	C.3.3
npW	Total volume of water used for non-potable uses, from all sources, including reclaimed water	m^3/year	C.3.3

Variable	Definition	Units	For Metrics
Category: Physical assets data			
L_{net}	Total length of the supply and distribution pipelines	km	D.3.1, D.3.3
V_t	Total operational volume of storage tanks for the considered system	m^3	D.3.2
N_{CSO}	Number of active CSO devices in the assessment year	No.	D.3.4
Q_{TCdw}	Daily treatment capacity of water treatment	m^3/day	D.3.8
Q_{TCww}	Daily treatment capacity of wastewater treatment	m^3/day	D.3.8
Category: Operational data			
$ne_{totalDW}$	Total number of samples of drinking water with exceedance, *i.e.*, sum of samples with microbial, chemical and indicator parameter exceedance	No./year	A.1.2
$n_{totalDW}$	Total number of drinking water samples analyzed in assessment period	No./year	A.1.2
$ne_{totalRW}$	Total number of samples of reclaimed water with exceedance, *i.e.*, sum of samples with microbial, chemical or indicator parameter exceedance	No./year	A.1.3
$n_{totalRW}$	Total number of reclaimed water samples analyzed in assessment period	No./year	A.1.3
$H_{<EFR}$	Amount of time (hours) during a year in which EFR is not achieved	h/year	B.1.1
H_{annual}	Total number of hours per year	h/year	B.1.1
A_{Total}	Total potential stormwater pollution area identified	m^2 or ha	B.1.2
NPC_{entry}	Sum of N, P and C entry to the water body	ton/year	B.2.1
$NPC_{retention}$	Sum of N, P and C retention capacity	ton/year	B.2.1
WF_{dw}	Water footprint in the drinking water system	m^3/year	B.3.1
WF_{ww}	Water footprint in the wastewater system	m^3/year	B.3.1
CF_{dw}	Carbon footprint in the drinking water system	kg CO_2 eq/year	B.3.2
CF_{ww}	Carbon footprint in the wastewater system	kg CO_2 eq/year	B.3.2
E_{dw}	Total energy used in the drinking water system (all processes)	kWh/year	B.3.3, C.3.5

Variable	Definition	Units	For Metrics
E_{ww}	Total energy used in the wastewater system (all processes)	kWh/year	B.3.3, C.3.5
E_{re}	Energy produced from water treatment or waste recovery processes	kWh/year	C.3.5
$W_{i,re}$	Material recovered	kg/year	C.3.1
$W_{i,in}$	Total potential recoverable material entering the treatment process or activity (including materials that are added and recovered during the process, e.g., catalysts)	kg/year	C.3.1
$N_{i,re}$	Nutrient recovered used as a fertilizer	kg/year	C.3.2
$N_{i,in}$	Total nutrient used as a fertilizer	kg/year	C.3.2
R_i	Number of registered incidents per year	No./year	D.3.3
CSO_r	Yearly total number of registered CSOs of the considered organization	No./year	D.3.4
$TR_{i,j}$	Maximum recorded time of restoration (out-of-service duration + recovery time)	days	D.3.5
Category: Demography and users attributes data			
NH_{Total}	Total number of households (and / or small business) in the area (specified by the user)	No.	A.2.1
Area	Total area served by the fountains or other points of public consumption in public spaces (area to be specified by the user)	km^2	A.2.2
NI_{Total}	Total number of industries requiring the service in an area (area to be specified by the user)	No.	A.2.3
$A_{ir\ Total}$	Total irrigated area (area to be specified by the user)	ha	A.2.4
WA	Overall water area of the whole catchment	km^2	B.2.2
AP	Number of people from the catchment area using the water system for recreational activities each year	No.	B.2.5
I	Inhabitants living in the catchment area	No.	B.2.5
P_{Total}	Number of total residents	No.	B.3.4
Category: Quality of service data			
$NH_{Connect}$	Number of households (and / or small business) that are connected to the service	No.	A.2.1

Variable	Definition	Units	For Metrics
N_{WAP}	Number of operational fountains and other points of public consumption in public spaces	No.	A.2.2
$NI_{Connect}$	Number of industries that are connected to the service	No.	A.2.3
$A_{Connect}$	Area of land irrigated with freshwater, reclaimed water and/or rainwater	ha	A.2.4
$A_{Treatment}$	Area of identified potential stormwater pollution areas where suitable treatment is implemented	m^2 or ha	B.1.2
$WA_{\geq good}$	Water area with a good ecological status or better	km^2	B.2.2
AP_{today}	Affected people by a flood event according to today's GIS-data and flood risk maps	No.	B.2.3
$AP_{reference\ year}$	Affected people by a flood event in the reference period	No.	B.2.3
C_{AS}	Number of customers covered by infrastructure dependent on other services with autonomy (back-up) solutions	No.	D.3.6
C_{OS}	Number of customers covered by infrastructure dependent on other services	No.	D.3.6
C_{RS}	Number of customers covered by infrastructure with redundant solutions	No.	D.3.7
C_{TOT}	Total number of customers served by infrastructure	No.	D.3.7
Category: Business and financial data			
PP_{GC}	Number of core green contracts	No.	C.1.4
$PP_{tot\text{-}C}$	Total number of public procurement contracts	No.	C.1.4
N_{GJ}	Number of new created, converted, maintained green jobs on a yearly basis	No./year	C.2.2
N_J	Total number of created, converted, maintained jobs on a yearly basis	No./year	C.2.2
BM_C	Number of new and modified circular economy business models put into practice during a period of time (yearly frequency is suggested)	No.	C.2.3
BM_{tot}	Number of total business models (new and existing) during the same period of time considered for the BMc	No.	C.2.3
R_{BP}	Yearly revenue generated from by-products recovery, around water due	€/year	A.3.4, C.2.1

Variable	Definition	Units	For Metrics
	to water reuse (avoided consumption, water selling) and from by-products recovered from wastewater treatment (salt, fertilizer, energy selling or avoided consumption, etc.)		
R_{tot}	Total revenues in the scope of the organization	€/year	C.2.1
C_{tot}	Yearly total costs excluding the investment subsidized	€/year	A.3.4
ICV	Infrastructure current (fair) value	€	D.2.1
IRC	Infrastructure replacement cost	€	D.2.1

Appendix C – Reference values

C.1 Justification of reference values for each metric

A.1.1 Water exploitation index, plus (WEI+) (%)

Strategic objective: A. Ensuring water for all relevant uses

Assessment criteria: A.1 Safe and secure fit-for-purpose water provision

National or European legislation	- None directly (Germany and EU) but the WFD aims to ensure a sustainable use of freshwater resources. - EU roadmap to a resource efficient Europe: Milestone for 2020 to limit water abstraction to below 20% of available renewable freshwater resources - Portuguese Law DL76/2016 establishes 4 classes of WEI+ to classify water scarcity (%): without scarcity [0-10[; low [10-20]; moderate]20-40]; severe >40 - Portuguese Environmental Agency updated study (2021) establishes 6 classes of WEI+ to classify water scarcity (%): without scarcity [0-10[; low [10-20[; moderate [20-30[; high [30-50[; severe [50-70[; extreme > =70	**Integrated analysis to derive the reference values for good, fair and poor performance** ● **good [0; 20[** ● **fair [20; 40[** ● **poor [40; +∞[**
Regulation or standardization	Absence of Europe-wide agreed formal targets	
Strategic plans	Global target (SDG 6.4: By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity. Generally considered are following indications: WEI+ > 20% = water scarcity, WEI+ ≥ 40% = severe water scarcity, i.e. the use of freshwater resources is clearly unsustainable. (EEA, Water exploitation index, plus (WEI+) (source: EEA) - Products Datasets - Eurostat (europa.eu))	
Theoretical concepts and technical requirements		
Literature reviews on best practices	Part of the set of water indicators published by several international organisations (FAO, OECD, Eurostat, Mediterranean Blue Plan) - WEI > 20% (Water scarcity), WEI > 40% (Severe water scarcity) (Raskin et al. 1997) - 60% reduction in annual total run-off would cause environmental water stress (Smakhtin et al. 2004) Casadei et al. (2020) on computation method.	
Statistical analysis of the metric values		

A.1.2 Safe drinking water (%)

Strategic objective: A. Ensuring water for all relevant uses

Assessment criteria: A.1 Safe and secure fit-for-purpose water provision

National or European legislation	- COUNCIL DIRECTIVE 98/83/EC quality of water intended for human consumption. - COUNCIL DIRECTIVE 2015/1787 - Portuguese law DL 152/2017 quality of water intended for human consumption. Establishes the parameters , parametric values andsample frequency for quality control	**Integrated analysis to derive the reference values for good, fair and poor performance** ● **good [98.5; 100]** ● **fair [94.5; 98.5[** ● **poor [0; 94.5[**
Regulation or standardization	The Portuguese water and waste services regulation authority (ERSAR) defines reference values for good performance [98.5-100]; fair [94.5-98.5[; unsatisfactory [0-94.5[	
Strategic plans	Portuguese Strategic Plan for the Water, Wastewater and Stormwater Sector (PENSAARP 2030) Goal >= 98.5% in 2024, 2027, 2030	
Theoretical concepts and technical requirements		
Literature reviews on best practices	EC (2016) Report from the Commission: Synthesis report on the quality of drinking water in the Union examining Member states reports for the 2011-2013 period. JMP (WHO/Unicef Joint Monitoring Programme, JMP) (2021) SDG indicator metadata. SDG 6.1.1.	
Statistical analysis of the metric values		

A.1.3 Compliant reclaimed water (%)

Strategic objective: A. Ensuring water for all relevant uses

Assessment criteria: A.1 Safe and secure fit-for-purpose water provision

National or European legislation	EU Regulation 2020/741 - Minimum requirements for water reuse in agricultural irrigation; Reclaimed water shall be considered to be in compliance with the requirements set out in Table 2 where the measurements for that reclaimed water meet all of the following criteria: — the indicated values for E. coli, Legionella spp. and intestinal nematodes are met in 90 % or more of the samples; none of the values of the samples exceed the maximum deviation limit of 1 log unit from the indicated value for E. coli and Legionella spp. and 100 % of the indicated value for intestinal nematodes; — the indicated values for BOD5, TSS, and turbidity in Class A are met in 90 % or more of the samples; none of the values of the samples exceed the maximum deviation limit of 100 % of the indicated value.	**Integrated analysis to derive the reference values for good, fair and poor performance** • **good [95; 100]** • **fair [90; 95[** • **poor [0; 90[**
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values		

A.1.4 Security and resilience index (Score (1-200))

