The water-smartness assessment framework (V_1)

Deliverable 6.2

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The water-smartness assessment framework (V_1)

D6.2: The water-smartness assessment framework (V_1)

Summary

D6.2 consists of the Version 1 of the B-WaterSmart Assessment Framework (BWS AF) developed by WP6 under Task 6.2. V_1 builds on the V_0 (MS16), which provided the preliminary list of the elements forming the framework. MS16 built on the theoretical background given by D6.1, describing the preliminary conceptual design of the framework. V_1 is a transitional step between V_0 and the final version V_2 (by Task 6.3). 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 Innovation Alliance (InAll) under the coordination of Task 1.4 in the period April-August 2022. Afterwards, the InAll have been trained to the use of the web application and, by using the feedback forms made available, their insights have been shared with Task 6.2. The feedback has been analyzed by Task 6.2 in September and either already addressed in V_1 or included in this document as input to Task 6.3. D6.2 is composed therefore by this supporting document and the web-application incorporating the updated version of the BWS-AF allowing further testing by the InAll. This document consists of two parts: part I includes background information about the BWS AF scope, the description of the co-creation process established with the InAll, and the updated version of the elements forming the framework V_1 (incorporated in the web-application), as well as the aggregated analysis of the feedbacks provided by the InAll. Part II addresses Task 3.9, which will convert the BWS AF V_2 into a dashboard, by sharing insights based on the experience gained during the development of the web-application and the validation phase. Last, D6.2 is closely related with D1.3 describing the scope and process of validation of V_0 and also providing insights to Task 6.3 and Task 3.9 from the InAll perspective.

Deliverable number	**Work package**
D6.2	WP6
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For abbreviations referring to the variables used to compute metrics, please see: Appendix C – List of variables adopted in BWS AF, V1

AC : Assessment Criteria

AF : Assessment Framework

BOD : Biological Oxygen Demand

BWS : B-WaterSmart

CE : Circular Economy

CICES : Common International Classification of Ecosystem Services

D : Deliverable

DMA : District Metered Area

DWD : Drinking Water Directives

EC : European Commission

EEA : European Economic Area

EFR : Environmental Flow Requirement

ES : Ecosystem Services

FAST : Framework ASsessment Tool

InAll : Innovation Alliance

IPCC : Intergovernmental Panel on Climate Change

IWA : International Water Association

LL : Living Labs

JRC : Joint Research Centre

JSON : JavaScript Object Notation

MS : Milestone

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

OECD : Organization for Economic Co-operation and Development

WFD : Water Framework Directives

WP : Work Package

SDG : Sustainable Development Goal

SO : Strategic Objective

SUD Sustainable Urban Drainage

T : Task

TSS : Total suspended solids

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 provides the means to achieve objective 6. So far, no harmonized and established approaches on how to assess the ‘water-smartness’ status or gains of a system, or society exist. Therefore, the mission of WP6 is to fill this gap by providing the definition of a water-smart society, operationalized into an applicable evaluation framework, which will be converted into an online dashboard (by Task 3.9) after being tested in Task 1.4 across the six Living Labs (LL) of the B-WaterSmart project.

WP6 is structured into three tasks: Task 6.1 covers the groundwork, including an extensive literature review and the gathering of preliminary user-requirements for the intended framework; Task 6.2 develops the framework up to version 1 (V_1) and Task 6.3 will further refine it after a period of testing performed by the LLs.

This deliverable presents the work fulfilled under Task 6.2 and therefore consists of the version 1 of the B-WaterSmart Assessment Framework (BWS AF). V_1 builds on the V_0 (Milestone (MS) 16), 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, describing the preliminary conceptual design of the framework.

V_1 is a transitional step between V_0 and the final version V_2 (to be delivered by Task 6.3).

To deliver V_1, first the information provided by MS16 have been embedded into a web-application (see Chapter 9) to facilitate a validation phase carried out by the project’s Innovation Alliance (InAll) under the coordination of Task 1.4 from April 2022. The web-application can only be accessed with credentials provided by the developer and in this phase of the project is limited to the InAll as users. This web-application was not originally envisaged and 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.

Afterwards, the InAll participants have been trained by WP6 in dedicated workshops organized by Task 1.4 to the use of the web application and then, by using feedback forms embedded in the web-application, their insights have been shared with Task 6.2 in the course of the validation phase.

Two rounds of validation have been planned with the InAll: the first one, focusing on a preliminary assessment of the framework and on the so-called “specific level” (at Strategic Objective, Assessment Criteria, and metrics levels) was performed until end of August 2022. The second one, with more in-depth evaluation of the framework as a whole, the so-called “generic level”, was performed in September 2022. The first round provided inputs to this deliverable, while the second round fed the deliverable D1.3 (also due in M26) under the responsibility of Task 1.4.

The feedbacks from round one (for a total of more than 4800 answers addressed) have been analyzed by Task 6.2 in September and either already addressed in V_1 or included in this document as input to Task 6.3. The validation performed in the period April-August 2022, mainly provided insights on the clarity and relevance of the proposed metrics, and only one of the metrics was considered irrelevant.

Overall, the InAll consider the AF useful to support their strategic planning and decision-making process. The users also find the flexibility of the AF beneficial as such the assessment can be tailor-made depending on their context of application. There are, however, some suggestions for improving the AF and these suggestions mainly focus on the extensive nature of the AF that requires the users to allocate their resources for data collection and conducting the assessment. The InAll also highlight that the AF can be complementary to other parallel/separate assessments currently in practice in their organization.

The BWS AF V_1, consists of five strategic objectives, seventeen assessment criteria and seventy-two related metrics. For each metric, the reference values, not included in V_0, have been provided in V_1 based on extensive literature review. Still the number of the metrics is considered too high to support any assessment, and therefore during Task 6.3 a process of iteration with the LLs and InAll will be established to at least distinguish between a list of core and additional metrics (as described in the conclusions section).

D6.2 is composed of this supporting document and the web-application incorporating the updated version of the BWS-AF allowing further testing by the InAll.

This document consists of two parts: Part I includes background information about the BWS AF scope (Chapter 1), the description of the co-creation process established with the InAll (Chapters 2-5), the aggregated analysis of the feedbacks provided by the InAll (Chapter 6), the updated version of the elements forming the framework V_1 (incorporated in the web-application) (Chapter 7) and the lessons learned (Chapter 8). Part II addresses Task 3.9, which will convert the BWS AF V_2 into a dashboard, by sharing insights based on the experience gained during the development of the web-application (Chapters 9).

Additional information is provided in the APPENDIX part, which includes a reminder on the proposed deployment "Methodology” described in D6.1 and applied in Task 1.4, a glossary of the terminology applied, the full list of variables defining the metrics of the framework, the proposed reference values, and the feedback forms embedded in the web-application to support the process of validation.

Lastly, as stated above, D6.2 is closely related with D1.3 that describes the scope and the process of validation of V_0 in further details but also provides insights to Task 6.3 and Task 3.9. Given the two deliverables are slightly overlapping in scope, the teams of Task 6.2 and Task 1.4 worked closely to ensure clear borders and minimized redundancy between the content of the two deliverables. More specifically, D6.2 focuses on the feedbacks received from the first round to revise the definitions of the strategic objectives, assessment criteria and metrics, while D1.3 analyzed the feedbacks processed by WP6 from both rounds of validation and converted them into a concrete list of recommendations.

By combining the information included in both D6.2 and D1.3, Task 6.3 will move towards the creation of the BWS AF V_2 building from V_1.

PART I – The B-WaterSmart Assessment Framework, V_1

1 The B-WaterSmart Assessment Framework (BWS AF)

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.

D6.1 (Ugarelli et al., 2021), by Task 6.1, served two objectives: the first being to provide the project definition of being a "water-smart society" and the other to outline the theoretical foundation of the water-smartness assessment framework.

As a result of Task 6.1, the following definition of a water-smart society has been proposed:

"*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."*

Building from D6.1, Task 6.2 moved to the operationalization of the definition into the framework, which (from the insights of the theoretical foundation) should be goal oriented. The first achievement of Task 6.2 has been the identification of a consolidated list of strategic objectives as summarized in B-WaterSmart MS16 supporting document (Ugarelli et al., 2022). To this aim, based on the dialogue with the LLs and insights from literature review, the three sentences in the definition were 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 the UN 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 framework. The full list of assessment criteria and metrics is provided in Section 1.4, while Chapter 7 offers the detailed definition for each element of the BWS AF, V_1.

Identifying the assessment criteria and the related metrics has been the most challenging mission of Task 6.2 in collaboration with the LLs and with contributions from WP2, 4 and 5 (the process is described in detail in Chapter 2).

Starting from a list of 14 strategic objective, 61 assessment criteria and about 90 metrics, the BWS AF V_1 consists now of 5 strategic objectives, 17 assessment criteria and 72 metrics.

Still the number of the metrics is considered too high to support any assessment, and therefore during Task 6.3 a process of iteration with the LLs and InAll will be established to at least distinguish between a list of core and additional metrics. The validation phase performed by the InAll in the period April-August 2022, mainly provided insights on the clarity and relevance of the proposed metrics, and none of the metrics was considered irrelevant. In this sense, V_1 is a transitional step between V_0 and the final version V_2 (by Task 6.3).

In the following sections, the scope, expected functionalities, potential main users, the current list of elements composing the BWS AF V_1 as well as a description of the simplified approach to visualize performance are presented

1.1 Objective of the BWS AF

The objectives of the framework are to:

1. assist practitioners 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.

1.2 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

1.3 The Framework’s main users

The envisaged users of the framework are:

1. **Living Labs' (LL) local[1], Innovation Alliance[2] 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 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.

1.4 The BWS AF content

1.4.1 The structure of BWS AF

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

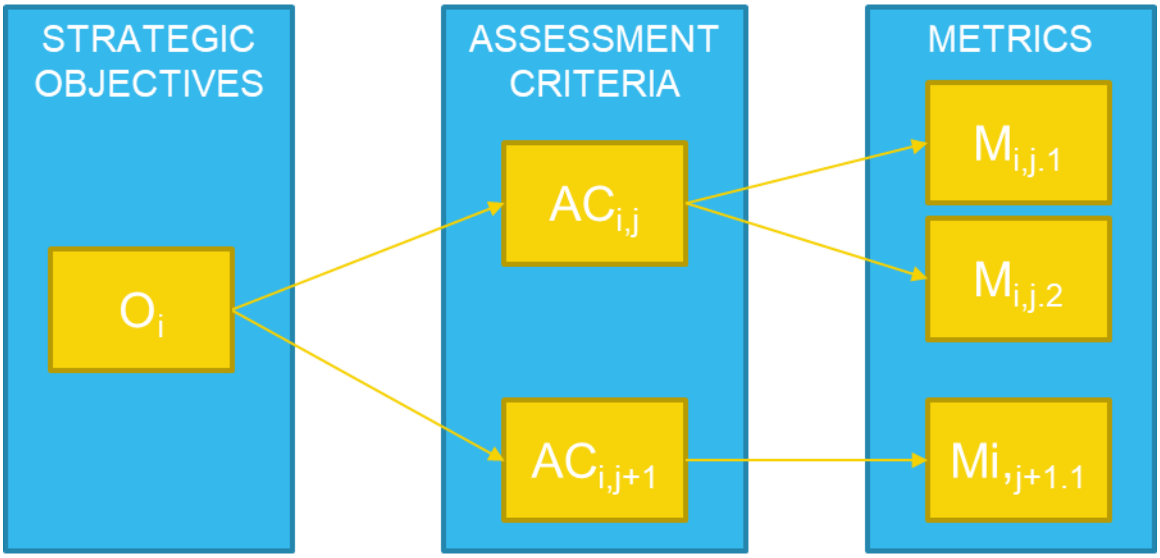

Figure 1 – The BWS AF tree structure

Its taxonomy (Table 2) consists of a list of selected strategic objectives. Each objective is specified by assessment criteria (Table 4) as points of view that allow for the

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[1] 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).

[2] 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).

assessment of the objectives. Each criterion in turn is described with a set of metrics (Table 5) which will serve to assess the distance from a set target. 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).

Strategic objectives, assessment criteria and metrics are described in full details in Chapter 7, as well as the nature of the proposed metrics (*i.e.,* indicator, index, score, scale) and the relative assessment method to be adopted.

Strategic objectives	Dimensions	Assessment criteria	Metrics

Table 2 – The back-bone structure of the B-WaterSmart Framework, V_1

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

Table 4 – Strategic objectives and assessment criteria of the BWS AF, V_1

Assessment Criteria (AC)	Metrics
A.1 Safe and secure fit-for-purpose water provision	A.1.1 Water resource exploitation index, plus (WEI+)
	A.1.2 Safe drinking water
	A.1.3 Compliant reclaimed water
	A.1.4 Security and resilience index – drinking water (DW)
	A.1.5 Security and resilience index – wastewater (WW)
A.2 Accessibility and equity (for any user)	A.2.1 Physical access to water supply (households and small businesses)
	A.2.2 Physical access to water supply in public spaces for quality of life
	A.2.3 Physical access to water supply (industrial use)
	A.2.4 Agriculture area with access to water for irrigation
	A.2.5 Number of points with potential conflicts of water use
A.3 Financial viability	A.3.1 Consumer willingness to pay
	A.3.2 Affordability
	A.3.3 Financial continuation
B.1 Safeguarded water ecosystems	B.1.1 EFR compliance rate
	B.1.2 Effective stormwater treatment
	B.1.3 Effective wastewater treatment
B.2 Enhanced ecosystem services to society	B.2.1 Benefits from regulating services (water quality)
	B.2.2 Maintaining nursery populations and habitats
	B.2.3 Regulation of extreme events
	B.2.4 Water provision by ecosystem

Assessment Criteria (AC)	Metrics
	B.2.5 People enjoying cultural ecosystem services
B.3 Resource efficiency	B.3.1 Water Footprint for drinking water
	B.3.2 Water Footprint for wastewater
	B.3.3 Carbon Footprint for drinking water
	B.3.4 Carbon Footprint for wastewater
	B.3.5 Energy consumption
	B.3.6 Drinking water consumption
C.1 Circular policy making	C.1.1 Statutory compliance
	C.1.2 Preparedness
	C.1.3 Policy instruments
	C.1.4 Green public procurement
	C.1.5 Level of ambition
C.2 Circular economy growth	C.2.1 By-products recovery revenues
	C.2.2 Green jobs
	C.2.3 Circular economy business models in practice
C.3 Resource recovery and efficient use	C.3.1 Water-related materials recovery
	C.3.2 Fertilizer production avoided
	C.3.3 Sludge beneficial use
	C.3.4 Water consumption from other sources
	C.3.5 Reclaimed water use
	C.3.6 Reclaimed water production
	C.3.7 Energy production
D.1 Enabling planning to promote adaptive change towards circularity and resilience	D.1.1 Infrastructure Planning Index for Adaptive Change
D.2	D.2.1 Infrastructure Value Index

Assessment Criteria (AC)	Metrics
Implementing adaptive change towards resilient infrastructure	D.2.2 Infrastructure Implementation Index for Adaptive Change
D.3 Effectiveness of the adaptive change towards resilient infrastructure (Diagnosis)	D.3.1 Linear water losses
	D.3.2 Water storage capacity
	D.3.3 Water retention
	D.3.4 Incident occurrences
	D.3.5 Combined Sewer Overflows
	D.3.6 Time for restoration
	D.3.7 Level of autonomy (of infrastructure)
	D.3.8 Level of redundancy
	D.3.9 Treatment capacity utilization
E.1 Awareness	E.1.1 Knowledge and education
	E.1.2 Local sense of urgency
	E.1.3 Hydrocitizenship
	E.1.4 Discourse embedding
E.2 Multi-sector network potential	E.2.1 Clear division of responsibility
	E.2.2 Network Cohesion
	E.2.3 Authority
	E.2.4 Room to maneuver
E.3 Stakeholder Engagement processes	E.3.1 Stakeholder inclusiveness
	E.3.2 Protection of core values
	E.3.3 Progress and variety of options
	E.3.4 Collaborative agents
E.4 Capacity building	E.4.1 Smart monitoring
	E.4.2 Evaluation
	E.4.3 Cross-stakeholder learning

Assessment Criteria (AC)		Metrics	
E.5	Information and knowledge sharing	E.5.1	Information availability and use
		E.5.2	Information transparency and sharing
		E.5.3	Knowledge cohesion

Table 5 – Assessment criteria and metrics of the BWS AF, V_1

1.4.2 The characterization of the metrics

The metrics composing the BWS AF V_1 are of different nature with different assessment methods required:

- **Indicators:** 43 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 percentage.
- **Indexes – questionnaire based:** 4 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.
- **Indexes – interview based:** 25 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 Likert scale.

The full list of the metrics with their characterization is given in Table 8.

1.5 The BWS AF visualization of performance

To allow the user to visualize the results of the assessment performed, in V_1 a simple visualization approach has been provided and embedded in the web-application used to validate V_1, the so-called **F.A.S.T.** (**F**ramework **AS**sessment **T**ool)[3] described in Chapter 9. The development of more advanced visualization options is part of the work of Task 3.9.

Since the metrics are expressed in different units, the approach proposed consists of visualizing the normalized value of the assessed metrics with respect to set values.