Strategic objective: A. Ensuring water for all relevant uses

Assessment criteria: A.1 Safe and secure fit-for-purpose water provision

National or European legislation	- COMMISSION DIRECTIVE (EU) 2015/1787 - Guidelines for Drinking Water Quality (WHO) concerning security of drinking water supply, on which the production, distribution, monitoring and analysis of parameters in drinking water is based - Council Directive 2008/114/EC of 8 December 2008; on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection - Portuguese Law DL 20/2022 establishes procedures for identifying, designating, protecting and increasing resilience of national and European critical infrastructures, proceeding with the consolidation in the law national transposition of Council Directive 2008/114/EC of 8 December 2008; - Portuguese Law 46/2018, de 13 August, Establishes the legal framework for cyberspace security, transposing Directive (EU) 2016/1148, of the European Parliament and of the Council, of 6 July 2016, on measures to ensure a high common level of network and information security across the Union	**Integrated analysis to derive the reference values for good, fair and poor performance** ● **good [140; 200]** ● **fair [75; 140[** ● **poor [0; 75[**
Regulation or standardization	European standard EN 15975-2 concerning security of drinking water supply, internationally recognised principles on which the production, distribution, monitoring and analysis of parameters in drinking water is based	
Strategic plans	European policy - Adaptation of drought and water conservation plans including public water supply specific plans;	
Theoretical concepts and technical requirements		
Literature reviews on best practices	Teixeira, R. et al. (2022). JRC Technical report. Water Security Plan Implementation Manual for Drinking Water Systems. doi10.2760/608997. How a water operator can organise its Water Security Plan, embedding it within its normal operational processes	
Statistical analysis of the metric values		

A.2.1 Physical access to drinking water supply for households and small businesses (%)

Strategic objective: A. Ensuring water for all relevant uses

Assessment criteria: A.2 Accessibility and equity (for people and for other uses)

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** **Predominantely urban areas** ● **good [95; 100]** ● **fair [80; 95[** ● **poor [0; 80[** **Intermediately urban areas** ● **good [90; 100]** ● **fair [80; 90[** ● **poor [0; 80[** **Predominantely rural areas** ● **good [80; 100]** ● **fair [70; 80[** ● **poor [0; 70[**
Regulation or standardization	The Portuguese water and waste services regulation authority (ERSAR) defines reference values for good performance [95-100]; fair [80-95[; unsatisfactory [0-80[in areas predominantely urban; good [90-100]; fair [80-90[; unsatisfactory [0-80[in areas intermediately urban; good [80-100]; fair [70-80[; unsatisfactory [0-70[in predominantely rural areas.	
Strategic plans	Portuguese Strategic Plan for the Water, Wastewater and Stormwater Sector (PENSAARP 2030) Goal >= 95% for predominantely urban areas; >= 90% for intermediately urban; >=80% for predominantely rural areas in 2024, 2027, 2030	
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values		

A.2.2 Physical access to drinking water supply in public spaces for quality of life (No./km^2)

Strategic objective: A. Ensuring water for all relevant uses

Assessment criteria: A.2 Accessibility and equity (for people and for other uses)

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** • **good [1; +∞[** • **fair [0.2; 1[** • **poor [0; 0.2[**
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices	The point of departure for setting up the reference value of this metric takes into account a measure of 'good' ratio between the number of drinking fountains in public space and the number of inhabitants in an urban setting (i.e. cities). In a report published by The European Association of Public Water Operators , the 'Cadiz model' was promoted with the aim to reach a ratio of 1 fountain for every 1000 inhabitants. Looking at the population data in Europe, the current number of inhabitants is 748,508,416 pe , and 72.5% of the population live in urban areas . This gives an estimate of 543,000 drinking fountains should ideally be made available in the urban areas in Europe, according to 'Cadiz model'. Converting this number into the ratio that is required by the metric by incorporating the total urban area in Europe (489,231 km^2) returns a value of ~1.1 drinking fountain/km^2. The number can be rounded down to 1 drinking fountain/km^2 given that this reference value is based on an urban planning of a European city which aims to an "ideal" condition, not just to a "good" status.	
Statistical analysis of the metric values	The table below highlights some examples of calculating the metric for some European cities. City / # Drinking fountains / Area [km^2] / Ratio [#/km^2] Paris / 1200 / 105.4 / 11.3 Cadiz* / 116 / 13.3 / 9 Torino / 181 / 130.2 / 1.4 Rome / 2000 / 1285 / 1.6 Venice / 71** / 414.6 / 0.17 *Planned, as per the report referenced above **50% out of the total of 142 drinking fountains are operational, https://www.veniceprojectcenter.org/vpc/opendata/fountain Some data is available, e.g. https://eaupotable.info/en/pt-portugal, but difficult to extract.	

City	# Drinking fountains	Area [km^2]	Ratio [#/km^2]
Paris	1200	105.4	11.3
Cadiz*	116	13.3	9
Torino	181	130.2	1.4
Rome	2000	1285	1.6
Venice	71**	414.6	0.17

A.2.3 Physical access to water supply for industrial use (%)		
Strategic objective: A. Ensuring water for all relevant uses		
Assessment criteria: A.2 Accessibility and equity (for people and for other uses)		
National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** • good [95; 100] • fair [80; 95[• poor [0; 80[
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices	Considered the same reference values of A.2.1 for “Predominantely urban areas”	
Statistical analysis of the metric values		

A.2.4 Physical access to water for irrigation (%)

Strategic objective: A. Ensuring water for all relevant uses

Assessment criteria: A.2 Accessibility and equity (for people and for other uses)

National or European legislation	- WFD - CAP - Commission Communication COM(2006)508 final : Development of agri-environmental indicators for monitoring the integration of environmental concerns into the common agricultural policy (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52006DC0508&from=EN) - Commission Staff working document accompanying COM(2006)508 final (https://ec.europa.eu/eurostat/documents/2393397/2518883/itro_COMMISSION+STAFF+WORKING+DOCUMENT/47021509-d163-4572-aad7-e4bd0aad14ef)	**Integrated analysis to derive the reference values for good, fair and poor performance** ● **good [85; 100]** ● **fair [50; 85[** ● **poor [0; 50[**
Regulation or standardization	- CAP strategic plan regulation (Results indicator R.22 sustainable water use: share of irrigated land under commitments to improve water balance; document 2 accessed via https://eur-lex.europa.eu/resource.html?uri=cellar:aa85fa9a-65a0-11e8-ab9c-01aa75ed71a1.0003.02/DOC_2&format=PDF) - EU Regulation 2020/741	
Strategic plans	- CAP strategic plans (https://ec.europa.eu/info/sites/default/files/food-farming-fisheries/key_policies/documents/overview-cap-plans-ol-220331.pdf) (https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/cap-strategic-plans_en) - River basin management plans	
Theoretical concepts and technical requirements	- Tuninetti et al. 2019 - SDG 2.4.1 Sustainable agriculture - AEI Irrigation - T3 Proportion of agricultural land irrigated (ACP-EU Water Facility, Ref: 9 ACP RPR 50 #20; https://www.riob.org/IMG/pdf/KPI_Final_Report.pdf) - Wriedt et al. 2008 Water requi	
Literature reviews on best practices	Agri-environmental indicator - irrigation - Statistics Explained (europa.eu): - In 2016, 8.9 % of utilised agricultural area in the EU was irrigable (15.5 million hectares) but only 5.9 % was actually irrigated (10.2 million hectares). - Between 2005 and 2016, irrigable areas in the agricultural areas of the EU decreased by 3.5 % and irrigated areas by 6.1 %. - In 2016, Spain (15.7 %) and Italy (32.6 %) had the largest shares of irrigable areas in the agricultural areas of the EU. 'https://www.eea.europa.eu/data-and-maps/indicators/use-of-freshwater-resources-3/assessment-4: - annual average: agriculture accounts for 59% of total water use in Europe (most of which is in the southern basin) - around 7-8% of total agricultural area in EU is irrigated; reaching 15% in southern Europe; but around 40-45% of total water us in Europe is allocated to crop irrigation annually ; - especially intenisve: crop irrigation during summer (April-Aug) southern EU 80% of total water use	
Statistical analysis of the metric values	(Agri-environmental indicator - irrigation - Statistics Explained (europa.eu)) Data until 2016: https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=aei_ef_ir&lang=en	

A.3.1 Consumer willingness to pay (5-point Likert scales)

Strategic objective: A. Ensuring water for all relevant uses

Assessment criteria: A.3 Financial viability

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** ● good + or ++ ● fair 0 ● poor - or --
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values	Data of the 61 cases in in the GCF database is a good indication: a good score is being scored 40.5%, fair is being scored 40.4% and poor is being scored 19.1%.	

A.3.2 Affordability (5-point Likert scales)

Strategic objective: A. Ensuring water for all relevant uses
Assessment criteria: A.3 Financial viability

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** ● **good + or ++** ● **fair 0** ● **poor - or --**
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values	Data of the 61 cases in in the GCF database is a good indication: a good score is being scored 40.5%, fair is being scored 40.4% and poor is being scored 19.1%.	

A.3.3 Financial continuation (5-point Likert scales)

Strategic objective: A. Ensuring water for all relevant uses
Assessment criteria: A.3 Financial viability

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** • **good + or ++** • **fair 0** • **poor - or --**
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values	Data of the 61 cases in in the GCF database is a good indication: a good score is being scored 40.5%, fair is being scored 40.4% and poor is being scored 19.1%.	

D.3.1 Cost coverage ratio (-)

Strategic objective: A. Ensuring water for all relevant uses

Assessment criteria: A.3 Financial viability

		Integrated analysis to derive the reference values for good, fair and poor performance
National or European legislation		• good [100; 110] • fair [90; 100[or]110; 120] • poor [0; 90[or]120; +∞[
Regulation or standardization	The Portuguese water and waste services regulation authority (ERSAR) defined reference values for water supply and wastewater services: good performance [100; 110]; fair [90; 100[or]110; 120]; unsatisfactory [0; 90[or]120; +∞[	
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values		

B.1.1 Environmental flow requirement compliance rate (%)

Strategic objective: B. Safeguarding ecosystems and their services to society
Assessment criteria: B.1 Safeguarded water ecosystems

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** **Northern Europe** ● **good [60; 100]** ● **fair [40; 60[** ● **poor]0; 40[** **Southern Europe** ● **good [40; 100]** ● **fair [20; 40[** ● **poor [0; 20[**
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices	SDG6_EF_LOW2.pdf (unwater.org) Page 17 And Global environmental flow information for the sustainable development goals (cgiar.org) Page 20 Splits between central/northern Europe and southern Europe due to very different climates.	
Statistical analysis of the metric values		

B.1.2 Effective stormwater treatment (%)

Strategic objective: B. Safeguarding ecosystems and their services to society

Assessment criteria: B.1 Safeguarded water ecosystems

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** • good [95; 100] • fair [90; 95[• poor [0; 90[
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices	B.1.2 would be to follow on the wastewater metric (B.1.3) since we have a lot more data available for that metric. However, the target values should be set a little lower due to stormwater treatment being a fairly new endeavour compared to wastewater treatment. A suggestion would be to set the stormwater reference values compared to the wastewater values as following: Good (Stormwater) = Fair (Wastewater) Fair (Stormwater) = Poor (Wastewater) Poor (Stormwater) = an interval down in value from Poor (Wastewater)	
Statistical analysis of the metric values		