Each metric result X is normalized in relation to the Most Ambitious Objective (X_{max}) and its worst possible value (Most Unfeasible Value) (X_{min}). In this way, the user can see to what extent the most ambitious objectives are being achieved. For instance, 20% achieved. The most ambitious objective will be determined for each metric and could be a jointly defined value by the InAll in order to enable easy (visual) comparison between

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[3] FAST can be accessed only with credentials provided by the developer

progress amongst the InAll. In addition, for each metrics reference values and three targets can be entered.

Reference values are the judgement of what good, fair, and poor is for each metric. This judgement shall be established independently from the specific cases and be as stable as possible over time (it can be entered by the users, but WP6 has also provided suggestions for each metric based on extensive literature review, see Appendix D – Reference values).

Targets are the actual proposed values to be achieved for each metric and of the specific case within a given time frame (short, medium, or long term).

Figure 2 and Equation 1 provide an example of the scoring procedure of a hypothetical metric named ‘material reuse’. The targets apply to the individual Living Lab/InAll. The most ambitious objective is a jointly selected value of the 6 Living Labs/InAll that applies to the scoring rational of all Living Labs/InAll. In the example of material reuse, 25% of materials being reused would result in a score of 50% for this metric (see Equation 1).

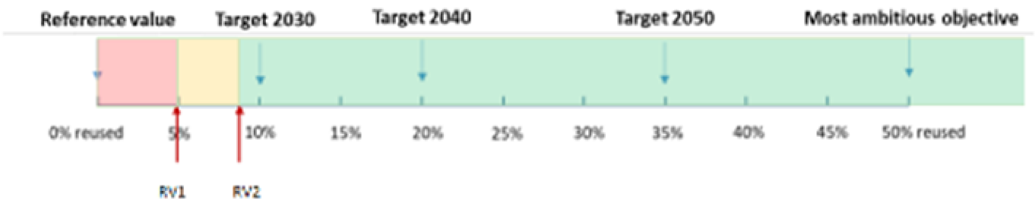


Figure 2 – Hypothetical example of a metric named ‘material reuse’ for an individual Living Lab/InAll.

Equation 1

- **X** = 25% materials being reused
- Most Unfeasible Value (***X****min*) = 0% material reuse
- Most ambitious objective (***X****max*) = 50%

$$\frac{X - Xmin}{Xmax - Xmin} * 100\% = \frac{25\% - 0\%}{50\% - 0\%} * 100\% = 50\% \text{ of most ambitious value attained.}$$

To visualize the performance at assessment criteria level the aggregation method adopted is simply the average of the scores of the metrics that belong to each assessment criteria. In turn, the resulting overall score of the assessment criteria can be averaged to arrive at an overall score for a strategic objective.

In the web-application the reference values, targets, minimum and maximum values are inserted by the user and results can be visualized as presented in section 9.1.2.4.

2 The process of co-creation of the BWS AF

The development of the BWS-AF is structured according to four phases (Figure 3). 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 this deliverable D6.2, and the prototype V_2 at M30 as deliverable D6.3. In the following, the work performed and the one to be 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 drives 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).
- Compiled 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 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 9.

By M26 (Prototype V_1, D6.2):

Through the feedback received from the InAll during the validation phase, and further interaction with Task 3.9, Task 6.2 has produced the BWS AF V_1, which:

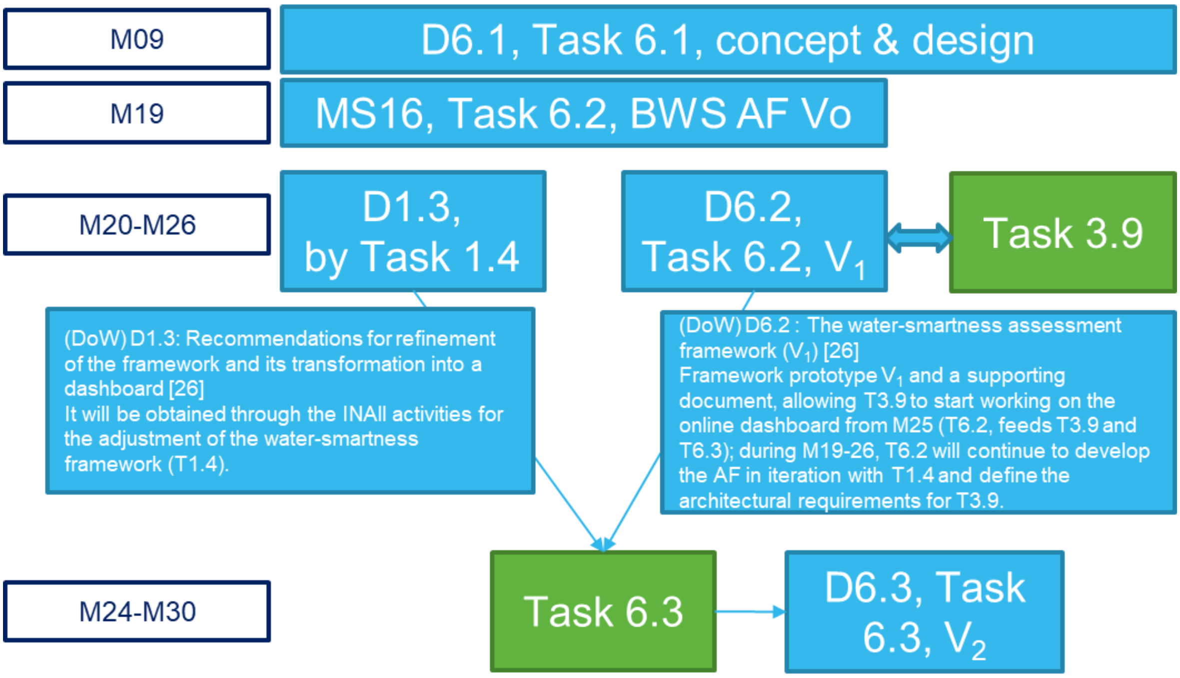
- Includes the improved definition of the metrics up to a mature level to be finalized by M30 (prototype V_2) through iteration with the InAll (see Chapter 7).
- Proposes for each metric reference values to be intended as "the judgement of what good, fair, and poor is for each metric for the stakeholders 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 (see Appendix D – Reference values).

- Presents in a structured way the feedback obtained by the InAll, based on feedback forms made available by Task 6.2, with an overview of the requirements already embedded by M30 in V_1 or as requirements to be embedded in V_2, by Task 6.3 (see Chapters 6 and 8);
- 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 online dashboard (see Chapter 9).

By M30 (Prototype V_2, D6.3):

Based on deliverable D1.3 (by Task 1.4 at M26) and this deliverable D6.2 describing: 1) the feedbacks of the InAll already addressed in V_1, and 2) the lessons learnt to be shared with Task 3.9, the process of refinement of the framework (Task 6.3) will continue from M27 until M30 (Prototype V_2), in parallel with the initial phase of its transformation into a software tool by Task 3.9 will start.



(DoW) D1.3: Recommendations for refinement of the framework and its transformation into a dashboard [26]
It will be obtained through the INAll activities for the adjustment of the water-smartness framework (T1.4).

(DoW) D6.2 : The water-smartness assessment framework (V_1) [26]
Framework prototype V_1 and a supporting document, allowing T3.9 to start working on the online dashboard from M25 (T6.2, feeds T3.9 and T6.3); during M19-26, T6.2 will continue to develop the AF in iteration with T1.4 and define the architectural requirements for T3.9.

Figure 3 – The four phases of co-development of the BWS-AF

3 The scope of the BWS AF validation phase

The validation phase of the BWS AF V_0, as for the DoW, was performed during the period April-September 2022 (M20-M24), under the guidance of WP1, T1.4. During the validation phase, the InAll learnt in a hands-on experience how to apply the BWS objective - oriented assessment framework as a key instrument for strategic planning and provide guided feedback to WP6 so to move to V_1 and V_2.

The activities planned for the InAll have been organized by Task 1.4 in five phases, each of them having a dedicated scope. The validation of the V_0 of the framework has been performed by the InAll while covering the phases 1 and 2, briefly described as follow (refer to D1.3 (Cardoso et al., 2022) for more details):

InAll Phase 1 Kick-off | 2 Months [Mar 22 – Apr 22]

- Establishment of the scope of the strategic planning to be carried out within InAll for each BWS LL problem-owner, including time horizons for planning and analysis and the geographical area of analysis.
- Analysis of the work already in place in the LL, survey of existing related processes and plans, strategic agenda or strategic plan (linked with Task 1.5 and D1.4);
- Detailed planning of activities.

InAll Phase 2 – Strategic assessment | 3 Months [May 22 – July 22 (further extended to August 22)]

- Analysis of the LL strategic agenda or plans in the face of establishing a water-smart society;
- Identification of BWS strategic objectives and definition of the BWS assessment system for each LL;
- Strategic assessment for plan production;
- Analysis of the results of the framework and feedback to WP6;
- Review and updates considering the validated agendas.

More specifically, the actual use of the BWS AF occurred in Phase 2 (extended to August 22 to accommodate delays due to the summer break), during which the InAll made use of the framework to perform a preliminary strategic assessment. While performing this exercise, the InAll were in the condition to provide WP6 with critical feedback on 1) the framework, as general instrument to support long-term strategic planning and on 2) the proposed metrics, in terms of their relevance, feasibility/applicability, completeness, etc. in supporting the identification of strategies. Feedback forms, embedded in the web-application, have been used by the InAll to provide an organized and structured feedback to WP6. The feedback forms are described in Chapter 4 and provided in Appendix E – Feedback forms.

Therefore, the aim of the validation was not to test the performance of a software, in terms of robustness for instance, but to validate if the content so far developed for the BWS AF could support the InAll in developing long-term strategies so to help improving the framework afterwards based on the received feedback.

The strategic plan results from the adoption of an iterative six-step process for continuously improving the transition process to a water - smart society (Figure 4) (see Appendix A – How to use the B-WaterSmart frameworkfor details). The use of the BWS AF at specific steps of the process (mainly STEPS 1, 2 and partially 3) should help the users to identify gaps and define directions for improvements of strategies in achieving water smarter levels (Figure 5).

“How ‘good‘ is the V_0 of the BWS AF in supporting this assessment?”, was the key question of the validation phase.

To this aim, the problem owners were guided by Task 1.4 along with the InAll, through multiple activities, during Phases 1 and 2, reflecting some of the iterative steps, on the use of the BWS AF so to better assess the usefulness of the preliminary version of the BWS AF to support strategic planning.

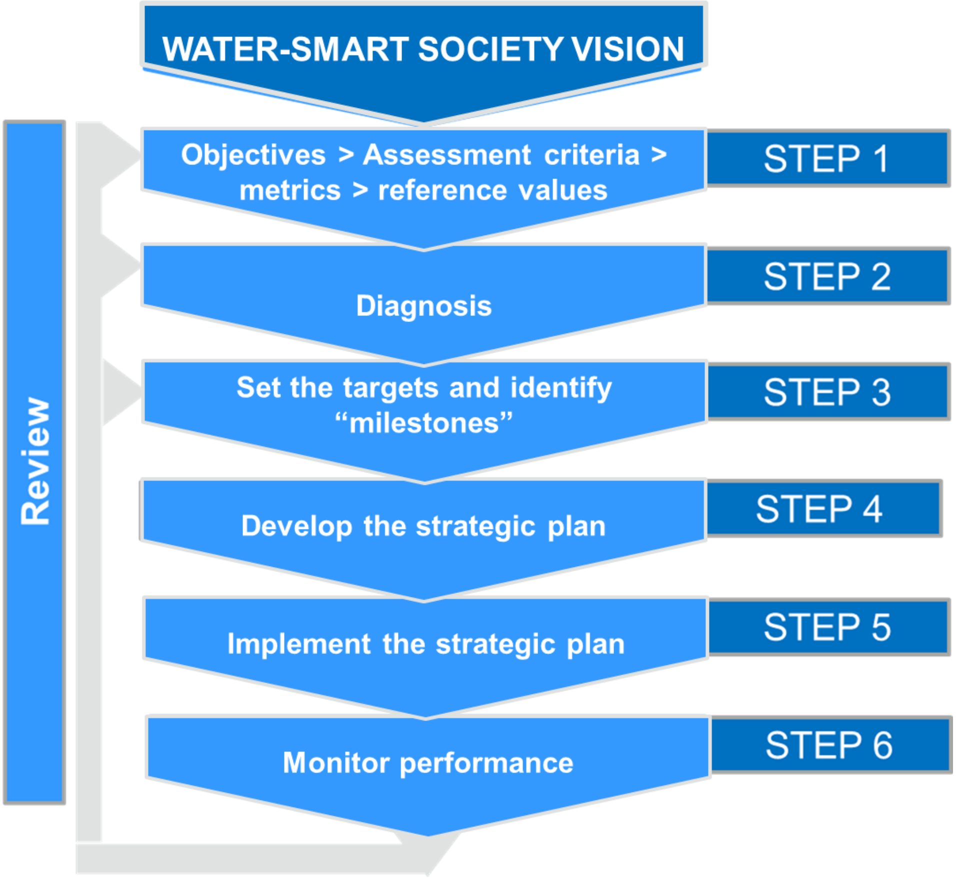


Figure 4 – The iterative six-step process to meet the water-smart vision proposed for the deployment of the B-WaterSmart framework (D6.1, WP6)

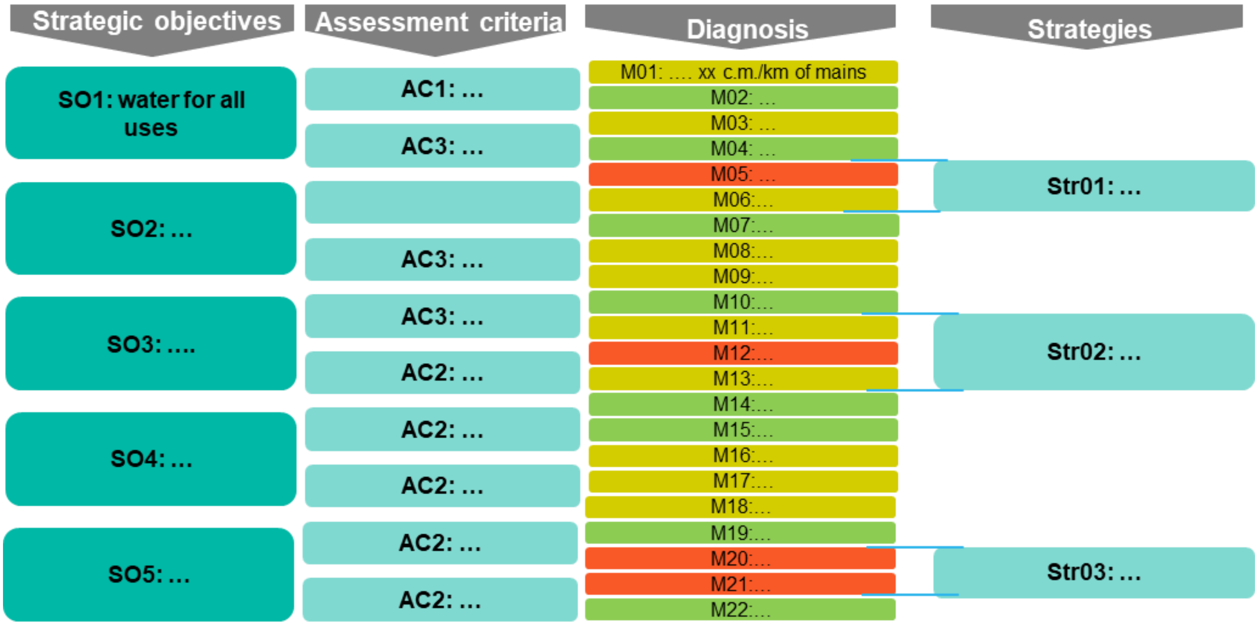


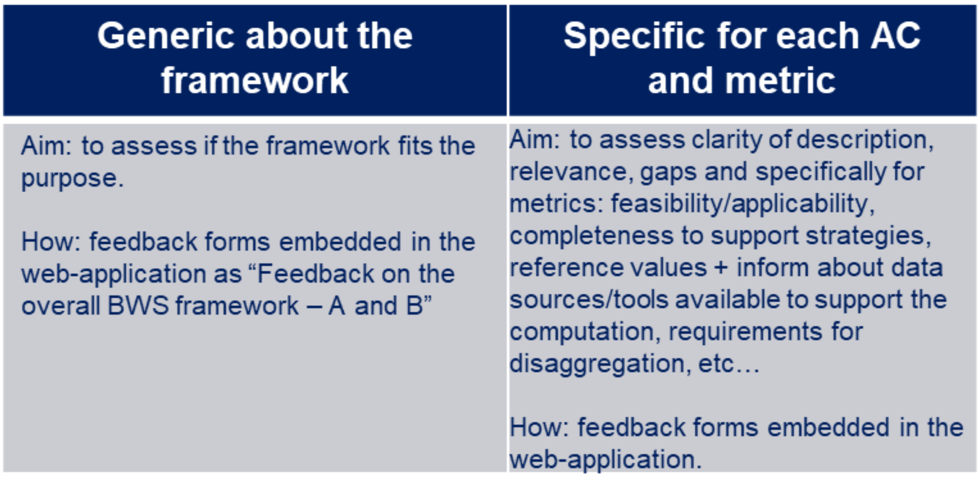
Figure 5 – From Strategic Objectives to Strategies (Source: Alegre H., WP1 presentation)

4 The feedback process from the InAll to WP6

A detailed plan, in the form of a GANTT chart has been developed by Task 6.2 to align in time and content the request of feedbacks from the InAll according to the progress of the InAll's phases 1 and 2 (see Chapter 3). The Gantt chart is made available for the project partners in the B-WaterSmart project NextCloud repository at: https://nextcloud.b-watersmart.eu/index.php/s/P5zwbqDBFq8ADNq

The Gantt chart was adapted on need during the course of the validation phase and will be extended to guide the progress of Task 6.3 after M24.