B.1.3 Effective wastewater treatment (%)		
Strategic objective: B. Safeguarding ecosystems and their services to society		
Assessment criteria: B.1 Safeguarded water ecosystems		
National or European legislation	- COUNCIL DIRECTIVE 91/271/EEC Wastewater treatment - COUNCIL DIRECTIVE 2000/60/EC, WFD, according to the use of the receiving waters - Portuguese law DL 152/97 wastewater treatment. - Portuguese law DL 236/98 quality objectives for different uses. Establishes the parameters , parametric values andsample frequency for quality control	**Integrated analysis to derive the reference values for good, fair and poor performance** • **good 100** • **fair [95; 100[** • **poor [0; 95[**
Regulation or standardization	The Portuguese water and waste services regulation authority (ERSAR) defines reference values for good performance [100]; fair [95-100[; unsatisfactory [0-95[	
Strategic plans	Portuguese Strategic Plan for the Water, Wastewater and Stormwater Sector (PENSAARP 2030) Goal >= 90% in 2024, >= 95% in 2027, >= 99% in 2030	
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values		

B.2.1 Water body self-purification (%)

Strategic objective: B. Safeguarding ecosystems and their services to society
Assessment criteria: B.2 Enhanced ecosystem services to society

National or European legislation	Water Framework Directive; explanation: Improving the ecological status is the key driver to maintain habitats; https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0060	**Integrated analysis to derive the reference values for good, fair and poor performance** ● **good [40; 100]** ● **fair [10; 40[** ● **poor [0; 10[**
Regulation or standardization	Different ratified national laws and institutions caring for implementation	
Strategic plans	Biodiversity strategy for 2030 in the EU (https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en).	
Theoretical concepts and technical requirements	The underlying concept is the ecosystem service theory, manifested in specific ecosystem services selectable from CICES (EEA, 2018)	
Literature reviews on best practices	Best practice studies of "The Economics of Ecosystems & Biodiversity" (TEEB) can be found e.g. here: https://teebweb.org/publications/	
Statistical analysis of the metric values	NA	

B.2.2 Maintaining nursery populations and habitats (%)

Strategic objective: B. Safeguarding ecosystems and their services to society
Assessment criteria: B.2 Enhanced ecosystem services to society

National or European legislation	Water Framework Directive; explanation: Improving the ecological status is the key driver to maintain habitats; https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0060	**Integrated analysis to derive the reference values for good, fair and poor performance** ● **good [40; 100]** ● **fair [10; 40[** ● **poor [0; 10[**
Regulation or standardization	Different national laws; e.g. in Germany ratified in the "Wasserhaushaltsgesetz" ("Waterbalance law") plus others ("Surface water law" and "Groundwater law")	
Strategic plans	River Basin Management Plans: https://ec.europa.eu/environment/water/participation/map_mc/map.htm; generally: Biodiversity strategy for 2030 in the EU (https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en).	
Theoretical concepts and technical requirements	based on "ecological status", defined by biological parameters	
Literature reviews on best practices	Implementation of measures to archieve the aims of the WFD https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021SC0970; generally: Best practice studies of “The Economics of Ecosystems & Biodiversity” (TEEB) can be found e.g. here: https://teebweb.org/publications/	
Statistical analysis of the metric values	Example (in German), from River Basin Management Plan "Rhine": https://www.umweltbundesamt.de/sites/default/files/medien/1968/dokumente/steckbrief_flussgebietseinheit_rhein.pdf	

B.2.3 Flood damage prevention (%)

Strategic objective: B. Safeguarding ecosystems and their services to society

Assessment criteria: B.2 Enhanced ecosystem services to society

National or European legislation	Flood-Risk-Management-Directive https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32007L0060	**Integrated analysis to derive the reference values for good, fair and poor performance** • **good [90; 100]** • **fair [60; 90[** • **poor [0; 60[**
Regulation or standardization	Different ratified national laws and institutions caring for implementation	
Strategic plans	In Germany: "Hochwasserrisikomanagementpläne"; Generally: Biodiversity strategy for 2030 in the EU (https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en).	
Theoretical concepts and technical requirements	based on "Areas of Potential Significant Flood Risk under the Floods Directive"	
Literature reviews on best practices	Regulation reports: https://ec.europa.eu/environment/water/water-framework/impl_reports.htm (for individual member state reports scroll to "Assessments, for each Member State individually, of their 2nd Preliminary Flood Risk Assessments, published as consultant studies " Research example:https://www.researchgate.net/profile/Tomasz-Dysarz/publication/226522598_Assessing_River_Flood_Risk_and_Adaptation_in_Europe_-_Review_of_Projections_for_the_Future/links/0deec5166ec973d306000000/Assessing-River-Flood-Risk-and-Adaptation-in-Europe-Review-of-Projections-for-the-Future.pdf?origin=publication_detail	
Statistical analysis of the metric values	NA	

B.2.4 Water provision by the ecosystem (%)

Strategic objective: B. Safeguarding ecosystems and their services to society

Assessment criteria: B.2 Enhanced ecosystem services to society

National or European legislation	Water Framework Directive; explanation: Improving the ecological status is the key driver to maintain habitats; https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0060	**Integrated analysis to derive the reference values for good, fair and poor performance** ● **good [40; 100]** ● **fair [10; 40[** ● **poor [0; 10[**
Regulation or standardization	Different ratified national laws and institutions caring for implementation	
Strategic plans	Biodiversity strategy for 2030 in the EU (https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en).	
Theoretical concepts and technical requirements	The underlying concept is the ecosystem service theory, manifested in specific ecosystem services selectable from CICES (EEA, 2018); relevant is the water provision by the ecosystem, codes 4.2.1.1-4.2.2.3 in CICES V5.1 (https://cices.eu/)	
Literature reviews on best practices	Best practice studies of “The Economics of Ecosystems & Biodiversity” (TEEB) can be found e.g. here: https://teebweb.org/publications/	
Statistical analysis of the metric values	NA	

B.2.5 People enjoying cultural ecosystem services (%)		
Strategic objective: B. Safeguarding ecosystems and their services to society		
Assessment criteria: B.2 Enhanced ecosystem services to society		
National or European legislation	Nature restoration lay to restore ecosystems for people, the climate and the planet (https://environment.ec.europa.eu/topics/nature-and-biodiversity/nature-restoration-law_en).	**Integrated analysis to derive the reference values for good, fair and poor performance** ● **good [40; 100]** ● **fair [10; 40[** ● **poor [0; 10[**
Regulation or standardization	EU Target: Nature restoration measures covering at 20% of the EU's land and sea areas by 2030, and ultimately all ecosystems in need of restoration by 2050. This is the basis for enabling cultural ecosystems for as much EU citizens as possible (https://environment.ec.europa.eu/topics/nature-and-biodiversity/nature-restoration-law_en).	
Strategic plans	Biodiversity strategy for 2030 in the EU (https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en).	
Theoretical concepts and technical requirements	The underlying concept is the ecosystem service theory, manifested in specific ecosystem services selectable from CICES (EEA, 2018); relevant are different cultural services, e.g. codes 3.1.1.1-3.2.2. and 6.1.1.1-6.2.2.1 in CICES V5.1 (https://cices.eu/)	
Literature reviews on best practices	https://ec.europa.eu/environment/water/flood_risk/better_options.htm	
Statistical analysis of the metric values	NA	

B.3.1 Water footprint (m^3/m^3)

Strategic objective: B. Safeguarding ecosystems and their services to society

Assessment criteria: B.3 Resource efficiency

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** **For WS** • **good [0.0; 1.0]** • **fair]1.0; 1.5]** • **poor]1.5; +∞[** **For WW** • **good [0.0; 1.0]** • **fair]1.0; 2.0]** • **poor]2.0; +∞[**
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values	Average values calculated from Cetaqua studies in different water treatment plants. Literature studies for wastewater stay in 1.45 m^3/m^3 average	

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B.3.2 Carbon footprint (kgCO_{2eq}/m^3)

Strategic objective: B. Safeguarding ecosystems and their services to society

Assessment criteria: B.3 Resource efficiency

		Integrated analysis to derive the reference values for good, fair and poor performance
National or European legislation		• good [0; 0.3] • fair]0.3; 0.7] • poor]0.7; +∞[
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements	ECAM tool provides an online computatin for all GHG scopes (http://www.wacclim.org/ecam/)	
Literature reviews on best practices	EBC 2013-2020. Drinking water. Total climate footprint of the participants of this years' benchmarking exercise in kg CO_2 equivalent per property per year. The climate footprint medias ranges from 0.07 to 0.19 $CO_{2\ eq}$. / m^3 drinking water. Total climate footprint of the participants of this years' benchmarking exercise in kg CO2 equivalent per property per year. The climate footprint ranges from 7.3 to 11.5 kg $CO_{2eq.}$ / EP (considering 200 L/EP, varies from 0.1 to 0.16 kg $CO_{2eq.}$ / m^3 Carbon footprint for drinking water: https://www.sciencedirect.com/science/article/pii/S2666789422000101 Current carbon footprint: 0.8 kg CO_{2eq}/m^3 (assumed as baseline for a reverses osmosis treatment plant in operational phase) Target: 0.24 kg CO_{2eq}/m^3 > 0.7 Poor > 0.3 to 0.7 fair < 0.3 Good Carbon footprint for treated wastewater: Baseline for kg CO_{2eq}/$m^3$of treated wastewater: 0.8 (based on WWTPs studied in Baltic coast in Poland and Finland https://www.sciencedirect.com/science/article/pii/S0048969721055133)	
Statistical analysis of the metric values	Jorge et al. (2021) define reference values for wastewater systems for scope 2: good performance [0; 0.3]; fair [0.3; 0.5]; unsatisfactory [0.5; +∞[	

B.3.3 Energy consumption (kWh/m^3)