As mentioned above, feedback forms, as questionnaires, have been prepared by WP6 and embedded in the web-application to facilitate the process of validation by the InAll. Two levels of forms have been created: the generic level and the specific level (Figure 6); the generic level addresses questions about the relevance of the framework in supporting strategic planning, while the specific levels cover the feasibility, relevance and value of assessment criteria (AC) and metric. The full list of questions is provided in Appendix E – Feedback forms.



Generic about the framework	Specific for each AC and metric
Aim: to assess if the framework fits the purpose. How: feedback forms embedded in the web-application as "Feedback on the overall BWS framework – A and B"	Aim: to assess clarity of description, relevance, gaps and specifically for metrics: feasibility/applicability, completeness to support strategies, reference values + inform about data sources/tools available to support the computation, requirements for disaggregation, etc… How: feedback forms embedded in the web-application.

Figure 6 – The different levels of the feedback forms made available to the InAll through the web-application.

Under the frame of collaboration with Task 1.4, it was agreed that, after the validation phase, WP6 would process and address in D6.2 the feedbacks related to the "specific level", while WP1 would make use of all the feedbacks processed by WP6, including the "generic level" to come up with a concrete list of recommendations.

A particular effort has been dedicated to the feedback process related to the metrics defined as Indexes – interview based. For those metrics, interview-based, the validation process not only assessed the specific metrics proposed, but also the interview approach so to guide the WP6 team in further refining the way of conducting the interviews and provide together with V_2 a guiding document for performing the interviews. The interview process is described in Chapter 5 and the lessons learnt during the validation phase are summarized in Chapter 8.

5 The interview process proposed for the Indexes – interview based

5.1 The interview-based metrics

For the 25 interview-based metrics, the scoring is based on a 5-point Likert scale and mixed methods are envisioned to be applied to justify the selected Likert score. These methods consist of:

I) **Literature review** of policy documents, reports, scientific reports, or grey literature including websites, social media or newspapers.

II) In-depth **interviews** with key stakeholders. As a minimum requirement, at least three stakeholder perspectives need to be accounted for in the scoring of each metric.

III) The interviewees get the opportunity to provide **feedback** on the preliminary score justifications in the form of providing additional information, argumentation, and examples. The independent assessor collects the feedback of each stakeholder and put them together in a final score and score justification.

The metrics deliberately go beyond an assessment of an LL or individual organizations such as a municipality or utility. The metrics focus on the regional conditions in which they operate. In this testing phase, the metrics have been scored and the score has been justified based on a limited number of interviews with partners within the InAll network. The aim of the testing phase is for the LLs to get acquainted with the metrics, the methodology and get a justification of the score.

The 25 metrics are split across three strategic objectives:

A. **Ensuring water for all relevant uses**
Three metrics: **A.3.1** consumer willingness to pay, **A.3.2** affordability and **A.3.3** financial continuation.

C. **Boosting value creation around water**
Four metrics: **C.1.1** statutory compliance, **C.1.2** preparedness, **C.1.3** policy instruments and **C.1.5** level of ambition.

E. **Engaging citizens and actors across sectors in continuous co-learning and innovation**
18 metrics: **E.1.1** knowledge and education, **E.1.2** local sense of urgency, **E.1.3** Hydrocitizenship, **E.1.4** discourse embedding, **E.2.1** clear division of responsibilities, **E.2.2** network cohesion, **E.2.3** authority, **E.2.4** room to maneuver, **E.3.1** stakeholder inclusiveness, **E.3.2** protection of core values, **E.3.3** progress and variety of options, **E.3.4** collaborative agents, **E.4.1** smart monitoring, **E.4.2** evaluation, **E.4.3** cross-stakeholder learning, **E.5.1** information availability and use, **E.5.2** information transparency and sharing, and **E.5.3** knowledge cohesion.

A team of social scientists has performed interviews with InAll representatives of each LL. Since the full-scale application of the B-WaterSmart framework and its continued application will be done by many different people, the approach of having a different (team of) assessor(s) for each LL was deliberately chosen to make sure that the broadest range of feedback and improvement options were identified. To restrain the length of the interviews to approximately one hour/ one hour and a half each, the score assessment of the 25 metrics has been divided over three separate interviews. For each interview, metrics have been matched with the background of the interviewee. Some cross checking of metrics across interviewees was also performed to improve the reliability of the score justifications.

Lessons from this test phase are formulated using both LL feedback provided verbatim by interviewees and through personal communication with the different interviewers involved in the validation process of the proposed assessment framework (see Chapter 8).

5.2 The interview method applied

In the following the interview method applied is presented. After the phase of testing, the approach will be modified based on the lessons learnt described in section 8. 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. and D5.1 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 6 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 6 – 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.

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 7 for each of the 25 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. Examples should be asked to the interviewee 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 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 your 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.

6 The feedback from the InAll and the Task 6.2 response

The following sections provides the feedback received by the InAll during the validation phase at Strategic Objective (SO) level, Assessment Criteria (AC) level and at metrics level. Specifically for the metrics, a distinction is made for the quantitative and questionnaire-based metrics and the interview-based metrics. This chapter will highlight the main categories of changes already addressed in V_1 (versus V_0) and those provided as inputs to Task 6.3 towards the final version V_2. Concrete recommendations for Task 6.3 based on the information provided below can be found in D1.3.

6.1 Overview of SO-level feedbacks

In summary, the feedbacks can be categorized in two main groups:

I. Clarity of definitions

In general, LLs find the SO definitions quite clear, but the following feedback for improvement is given:

SOA –One LL that highlights the need for a general revision of the three ACs and a minor revision of one metric.

SOB - One LL that highlights the need for a general revision of the three ACs and another LL that questions the applicability of the AC B1 and B2 in their own context.

SOC – One LL is suggesting a minor revision of the definition.

SOD - Two LLs that highlight the need for minor revisions of the three ACs.

SOE –One LL suggests reducing the number of ACs in order to balance the importance of this particular SO in comparison to the others.

II. Assessment coverage

In general, LLs find the coverage of the SOs in AF reasonably comprehensive, but the following feedback for improvement is given:

SOA – One LL suggests considering funding availability and qualitative condition assessment. In addition, another LL suggests a stronger focus on assessing future water availability.

SOB – One LL would like to consider not only the compliance level of wastewater treatment according to the regulation, but also to consider the progress beyond the state-of-the-art.

SOC – One LL highlights the lack of contribution to circularity from the use of external reused-recycled-recovered products in their own activities.

SOD – One LL comments about the need of including the aspects related to governance of the climate change in the assessment.

6.2 Overview of AC-level feedbacks

In summary, the feedbacks can be categorized in three main groups.

I. Clarity of definitions

In general, LLs find the AC definitions rather clear, but the following feedback for improvement is given:

AC A.1 – One LL is questioning about the applicability in their context.

AC B.3 – Three LLs highlight the lack of clarity which makes evaluation rather difficult. In addition, one LL is questioning about the applicability in their context.

AC E.2, AC E.4, and AC E.5 – One LL is underlining the redundancy of some indicators, hence, reducing the numbers of indicators is preferable to balance amongst the different SOs.

AC E.3 – One LL is underlining the redundancy of some indicators, hence, reducing the numbers of indicators is preferable to balance amongst the different SOs. Another LL is underlining the high level of subjectivity in evaluation several metrics in this particular AC.

II. Assessment Coverage

In general, LLs find the AC coverage comprehensive, but the following feedback for improvement is given:

AC A.1 – One LL is stating that the resilience assessment is not enough comprehensive and puts too much focus on the process rather than other aspects e.g. storage capacity, diversity of water sources.

AC B.1 – One LL is suggesting that Sustainable Urban Drainage (SUDs) and Combined Sewer Overflows (CSOs) should have more relevance for this AC.

AC B.2 – One LL recommends that the number of successful Ecosystem Services (ESS) implementation should be part of the assessment. Another LL suggests quantification of co-benefit of ESS to be included in the assessment (*e.g.,* heat effect reduction, impact on health)

AC B.3 – One LL is proposing the adoption of a metric about production/consumption of renewable energy

AC C.1 – One LL is proposing the adoption of a metric about relevance of water challenges and sustainability in policy making.

AC C.3 – One LL advises to include the external renewable energy production in the circularity assessment.

AC D.2 – One LL is stressing the relevance of including the benefits of the blue-green solutions. Another LL suggests the importance of tools such as GIS, ageing models, demand forecast to support maintenance and infrastructure renewal.

AC D.3 – One LL points out complementary metrics for water leakage assessment would be beneficial.

AC E.4 – One LL recommends a focus on issues of perception in strategic planning, often considered not neutral or reliable by the stakeholders.

AC E.5 – One LL proposes to consider the concept of adopting tools to enable knowledge sharing in the existing metrics E.5.1 and E.5.2.

III. Mismatch between AC and metrics

In general, LLs find metrics in the ACs are properly placed, but the following feedback for improvement is given:

AC A.1 – One LL proposes to remove AWEI (A.1.2) (share of alternative water use for drinking water purposes and/or % of freshwater savings).

AC B.3 and AC C.3 – One LL states that these two ACs are similar and the indicators for these ACs can be rearranged/exchanged.

AC D.3 – This particular AC is similar to AC A.1, hence, the indicators for these ACs can be rearranged/exchanged.

AC E.1 – One LL suggests that removing E.1.4 would be beneficial.

6.3 Overview of metric-level feedbacks

6.3.1 Calculation- and questionnaire-based metrics

The feedbacks can be grouped into the following points:

I. Clarity of the definition

A.1.1 – One LL is stating that this metric is not clear when it comes to a complex system involving different sources, while another LL suggests that description of components in the equation is not well formulated.

A.1.2 – One LL highlights the subjectivity of the concept of availability described in the metric, *e.g.,* different views of availability may arise depending on its interpretation (*e.g.,* administrative, physical, temporal).

A.1.3 – One LL is suggesting adding consideration of complementary analyses, while another LL points out the issue of the metric unit (in %) that may mislead the overall water quality compliance.

A.1.4 – One LL is suggesting adding references to sector-based regulations (*e.g.,* aquaculture, urban water reuse, etc.).

A.1.6 – One LL points out a potential issue if the metric is used to assess multiple organizations with cross-responsibilities. Moreover, the reference should be given in English and at times the description given is not so clear.

A.2.1 – One LL suggests merging of A.2.1 and A.2.3 given that these metrics differentiate only in terms of the scale. Alternatively, the metric should be just disaggregated into different categories.

A.2.2 – One LL suggests that a user should be able to insert other examples of water supply access point in addition to that in the current definition of the metric.

A.2.3 – One LL underlines the fact that some large industries may have their own separate water supply system, and hence, may be overlooked by the metric definition. One LL made a reference to combining this metric to A.2.1 and/or making disaggregation possible.

A.2.4 – Two LLs suggest refinement of the definition of 'area' in the metric. The point of departure is the fact that agriculture areas should have access to some sort of water source(s).

A.2.5 – Two LLs questions the definition of 'conflict' in this metric and the relevant time frame for the evaluation.

B.1.1 – Two LLs questions how environmental flows requirements (EFR) can be determined/measured although data may readily be available at basin level. In addition, if an area is served by more than a river, a weighing based on EFR should be considered. Alternatively, the metric should be renamed as 'EFR compliance rate'.

B.1.2 – Two LLs questions the definition of 'polluted stormwater' that needs further clarification and propose either CSOs or number of untreated stormwater release as an alternative. One LL suggest a clearer definition of area in the metric calculation.

B.1.3 – Two LLs argue that the alternative 2 (volume-based calculation) for metric calculation is the better assessment.

B.2.1 – Two LLs imply that evaluation of this metric can prove difficult, *e.g.,* direct correlation/quantification of revenues generated, and suggest a simpler way to calculate the metric *e.g.,* by considering only the limiting factor substance (*e.g.,* phosphorus).

B.2.3 – One LL argues that Nature based Solutions (NBS) should be included in the assessment, and another LL suggests reformulating the metric referring to the Common International Classification of Ecosystem Services (CICES).

B.2.4 – One LL is questioning if the assessment should not be limited to just groundwater, and another LL suggests reformulating the metric referring to CICES.

B.2.5 – One LL is suggesting that the metric should also take into account tourism (which flows are also indirectly calculable). A list of relevant services for recreational activities should be given, together with the perimeter of the calculation. It is highly recommended a disaggregation per type of service. Moreover, a definition of what is intended for "cultural ecosystem services" should be given. One LL is questioning the definition of water bodies in the metric that may exclude their own specific context of water body.

B.3.1 and B.3.2 – Two LLs are questioning the metric definition *i.e.,* more comprehensive aspects of water footprint calculation that includes direct and indirect resource appropriations.

B.3.3 and B.3.4 – One LL highlights it is important to provide a standardized methodology to calculate the carbon footprint. Providing a "list of sources of emissions" to be considered in the numerator for the two calculations can be helpful. In addition, a parallel evaluation by a Life Cycle Assessment (LCA) expert to have more insights is necessary.

B.3.5 – One LL is questioning whether the metric covers net or gross energy consumption. One LL suggests a better scope/perimeter of the evaluation.

B.3.6 – One LL is suggesting a better definition of the context/activities covered by the metric owing to the complexity of setting relevant reference values of this metric.

C.1.4 – One LL implies the need of better definition of the metric. It is fine to choose a desired frequency to calculate this metric, but in this case the moment of stipulation could be the criteria for a contract to be considered or not. One LL comments on the criteria to call a contract "green", and another LL is questioning if the green contracts evaluated should be water-related.

C.2.1 – One LL implies the costs for final disposal that may be higher than the revenues generated.

C.2.2 – Two LLs commented on the vague definition of the metric and suggest reference can be made to standard definition at EU level.

C.2.3 – Two LLs have the opinion to refine the metric definition, preferably referring to a standardized definition. In addition, one LLs also question about the time horizon of such a 'new' business model.

C.3.1 – One LL suggests including sludge and other substances. Furthermore, the definition of the two variables in the formula could refer to the term "material" instead of "waste". The term 'total potential recoverable material' is preferred. One LL compares the metric with C.2.1 in which revenues are included.

C.3.2 – One LL highlights the unclear definition and method of computation. In their opinion, other activities that can help reduce fertilizer production, *e.g.,* wastewater sludge application should be considered. In addition, the total use of fertilizer also depends strongly on the area of applications.

C.3.3 – One LL highlights the redundancy of this metric with C.3.1. Another LL suggests renaming of the metric to give a more direct indication of what is measured by the metric, In addition, quality of the sludge may also play role in determining its beneficial use.

C.3.4 – One LL suggests that the metric may be too specific and only applicable at company level, and one LL highlights the need of a list of alternative water resource to be considered by different users.

C.3.5 – Two LLs has the opinion that this metric is redundant with C.3.4, and hence can be a part of disaggregation of the previous metric.

C.3.6 – One LL implies that this metric is redundant with C.3.4 and C.3.5.

C.3.7 – One LL suggests rephrasing the metric owing to the fact that energy can also be produced within the process without retaining or recovering wastes. In addition, the metric might be redundant with carbon footprint in the SO B. One LL suggests alternative energy productions, *e.g.,* turbines and micro-turbines in water transport/distribution networks, to be included.

D.1.1 – One LL thinks the metric is too wide and includes many aspects related to the ability to draft a strategic plan for infrastructure. Metric A.1.5 should also be considered in relation to the existence of risk management plans. In addition, one would need a clear perspective in answering the questionnaire.

D.2.2 – One LL suggests the concept of adaptation and flexibility needs to be better covered by the metric.

D.3.1 – Two LLs suggest improvement of the metric. One is highlighting the fact that there are better metrics addressing the issue, and one suggests redundancy with some other metrics.

D.3.2 – One LL suggests evaluating the metric can be a complex task, and another LL suggests the water distribution seems not to be reflected in the indicator but is urgently required.

D.3.3 – One LL is asking for inclusion of non-conventional resources in the evaluation.

D.3.4 – one LL requests a clearer definition of incident and system boundaries.

D.3.5 – One LL is asking for the missing definition of CSO devices of the system, and one LL suggests substituting the formula with indicator M4a proposed by ARERA (Frequency of floodings and/or sewer overflows).

D.3.6 – One LL suggests defining the metric as number of days per year.

D.3.8 – One LL suggests a better definition of redundancy, and one LL suggests system boundaries need to be defined, and hydraulic reliability studies need to be carried out for the specific system under consideration.

D.3.9 – One LL says that the metric definition is limited to wastewater, but water production is mentioned in disaggregation. Another LL requests a reference with English translation and a time reference for the calculation.

II. Feasibility and relevance of the metric evaluation

A.1.1 – One LL is saying that only groundwater is relevant for their context and suggests the metric to be split into different types of water resources and different sectors. One LL focuses also on the context of their organization being a part of an extremely complex system. Hence, in their view, the metric can only be calculated at a large level.