Strategic objective: B. Safeguarding ecosystems and their services to society

Assessment criteria: B.3 Resource efficiency

National or European legislation	Taxonomy criteria: “The net average energy consumption for abstraction and treatment equals to or is lower than 0.5 kWh per cubic meter produced water supply.” "The net energy consumption of the wastewater treatment plant equals to or is lower than: 1. 35 kWh per population equivalent (p.e.) per annum for treatment plant capacity below 10,000 p.e.; 2. 25 kWh per population equivalent (p.e.) per annum for treatment plant capacity between 10,000 and 100,000 p.e.; 3. 20 kWh per population equivalent (p.e.) per annum for treatment plant capacity above 100,000 p.e."
Regulation or standardization	The Portuguese water and waste services regulation authority (ERSAR) defined the metric for treatment in the WW system profile (without reference values) and another metric related to elevation (kWh/m3/100m)
Strategic plans	Portuguese Strategic Plan for the Water, Wastewater and Stormwater Sector (PENSAARP 2030) Goal <= 0.40 kWh/m^3/100m in 2024, 2027 and 2030
Theoretical concepts and technical requirements	
Literature reviews on best practices	Jorge et al (2021) define reference values for wastewater systems: - for collection systems: good performance [0; 0.2]; fair [0.2; 0.3]; unsatisfactory [0.3; +∞[- for bulk systems good performance [0; 0.5]; fair [0.5; 0.6]; unsatisfactory [0.6; +∞[The reference values proposed by Silva and Rosa (2015) for the unit energy consumption in WWTPs reflect the overall inverse relations observed with the volume treated and are specific for activated sludge systems (conventional, with coagulation/filtration (C/F) and with nitrification and C/F) and trickling filters. The European Benchmarking Co-operation (2021) with 41 countries - median of 0.5 kWh/m^3 for production and distribution (range 0.1-1.8) In WWTPs the median was 31.4 kWh/PE (range 10-63.3) - considering 200L/PE/d the value correspond to 0.43 kWh/m^3 (range 0.14-0.87)
Statistical analysis of the metric values	Activated sludge systems without primary sedimentation present a P25-P75 of 0.72-1.34 kWh/m3, AS systems with primary sedimentation a P25-P75 of 0.31-0.84 kWh/m3. Portugal Data from RASARP: - energy consumption in WS - 1,04 kWh/m^3 (2014) to 1,19 kWh/m^3 (2017); 2020: 0.21 median; 0.06-0.78 P25-P75 - energy consumption in WW - 0,49 kWh/m^3 (2014) to 0,66 kWh/m^3 (2017); 2020: 0.85 median; 0.43-1.98 P25-P75 Avaler project with 13 utilities - WS - 1 kWh/m^3 average (0.17-0.85-1.6, P25-P50-P75), 0.03-2.8 min-max WW - 0.46 kWh/m^3 average (0.04-0.53-0.69, P25-P50-P75), 0.02-1.1 min-max

Integrated analysis to derive the reference values for good, fair and poor performance

For WS

- **good [0; 0.5]**
- **fair]0.5; 0.8]**
- **poor]0.8; +∞[**

For WW

- **good [0; 0.6]**
- **fair]0.6; 0.9]**
- **poor]0.9; +∞[**

B.3.4 Drinking water consumption (L/(capita.day)

Strategic objective: B. Safeguarding ecosystems and their services to society

Assessment criteria: B.3 Resource efficiency

National or European legislation	-Portuguese Law DR23/95 defines for design values for domestic uses between 80 and 175 (depending on the population size) if no other information is available ,and for comercial intensive areas 50.	**Integrated analysis to derive the reference values for good, fair and poor performance** ● **good [80; 150]** ● **fair]150; 175] or [50; 80[** ● **poor [0; 50[or]175; +∞[**
Regulation or standardization		
Strategic plans	Portuguese Strategic Plan for the Water, Wastewater and Stormwater Sector (PENSAARP 2030) Goal <= 175 in 2024, <=150 in 2027, <= 140 in 2030 accounting for domestic and non domestic volumes	
Theoretical concepts and technical requirements	According to the World Health Organization (WHO), between 50 and 100 litres of water per person per day are needed to ensure that most basic needs are met and few health concerns arise. https://www.un.org/waterforlifedecade/pdf/human_right_to_water_and_sa	
Literature reviews on best practices	Benchmark data from 2010 for the same two federal states for residential water consumption are much more uniform, with mean values of 124 l/capita/day to 126 l/capita/day (about 45 m^3/capita/year) and upper 90 percentiles of 161 l/capita/day and 159 l/capita/day, respectively. For France, the mean values weighted by population were 151 l/capita/day for about 3 700 utilities serving about 32 million people (EEA, 2014)	
Statistical analysis of the metric values	In 2021, average residential drinking water consumption for member countries is 124 litres per inhabitant per day. https://www.eureau.org/resources/publications/eureau-publications/5824-europe-s-water-in-figures-2021/file 144 litres of water per person per day is supplied to households in Europe https://www.eea.europa.eu/signals/signals-2018-content-list/articles/water-use-in-europe-2014 [79.5-943.4] in 2019 eurostat (abstraction per capita) https://ec.europa.eu/eurostat/databrowser/view/ten00003/default/table?lang=en 186 litres oer person per day in Portugal (RASARP 2021)	

C.1.1 Statutory compliance (5-point Likert scales)		
Strategic objective: C. Boosting value creation around water		
Assessment criteria: C.1 Circular policy making		
National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** • good + or ++ • fair 0 • poor - or --
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values	Data of the 61 cases in in the GCF database is a good indication: a good score is being scored 40.5%, fair is being scored 40.4% and poor is being scored 19.1%.	

C.1.2 Preparedness (5-point Likert scales)

Strategic objective: C. Boosting value creation around water

Assessment criteria: C.1 Circular policy making

		Integrated analysis to derive the reference values for good, fair and poor performance
National or European legislation		• good + or ++ • fair 0 • poor - or --
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values	Data of the 61 cases in in the GCF database is a good indication: a good score is being scored 40.5%, fair is being scored 40.4% and poor is being scored 19.1%.	

C.1.3 Policy instruments (5-point Likert scales)

Strategic objective: C. Boosting value creation around water

Assessment criteria: C.1 Circular policy making

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** • **good + or ++** • **fair 0** • **poor - or --**
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values	Data of the 61 cases in in the GCF database is a good indication: a good score is being scored 40.5%, fair is being scored 40.4% and poor is being scored 19.1%.	

C.1.4 Green public procurement (%)

Strategic objective: C. Boosting value creation around water
Assessment criteria: C.1 Circular policy making

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** • **good [50; 100]** • **fair [10; 50[** • **poor [0; 10[**
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices	Non green (<=10% core green) Comprehensive green (10-50% core green) Core green (=>50% core green)	
Statistical analysis of the metric values		

C.1.5 Level of ambition (5-point Likert scales)

Strategic objective: C. Boosting value creation around water
Assessment criteria: C.1 Circular policy making

		Integrated analysis to derive the reference values for good, fair and poor performance
National or European legislation		• good + or ++ • fair 0 • poor - or --
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values	Data of the 61 cases in in the GCF database is a good indication: a good score is being scored 40.5%, fair is being scored 40.4% and poor is being scored 19.1%.	

C.2.1 By-products recovery revenues (%)

Strategic objective: C. Boosting value creation around water

Assessment criteria: C.2 Circular economy growth

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** ● **good >interest rate+0.5** ● **fair [interest rate; interest rate+0.5]** ● **poor < interest rate**
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements	Based on the reference interest rates of the European Central Bank	
Literature reviews on best practices		
Statistical analysis of the metric values		

C.2.2 Green jobs (%)

Strategic objective: C. Boosting value creation around water
Assessment criteria: C.2 Circular economy growth

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** ● **good [6; 100]** ● **fair [3; 6[** ● **poor [0; 3[**
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices	https://www.climatescorecard.org/project/report-31/	
Statistical analysis of the metric values		

C.2.3 Circular economy business models in practice (%)		
Strategic objective: C. Boosting value creation around water		
Assessment criteria: C.2 Circular economy growth		
National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** • good [50; 100] • fair]0; 50[• poor 0
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices	Scenario 0 : no new business model applied Scenario 1: 1-3 new business model applied Scenario 2: >3 new business models applied	
Statistical analysis of the metric values		

C.3.1 Water-related materials recovery (%)

Strategic objective: C. Boosting value creation around water

Assessment criteria: C.3 Resource recovery and use

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** • **good [15; 100]** • **fair [10; 15[** • **poor [0; 10[**
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices	This values are references for phosphorus recovery from the EU Taxonomy. This can be applied to any other material: NaCl, N, … but we can fix and change the reference values once we have results from the B-WaterSmart project. (e.g. maybe some materials can achieve >50% of recovery because it's easier or any other material have maximum a 10% recovery depending on the difficulty of recovery). https://ec.europa.eu/sustainable-finance-taxonomy/taxonomy-compass https://eu-taxonomy.info/	
Statistical analysis of the metric values		

C.3.2 Fertilizer production avoided (%)

Strategic objective: C. Boosting value creation around water

Assessment criteria: C.3 Resource recovery and use

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** ● **good [30; 100]** ● **fair [5; 30[** ● **poor [0; 5[**
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices	Reference: https://ec.europa.eu/commission/presscorner/detail/de/MEMO_16_826 https://nutriman.net/EU-Fertiliser-Regulation (**Note that this CE guide is from 2016 and an updated version is expected to be released during the next months)	
Statistical analysis of the metric values		

C.3.3 Reclaimed water in non-potable uses (%)

Strategic objective: C. Boosting value creation around water

Assessment criteria: C.3 Resource recovery and use

National or European legislation	- Portuguese DL 119/2019 (21 August) - EU Regulation 2020/741 – Minimum requirements for water reuse in agricultural irrigation	**Integrated analysis to derive the reference values for good, fair and poor performance** ● **good 1/3 of C.3.4 reference values** ● **fair 1/3 of C.3.4 reference values** ● **poor 1/3 of C.3.4 reference values** **1/3 ratio should be adjusted to reflect potables and non-potables uses**
Regulation or standardization	Standardisation '- ISO 16075 (parts 1 to 5) Guidelines for treated wastewater use for irrigation - ISO 20426:2018 Guidelines for health risk assessment and management for non-potable water reuse and ISO 20761:2018 Water reuse in urban areas - ISO 20760-1:2018 — Water reuse in urban areas — Part 1: Design principle of a centralised water reuse system	
Strategic plans		
Theoretical concepts and technical requirements	EU Regulation 2020/741 and Portuguese DL 119/2019 Treatment requirements and barriers needed for each use	
Literature reviews on best practices	- Israel > 40% of the total water use in agriculture (Tarchitzky et al. 2019) - Water reuse represents less than 0.5% of annual EU freshwater withdrawals - 10% in China 2015 (Goal 15% in 2020) - Portugal 1.3% of the authorized water consumption (RASARP 2020)	
Statistical analysis of the metric values	The reused wastewater volume would save 0,9% of the total water abstraction in the year 2025. While for most countries the substitution potential is less than 0.5%, Malta, Cyprus and Spain could cover up 26%, 7.6% and 3% of their future water demand respectively	

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C.3.4 Reclaimed water production (%)

Strategic objective: C. Boosting value creation around water

Assessment criteria: C.3 Resource recovery and use

National or European legislation	- Portuguese DL 119/2019 (21 August) - EU Regulation 2020/741 – Minimum requirements for water reuse in agricultural irrigation	**Integrated analysis to derive the reference values for good, fair and poor performance** **WEI+ < 10** ● **good [5; 100]** ● **fair [0.5; 5[** ● **poor [0; 0.5[** **10 ≤ WEI+ < [10; 30[** ● **good [10; 100]** ● **fair [5; 10[** ● **poor [0; 5[** **30 ≤ WEI+ [30; < 70[** ● **good [20; 100]** ● **fair [10; 20[** ● **poor [0; 10[** **WEI+ >=70** ● **good [30; 100]** ● **fair [15; 30[** ● **poor [0; 15[**
Regulation or standardization	Standardisation '- ISO 16075 (parts 1 to 5) Guidelines for treated wastewater use for irrigation - ISO 20426:2018 Guidelines for health risk assessment and management for non-potable water reuse and ISO 20761:2018 Water reuse in urban areas - ISO 20760-1:2018 — Water reuse in urban areas — Part 1: Design principle of a centralised water reuse system Regulation The Portuguese water and waste services regulation authority (ERSAR) Depending on the water exploitation index: - WEI+ < 10% good: > 5%; poor performance: < 0.5% - WEI+ < 30% good: > 10%; poor performance: < 5% - WEI+ < 70% good: > 20%; poor performance: < 10% - WEI+ > 70% good: > 30%; poor performance: < 15%	
Strategic plans	Portuguese Strategic Plan for the Water Supply Sector and Wastewater Management (PEAASAR 2014-2020) Goal of 10% in 2025 and 20% in 2030	
Theoretical concepts and technical requirements	EU Regulation 2020/741 and Portuguese DL 119/2019 Treatment requirements and barriers needed for each use	
Literature reviews on best practices	- Israel 85.5% in 2019 (Tarchitzky et al. 2019) - Cyprus 90%; Malta 60%; Greece, Italy, Spain 5-12% (EC 2021) - Portugal 1.2% (RASARP 2020) - Water reuse represents approx. 2.4% of the treated urban wastewater	
Statistical analysis of the metric values		