A.1.2 – One LL comments on the availability of data, with variables which are not readily available for the evaluation. Two LLs suggest disaggregation of the metric at local/regional level, and alternative water resources/sectors.

A.1.3 – Two LLs are suggesting metric disaggregation based on different water utilities and/or service area. Three LLs suggest disaggregation into different sectors depending on the reclaimed water use purposes.

A.1.4 – One LL is highlighting the lack of water quality requirements in some specific sectors, *e.g.,* aquaculture.

A.1.5 and A.1.6 – One LL suggests disaggregation based on water sectors

A.2.1 – One LL raises a concern about data availability. One LL suggests disaggregation into 3 categories (size dependent) and 2 types of connection (wastewater and drinking water). For this purpose, the reference values should also be verified and disaggregated.

A.2.2 – One LL raises a concern about data availability mainly due to a) unavailable data on public water supply points collected by local authorities or water managers; b) data are available, but from different authorities/water managers/other institutions, so aggregating them might be challenging.

A.2.3 – One LL asks for similar disaggregation groups as in A.2.2.

A.2.4 – One LL suggests disaggregation based on water sectors.

A.2.5 – One LL thinks this metric is rather unclear might be redundant with the other indicators.

B.1.2 – One LL highlights that 1) CSO is not considered, 2) SUDs do not seem to be considered (only treatment plants are mentioned), 3) Treating stormwater in a treatment plant is not actually a good practice (*e.g.,* in terms of energy and chemicals), 4) For extremely irregular rain patterns, it is just impossible to treat stormwater

B.2.1 – Three LLs think that evaluating this metric is difficult due to extensive data requirements and the fact that the data may not be available.

B.2.4 – One LL is suggesting disaggregation per ground water body.

B.2.5 – One LL is suggesting a disaggregation per type of service, considering all touristic activities and other services. One LL suggests disaggregation based on different areas.

B.3.1 – One LL suggesting an alternative way of calculating the water footprint based on water losses and own water consumption over water provision. One LL mentions data is unavailable for their context.

B.3.2 – One LL suggests disaggregation based on three resources targeted in their context of application (effluent, nitrogen, and sludge)

B.3.3 – One LL suggests an alternative calculation based on energy used and CO_2 equivalents

B.3.4 – One LL suggest that it can be useful to break it down into different areas as energy, goods, transportation, construction, etc., or different areas/facilities

B.3.5 – Each LL suggests different way of disaggregation based on *e.g.,* alternative water sectors/ alternative water resources, per process (water supply / wastewater collection / wastewater treatment), and resources targeted (effluent, nitrogen and sludge).

B.3.6 – Two LLs suggest different way of disaggregation based on *e.g.,* different categories of users, and different waterworks and their customers

C.1.5 – One LL implies the need differentiate assessment based on different actors (utility, City Council, Regional Administration)

C.2.1 – Three LLs suggest disaggregation based on *e.g.,* infrastructure component (or at least Wastewater treatment plants (WWTP) and Drinking water treatment plants (DWTP)), resources targeted (effluent, nitrogen, and sludge), or utility level.

C.2.2 and C.2.3 – One LL suggests disaggregation based on local/regional level.

C.3.1 – Two LLs suggest different way of disaggregation based on *e.g.,* resources targeted (effluent, nitrogen and sludge) and type of utility (wastewater/drinking water).

C.3.3 – One LL asks for disaggregation per plant.

C.3.4 – One LL asks for disaggregation for rain harvesting and reclaimed water, and two LLs suggest disaggregation based on alternative water resources.

C.3.5 – One LL asks for disaggregation for different categories of users.

C.3.6 – One LL asks for disaggregation for rain harvesting and reclaimed water, and another LL suggests disaggregation per plant.

C.3.7 – Two LLs suggest disaggregation per plant.

D.1.1 – One LL asks for disaggregation for different water sectors.

D.2.1 – Three LLs suggest disaggregation based on water sector/infrastructure.

D.2.3 – One LL asks for disaggregation for different water sectors.

D.3.1 – Two LLs suggest disaggregation based on service area, and another LL suggests disaggregation for different water sectors.

D.3.2 – Two LLs suggest disaggregation for different water sectors

D.3.3 – One LL argues that by using the area as denominator of the fraction means that the rainfall volume and profile of the site is not being considered. Low and (very) irregular rainfall limits the maximum retention capacity.

D.3.4 – Two LLs suggest disaggregation for different water sectors and one LL suggests disaggregation for the type of incident.

D.3.5 – One LL is asking for event-based disaggregation.

D.3.6 – Three LLs suggest disaggregation based on water sector/infrastructure.

D.3.7 – Two LLs suggest disaggregation for different water sectors.

D.3.8 – Two LLs suggest disaggregation for different water sectors.

D.3.9 – One LL suggests disaggregation for different plant.

6.3.2 Interview-based/social-governance metrics

The incorporation of metric level feedback is bundled in three main themes:

I. Definitions

Two LLs point out that they perceive some ambiguity in what some metrics refer to. This point was raised in relation to metrics A.3.1 and A.3.2 which respectively assess the consumer willingness to pay and affordability of water services. What these water services exactly are is not defined in the metric description (hence the perceived ambiguity). Since water-smartness is a broad concept that translates in many water-related services varying between LLs, water services is deliberately not pre-defined. Instead, it is recommended to define the water services that have been considered in scoring this metric explicitly in the justification of the metric. In this way, there is room for the LLs to tailor metrics to their specific contexts. Defining to what water services refer to can be done by the interviewer with the support the interviewees, particularly the LL representatives. Preferably this definition is consistent across all metrics of the framework. A methodological guidance on this point will be provided at the relevant metrics.

Accordingly, for AC 1 circular policy making, there was a request from two LLs to define circular policy making. In essence it refers to the policies that relate to the inhibition or boosting of value creation around water. However, which policies are at play is rather site specific and their combined impact requires thorough investigation. Hence, in phase 2 of the assessment it is recommended that an outline of policies that are considered is listed in the score justifications of metrics C.1.1 statutory compliance, C.1.3 policy instruments, and C.1.5 level of ambition. This list can be developed through desk study and can be supplemented through input obtain by stakeholder interviews. A methodological guidance on this point will be provided for these indicators. One LL remarked that for metric E.1.2 local sense of urgency and E.3.1 stakeholder inclusiveness could be specified per stakeholder. This is indeed an important first step and this will be clarified with a methodological guidance for these metrics.

II. Ways of enhancing the scoring accuracy

It was also pointed out that many metrics under SO E would score high if the LL was considered because if for instance metrics like E.1.1 knowledge and education and E.1.2 local sense of urgency would be low, a LL would not have been able to establish in the first place. This is spot on. How the LL contribute to these indicators is an important part of the score justification and is likely to be positive. For the regional context however, a LL can be rather different from its surroundings.

Another LL noted that the accurate monitoring of metrics E.1.1 (knowledge and education) would benefit from a survey. Indeed, more accurate monitoring for this indicator is possible through a survey and this option can be considered by each LL individually. The suggestion will be included in in the methodological guidance for this metric.

Overlap between metric E.1.3 Hydrocitizenship with respectively E.1.1 knowledge and education and E.1.2 local sense of urgency is pointed out by one LL. We acknowledge this observation and are considering several options to address it. This will be clarified soon in D6.2.

Finally, for metric E.4.1 smart monitoring, one LL asks to indicate what kind of situation the monitoring refers to. The Likert scoring makes a distinction between monitoring that is sufficient to identify alarming situations, underlying trends or whether the level of monitoring is even more advance and therefore has predictive value. What exact monitoring situations are relevant for the LLs can vary substantially. Hence, as a methodological guidance, the critical situations in each LL that require monitoring will need to be identified before scoring the metric. This can be done in phase 2 through literature review and further supplemented by stakeholder interviews together with input from the LLs. Again, a specific note will be added to clarify this point.

III. Dealing with subjectivity

One LL expressed that particularly for scoring of metric E.1.4 discourse embedding and E.3.2 protection of core values (of stakeholders), a certain level of subjectivity could play a role. Indeed, the answer would depend on who you ask. Hence, the stakeholder answers in phase 2 are likely to vary. Another LL points out that putting the different stakeholder responses together for these metrics would provide valuable insight into how this is perceived. Indeed, this collection of stakeholder perceptions would be critical knowledge for enabling water-smart solutions to be adopted beyond the experimental setting of the LL. A similar consideration for metric E.3.4 collaborative agents can be made. In this metric the presence of key persons that look for unconventional collaborations is assessed. One LL points out that the word ‘unconventional’ is a subjective term. This is indeed the case, however in the score justification the unconventional collaborations need to be specified and therefore provide a good reference point to reduce subjectivity. A methodological guidance will be added to clarify this point. Finally, subjectivity cannot be fully eliminated when considering important aspect of water-smartness that relate to policy, awareness, engagement, or learning. This is not a reason to leave them out when making strategic decisions. Hence, including these more subjective components in a well substantiated and explicit manner can strengthen this decision-making.

6.4 Overview of the improvements adopted in V_1

6.4.1 SO-Level

Given that most of the LLs gave positive responses to the SO-level feedback question, the revision covers a few minor issues regarding the two response categories identified: clarity of definition and the assessment coverage. The comments on the clarity of the definitions have been addressed where necessary without deviating away from the initial water-smart society definition set in D6.1. The majority of comments on assessment coverage addresses issues at AC- or metric-level, hence will be discussed in the following sections.

6.4.2 AC-Level

Some changes in the definition of the ACs have been implemented and adjusted according to the comments from LL, especially in AC B.3 and the metrics therein to make the evaluation process simpler. Comments on the socio-governance ACs (E.2, E.4, and E.5) are addressed fully and discussed in Section 6.4.4 below.

A few critics on the assessment coverage on some specific ACs in all SOs are also addressed. Most of these comments suggest making metrics disaggregation easier to adapt with their context of application that can be very specific. Not all suggestions for disaggregation are covered in V_1, but the proposed aggregations are now written as part of the specific section in each metric.

6.4.3 Calculation and questionnaire-based metrics

The comments from InAll were duly addressed by the metric contributors addressing the issues with the definition clarity and the feasibility and relevance of the metric evaluation. Some major revisions were made in a number of metrics *e.g.,* Metric A.1.2 – Alternative Water Resource Exploitation Index (AWEI) was taken out of the assessment framework and disaggregation of Water Footprint, Carbon Footprint, and Safety and Resilience Index (SRI).

6.4.4 Interview-based metrics

Definitions

Accordingly, for **AC C1** circular policy making, there was a request from two LLs to specify what is meant by circular policy-making. The answer to this question is site specific and requires thorough investigation. Hence, in phase 2 of the assessment it is recommended that an outline of policies that are considered is listed in the score justifications of metrics **C.1.1** statutory compliance, **C.1.3** policy instruments, and **C.1.5** level of ambition. This list can be developed through desk study and can be supplemented through input obtain by stakeholder interviews. A methodological guidance on this point will be provided for these indicators. One LL remarked that for metric **E.1.2** local sense of urgency and **E.3.1** stakeholder inclusiveness could be specified per stakeholder. This is indeed an important first step and this will be clarified with a methodological guidance for these metrics.

Ways of enhancing the score accuracy

It was also pointed out that many metrics under **SO E** would score high if the LL was considered because if, for instance metrics like **E.1.1** knowledge and education and **E.1.2** local sense of urgency would be low, a LL would not have been able to establish in the first place. This is spot on. How the LL contribute to these indicators is an important part of the score justification and is likely to be positive. For the regional context however, a LL can be rather different from its surroundings. Overlap between metric **E.1.3** Hydrocitizenship and **E.1.1** knowledge and education and **E.1.2** local sense of urgency is pointed out by one LL. Another LL noted that in order to accurately track progress metrics **E.1.1** would require a survey.

One LL pointed to the great similarity between metrics **E.2.1**, Clear division of responsibility, and **E.2.2**, Network cohesion. This is because both metrics refer to the interaction between the different stakeholders. What is important to clarify is that the first one focuses on the existence of demarcated and clear positions of responsibility among partners. While the second is focused on whether there is cohesion in this network, sharing of goals and adequate operational capacity. Same LL indicated that the legitimate forms of power and authority present that enable long-term, integrated, and sustainable water-smart solutions (metric **E.2.3**) could be merged with another metric. Based on the score justifications after stakeholder interviews in phase 2, this suggestion can and will be fully considered.

One LL suggested that metric **E.5.2** information transparency and sharing, could be merged with the previous metric, **E.5.1** information availability and use. Based on the score justifications after stakeholder interviews in phase 2, this suggestion can and will be fully considered. The same LL adds that metric **E.5.3**, on knowledge cohesion could be integrated with metric **E.4.3**, on cross-stakeholders learning. However, the difference between knowledge and learning is more substantial.

Finally, for metric **E.4.1** smart monitoring, one LL asks to indicate what kind of situation the monitoring refers to. The Likert scoring makes a distinction between monitoring that is sufficient to identify alarming situations, underlying trends or whether the level of monitoring is even more advance and therefore has predictive value. What exact monitoring situations are relevant for the LLs can vary substantially. Hence, as a methodological guidance, the critical situations in each LL that require monitoring will need to be identified before scoring the metric. This can be done in phase 2 through literature review and further supplemented by stakeholder interviews together with input from the LLs. Again, a specific note will be added to clarify this point.

Dealing with subjectivity

One LL expressed that particularly for scoring of metric **E.1.4** discourse embedding and **E.3.2** protection of core values (of stakeholders), a certain level of subjectivity could play a role. Indeed, the answer would depend on who you ask. Hence, the stakeholder answers in phase 2 are likely to vary. Another LL points out that putting the different stakeholder responses together for these metrics would provide valuable insight into how this is perceived. Indeed, this collection of stakeholder perceptions would be critical knowledge for enabling water-smart solutions to be adopted beyond the experimental setting of the LL. A similar consideration for metric **E.3.4** collaborative agents can be made. In this metric the presence of key persons that look for unconventional collaborations is assessed. One LL points out that the word ‘unconventional’ is a subjective term. This is indeed the case, however in the score justification the unconventional collaborations need to be specified and therefore provide a good reference point to reduce subjectivity. A methodological guidance will be added to clarify this point. Finally, subjectivity cannot be fully eliminated when considering important aspect of water-smartness that relate to policy, awareness, engagement, or learning. This is not a reason to leave them out when making strategic decisions. Accordingly, trying to include these more subjective components in a well substantiated and explicit manner can strengthen this decision-making.

7 Strategic Objectives, Assessment criteria and Metrics

Mirroring the BWS AF tree-structure (see section 1.4), 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 7.

The full list of variables adopted in the V_1 of the BWS AF is provided in Appendix C – List of variables adopted in BWS AF, V_1.

Given the continuous work on refinement of metrics along with the collaboration with the InAll, this section will be kept as a living document for updating as and when required until the V_2 of the BWS AF will be finalized.

Field	Description
Metric Name	Name of the metric.
Definition and Rationale	a) definition, b) concepts, and c) rational 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).
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).

Field	Description
	In some cases, alternative metrics from literature review are proposed for further assessment along with the InAll.
References	References, when based on literature review.

Table 7 – Metrics template

Navigation page across the Framework

Table 8 has been included to facilitate the reader to navigate through the different objectives, criteria and metrics described in this document, by selecting the field of interest directly from the table. The same labelling of the strategic objectives, assessment criteria and metrics adopted in the excel file is adopted in this section. The table also provides an overview of the different nature of the metrics' output and of the related assessment method.

Strategic Objective (SO)	Assessment Criteria (AC)		Metrics		Assessment method/output
A. SO A - Ensuring water for all relevant uses	A.1	AC A.1 "Safe and secure fit-for-purpose water provision"	A.1.1	Metric “A.1.1” Water resource exploitation index +	Quantitative/Index
			A.1.2	Metric "A.1.2" Safe drinking water	Quantitative/Index
			A.1.3	Metric “A.1.3” Compliant reclaimed water	Quantitative/Indicator
			A.1.4	Metric "A.1.4" Safety and Resilience Index - DW	Questionnaire/score
			A.1.5	Metric "A.1.5" Safety and Resilience Index - WW	Questionnaire/score
	A.2	AC A.2 “Accessibility and equity (for any user)”	A.2.1	Metric "A.2.1" Physical access to water supply (households and small business)	Quantitative/Indicator
			A.2.2	Metric "A.2.2" Physical access to water supply in public spaces for quality of life	Quantitative/Indicator
			A.2.3	Metric "A.2.3" Physical access to water supply (industrial use)	Quantitative/Indicator

Strategic Objective (SO)	Assessment Criteria (AC)		Metrics		Assessment method/output
			A.2.4	Metric "A.2.4" Agriculture area with access to water for irrigation	Quantitative/Indicator
			A.2.5	Metric "A.2.5" Number of points with potential conflicts of water use	Quantitative/number
	A.3	AC A.3 “Financial viability”	A.3.1	Metric “A.3.1” Consumer willingness to pay	3-steps method/ scale
			A.3.2	Metric “A.3.2” Affordability	3-steps method/ scale
			A.3.3	Metric “A.3.3” Financial continuation	3-steps method/ scale
B. SO B - Safeguarding ecosystems and their services to society	B.1	AC B.1 “Safeguarded water ecosystems”	B.1.1	Metric "B.1.1" EFR Compliance Rate	Quantitative/Indicator
			B.1.2	Metric "B.1.2" Effective stormwater treatment	Quantitative/Indicator
			B.1.3	Metric "B.1.3" Effective wastewater treatment	Quantitative/Indicator
	B.2	AC B.2 “Enhanced ecosystem services to society”	B.2.1	Metric “B.2.1” Benefits from regulating services (water quality)	Quantitative/Indicator
			B.2.2	Metric “B.2.2” Maintaining nursery populations and habitats	Quantitative/Indicator
			B.2.3	Metric “B.2.3” Regulation of extreme events	Quantitative/Indicator
			B.2.4	Metric “B.2.4” Water provision by ecosystem	Quantitative/Indicator
			B.2.5	Metric “B.2.5” People enjoying cultural ecosystem services	Quantitative/Indicator
	B.3	AC B.3 “Resource efficiency”	B.3.1	Metric "B.3.1" Water Footprint for drinking water	Quantitative/Indicator
			B.3.2	Metric "B.3.2" Water Footprint for wastewater	Quantitative/Indicator
			B.3.3	Metric "B.3.3" Carbon Footprint for drinking water	Quantitative/Indicator
			B.3.4	Metric "B.3.4" Carbon Footprint for wastewater	Quantitative/Indicator

Strategic Objective (SO)	Assessment Criteria (AC)		Metrics		Assessment method/output
			B.3.5	Metric "B.3.5" Energy consumption	Quantitative/Indicator
			B.3.6	Metric "B.3.6" Drinking water consumption	Quantitative/Indicator
C. SO C - Boosting value creation around water	C.1	AC C.1 “Circular policy making”	C.1.1	Metric “C.1.1" Statutory compliance	3-steps method/ scale
			C.1.2	Metric “C.1.2" Preparedness	3-steps method/ scale
			C.1.3	Metric “C.1.3" Policy instruments	3-steps method/ scale
			C.1.4	Metric “C.1.4" Green public procurement	3-steps method/ scale
			C.1.5	Metric “C.1.5" Level of ambition	3-steps method/ scale
	C.2	AC C.2 “Circular economy growth”	C.2.1	Metric “C.2.1" By-products recovery revenues	Quantitative/Indicator
			C.2.2	Metric “C.2.2” Green jobs	Quantitative/Indicator
			C.2.3	Metric “C.2.3” Circular economy business models in practice	Quantitative/Indicator
	C.3	AC C.3 “Resource recovery and efficient use”	C.3.1	Metric “C.3.1" Water-related materials recovery	Quantitative/Indicator
			C.3.2	Metric “C.3.2" Fertilizer production avoided	Quantitative/Indicator
			C.3.3	Metric “C.3.3" Sludge beneficial use	Quantitative/Indicator
			C.3.4	Metric “C 3.4" Water consumption from other sources	Quantitative/Indicator
			C.3.5	Metric “C.3.5” Reclaimed water use	Quantitative/Indicator
			C.3.6	Metric “C.3.6” Reclaimed water production	Quantitative/Indicator
			C.3.7	Metric “C.3.7" Energy production	Quantitative/Indicator
D. SO D - Promoting adaptive change	D.1	AC D.1 “Enabling planning to promote adaptive change	D.1.1	Metric “D.1.1” Infrastructure Planning Index for Adaptive Change	Questionnaire/score

Strategic Objective (SO)	Assessment Criteria (AC)		Metrics		Assessment method/output
towards resilient infrastructure		towards circularity and resilience”			
	D.2	AC D.2 “Implementing adaptive change towards resilient infrastructure”	D.2.1	Metric “D.2.1” Infrastructure Value Index	Quantitative/Index
			D.2.2	Metric “D.2.2” Infrastructure Implementation Index for Adaptive Change	Questionnaire/score
	D.3	AC D.3 “Effectiveness of the adaptive change towards resilient infrastructure (Diagnosis)”	D.3.1	Metric “D.3.1” Linear water losses	Quantitative/Indicator
			D.3.2	Metric “D.3.2” Water Storage Capacity	Quantitative/Indicator
			D.3.3	Metric “D.3.3” Water retention	Quantitative/Indicator
			D.3.4	Metric “D.3.4” Incident occurrences	Quantitative/Indicator
			D.3.5	Metric “D.3.5” Combined Sewer Overflows	Quantitative/Indicator
			D.3.6	Metric “D.3.6” Time for restoration	Quantitative/Indicator
			D.3.7	Metric “D.3.7” Level of autonomy (of infrastructure)	Quantitative/Indicator
			D.3.8	Metric “D.3.8” Level of redundancy	Quantitative/Indicator
			D.3.9	Metric “D.3.9” Treatment capacity utilization	Quantitative/Indicator
E. SO E – Engaging citizens and actors across sectors in continuous co-learning and innovation	E.1	AC E.1 “Awareness”	E.1.1	Metric “E.1.1” Knowledge and education	3-steps method/ scale
			E.1.2	Metric “E.1.2” Local sense of urgency	3-steps method/ scale
			E.1.3	Metric “E.1.3” Hydrocitizenship	3-steps method/ scale
			E.1.4	Metric “E.1.4” Discourse embedding	3-steps method/ scale
	E.2	AC E.2 “Multi-sector network potential”	E.2.1	Metric “E.2.1” Clear division of responsibility	3-steps method/ scale
			E.2.2	Metric “E.2.2” Network Cohesion	3-steps method/ scale

Strategic Objective (SO)	Assessment Criteria (AC)		Metrics		Assessment method/output
			E.2.3	Metric “E.2.3” Authority	3-steps method/ scale
			E.2.4	Metric “E.3.4” Collaborative agents	3-steps method/ scale
	E.3	AC E.3 “Stakeholder Engagement processes”	E.3.1	Metric “C.3.2" Fertilizer production avoided	3-steps method/ scale
			E.3.2	Metric “E.3.2” Protection of core values	3-steps method/ scale
			E.3.3	Metric “E.3.3” Progress and variety of options	3-steps method/ scale
			E.3.4	Metric “E.3.4” Collaborative agents	3-steps method/ scale
	E.4	AC E.4 “Capacity building”	E.4.1	Metric “E.4.1” Smart Monitoring	3-steps method/ scale
			E.4.2	Metric “E.4.2” Evaluation	3-steps method/ scale
			E.4.3	Metric “E.4.3” Cross-stakeholders Learning	3-steps method/ scale
	E.5	AC E.5 “Information and knowledge sharing”	E.5.1	Metric “E.5.1” Information availability and use	3-steps method/ scale
			E.5.2	Metric “E.5.2” Information transparency and sharing	3-steps method/ scale
			E.5.3	Metric “E.5.3” Knowledge cohesion	3-steps method/ scale

Table 8 – Navigation page across the BWS AF, V_1

7.1 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.

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

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

7.1.1.1 Metric “A.1.1” Water resource exploitation index +

Metric Name

Water resource 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 7 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).

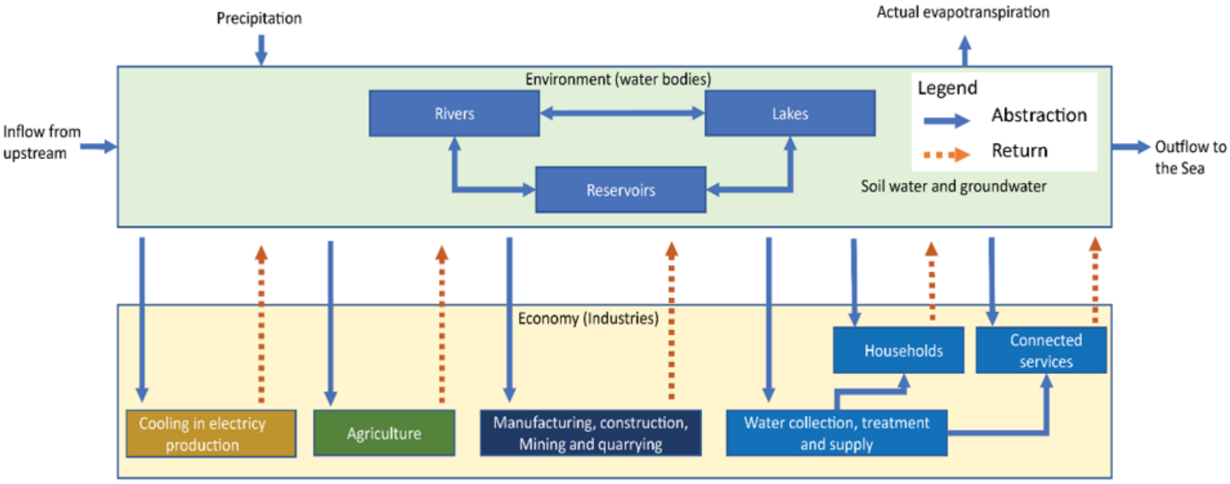


Figure 7 – Conceptual model of the WEI+ computation.

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 = Water use = Abstraction – Return
- RWR = Renewable water resources = Outflow + (Abstraction-Return) – change in storage
    - Change in storage = Water in (lakes + reservoirs) – water out (lakes + reservoirs)
- EFR = Environmental flows requirement component; if no data available, then 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	< 20
🟡	Fair	20-40
🔴	Poor	≥ 40

Suggested Supplementary Metrics

B.1.1 Compliant minimum waterflow

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/

7.1.1.2 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 (Drinking Water Directives); 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
- $n_{etotalDW}$ = total number of samples with exceedance, *i.e.,* sum of samples with microbial, chemical and indicator parameter exceedance
    - $n_{e_{totalDW}} = \sum ne_i$, with
    - nei = number of samples with indicator parameter for indicator group ‘i’, with ‘i’ = microbial, chemical, (indicator) parameter exceedance
- $n_{totalDW}$ = total number of 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 Safety and Resilience Index – DW

A.1.5 Safety and Resilience Index – WW

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))

7.1.1.3 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

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

where

- $C_{totalRW}$ = Percentage of total compliance for safe reclaimed water
- $n_{etotalRW}$ = total number of samples with exceedance, *i.e.,* sum of samples with microbial, chemical or indicator parameter exceedance
    - $\sum_{i=A}^{D} n_{e_{totalRW}} = \left(n_{M_i} + n_{C_i} + n_{I_i}\right)$, 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
- $n_{totalRW}$ = total number of 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 Safety and Resilience Index – DW

A.1.5 Safety and Resilience Index – WW

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

7.1.1.4 Metric "A.1.4" Safety and Resilience Index - DW

Metric Name

Safety and Resilience Index for drinking water (SRI-DW)

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 awareness, communication and plan to manage risks implemented and effective.

Concepts: The SRI aims to assess the aspects considered essential for a resilient drinking water supply service, considering 4 classes (Governance and safety operationalization, Risk management, Communication and Existence of a plan), and 5 categories related to water 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 utility's responsible teams.

Method of Computation and Other Methodological Considerations

SRI is defined by a set of questions (Table 9) 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]

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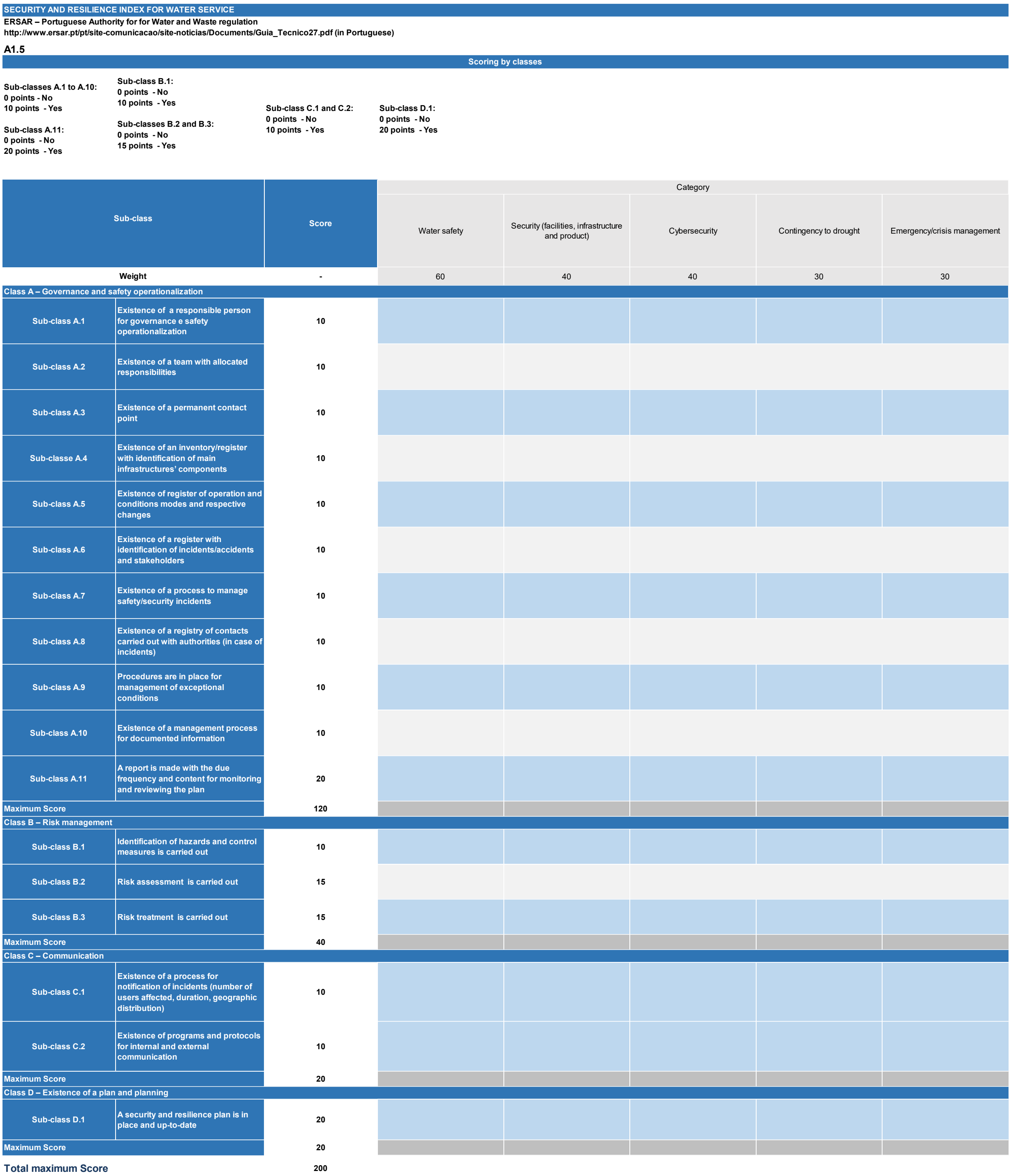
[4] The repository can be accessed only by the project's partners. The file and related questions will be embedded in the Dashbord in further developments of the project.



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 9 – Screenshot of the questionnaire supporting the assessment of the A1.5 (security and resilience) index for water drinking service

Unit

[-]

Data Disaggregation

Disaggregated by different sectors of the drinking water 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

7.1.1.5 Metric "A.1.5" Safety and Resilience Index - WW

Metric Name

Safety and Resilience Index for wastewater (SRI-WW)

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 awareness, communication and plan to manage risks implemented and effective.

Concepts: The SRI aims to assess the aspects considered essential for a resilient wastewater service, considering 4 classes (Governance and safety operationalization, Risk management, Communication and Existence of a plan), and 5 categories related to water 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 wastewater utility's responsible teams.