C.3.5 Energy production (%)

Strategic objective: C. Boosting value creation around water

Assessment criteria: C.3 Resource recovery and use

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** **For WS** ● **good [10; +∞[** ● **fair [5; 10[** ● **poor [0; 5[** **For WW** ● **good [20; +∞[** ● **fair [10; 20[** ● **poor [0; 10[** **For Waste** ● **good [100; +∞[** ● **fair [50; 100[** ● **poor [0; 50[**
Regulation or standardization	The Portuguese water and waste services regulation authority (ERSAR) - For water and wastewater (with collection/drainage service) utilities: Reference values for good performance >10%; fair [5-10[; unsatisfactory [0-5[- For WWTP Reference values for good performance >20%; fair [10-20[; unsatisfactory [0-10[- For Urban Waste Reference values for good performance >100%; fair [50-100[; unsatisfactory [0-50[	
Strategic plans	Portuguese Strategic Plan for the Water Supply Sector and Wastewater and Stormwater Management (PENSAARP 2030) - Goal of 5% in 2024, 7.5% in 2027 and 10% in 2030 for water distribution and wastewater (with collection/drainage service) utilities - Goal of 2% in 2024, 10% in 2027 and 20% in 2030 for water bulk systems - Goal of 10% in 2024, 15% in 2027 and 20% in 2030 for wastewater bulk systems with WWTP utilities	
Theoretical concepts and technical requirements	Based on the potential for methane generation (0.0007-0.0011 BOD_5 (BOD_5 in mg/L) (Silva & Rosa 2015) e.g., for 110–350 mg/L -> 0.074–0.389 kWh/m^3 (depending on the consumption, energy production may achieve 100%)	
Literature reviews on best practices	Energy production feasibility is linked to the plant's size (> ca. 18500 m^3/d, CHP 2011) and wastewater characteristics - 0.074–0.15 kWh/m^3 (15-108%) are reported in the literature (Silva & Rosa 2015) - Portuguese field study results (0.01–0.29 kWh/m^3 -> 4-50% (Silva & Rosa 2020) - the Strass WWTP exceeds the plant self-sufficiency (108%, Wett et al. 2007) - PT WW utilities varied from 1 to 36 % (RASARP 2020) - PT W utilities varied from 1 to 26 % (RASARP 2020) - International Committees About Circular Economy OECD. The OECD Inventory of Circular Economy indicators, https://www.oecd.org/cfe/cities/InventoryCircularEconomyIndicators.pdf	
Statistical analysis of the metric values		

D.1.1 Infrastructure planning index for adaptive change (Score (1-100))

Strategic objective: D. Promoting adaptive change towards resilient infrastructure

Assessment criteria: D.1 Enabling planning to promote adaptive change towards circularity and resilience

		Integrated analysis to derive the reference values for good, fair and poor performance
National or European legislation		• good [70; 100] • fair [40; 70[• poor [0; 40[
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements	- 40 corresponds to the minimum requirements to consider existence of an infrastructure planning for adaptive change, meaning that the plan exists and is being developed following a proper approach considering the adequate characteristics, even it is not completed yet or needs to be quite improved regarding inclusion of adaptive change concerns. - 70 corresponds to the existence of an infrastructure planning for adaptive change, meaning that the plan exists, it was developed following a proper approach and considers the adequate characteristics regarding adaptive change, even if some improvement opportunities exist.	
Literature reviews on best practices		
Statistical analysis of the metric values		

D.2.1 Infrastructure Value Index (-)

Strategic objective: D. Promoting adaptive change towards resilient infrastructure

Assessment criteria: D.2 Implementing adaptive change towards resilient infrastructure

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** ● **good [0.4; 0.6]** ● **fair [0.2; 0.4[or]0.6; 0.8]** ● **poor [0.0; 0.2[or]0.8; 1.0]**
Regulation or standardization	- DWA (2006). DWA-M 143-14E:2005. Rehabilitation of drainage systems outside buildings. Part 14: Rehabilitation strategies. DWA German Association for Water, Wastewater and Waste. '- The Portuguese water and waste services regulation authority (ERSAR) considers this metric as system profile Good performance [0.4-0.6] Acceptable performance [0.2-0.4[or]0.6-0.8] Unsatisfactory perofrmance [0.0-0.2[or]0.8-1.0]	
Strategic plans	Portuguese Strategic Plan for the Water, Wastewater and Stormwater Sector (PENSAARP 2030) Goal >= 0.4 and >=0.6 in 2030 for WS and WSS	
Theoretical concepts and technical requirements		
Literature reviews on best practices	- Alegre, H., Vitorino, D., & Coelho, S. (2014). Infrastructure value index: a powerful modelling tool for combined long-term planning of linear and vertical assets. Procedia Engineering, 89, 1428-1436.	
Statistical analysis of the metric values		

D.2.2 Infrastructure implementation index for adaptive change (Score (1-100))

Strategic objective: D. Promoting adaptive change towards resilient infrastructure

Assessment criteria: D.2 Implementing adaptive change towards resilient infrastructure

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** • **good [70; 100]** • **fair [40; 70[** • **poor [0; 40[**
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements	- 40 corresponds to the minimum requirements to consider that the infrastructure planning for adaptive change is being implemented and it is monitored or reviewed, even if the implementation is not fully compliant with the plan, requiring to be quite improved. - 70 corresponds to an infrastructure planning for adaptive change adequately implemented, monitored and reviewed, even if some improvement opportunities exist.	
Literature reviews on best practices		
Statistical analysis of the metric values		

D.3.1 Linear water losses (m^3/(year. Km))

Strategic objective: D. Promoting adaptive change towards resilient infrastructure

Assessment criteria: D.3 Effectiveness of the adaptive change towards resilient infrastructure (Diagnosis)

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** **For distribution** ● **good [0; 1100]** ● **fair]1100; 1800]** ● **poor]1800; +∞[** **For bulk systems** ● **good [0; 1800]** ● **fair]1800; 2700]** ● **poor]2700; +∞[**
Regulation or standardization	The Portuguese water and waste services regulation authority (ERSAR) defined reference values for water distribution: good performance [0; 3,0]; fair]3,0; 5,0]; unsatisfactory]5,0; +∞[and for bulk systems: good performance [0; 5,0]; fair]5,0; 7,5]; unsatisfactory]7,5; +∞[m^3/km/d	
Strategic plans	Portuguese Strategic Plan for the Water, Wastewater and Stormwater Sector (PENSAARP 2030) Goal for distribution <= 3 m^3/km/d in 2024, 2027 and 2030 Goal for bulk systems <= 5 m^3/km/d in 2024, 2027 and 2030	
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values	2020 EBC group face distribution losses between 0.8 and 71.3 m^3 per km mains length per day. The median value for the group is 8-5 m^3 / km / day 2021 EBC group face distribution losses between 4.6 and 176.4 m^3 /km / d. The median value for the group is 20,2 m^3 / km / d	

D.3.2 Water storage capacity (days)

Strategic objective: D. Promoting adaptive change towards resilient infrastructure

Assessment criteria: D.3 Effectiveness of the adaptive change towards resilient infrastructure (Diagnosis)

National or European legislation	Portuguese law DR 23/95, 23 august (art 70) – defines 1-2 days for WS depending on the population and risk	**Integrated analysis to derive the reference values for good, fair and poor performance** **For drinking water systems and wastewater treatment plants** ● **good [1; 2]** ● **fair [0.5; 1[or]2; +∞[** ● **poor [0; 0.5[** **For rainwater harvesting systems** ● **good [4; +∞[** ● **fair [1; 4[** ● **poor [0; 1[**
Regulation or standardization	The Portuguese water and waste services regulation authority (ERSAR) defined this metric in the WS system profile (without reference values)	
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices	The sizing of the storage tank(s) will depend on how much rainwater can be harvested and how much potable water demand the designer wishes to substitute. However, a larger storage capacity will increase the cost. No rules in the literature for the rainwater uses for irrigation and street washing, Carollo, M., Butera, I., & Revelli, R. Water savings and urban storm water management: Evaluation of the potentiality of rainwater harvesting systems from the building to the city scale. PLOS ONE, 17(11), e0278107. https://doi.org/10.1371/journal.pone.0278107- Donatello S., Dodd N. & Cordella M., 2021. Level(s) indicator 3.1: Use stage water consumption user manual: introductory briefing, instructions and guidance (Publication version 1.1). JRC, European Commission.	
Statistical analysis of the metric values		

D.3.3 Incident occurences (No./100 km/year)

Strategic objective: D. Promoting adaptive change towards resilient infrastructure

Assessment criteria: D.3 Effectiveness of the adaptive change towards resilient infrastructure (Diagnosis)

		Integrated analysis to derive the reference values for good, fair and poor performance
National or European legislation		**For water supply systems** **bursts in distribution** ● good [0; 30] ● fair]30; 60] ● poor]60; +∞[**For wastewater systems** **floods** ● good [0; 0.5] ● fair]0.5; 2] ● poor]2; +∞[**collapses** ● good [0; 1.0] ● fair]1.0; 2.0] ● poor]2.0; +∞[
Regulation or standardization	The Portuguese water and waste services regulation authority (ERSAR) defined reference values for burst in water distribution: good performance [0; 30]; fair]30; 60]; unsatisfactory]60; +∞[and for bulk systems: good performance [0; 15]; fair]15; 30]; unsatisfactory]30; +∞[For flooding, good performance [0; 0.5]; fair]0.5; 2]; unsatisfactory]2; +∞[For collapse in collection/drainage, good performance 0; fair]0.0; 1.0]; unsatisfactory]1.0; +∞[For collapse in bulk systems, good performance 0; fair]0.0;2.0]; unsatisfactory]2.0; +∞[	
Strategic plans	Portuguese Strategic Plan for the Water, Wastewater and Stormwater Sector (PENSAARP 2030) Goal for burst in distribution <= 30 in 2024, 2027 and 2030 Goal for burst in bulk systems <= 15 in 2024, 2027 and 2030 Goal for collapse = 0 in 2024, 2027 and 2030	
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values	EBC 2021 , results for mains failures vary widely within the current EBC group with values ranging from 0 to 178 failures per 100 km. Factors that may influence the mains failure rate include the network condition, soil condition, traffic load and water pressure. It is also worth mentioning that an improvement in monitoring failures may (at first) cause an increase in mains failures, as not in all cases failures are currently properly registered. The median value is 13,7 No. / 100 km. The number of flooding incidents per 100 km sewer vary for the vast majority of utilities in the current EBC group between 0 and 2,5 with a median value of 0 No. / 100 km sewer.	

D.3.4 Combined sewer overflows (No./device/year)

Strategic objective: D. Promoting adaptive change towards resilient infrastructure

Assessment criteria: D.3 Effectiveness of the adaptive change towards resilient infrastructure (Diagnosis)

National or European legislation	
Regulation or standardization	The Portuguese water and waste services regulation authority (ERSAR) defines as unsatisfactory a CSO device with an overflow frequency in terms of days with overflow occurences is greater than 30/year for non sensitive receiving bodies, <=10/year for recreational uses, 6/year for sensitive and 3/season for bathing waters.
Strategic plans	Portuguese Strategic Plan for the Water, Wastewater and Stormwater Sector (PENSAARP 2030) adopts the same metrics of ERSAR
Theoretical concepts and technical requirements	
Literature reviews on best practices	UPM methodology (http://www.fwr.org/UPM3/). Spills frequency <= than 30/year for non sensitive receiving bodies, <=10/year for recreational uses, <=6/year for sensitive and 3/season for bathing waters. https://www.gov.uk/government/publications/water-companies-environmental-permits-for-storm-overflows-and-emergency-overflows/water-companies-environmental-permits-for-storm-overflows-and-emergency-overflows
Statistical analysis of the metric values	

Integrated analysis to derive the reference values for good, fair and poor performance

Non sensitive water bodies
- **good [0; 30]**
- **fair]30; 60]**
- **poor]60; +∞[**

Non sensitive water bodies and recreational uses
- **good [0; 5]**
- **fair]5; 10]**
- **poor]10; +∞[**

Sensitive water bodies
- **good [0; 6]**
- **fair]6; 12]**
- **poor]12; +∞[**

Bathing waters
- **good [0; 2]**
- **fair]2; 3]**
- **poor]3; +∞[**

D.3.5 Time for restoration (days)

Strategic objective: D. Promoting adaptive change towards resilient infrastructure

Assessment criteria: D.3 Effectiveness of the adaptive change towards resilient infrastructure (Diagnosis)

		Integrated analysis to derive the reference values for good, fair and poor performance
National or European legislation		● good [0.0; 0.25] ● fair]0.25; 1.0] ● poor]1.0; +∞[
Regulation or standardization	The Portuguese water and waste services regulation authority (ERSAR) defined as duration for considering a failure of the service 6 hours in 3 generations of the assessment system, and was revised for 4 hours in the last one.This metric assesses the impact of the failure in the quality of service for the user.	
Strategic plans	Portuguese Strategic Plan for the Water, Wastewater and Stormwater Sector (PENSAARP 2030) adopts the same metrics of ERSAR	
Theoretical concepts and technical requirements	A low value of the max TR means that if a structural failure occurs in the system, it can be quickly restored, while a high value means the system is more robust	
Literature reviews on best practices	In RESCCUE project (ref) the metric for WS, WW and SW “Maximum out-of-service period for all failures in infrastructure, including recovery time, last year (days) “ considers <= 1 as good,]1,3] fair,]3,6] and >6 two levels of unsatisfactory. This metric assesses the impact of the failure in the city functioning.	
Statistical analysis of the metric values		

D.3.6 Level of autonomy (%)

Strategic objective: D. Promoting adaptive change towards resilient infrastructure

Assessment criteria: D.3 Effectiveness of the adaptive change towards resilient infrastructure (Diagnosis)

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** ● **good [80; 100]** ● **fair [70; 80[** ● **poor [0; 70[**
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements	It refers to the part of the infrastructure that does not depend on other services or that it is dependent on other services (e.g. energy) where autonomy solutions are implemented (e.g., electrical generators).	
Literature reviews on best practices	In RESCCUE project (ref) the metric for WS, WW and SW “Autonomy from infrastructures of other services (%) “ considers >=80 as good, [70,80[fair, <70 unsatisfactory.	
Statistical analysis of the metric values		

D.3.7 Level of redundancy (%)

Strategic objective: D. Promoting adaptive change towards resilient infrastructure

Assessment criteria: D.3 Effectiveness of the adaptive change towards resilient infrastructure (Diagnosis)

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** • **good [90; 100]** • **fair [80; 90[** • **poor [0; 80[**
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements	It refers to the part of the infrastructure where autonomy solutions are implemented	
Literature reviews on best practices	In RESCCUE project (ref) the metric for WS, WW and SW “Level of redundancy (%) “ considers 100 as fully redundant, [90,100[good, [80,90[fair, <80 unsatisfatory.	
Statistical analysis of the metric values		

D.3.8 Treatment capacity utilization (%)

Strategic objective: D. Promoting adaptive change towards resilient infrastructure

Assessment criteria: D.3 Effectiveness of the adaptive change towards resilient infrastructure (Diagnosis)

		Integrated analysis to derive the reference values for good, fair and poor performance
National or European legislation		**For WS** ● **good [70; 90]** ● **fair [60; 70[or]90; 110]** ● **poor [0; 60[or]110; +∞[** **For WW** ● **good [70; 95]** ● **fair [60; 70[or]95; 120]** ● **poor [0; 60[or]120; +∞[**
Regulation or standardization	The Portuguese water and waste services regulation authority (ERSAR) defined reference values for WS: good performance [70; 90]; fair [60; 70[ou]90; 110]; unsatisfactory [0; 60[ou]110; +∞[and for WWS: good performance [70; 95]; fair [60; 70[ou]95; 120]; unsatisfactory [0; 60[ou]120; +∞[	
Strategic plans	Portuguese Strategic Plan for the Water, Wastewater and Stormwater Sector (PENSAARP 2030) Goal <= 70-90 in 2024, 2027 and 2030	
Theoretical concepts and technical requirements	Overutilization could compromisse the water quality. Subutilization could compromisse infrastrutural, environmental and economic sustainability.	
Literature reviews on best practices	The capacity utilization (defined as the ratio of volume treated per treatment capacity expressed by the design flow) affects the plant energy performance, the lower the utilization the lower the efficiency (Silva and Rosa 2015, Castellet-Viciano et al. 2018, Vaccari et al. 2018, Silva el al. 2022)	
Statistical analysis of the metric values	- Plant utilization ratios below 0.8 (and particularly below 0.7) affected the energy performance of many WWTPs, whereas above 0.8 no such effect was found (Silva et al 2022). - The capacity utilization often affects the energy performance, i.e. the closer the WWTP is to its design capacity the more efficient the operations and processes are, including the unit energy consumption (WERF 2011) – 0.15–0.43 kWh/m^3 for 80% capacity vs. 0.32–0.60 kWh/m^3 for 50% capacity.	

E.1.1 Knowledge and education (5-point Likert scales)

Strategic objective: E. Engaging citizens and actors across sectors in continuous co-learning and innovation

Assessment criteria: E.1 Awareness and knowledge

		Integrated analysis to derive the reference values for good, fair and poor performance
National or European legislation		• good + or ++ • fair 0 • poor - or --
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values	Data of the 61 cases in in the GCF database is a good indication: a good score is being scored 40.5%, fair is being scored 40.4% and poor is being scored 19.1%.	

E.1.2 Information availability and use (5-point Likert scales)		
Strategic objective: E. Engaging citizens and actors across sectors in continuous co-learning and innovation		
Assessment criteria: E.1 Awareness and knowledge		
National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** • good + or ++ • fair 0 • poor - or --
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values	Data of the 61 cases in in the GCF database is a good indication: a good score is being scored 40.5%, fair is being scored 40.4% and poor is being scored 19.1%.	

E.1.3 Local sense of urgency (5-point Likert scales)

Strategic objective: E. Engaging citizens and actors across sectors in continuous co-learning and innovation

Assessment criteria: E.1 Awareness and knowledge

		Integrated analysis to derive the reference values for good, fair and poor performance
National or European legislation		• good + or ++ • fair 0 • poor - or --
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values	Data of the 61 cases in in the GCF database is a good indication: a good score is being scored 40.5%, fair is being scored 40.4% and poor is being scored 19.1%.	

B-WaterSmart

E.1.4 Water smart culture (5-point Likert scales)		
Strategic objective: E. Engaging citizens and actors across sectors in continuous co-learning and innovation		
Assessment criteria: E.1 Awareness and knowledge		
National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** • **good + or ++** • **fair 0** • **poor - or --**
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values	Data of the 61 cases in in the GCF database is a good indication: a good score is being scored 40.5%, fair is being scored 40.4% and poor is being scored 19.1%.	

E.1.5 Smart monitoring (5-point Likert scales)

Strategic objective: E. Engaging citizens and actors across sectors in continuous co-learning and innovation

Assessment criteria: E.1 Awareness and knowledge

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** • good + or ++ • fair 0 • poor - or --
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values	Data of the 61 cases in in the GCF database is a good indication: a good score is being scored 40.5%, fair is being scored 40.4% and poor is being scored 19.1%.	

E.2.1 Clear division of responsibility (5-point Likert scales)

Strategic objective: E. Engaging citizens and actors across sectors in continuous co-learning and innovation

Assessment criteria: E.2 Multi-sector network potential

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** • good + or ++ • fair 0 • poor - or --
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values	Data of the 61 cases in in the GCF database is a good indication: a good score is being scored 40.5%, fair is being scored 40.4% and poor is being scored 19.1%.	

E.2.2 Authority (5-point Likert scales)

Strategic objective: E. Engaging citizens and actors across sectors in continuous co-learning and innovation

Assessment criteria: E.2 Multi-sector network potential

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** ● **good + or ++** ● **fair 0** ● **poor - or --**
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values	Data of the 61 cases in in the GCF database is a good indication: a good score is being scored 40.5%, fair is being scored 40.4% and poor is being scored 19.1%.	

E.2.3 Room to maneuver (5-point Likert scales)

Strategic objective: E. Engaging citizens and actors across sectors in continuous co-learning and innovation

Assessment criteria: E.2 Multi-sector network potential

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** ● **good + or ++** ● **fair 0** ● **poor - or --**
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values	Data of the 61 cases in in the GCF database is a good indication: a good score is being scored 40.5%, fair is being scored 40.4% and poor is being scored 19.1%.	

E.3.1 Stakeholder inclusiveness (5-point Likert scales)

Strategic objective: E. Engaging citizens and actors across sectors in continuous co-learning and innovation

Assessment criteria: E.3 Stakeholder engagement processes

		Integrated analysis to derive the reference values for good, fair and poor performance
National or European legislation		• good + or ++ • fair 0 • poor - or --
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values	Data of the 61 cases in in the GCF database is a good indication: a good score is being scored 40.5%, fair is being scored 40.4% and poor is being scored 19.1%.	