Method of Computation and Other Methodological Considerations

SRI is defined by a set of questions (Table 10) 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[5]

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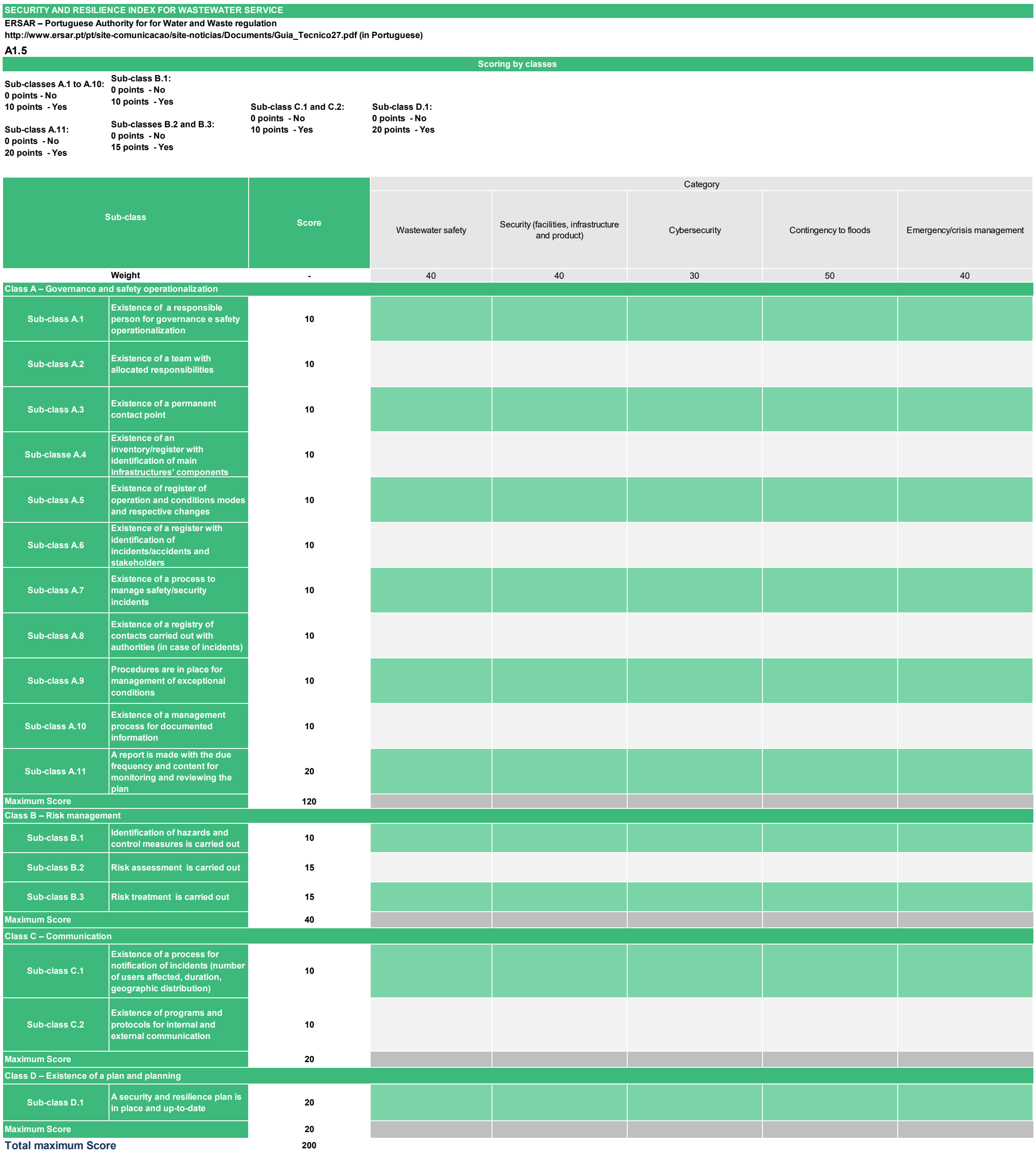
[5] The repository can be accessed only by the project's partners. The file and related questions will be embedded in the Dashbord in further developments of the project.



SECURITY AND RESILIENCE INDEX FOR 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 10 – Screenshot of the questionnaire supporting the assessment of the A1.5 (security and resilience) index for wastewater service

Unit

[-]

Data Disaggregation

Disaggregated by different sectors 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

7.1.2 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.

7.1.2.1 Metric "A.2.1" Physical access to water supply (households and small business)

Metric Name

Physical access to water supply (households and small businesses) ($P_{HConnect}$).

Definition and Rationale

Definition: The physical access to 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 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

$NH_{Connect}$: Number of households (and / or small business) that are connected to the service;

NH_{Total} : 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 (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

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

Metric Name

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

Definition and Rationale

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

$N_{.WAP}$: Number of operational fountains and other points of public consumption in public spaces

$Area$: The area considered (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	< 0.2

Suggested Supplementary Metrics

-

References

Note for the validation phase: This metric has been proposed as requirement by the Lisbon LL – it has been adapted from the indicator QS6 in IWA (2016)

7.1.2.3 Metric "A.2.3" Physical access to water supply (industrial use)

Metric Name

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

Definition and Rationale

Definition: The physical access to water is expressed as the percentage of industries connected to the waterworks system 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

$NI_{Connect}$ is the number of industries that are connected to the service.

NI_{Total} is the total number of industries in the 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

-

7.1.2.4 Metric "A.2.4" Agriculture area with access to water for irrigation

Metric Name

Agriculture area with access to water for irrigation ($PA_{Connect}$)

Definition and Rationale

Definition: Area of agricultural land with access to irrigation (freshwater, re-used water, rainwater) as a proportion of total agricultural area.

Concepts: The access to water supply for agriculture use reflects the accessibility to water to be used for irrigation.

Rationale and interpretation: the rationale is to assess water stress for agriculture use.

Data Sources and Collection Method

There are practical difficulties in accurately defining the agricultural areas irrigated from specific water withdrawals, especially for groundwater. Groundwater withdrawals on farms, either from shallow wells or deep aquifers, can be difficult to monitor since in most cases groundwater withdrawals are not metered. Most OECD countries have incomplete series of data for total and agricultural water abstraction and irrigated and irrigable areas (see OECD Compendium of Agri-environmental Indicators | OECD iLibrary (oecd-ilibrary.org)).

Method of Computation and Other Methodological Considerations

The metric is assessed as the percentage of Area of agricultural land with access to irrigation (freshwater, re-used water, rainwater) ($PA_{Connect}$) over the total

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

where

$A_{Connect}$ is the area of agricultural land with access to irrigation (hectares);

A_{Total} is the total agricultural area (area to be specified by the user) (hectares)

Unit

[%]

Data Disaggregation

The user should define if disaggregation for different water demands based on the type of agriculture/crop should be considered. The same for the different sources, disaggregating by different water sectors.

Reference Values

🟢	Good	> 50
🟡	Fair	30-50
🔴	Poor	0-30

Suggested Supplementary Metrics

A.2.5 Number of points of conflict.

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

-

7.1.2.5 Metric "A.2.5" Number of points with potential conflicts of water use

Metric Name

Number of points with potential conflicts of water use ($N_{conflict}$)

Definition and Rationale

Definition: This indicator is used to assess the extent of potential conflicts for competitive uses of freshwater (*e.g.,* agriculture or industries in the same area); it is expressed as the number of identified potential conflicts in a certain area, and it is related to the availability of freshwater.

Concepts: Conflicts resulting from insufficient availability of water is a problem in rural and isolated areas, especially in arid and semi-arid regions.

Rationale and Interpretation: It helps to identify the need of strategies for more efficient identification and exploitation of alternative sources (reuse), therefore linking with the metric A1.2 on exploitation of non-potable water. The aim is to identify potential water stress situations and reduce their number by identifying adequate strategies. This indicator can be measured over time and used as a benchmark in order to map progress made towards managing and reducing conflicts due to insufficient water availability.

Data Sources and Collection Method

It can be assessed at sub-basin or basin-wide level. The basin organization or other relevant institution draws up inventory of different potential conflicts of use linked to water availability from freshwater (surface and groundwater). These can be listed using an assessment grid or a score card (*e.g.,* looking at distribution frequency and location).

Data could be obtained from local river/lake basin organizations, water utilities or other responsible institutions (where collected).

Method of Computation and Other Methodological Considerations

The number of points is the amount of use conflicts related to water availability in a basin. The sum of the identified potential conflicts provides the indicator score.

$$N_{conflict} = \sum P_{conflict}$$

where

$N_{conflict}$: The sum of the identified potential conflicts.

$P_{conflict}$: Conflict of use related to water availability in a basin

Unit

N. (to be scored)

Data Disaggregation

Disaggregation per categories of users (*e.g.,* agriculture versus agriculture; Industry versus industry; agriculture versus industry; etc.) or magnitude can help prioritizing action and help responsible authorities determine which conflicts may require more immediate attention.

Reference Values

Not available.

Suggested Supplementary Metrics

Indicators looking at the pressures on water availability would supplement this indicator well. E.g.:

A.1.1 Water resource exploitation index, plus (WEI+), A.2.4 Agriculture area with access to water for irrigation.

References

KPI Final Report (riob.org), page 15.

7.1.3 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.

7.1.3.1 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 Section 5.2 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

-

7.1.3.2 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 Section 5.2 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

-

7.1.3.3 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 Section 5.2 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

-

7.2 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.

7.2.1 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.

7.2.1.1 Metric "B.1.1" EFR Compliance Rate

Metric Name

EFR 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

$$EFR_{CR} = \frac{H_{<EFR}}{H_{annual}} \times 100$$

where

$H_{<EFR}$: Amount of time (hours) during a year in which EFR is not achieved

H_{annual}: Total number of hours per year (8760 or 8784)

Unit

[%]

Data Disaggregation

Not relevant

Reference Values

- Northern Europe

🟢	Good	≤ 40
🟡	Fair	40-60
🔴	Poor	> 60

- Southern Europe

🟢	Good	≤ 20
🟡	Fair	20-40
🔴	Poor	> 40

Suggested Supplementary Metrics

A1.1 Water resource 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

7.2.1.2 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:

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

A_{Total}: Total area (m^2 or ha) of identified potential stormwater pollution areas

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 which contributes most and least to the metric.

Reference Values

🟢	Good	95-100
🟡	Fair	90-95
🔴	Poor	0-90

Suggested Supplementary Metrics

-

References

-

7.2.1.3 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

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

where:

$V_{Treatment}$: Volume (m^3) of treated wastewater complying with legal requirements

V_{Total}: Total volume (m^3) of wastewater generated

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

-

7.2.2 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.

7.2.2.1 Metric “B.2.1” Benefits from regulating services (water quality)

Metric Name

Benefits from regulating services (water quality) (SPR_{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

After assessing what is the most critical substance among N, P and C in the considered area, determine these variables for a specific year:

- N-retention capacity in t
- N-entry in t

OR

- P retention capacity in t
- P-entry in t

OR

- C retention capacity in t
- C-entry in t

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

$$SPR_{NPC} = \frac{NPC_{\frac{retention}{a}}}{NPC_{\frac{entry}{a}}} \times 100$$

where

$NPC_{\frac{retention}{a}}$: Sum of N, P and C retention capacity in tons per year

$NPC_{\frac{entry}{a}}$: Sum of N, P and C entry in tons per year

Unit

[%]

Data Disaggregation

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

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.

7.2.2.2 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

$WA_{\geq good}$= Water area (in km^2) with at least a good ecological status or better

WA = Overall water area (in km^2) 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	< 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.

7.2.2.3 Metric “B.2.3” Regulation of extreme events

Metric Name

Regulation of extreme events (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 annual average of protected people by the ecosystem in percentage, by relating the averaged protected people of the total of affected people by floods for a situation without 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” 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 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 people affected) without 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.

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

$$FDP = \frac{AP_{with}}{AP_{without}} \times 100$$

where

AP_{with}= Affected People by a flood event with flood protection by the ecosystem

$AP_{without}$= Affected People by a flood event without flood protection by the ecosystem

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	40-100
🟡	Fair	10-40
🔴	Poor	< 10

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.

7.2.2.4 Metric “B.2.4” Water provision by ecosystem

Metric Name

Water provision by 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:

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

Annotation:

W_t = Water available for abstraction from the ecosystem in year t

W_{t-1}= Water available for abstraction from the ecosystem in the previous year t-1

All variables are expressed in million m^3 per year

Unit

[%]

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

Data Disaggregation

Reference Values

🟢	Good	40-100
🟡	Fair	10-40
🔴	Poor	< 10

Suggested Supplementary Metrics

-

References

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

7.2.2.5 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.

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 11 – 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 = 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 = 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

🟢	Good	40-100
🟡	Fair	10-40
🔴	Poor	< 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.

7.2.3 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.

7.2.3.1 Metric "B.3.1" Water Footprint for drinking water

Metric Name

Water Footprint for drinking water (WFD)

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. Water footprint (WF) is an indicator of direct and indirect freshwater resources appropriation. Directly used water is the amount used in the production, while indirect is the amount used in producing products, processes, systems etc. that is used in the production 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 the product. It is estimated by considering water consumption and pollution in all steps of the production 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. 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. 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. 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.

$$WFD = \frac{WF_{dw}}{DWC}$$

where

- WF_{dw} is the water footprint in drinking water system (m^3/year), 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, for example a year.

- DWC (m^3/year) is the volume of the drinking water consumption.

Unit

[m^3/m^3]

Data Disaggregation

Data for WF can be disaggregated down on each component of the water 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

Suggested Supplementary Metrics

B.3.6 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

7.2.3.2 Metric "B.3.2" Water Footprint for wastewater

Metric Name

Water Footprint for wastewater (WFW)

Definition and Rationale

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

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 collecting and treating 1 m^3 of wastewater and reclaimed water. This includes water used in the whole of the wastewater collection, treatment plant and reclamation plant, water used for operation of the reclaimed water network, and water which is lost through leakages in the reclaimed water network. This is water that is contributing to the wastewater collection and treatment and water reclamation, 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 1m^3 of treated 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.

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.

$$WFW = \frac{WF_{ww}}{TWW}$$

where

- WF_{ww} (m^3/year) is the water footprint in the wastewater collection, treatment and reclaimed water system, should be collected for every process and product that is being used in the system through a period of time, for example a year.
- TWW (m^3/year) is the volume of wastewater treated and the reclaimed water.

Unit

[m^3/m^3]

Data Disaggregation

Data for WF can be disaggregated down on each component of the water system, treatment stages, pumps, pipes etc.

Reference Values

🟢	Good	0.0-1.0
🟡	Fair	1.0-2.0
🔴	Poor	> 2.0

Suggested Supplementary Metrics

-

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

7.2.3.3 Metric "B.3.3" Carbon Footprint for drinking water

Metric Name

Carbon Footprint for drinking water (CFP_D)

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. 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; INDIRECT EMISSIONS: Emissions derived from activities that occur in sources that are not owned or controlled by the organization. Drinking water consumption concept is described in B.3.1. 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

$$CFP_D = \frac{CFP_{dw}}{DWC}$$

where

- CFP_{dw} (kg CO_2 equivalents/year), is the carbon footprint in the drinking water systems, should be collected for every process and product (this includes carbon emissions in the whole of the treatment plant and in the drinking water network) that is being used in the system through a period of time, for example a year.
- DWC (m^3/year) is the volume of the drinking water consumption.

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_{dw} due to, for instance, industrial, residential or public use).

Reference Values

🟢	Good	≤ 0.3
🟡	Fair	0.3-0.7
🔴	Poor	> 0.7

Suggested Supplementary Metrics

B.3.5 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.

7.2.3.4 Metric "B.3.4" Carbon Footprint for wastewater

Metric Name

Carbon Footprint for wastewater (CFP_W)

Definition and Rationale

Definition: This metric is defined as the carbon footprint that is emitted directly and indirectly for the collection and treatment of 1 m^3 of treated 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 Intergovernmental Panel on Climate Change (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; INDIRECT EMISSIONS: Emissions derived from activities that occur in sources that are not owned or controlled by the organization. Drinking water consumption concept is described in B.3.1. 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 CO_2 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 CO_2 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.

$$CFP_W = \frac{CFP_{ww}}{TWW}$$

where

- CFP_{ww} (kg CO_2 equivalents/year), is the carbon footprint in the wastewater collection, treatment and reclaimed water system, should be collected for every process and product that is being used in the system through a period of time, for example a year
- TWW (m^3/year) is the volume of wastewater treated and the reclaimed water.

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.

Reference Values

🟢	Good	≤ 0.3
🟡	Fair	0.3-0.7
🔴	Poor	> 0.7

Suggested Supplementary Metrics

B.3.5 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.

7.2.3.5 Metric "B.3.5" Energy consumption

Metric Name

Energy consumption (Total) (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}).

$$E_{\mathrm{eff}} = \frac{E_{total}}{V_w}$$

where

E_{total} = Total energy used in the whole system (all processes) (kWh/year)

V_w = water produced/treated (m^3/year)

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	≤ 0.5
🟡	Fair	0.5-0.8
🔴	Poor	> 0.8

- For wastewater

🟢	Good	≤ 0.6
🟡	Fair	0.6-0.9
🔴	Poor	> 0.9

Suggested Supplementary Metrics

B.3.3 Carbon footprint for drinking water and B.3.4 Carbon footprint for wastewater.

References

Reference for the alternative metrics:

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

7.2.3.6 Metric "B.3.6" Drinking water consumption

Metric Name

Drinking water consumption per capita (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-effective (water reducing) products and installations that are installed and used (by inhabitants. Annual drinking water production/consumption includes water used for industry, public use, leakages and other unaccounted for water use. This water use has to be estimated and deducted from the water production before averaging the personal water consumption.

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. Reducing this water consumption is very important for the reduction of impact on the water ecosystems, since this water demand is a large part of the total water demand in a city. Measuring this metric gives the organization an ability to compare how personal water use is in comparison with other organizations, and gives an impression of the need for investing more in water management campaigns (towards the public), and for installing more (on a city-wide level) water-effective products and installations

Data Sources and Collection Method

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 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} = Drinking water consumption per capita (in l/pe/day)

DWP = Annual drinking water production (in m^3)

V_{Loss} = Annual water leakage (in m^3)

V_{OU} = Annual water consumptions for other use than domestic use (public, industrial, etc.) (in m^3)

P_{total}= Number of total residents

If a utility has water meters installed in most of the private residences it is possible to calculate the average water consumption based on the measurement data form the meters. This will give the most accurate estimation of water consumption since it is based on specific individual data.

Unit

[l/pe/day]

Data Disaggregation

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

Reference Values

🟢	Good	100-150
🟡	Fair	150-175
🔴	Poor	> 175

Suggested Supplementary Metrics:

C.3.4 Water consumption from other sources.

D.3.1 Linear water losses

References

-

7.3 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.

7.3.1 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.

7.3.1.1 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 Section 5.2 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

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7.3.1.2 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 Section 5.2 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, cocreated 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/

7.3.1.3 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 Section 5.2 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/

7.3.1.4 Metric “C.1.4" Green public procurement

Metric Name

Green public procurement in terms of the number of contracts (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 as a proxy 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). There are two indicators for measuring the quantitative level of GPP.