E.3.2 Protection of core values (5-point Likert scales)

Strategic objective: E. Engaging citizens and actors across sectors in continuous co-learning and innovation

Assessment criteria: E.3 Stakeholder engagement processes

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** • **good + or ++** • **fair 0** • **poor - or --**
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values	Data of the 61 cases in in the GCF database is a good indication: a good score is being scored 40.5%, fair is being scored 40.4% and poor is being scored 19.1%.	

E.3.3. Cross-stakeholder learning (5-point Likert scales)

Strategic objective: E. Engaging citizens and actors across sectors in continuous co-learning and innovation

Assessment criteria: E.3 Stakeholder engagement processes

		Integrated analysis to derive the reference values for good, fair and poor performance
National or European legislation		• good + or ++ • fair 0 • poor - or --
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values	Data of the 61 cases in in the GCF database is a good indication: a good score is being scored 40.5%, fair is being scored 40.4% and poor is being scored 19.1%.	

E.3.4. Collaborative agents (5-point Likert scales)

Strategic objective: E. Engaging citizens and actors across sectors in continuous co-learning and innovation

Assessment criteria: E.3 Stakeholder engagement processes

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** ● good + or ++ ● fair 0 ● poor - or --
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values	Data of the 61 cases in in the GCF database is a good indication: a good score is being scored 40.5%, fair is being scored 40.4% and poor is being scored 19.1%.	

C.2 Summary table of reference values

The reference values proposed for each metric are presented below.

Strategic Objective (SO)	Assessment criteria (AC)	Metric	Unit	Reference values
A. Ensuring water for all relevant uses	A.1 Safe and secure fit-for-purpose water provision	A.1.1 Water exploitation index, plus (WEI+)	%	• good [0; 20[• fair [20; 40[• poor [40; +∞[
		A.1.2 Safe drinking water	%	• good [98.5; 100] • fair [94.5; 98.5[• poor [0; 94.5[
		A.1.3 Compliant reclaimed water	%	• good [95; 100] • fair [90; 95[• poor [0; 90[
		A.1.4 Security and resilience index	Score (1-200)	• good [140; 200] • fair [75; 140[• poor [0; 75[
	A.2 Accessibility and equity (for people and for other uses)	A.2.1 Physical access to drinking water supply for households and small businesses	%	Predominantely urban areas • good [95; 100] • fair [80; 95[• poor [0; 80[Intermediately urban areas • good [90; 100] • fair [80; 90[• poor [0; 80[Predominantely rural areas • good [80; 100] • fair [70; 80[• poor [0; 70[
		A.2.2 Physical access to drinking water supply in public spaces for quality of life	No./km^2	• good [1; +∞[• fair [0.2; 1[• poor [0; 0.2[
		A.2.3 Physical access to water supply for industrial use	%	• good [95; 100] • fair [80; 95[• poor [0; 80[
		A.2.4 Physical access to water for irrigation	%	• good [85; 100] • fair [50; 85[• poor [0; 50[
	A.3 Financial viability	A.3.1 Consumer willingness to pay	5-point Likert scales	• good + or ++ • fair 0 • poor - or --
		A.3.2 Affordability	5-point Likert scales	• good + or ++ • fair 0 • poor - or --
		A.3.3 Financial continuation	5-point Likert scales	• good + or ++ • fair 0 • poor - or --
		A.3.4 Cost coverage ratio	-	• good [100; 110] • fair [90; 100[or]110; 120] • poor [0; 90[or]120; +∞[

Strategic Objective (SO)	Assessment criteria (AC)	Metric	Unit	Reference values
B. Safeguarding ecosystems and their services to society	B.1 Safeguarded water ecosystems	B.1.1 Environmental flow requirement compliance rate	%	Northern Europe • good [60; 100] • fair [40; 60[• poor [0; 40[Southern Europe • good [40; 100] • fair [20; 40[• poor [0; 20[
		B.1.2 Effective stormwater treatment	%	• good [95; 100] • fair [90; 95[• poor [0; 90[
		B.1.3 Effective wastewater treatment	%	• good 100 • fair [95; 100[• poor [0; 95[
	B.2 Enhanced ecosystem services to society	B.2.1 Water body self-purification	%	• good [40; 100] • fair [10; 40[• poor [0; 10[
		B.2.2 Maintaining nursery populations and habitats	%	• good [40; 100] • fair [10; 40[• poor [0; 10[
		B.2.3 Flood damage prevention	%	• good [90; 100] • fair [60; 90[• poor [0; 60[
		B.2.4 Water provision by the ecosystem	%	• good [40; 100] • fair [10; 40[• poor [0; 10[
		B.2.5 People enjoying cultural ecosystem services	%	• good [40; 100] • fair [10; 40[• poor [0; 10[
	B.3 Resource efficiency	B.3.1 Water footprint	m^3/m^3	For WS • good [0.0; 1.0] • fair]1.0; 1.5] • poor]1.5; +∞[For WW • good [0.0; 1.0] • fair]1.0; 2.0] • poor]2.0; +∞[
		B.3.2 Carbon footprint	$kgCO_2eq/m^3$	• good [0; 0.3] • fair]0.3; 0.7] • poor]0.7; +∞[
		B.3.3 Energy consumption	kWh/m^3	For WS • good [0; 0.5] • fair]0.5; 0.8] • poor]0.8; +∞[For WW • good [0; 0.6] • fair]0.6; 0.9] • poor]0.9; +∞[
		B.3.4 Drinking water consumption	L/(capita.day)	• good [80; 150] • fair]150; 175] or [50; 80[• poor [0; 50[or]175; +∞[

Strategic Objective (SO)	Assessment criteria (AC)	Metric	Unit	Reference values
C. Boosting value creation around water	C.1 Circular policy making	C.1.1 Statutory compliance	5-point Likert scales	● good + or ++ ● fair 0 ● poor - or --
		C.1.2 Preparedness	5-point Likert scales	● good + or ++ ● fair 0 ● poor - or --
		C.1.3 Policy instruments	5-point Likert scales	● good + or ++ ● fair 0 ● poor - or --
		C.1.4 Green public procurement	%	● good [50; 100] ● fair [10; 50[● poor [0; 10[
		C.1.5 Level of ambition	5-point Likert scales	● good + or ++ ● fair 0 ● poor - or --
	C.2 Circular economy growth	C.2.1 By-products recovery revenues	%	● good > interest rate + 0.5 ● fair [interest rate; interest rate + 0.5] ● poor < interest rate Based on the reference interest rates of the European Central Bank
		C.2.2 Green jobs	%	● good [6; 100] ● fair [3; 6[● poor [0; 3[
		C.2.3 Circular economy business models in practice	%	● good [50; 100] ● fair]0; 50[● poor 0
	C.3 Resource recovery and use	C.3.1 Water-related materials recovery	%	● good [15; 100] ● fair [10; 15[● poor [0; 10[
		C.3.2 Fertilizer production avoided	%	● good [30; 100] ● fair [5; 30[● poor [0; 5[
		C.3.3 Reclaimed water in non-potable uses	%	● good 1/3 of C.3.4 reference values ● fair 1/3 of C.3.4 reference values ● poor 1/3 of C.3.4 reference values 1/3 ratio should be adjusted to reflect potables and non-potables uses

Strategic Objective (SO)	Assessment criteria (AC)	Metric	Unit	Reference values
		C.3.4 Reclaimed water production	%	WEI+ < 10 • good [5; 100] • fair [0.5; 5[• poor [0; 0.5[10 ≤ WEI+ <30 • good [10; 100] • fair [5; 10[• poor [0; 5[30 ≤ WEI+ < 70 • good [20; 100] • fair [10; 20[• poor [0; 10[WEI+ >=70 • good [30; 100] • fair [15; 30[• poor [0; 15[
		C.3.5 Energy production	%	For WS • good [10; +∞[• fair [5; 10[• poor [0; 5[For WW • good [20; +∞[• fair [10; 20[• poor [0; 10[For Waste • good [100; +∞[• fair [50; 100[• poor [0; 50[
D. Promoting adaptive change towards resilient infrastructure	D.1 Enabling planning to promote adaptive change towards circularity and resilience	D.1.1 Infrastructure planning index for adaptive change	Score (1-100)	• good [70; 100] • fair [40; 70[• poor [0; 40[
	D.2 Implementing adaptive change towards resilient infrastructure	D.2.1 Infrastructure value index	-	• good [0.4; 0.6] • fair [0.2; 0.4[or]0.6; 0.8] • poor [0.0; 0.2[or]0.8; 1.0]
		D.2.2 Infrastructure implementation index for adaptive change	Score (1-100)	• good [70; 100] • fair [40; 70[• poor [0; 40[
	D.3 Effectiveness of the adaptive change towards resilient infrastructure (Diagnosis)	D.3.1 Linear water losses	m^3/(year.km)	For distribution • good [0; 1100] • fair]1100; 1800] • poor]1800; +∞[For bulk systems • good [0; 1800] • fair]1800; 2700] • poor]2700; +∞[

Strategic Objective (SO)	Assessment criteria (AC)	Metric	Unit	Reference values
		D.3.2 Water storage capacity	days	For drinking water systems and wastewater treatment plants • good [1; 2] • fair [0.5; 1[or]2; +∞[• poor [0; 0.5[for rainwater harvesting systems • good [4; +∞[• fair [1; 4[• poor [0; 1[
		D.3.3 Incident occurrences	No./100 km/year	For water supply systems bursts in distribution • good [0; 30] • fair]30; 60] • poor]60; +∞[For wastewater systems floods • good [0; 0.5] • fair]0.5; 2] • poor]2; +∞[collapses • good [0; 1.0] • fair]1.0; 2.0] • poor]2.0; +∞[
		D.3.4 Combined sewer overflows	No./device/year	Non sensitive water bodies • good [0; 30] • fair]30; 60] • poor]60; +∞[Non sensitive water bodies and recreational uses • good [0; 5] • fair]5; 10] • poor]10; +∞[Sensitive water bodies • good [0; 6] • fair]6; 12] • poor]12; +∞[Bathing waters • good [0; 2] • fair]2; 3] • poor]3; +∞[
		D.3.5 Time for restoration	days	• good [0.0; 0.25] • fair]0.25; 1.0] • poor]1.0; +∞[
		D.3.6 Level of autonomy	%	• good [80; 100] • fair [70; 80[• poor [0; 70[
		D.3.8 Level of redundancy	%	• good [90; 100] • fair [80; 90[• poor [0; 80[

Strategic Objective (SO)	Assessment criteria (AC)	Metric	Unit	Reference values
		D.3.8 Treatment capacity utilization	%	For WS • good [70; 90] • fair [60; 70[or]90; 110] • poor [0; 60[or]110; +∞[For WW • good [70; 95] • fair [60; 70[or]95; 120] • poor [0; 60[or]120; +∞[
E. Engaging citizens and actors across sectors in continuous co-learning and innovation	E.1 Awareness and knowledge	E.1.1 Knowledge and education	5-point Likert scales	• good + or ++ • fair 0 • poor - or --
		E.1.2 Information availability and use	5-point Likert scales	• good + or ++ • fair 0 • poor - or --
		E.1.3 Local sense of urgency	5-point Likert scales	• good + or ++ • fair 0 • poor - or --
		E.1.4 Water smart culture	5-point Likert scales	• good + or ++ • fair 0 • poor - or --
		E.1.5 Smart monitoring	5-point Likert scales	• good + or ++ • fair 0 • poor - or --
	E.2 Multi-sector network potential	E.2.1 Clear division of responsibility	5-point Likert scales	• good + or ++ • fair 0 • poor - or --
		E.2.2 Authority	5-point Likert scales	• good + or ++ • fair 0 • poor - or --
		E.2.3 Room to maneuver	5-point Likert scales	• good + or ++ • fair 0 • poor - or --
	E.3 Stakeholder Engagement processes	E.3.1 Stakeholder inclusiveness	5-point Likert scales	• good + or ++ • fair 0 • poor - or --
		E.3.2 Protection of core values	5-point Likert scales	• good + or ++ • fair 0 • poor - or --
		E.3.3. Cross-stakeholder learning	5-point Likert scales	• good + or ++ • fair 0 • poor - or --
		E.3.4. Collaborative agents	5-point Likert scales	• good + or ++ • fair 0 • poor - or --

Appendix D – Improved interview guide

In the following the interview method applied is presented. The interview method supports the assessment of the interview-based metrics.