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} (-) is the number of green public procurement contracts
- $PP_{tot\text{-}C}$ (-) is the 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
🟡	Fair	10-50
🔴	Poor	<10

Suggested Supplementary Metrics

-

References

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

7.3.1.5 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 Section 5.2 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 organisation’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/

7.3.2 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.

7.3.2.1 Metric “C.2.1" By-products recovery revenues

Metric Name

By-products recovery revenues (BPR)

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, 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

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

where:

- R_{BP} (€/year) is the 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, etc.)
- R_{tot} (€/year) is the 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 by- products. 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/)

7.3.2.2 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} (- / year) is the number of new created, converted, maintained green jobs on a yearly basis
- N_J (- / year) is the total number of created, converted, maintained green 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
🟡	Fair	3-6
🔴	Poor	< 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

7.3.2.3 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, 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 (-) is the number of new and modified business models put into practice is the number of new and modified circular business models put into practice during a period of time (yearly frequency is suggested).
- BM_{tot} (-) is the 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
🟡	Fair	1-50
🔴	Poor	0

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)

7.3.3 AC C.3 “Resource recovery and efficient use”

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

7.3.3.1 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 after a treatment process or activity.

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. It can be considered a drinking water / wastewater treatment plant, an industry.

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). 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

The data sources are represented by the internal registers of the organization regarding the waste entering to the treatment process or activity and the waste 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) is the material of the same type recovered
- $W_{i,in}$ (kg/year) is the total potential recoverable material of the same type entering the treatment process or activity (including materials that are added and recovered during the process for *e.g.,* catalysts)

Unit

[%]

Data Disaggregation

This indicator can be disaggregated by type of utility (wastewater/drinking water) and by resources targeted (*e.g.,* 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
🟡	Fair	10-15
🔴	Poor	< 10

Suggested Supplementary Metrics

B 3.1 Water footprint for drinking water

B.3.2 Water footprint for wastewater,

B 3.3 Carbon footprint for drinking water

B 3.4 Carbon footprint for wastewater

C.2.1 By-products recovery revenues.

References

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

7.3.3.2 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) is nutrient recovered used as a fertilizer
- $N_{i,tot}$ (kg/year) is the 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
🟡	Fair	5-30
🔴	Poor	< 5

Suggested Supplementary Metrics

B 3.3 Carbon footprint for drinking water

B 3.4 Carbon footprint for wastewater

C3.1 Water-related materials recovery.

References

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

7.3.3.3 Metric “C.3.3" Sludge beneficial use

Metric Name

Sludge beneficial use (SBU)

Definition and Rationale

Definition: This indicator is defined as the percentage sludge that may be recovered and suitable for its reuse after a treatment process or activity to enhance agronomic and energy valorisation activities within the site of interest.

Concepts: Suitability for reuse is the sludge left out after a treatment process or activity should enhance the agronomic applications or energy production through its nutrient content or anaerobic treatment, respectively.

Rationale and Interpretation: Sludge produced from a treatment process (*e.g.,* during urban or industrial wastewater treatment) is usually disposed without analyzing its reusability. This sludge can be treated or stabilized so as to obtain an additional resource which could be used to enhance agronomic activities or energy production within the site of interest.

Data Sources and Collection Method

Data will be provided by the organization, based on real data from sludge disposal and reuse data and the data could be collected annually or more frequently.

Method of Computation and Other Methodological Considerations

$$SBU = \frac{X_{re}}{X_{tot}} \times 100$$

where

- X_{re} (tons/year) is the sludge recovered and suitable for its reuse
- X_{tot} (tons/year) is the total sludge produced

Unit

[%]

Data Disaggregation

Data can be disaggregated based on different plants and on types of reuse - agronomic activities/ composting/ energy production/new products within the scope of the organization.

Reference Values

🟢	Good	100
🟡	Fair	95-100
🔴	Poor	0-95

Suggested Supplementary Metrics

B 3.3 Carbon footprint for drinking water

B 3.4 Carbon footprint for wastewater

References

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

7.3.3.4 Metric “C 3.4" Water consumption from other sources

Metric Name

Water consumption from other sources (WC_{os})

Definition and Rationale

Definition: This metric is defined as the percentage of water used for potable and non-potable use from other sources per total water consumption.

Concepts: Water consumption from other sources implicitly measures the quantity of water saved by the use of alternative water resources (*e.g.,* use of non-potable groundwater or reclaimed water for irrigation and street cleaning, use of reclaimed water for potable use, water from sustainable urban drainage systems (SUDs), stormwater collected for irrigation, water retention for groundwater replenishment) for potable and non-potable uses.

Rationale and Interpretation: In many countries, fresh and treated water is used for non-potable uses such as mentioned above. Water exploitation for these uses can be reduced by supplementing water needs from alternate sources without compromising the safety and quality of processes in which they are used.

It reflects the reduction in use of produced water due to increased use of alternative sources (*e.g.,* reclaimed water)

Data Sources and Collection Method

Data will be provided by the organizations, 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

$$WC_{OS} = \frac{V_{other}}{TCW} \times 100$$

where

- V_{other} (m^3/year) is the total volume of water used from alternative sources
- TCW (m^3/year) is the total water volume used from all the sources.

Unit

[%]

Data Disaggregation

Data can be disaggregated based on different potable and non-potable use cases within the scope of the organization (Industry(ies), city or municipality), and on the type of alternative water resources used, for rain harvesting and reclaimed water.

Reference Values

🟢	Good	> 40
🟡	Fair	10-40
🔴	Poor	< 10

Suggested Supplementary Metrics

B 3.1 Water footprint for drinking water

B 3.2 Water footprint for wastewater

References

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

7.3.3.5 Metric “C.3.5” Reclaimed water use

Metric Name

Reclaimed water use (RWU)

Definition and Rationale

Definition: This metric is defined as the volume of reclaimed water used over the total water consumption.

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 in the total water consumption. 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 efficient use of water. The higher the reclaimed water used the lower the freshwater consumption.

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, and the data could be collected annually or more frequently.

Method of Computation and Other Methodological Considerations

$$RWU = \frac{RW}{TCW} x\, 100$$

where:

- RW (m^3/year) is the volume of reclaimed water utilized by the organization for different scopes (*e.g.,* irrigation, street cleaning)
- TCW (m^3/year) is the total volume of water consumed for all the different sources, including the reclaimed water used.

Unit

[%]

Data Disaggregation

Disaggregated for the different uses and users’ categories.

Reference Values

🟢	Good	≥ 15
🟡	Fair	1-15
🔴	Poor	< 1

Suggested Supplementary Metrics

C.3.6 Reclaimed water production.

References

-

7.3.3.6 Metric "C.3.6" 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 efficient 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

$$RWP = \frac{V_{reclaimed}}{V_{WW,treated}} \ x\ 100$$

where

- $V_{reclaimed}$ (m^3/year) is the 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).
- $V_{WW,treated}$ (m^3/year) is the total volume of wastewater treated in wastewater treatment plants under the responsibility of the utility.

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
🟡	Fair	0.5-5
🔴	Poor	< 0.5

- WEI+ [10-30]

🟢	Good	≥ 10
🟡	Fair	5-10
🔴	Poor	< 5

- WEI+ [30-70]

🟢	Good	≥ 20
🟡	Fair	10-20
🔴	Poor	< 10

- WEI+ ≥ 70

🟢	Good	≥ 30
🟡	Fair	15-30
🔴	Poor	< 15

Suggested Supplementary Metrics

B 3.1 Water footprint for drinking water

B 3.2 Water footprint for wastewater

C.3.5 Reclaimed water use.

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

7.3.3.7 Metric “C.3.7" 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

$$EP = \frac{E_{re}}{E_{total}} \times 100$$

where

- E_{re} (kWh/year) is the energy produced from water treatment or waste recovery process
- E_{total}(kWh/year) is the total energy consumed

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	< 5

- For wastewater

🟢	Good	≥ 20
🟡	Fair	10-20
🔴	Poor	< 10

- For waste

🟢	Good	≥ 100
🟡	Fair	50-100
🔴	Poor	0-50

Suggested Supplementary Metrics

B 3.3 Carbon footprint for drinking water

B 3.4 Carbon footprint for wastewater

B 3.5 Energy consumption

C.3.3 Sludge beneficial use.

References

International Committees About Circular Economy

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

7.4 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.

7.4.1 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.

7.4.1.1 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 is an index assessing 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 to navigate towards circularity and resilience, in the process of addressing 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 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 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 8), 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[6]

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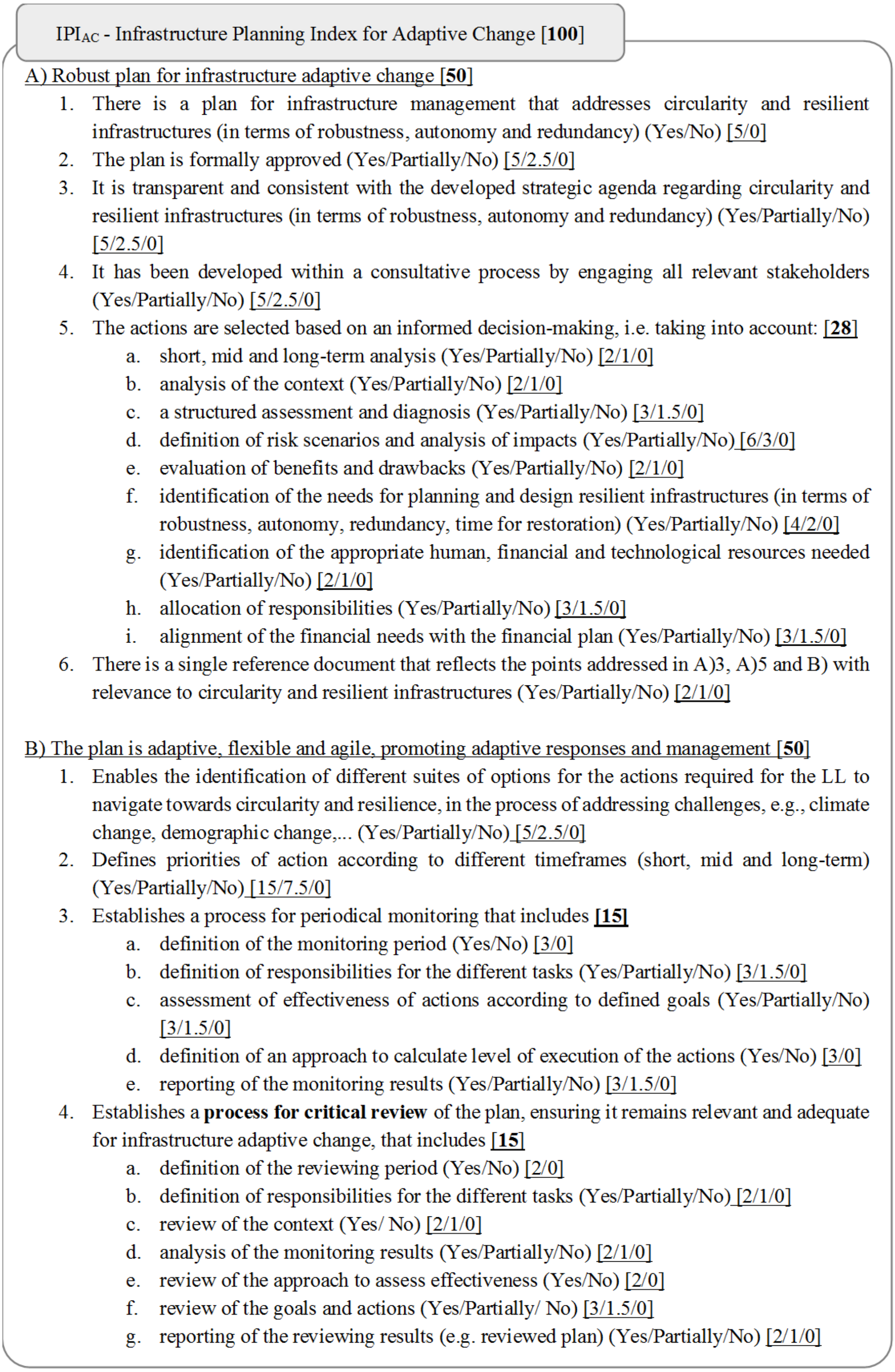
[6] The repository can be accessed only by the project's partners. The file and related questions will be embedded in the Dashbord in further developments of the project.



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 8 – 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, storm water system, etc.) and service area.

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.

7.4.2 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 implementations of solutions to achieve resilient infrastructures, reflecting if adaptive change is implemented or considered, namely regarding flexibility and innovative solutions.

7.4.2.1 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

$$IVI = \frac{ICV}{IRC} \times 100$$

where

- ICV(€) is the infrastructure current (fair) value
- IRC (€) is the 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, storm water system, etc.).

Reference Values

🟢	Good	0.4-0.6
🟡	Fair	0.2-0.4 AND 0.6-0.8
🔴	Poor	0.0-0.2 AND 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.

7.4.2.2 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 is an index providing 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 to identify 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 9). 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 [7]

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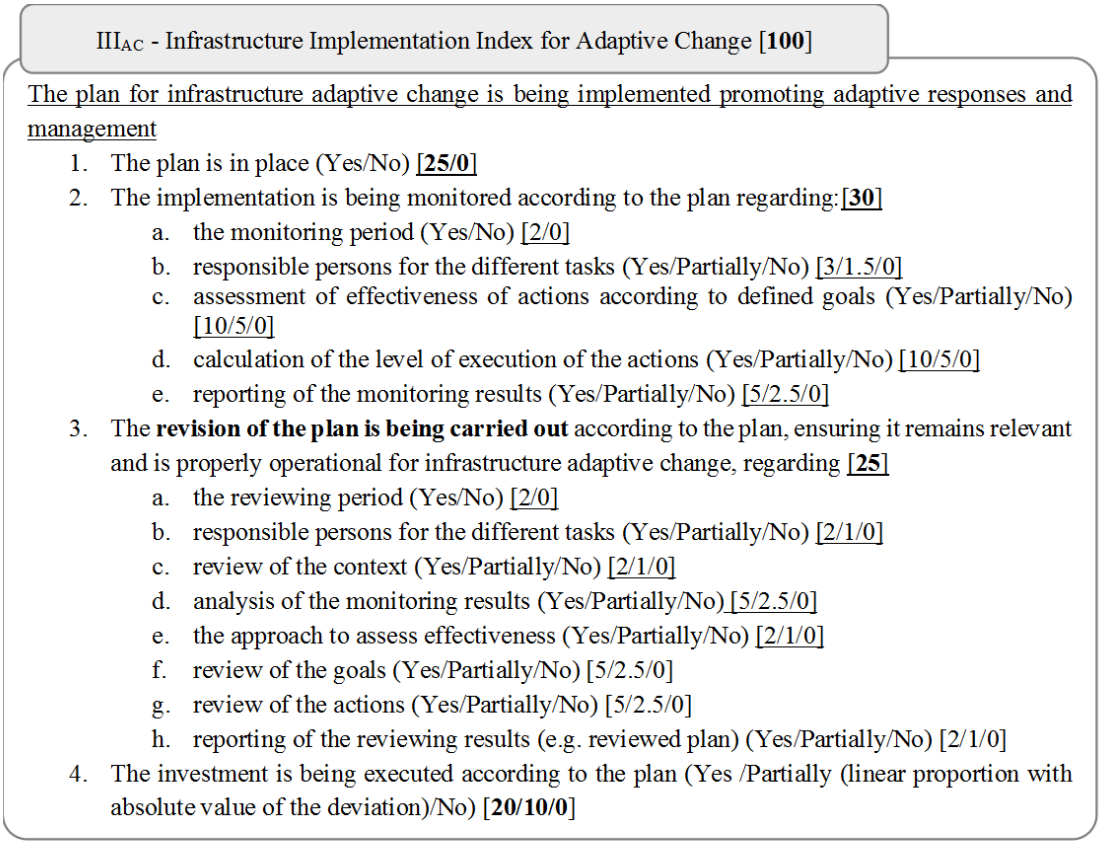
[7] The repository can be accessed only by the project’s partners. The file and related questions will be embedded in the Dashbord in further developments of the project.



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 9 – 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, storm water system, etc.).

Reference Values

🟢	Good	70-100
🟡	Fair	40-70
🔴	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.

7.4.3 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).

7.4.3.1 Metric “D.3.1” Linear water losses

Metric Name

Linear water losses (LWL)

Definition and Rationale

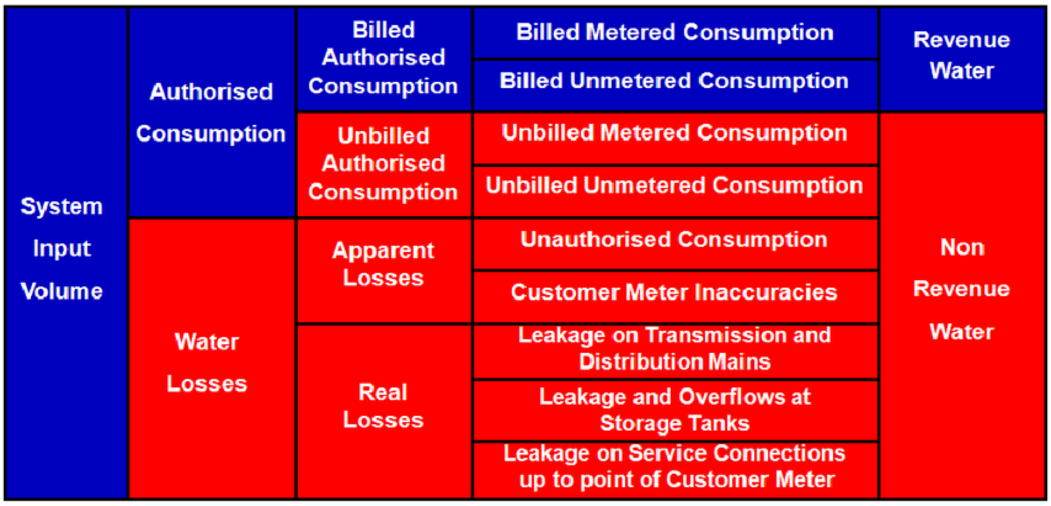
Definition: Linear water losses are defined as the ratio of the volume of yearly water losses and the total length of the supply and/or distribution pipes of the utility for the assessment year.