Who is conducting the interviews?

> Interview qualifications
>
> An interviewer has preferably the following set of skills and experience: She or he has professional experience with conducting interviews. Has at least five years of experience in the water sector and adjacent fields such as circular systems or climate adaptation, either as a scientist of practitioner. Is reasonably acquainted with the process and activities within the Living Lab. Is able to have a broad overview by having a generic understanding of technical knowledge, practical processes and scientific data collection and validation processes. Able to critically reflect and communicate from a broader societal perspective beyond a specific organization or interest. The interviewer is a particular good listener with adequate reporting skills and is knowledgeable of privacy regulation and how to deal with request for anonymity by interviewers (if applicable). Interviewer is being recognized by the management team of the organization providing

Two options are available for conducting the interviews:

- **Option 1**: at least 10 interviews by an independent interviewer outside the organization of the living lab who is responsible for the scoring and justification of the scoring.
- **Option 2**: with less than 10 interviews, a group of about five people with various expertise and roles in the organization(s) of the living lab are jointly responsible for the scoring and justification of the scoring.

A triangular method is applied consisting of three steps.

Step 1: Desk study

A justification of a preliminary score is given, based on information from reports, studies, websites, policy documents, etc. Information sources should be added through standardized referencing. This preliminary score and its justification provide a solid preparation for the interviews and can be adopted later based on information obtained through the interviews and the feedback from the interview (step 2 and 3).

Step 2: Interviews

Selecting interviews: The most relevant stakeholders for Living Labs' water-smartness challenges are being explored with the help of the Living Lab coordinator and using information on websites, reports, and other online documents too. Additional interviews to identify relevant stakeholders are optional. At least six and ideally ten key stakeholders need to be identified. They form the selection pool for the interviews of specific metrics of the BWS-AF.

Stakeholder categorization and selection:

In B-WaterSmart, a thorough process of stakeholder identification was carried out in preparation for the Community of Practice (CoPs) in May 2021 (D1.1. – "CoP Architecture and Stakeholder Mapping for each Living Lab"). In addition, from March 2022 onwards, each Living Lab has performed regular CoP meeting with a diversity of participants, including national agencies, regulators, water utilities and environment NGOs.

The key stakeholders who should be considered for interviews are the ones already involved in these participatory efforts. While D1.1 (Rebelo *et al.* 2021) and D5.1 (Gomes *et al.* 2021) provide guidelines for the process, the stakeholder maps and the roles attributed to each person/institution in the CoPs vary according to the characteristics and scope of the LL. Table 18 includes the typologies of stakeholders considered for the B-WaterSmart CoPs.

Type of Stakeholder
Government institution
Municipality
Regional/Local authority
Service/Technology provider
Utilities (water, waste, wastewater, energy, multi-services)
Regulator
Financial/funder
Sectoral association
Environmental NGO
Local association
Research/academia
Industry
Umbrella organisation
Agriculture sector
Water Board
Other

Table 18 – Typologies of stakeholders defined for stakeholder mapping at the B-WaterSmart LLs (WP1 and WP5)

Following the identification, it is recommended to conduct an exercise of stakeholder analysis, which will help to ensure that diverse perspectives are represented. Furthermore, it is important that the interviewer is aware of the relationships between stakeholders, and of their levels of interest and positions held, when preparing and conducting the interviews for the scoring. This preparatory process should consider the following aspects (D5.1, June 2021):

- core governance functions (strategic planning, policy-making, regulation, financing, service delivery, water resources management, monitoring, evaluation);
- interactions (co-ordination, partnership, consultation, information sharing, etc.);
- interests in the issue at hand (low - status quo - to high - committed to the process), with possible gaps and overlaps.
- the scale at which they operate (local, city, metropolitan, regional, national, EU, global).

In addition, Milestone 3 internal report "Guidelines to Operate LLs and CoPs" (February 2021) provides a template that can be used to fill in this information and also the contact details of the stakeholders (Annex A of Milestone 3).

Interview selection & preparation:

At least one elective representative from the policy field you are assessing is selected. Three to five interviews per metric are recommended. An interview typically focuses on several metrics matching the interview expertise or background. The interviewees' contact details need to be safely stored. An informed consent form will be presented in the local language to be signed and anonymous reference codes need to be applied in the metrics score justification (*e.g.,* interviewee 1). The informed consent forms, included in D1.1 as annexes to be used for CoPs, already reviewed by the B-WaterSmart coordination and the Project's Ethics Advisor, can be adapted for this purpose. In any case, it is recommended to have the updated version re-validated by both parties, to ensure that all applicable legislation and project procedures are adequately followed.

Set the scene:

Before the interviews take place, it is important that the procedure is clear not only for the interviewees but for the interviewers. For interviewers, it is necessary to look at the set of metrics and identify those that are important to their living lab. Also, understand the questions and adapt them to the local context is crucial for getting consistent results. Often, the questions will not cover all the specificities of different locations or the scoring will not fully fit the local reality.

A meeting before the interview takes place can be arranged to present the scope and topics to be addressed during the interview.

Conducting interviews:

The interviews are semi-structured and in-depth in nature. The metrics' questions are only for the assessor to answer and are not suitable as direct interview questions. The interview questions need to align with the background and/or expertise of the interviewee. In other word, translate the pre-defined question (provided in Chapter 2 for each of the 19 interview-based metrics and corresponding scoring) into multiple more simple questions that match the interviewees background and expertise. The questions need to be open questions with follow-up questions to either target specific elements or for further clarification. The interviewee should be asked to provide examples to clarify or validate their statements as much as possible. There are four points to keep in mind for conducting the interviews:

1. In interviews information are gathered on several metrics. The metrics that needs to be discussed with the interviewee should be prioritized. The priorities can be based on the interviewees' background and the information that is required to complete the framework. Often there is no time to discuss all the metrics. In general, an in-depth discussion of a few metrics with an expert is most valuable for your analysis.
2. It is recommended that interviews take about an hour to ensure high quality information exchange. An hour is often not enough to discuss all the metrics (hence the prioritization of metrics). Time should be reserved to start a comfortable conversation, explain the meaning of this assessment, point out your confidentiality arrangements, and announce that you would like to receive written feedback on your interview summary.
3. Interviews are preferably recorded and stored in a safe environment too (with permission of the interviewee). Alternatively, the recording can be deleted after finalizing the metrics score justification, and this option can be offered to the interviewee. Sometimes the interviewee does not give consent to a recording. In that case written notes only should be used.
4. Preferably, these interviews should be ensured by an independent person with experience in conducting qualitative data collection.

Step 3: Feedback

The interviewees should be given the opportunity to provide constructive written feedback and further input after the interview to improve the quality of argumentation. Hence, it is recommended to summarize the findings of the interview for the metric in an anonymous way and send this to the interviewees. It is advised to set an end-date for feedback and make the statement that if no feedback is received after this end-date, the researcher assumes that the interviewee agrees with the content.

Assigning an accuracy score for the metrics

Add an accuracy label for each metric according to traffic light model:

- **Green**: Confident of validity and legitimacy of score. Multiple interviews and stakeholders provide similar information. Statements are further supported by policy documents, plans or other written information.
- **Grey**: sufficiently confident of the validity and legitimacy of score. Most interviews and stakeholders provide similar information. No strong discrepancies. Limited number of interviews (<3 interviews for a single metric) or limited number of policy documents plans or other written information that can support interview statements.
- **Red**: More information, monitoring or discussion (with stakeholder) is necessary to improve the score accuracy of this metrics.

This accuracy label can help identify data gaps and provide insight in the liability of curtain scores and observations in the communication to others.

Generic advices for conducting interviews

The B-WaterSmart interview-based metrics assesses various broad aspects with respect to the specific topics of the living labs on a yearly basis building on the justifications provided last year and on the input of all interviews within the organization of the living lab owner(s) as well as key stakeholders. The interviewer will need to answer pre-defined questions for each interview-based metric by scoring it according to a Likert-type scoring scale that is rather generic. Here the justification is essential to make the fit with the Living lab context and ensure the relevance for the particular initiatives and information necessary to support strategic decision-making.

For conducting the interviews to following 10 general advices apply:

1. Ensure that you know who you are interviewing, and what their interests are. This makes you more aware of potentially biased answers.
2. Never literally ask the pre-defined question! It is your task as an interviewer to get all the information needed to answer these pre-defined questions. It is also your task to formulate your own questions considering the person in front of you.
3. Ensure that you start a comfortable conversation and get as much information out of that to score the indices. After about a half hour you can check which indices you have missed and ask extra questions.
4. Consider your first and second interview as an exercise.
5. Make sure that you record everything! (With explicit permission of the interviewee.)
6. The real honest answers to some questions can be avoided by the interviewee. Make sure that you ask this question several times in a different way or get back on it at a later stage in the interview. Try to be friendly under all circumstances.

7. Preparation is important! The key concepts regarding the issue are different than you may be used to. It also helps you identify when someone is avoiding a certain issue or is being to positive or negative about it.
8. Try to stick to the specific ‘living lab challenge’ as much as possible. Interviewees might reply to your answer by talking about different issues or subjects. The metrics you score always specifically related to the living lab scope and strategic goals.
9. Be bolt and ask important people for an interview. This is generally accepted and common practice for foreign researchers.
10. Most of all, be neutral, object and friendly at all times. This includes being clear in expectation management. It is not the interviewee but you or your team who is in charge of an adequate scoring of the metrics. The interviewee has a role in assisting in getting the best information to do so but is not in the position to co-determine the metric scores.

B-WaterSmart

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 869171. The publication reflects only the authors' views and the European Union is not liable for any use that may be made of the information contained therein.