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 pipes, 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 10.



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 10 – 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) represents the water losses in the assessment year, defined as shown in Figure 10.
- L_{net} (km) is the 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	0-1095
🟡	Fair	1095-1825
🔴	Poor	> 1825

- for bulk systems

🟢	Good	0-1825
🟡	Fair	1825-2738
🔴	Poor	> 2738

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.

7.4.3.2 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 (either for a water distribution system or for wastewater at the entrance of a treatment plant) and the average inflow to the considered system (water distribution system or wastewater treatment plant)

Concepts: The water storage capacity provides an insightful information about the number of days that the system can handle in case of the need of storing volume because of a malfunctioning.

Rationale and Interpretation: The reason of selecting this metric expressed as a time rather than other volumetric metrics is due to the will of reflecting more explicitly in operational terms the effectiveness of the storage volume in comparison with the average inflow to the considered system.

Data Sources and Collection Method

The water utility GIS, master plans, projects documents.

The operational part of the storage capacities of the tank (preferably on the 1st of January of the considered year) and the yearly average of water inflows should be considered.

Method of Computation and Other Methodological Considerations

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

where

- V_t (m^3) is the total operational volume of storage tanks for the considered system.
- Q_s (m^3/day) is the yearly average inflow entering the considered system

Unit

[day]

Data Disaggregation

This metric can be disaggregated for instance:

- for drinking water system
- for wastewater treatment plant

Reference Values

🟢	Good	1-2
🟡	Fair	0.5-1 AND 2-4
🔴	Poor	0-0.5 AND >4

Suggested Supplementary Metrics

-

References

-

7.4.3.3 Metric “D.3.3” Water retention

Metric Name

Water retention (WR)

Definition and Rationale

Definition: Water retention (WR) is the yearly amount of water from alternative non-conventional sources, retained in a given area, which can provide additional water supply, expressed as the yearly average volume of water retained in a specific area.

Concepts: The metric addresses resilience of the water infrastructure considering retention volumes used to mitigate flooding and territorial damages connected to rainwater.

Rationale and Interpretation: The yearly height of rain which is retained for a given area provides an information about the capabilities of that area to deal with extreme rain events, when it is crucial to mitigate flow peaks and release discharges with delays and lower values.

Data Sources and Collection Method

The water utility GIS, master plans, projects documents, rain data if the previous year relevant for the considered area.

Method of Computation and Other Methodological Considerations

$$WR = \frac{V_r}{A_t}$$

where

- V_r (L/year) is the total retained volume from alternative non-conventional sources with the purpose of additional water supply.
- A_t (m^2) is the area of the considered territory

Unit

[mm/year]

Data Disaggregation

This metric can be disaggregated for different areas, as well as different alternative non-conventional sources, such as sustainable urban drainage systems, stormwater collected for irrigation, water retention for groundwater replenishment.

Reference Values

- Agriculture

🟢	Good	≥ 68
🟡	Fair	34-68
🔴	Poor	< 34

- Industrial consumptions

🟢	Good	≥ 68
🟡	Fair	34-68
🔴	Poor	< 34

- Urban consumptions

🟢	Good	≥ 14
🟡	Fair	7-14
🔴	Poor	< 7

Suggested Supplementary Metrics

-

References

-

7.4.3.4 Metric "D.3.4" Incident occurrences

Metric Name

Incident occurrences in the system (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 (-) is the number of registered incidents in a given timeframe.
- L_{net} (km) is the 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 define well the data disaggregation, in order to distinguish the yearly incidents for different types of events.

Unit

[#/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

- Burst in distribution

🟢	Good	0-30
🟡	Fair	30-60
🔴	Poor	> 60

- Flooding

🟢	Good	0-0.5
🟡	Fair	0.5-2.0
🔴	Poor	> 2.0

- Collapse

🟢	Good	0-1.0
🟡	Fair	1.0-2.0
🔴	Poor	> 2.0

Suggested Supplementary Metrics

A.1.4 Safety and Resilience Index – DW.

A.1.5 Safety and Resilience Index – WW.

References

-

7.4.3.5 Metric “D.3.5” 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 CSOs devices in an assessment year.

Rationale and Interpretation: Frequency of yearly of the average 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 is the yearly total number of registered CSOs of the considered organization
- N_{CSO} is the number of active CSO devices in the assessment year

Unit

[-]

Data Disaggregation

-

Reference Values

- Non sensitive

🟢	Good	0-30
🟡	Fair	30-60
🔴	Poor	> 60

- Non sensitive and recreational use

🟢	Good	0-5
🟡	Fair	5-10
🔴	Poor	> 10

- Sensitive

🟢	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.

7.4.3.6 Metric "D.3.6" Time for restoration

Metric Name

Time for restoration (TR_{max})

Definition and Rationale

Definition: Maximum 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 more robust.

Data Sources and Collection Method

The data sources are internal records (work orders) of the water utility regarding failure occurrences, while the collection method should ensure that the considered failure events correspond 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 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 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

$[MAX(TR_{i,j})]_t$ is the 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 incident.

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 (2020a). 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.

7.4.3.7 Metric “D.3.7” 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} (-) is the number of customers covered by infrastructure dependent on other services with autonomy (back-up) solutions
- C_{OS} (-) is the 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
🟡	Fair	70-80
🔴	Poor	< 70

Suggested Supplementary Metrics

D.3.6 Time for restoration.

References

Cardoso MA, Brito RS, Pereira C, Gonzalez A, Stevens J, Telhado MJ (2020a). 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.

7.4.3.8 Metric “D.3.8” 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

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

where

- C_{RS} (-) is the number of customers covered by infrastructure with redundant solutions
- C_{TOT} (-) is the 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
🟡	Fair	80-90
🔴	Poor	< 80

Suggested Supplementary Metrics

-

References

Cardoso MA, Brito RS, Pereira C, Gonzalez A, Stevens J, Telhado MJ (2020a). 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.

7.4.3.9 Metric “D.3.9” 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

$$TCU = \frac{Q_{max-30}}{Q_{TC}}\ x\ 100$$

where

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

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

7.5 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.

7.5.1 AC E.1 “Awareness”

Description: Awareness refers to the understanding of causes, impact, scale and urgency of the water-related challenge and need for water-smart solutions.

7.5.1.1 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 Section 5.2 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. Cater 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

-

7.5.1.2 Metric “E.1.2” 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 Section 5.2 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. Water challenges are a main theme in local elections

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. It is a side topic in local elections
-	**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 on the political agenda during elections
--	**Resistance**	There is generally no sense of urgency and sometimes resistance to spend resources to address water challenges. It is not an item on the political agenda during elections, as is evident from the lack of (media-) attention

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

7.5.1.3 Metric “E.1.3” Hydrocitizenship

Metric Name

Hydrocitizenship (HCZ)

Definition and Rationale

Definition: Answer the following question: To what extent is there a local community sense (*i.e.,* citizens, stakeholders, and decision-makers) of water culture that can express awareness and willingness to change behavior for saving water and make room for the acceptance of water smart solutions in building a water smart society?

Concepts: The metric assesses the prevalence of a water culture which manifests itself through a willingness to change behaviors such as endorsing water conservation, water reuse and other behavioral changes relate to water-smart solutions.

Rationale and Interpretation: This change of behavior is arguably the very essence of transforming to a water-smart society and ensures the adoption and successful implementation of water-smart solutions.

Data Sources and Collection Method

See Section 5.2 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 there a local community sense (*i.e.,* citizens, stakeholders, and decision-makers) of water culture that can express awareness and willingness to change behavior for saving water and make room for the acceptance of water smart solutions in building a water smart society?

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

++	**Full internalization, engagement, and commitment for a responsible water management**	Because local community is fully aware of the water challenge, their causes, impacts, scale, and urgency, it is also engaged and committed to adopt all the necessary procedures towards a water-smart society, as well as for an efficient water management. This community expresses its culture of water through various participatory initiatives that involve all groups of citizens, assuming water as a central resource for human and environmental well-being, plenty integrated in everyday practices and policies.
+	**Moderate internalization, reasonable engagement and commitment for**	Some groups of the local community are engaged and committed to adopt some procedures towards a water-smart society. There are various incentives for actors to change current practices and approaches regarding the water challenge. The water challenge, however, is not yet fully

	a responsible water management	integrated into clear strategy, practices, and policies because some citizens are aware and responsible for an efficient water management. Punctually this community expresses its culture of water through participatory initiatives that involve some groups of citizens. Water is important but not necessarily understood as the most central resource for human and environmental well-being.
0	**Limited level of awareness and responsibility for responsible water management**	Despite a growing awareness as a result of exploratory local research regarding the causes and solutions of the water challenge, only some citizens of the local community are engaged and committed to adopt some procedures towards a water-smart society and an efficient water management. Very punctually this community expresses its culture of water through participatory initiatives. Water is not the central resource for human and environmental well-being.
-	**Conflicts on water uses constrains a responsible water management**	The water challenge is partly recognized, mainly due to external pressure instead of intrinsic motivations. There is no support to investigate its origin or to proceed to action or changing practices Due to some unequal access to water utilities, there are some conflicts on water management. The local community is not aware of what a water-smart society might be. There are some initiatives to raise awareness, but low levels of public participation. Water is important for human and environmental well-being, but water management is not responding well to local needs.
--	**Inefficient water use turns impossible a responsible water management**	There is unawareness of the water challenge with hardly any understanding of causes and effects or how current practices impact the water challenge, the city, or future generations There is neither engagement nor commitment to adopt procedures towards a water-smart society. Citizens are not aware of how water management works and what it entails. There is no culture of water. Water is not perceived as a resource that connects to human and environmental well-being.

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

-

7.5.1.4 Metric "E.1.4" Discourse embedding

Metric Name

Discourse embedding (DE)

Definition and Rationale

Definition: Answer the following question: To what extent is sustainable policy interwoven in historical, cultural, normative, and political context?

Concepts: The extent that water-smartness is interwoven in sustainable policy, in the historical, cultural and political context. Accordingly, the metric assesses the extent that is fits with the ruling norms embedded in the current discourse.

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 Section 5.2 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 sustainable policy interwoven in historical, cultural, normative, and political context?

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

++	**Embedding of sustainable implementations**	Local context is used smartly to accelerate policy implementation. Innovations are subdivided into suitable phases which are more acceptable and effectively enables sustainable practices. Effective policy implementation is enabled by a consensus that long term integrated policy is needed to address water challenges
+	**Consensus for sustainable actions**	There is a consensus that water-smartness is required, but substantial effort is necessary as there is little experience in implementing water-smart solutions in a long-term integrated approach. Furthermore, the decision-making periods are long as trust relations with new unconventional partners need to be built.

0	**Low sense of urgency embedded in policy**	Current policy fits the local context. Water challenges are increasingly identified, framed, and interwoven into local discourse, but the disregard of uncertainty prevents a sense of urgency that is necessary to adopt adequate water-smart adaptation measures. Decision-making often results in very compromised small short-term policy changes
-	**Persistent reluctance and poor embedding**	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. And the policy does not correspond with societal demands. This may lead to distrust between actors, inefficient use of resources and ineffective overall implementation
--	**policy mismatch**	Cultural, historical, and political context is largely ignored, leading to arduous policy implementation. Actors may not understand the scope, moral or to whom it applies or how to implement it (total confusion)

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

-

7.5.2 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.

7.5.2.1 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 Section 5.2 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 cooperation’s 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

-

7.5.2.2 Metric “E.2.2” Network Cohesion

Metric Name

Network Cohesion (NC)

Definition and Rationale

Definition: Answer the following question: To what extent is there interaction and cohesion with common goals and sharing of responsibilities, operational capacity and readiness for achieving a sustainable and water-smart society across and beyond the Living Lab’s responsibilities and jurisdictions?

Concepts: The degree that stakeholders have aligned their goals and share responsibilities, operational capacity, and readiness with the aim of commonly achieving sustainable and water-smart societies across and beyond borders.

Rationale and Interpretation: Networks operating in a cohesive effort to achieve a water-smart society is an important characteristic of actually achieving water-smart solutions.

Data Sources and Collection Method

See Section 5.2 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 there interaction and cohesion with common goals and sharing of responsibilities, operational capacity and readiness for achieving a sustainable and water-smart society across and beyond borders?

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

++	**High level of articulation and cohesion between different levels of governance and across sectors**	Formal commitment for an efficient transboundary cooperation with great operational capacity. Well established communication channels between actors across national borders. This collaborative process involves presence in forums in the search for cross-sector collaboration towards circular economy goals and sustainable water management, as well as specific mechanisms to ensure coherence between sectoral policies. These corporations are dynamic and result in fit-for-purpose problem solving necessary to solve complex, multi-level and unknown challenges (taken from the GCF “Clear division of responsibilities” scoring).
+	**Intermediate level of articulation and cohesion**	Articulation for cooperation between river basin actors, with availability and interest in the efficient management of water bodies and creation of water-smart solutions. There is a high degree of articulation, however there is a sectorization of

	between the different actors of the network	solutions and implementation of measures in a hierarchical scale of governance. The actions show a certain degree of connection however, there is a limited autonomy to develop solutions towards these common goals and the mobilization between the different sectors to set up a shared agenda.
0	**Limited articulation and cohesion between network actors**	Responsibilities are divided over a limited set of conventional actors and only few opportunities for new cooperation among different sectors. Decisions are centralized in certain groups, usually those with greater hierarchical power, as well as they have difficulties in recognizing common goals in the process of building water-smart solutions, resulting in inefficient actions that tend to work only in a short-term scope.
-	**Low degree of connection between actors and limited sharing of common goals**	Institutional fragmentation and barriers for effective cooperation. Solutions are generally developed in a top-down scheme. This means that such solutions are not validated by the different actors as there is no autonomy to produce actions that aim to cover the difficulties/interests presented by the whole group. There is also disarticulation between sectors, with solutions being developed based on the sectoral demands. Lack of dialogue between them and little space to discuss and negotiate a common approach to tackle water-related challenges.
--	**Inexistent Articulation of different actors and no sharing of common goals**	There is an unclear division of responsibilities and often the relationships are over-hierarchical. There is no recognition of common goals in the search for solutions. It generates actions without any articulation between the different levels of governance and sectors, producing solutions that are not concise and usually last short-term only.

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

-

7.5.2.3 Metric “E.2.3” 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 Section 5.2 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

-

7.5.2.4 Metric “E.2.4” 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 Section 5.2 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

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References

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7.5.3 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.

7.5.3.1 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 Section 5.2 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

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References

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7.5.3.2 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 Section 5.2 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

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References

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7.5.3.3 Metric “E.3.3” Progress and variety of options

Metric Name

Progress and variety of options (PVO)

Definition and Rationale

Definition: Answer the following question: to what extent are procedures clear and realistic, are a variety of alternatives co-created and thereafter selected from, and are decisions made at the end of the process to secure continued prospect of gain and thereby cooperative behaviour and progress in the engagement process?

Concepts: The extent that sufficient progress is ensured during stakeholder engagement in decision-making. This is to be ensured by clear and realistic procedures. In addition, a variety of alternatives need to be co-crated and only after full completion of these alternatives the selection of the solution can be done. In this way, different stakes, interests and solution potential is optimally used and the participants maintain a prospect of gain throughout the engagement process. Without this prospect of gain, the step out of the engagement process, solutions become suboptimal, and risks of dissatisfaction and resistance jeopardizes successful implementation of water-smart solutions, or the support of other water-smart initiatives run in parallel or in the future.

Rationale and Interpretation: Key features of how the stakeholder engagement process is organized in order to maintain progress and maximally benefit from the exploration of various alternative are essential to gain and maintain support for water-smart solutions. Since people typically tend to oppose change, such a well-organized engagement process is critical for transforming to a water-smart society.

Data Sources and Collection Method

See Section 5.2 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 procedures clear and realistic, are a variety of alternatives co-created and thereafter selected from, and are decisions made at the end of the process to secure continued prospect of gain and thereby cooperative behavior and progress in the engagement process?

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

++	**Active engagement with choice selection at the end of the cooperation**	There is active engagement of all relevant stakeholders and clarity of participation procedure and realistic deadlines. The range of alternatives is fully explored, and selection of the best alternatives occurs at the end of the process. Reviews of stakeholder meetings provide the alternatives addressed. Stakeholders are engaged throughout the whole process as specified in contractual agreements
+	**Active involvement with abundant choice variety**	Stakeholders are actively involved and there is sufficient room for elaborating alternatives. Procedures, deadlines, and agreements are unclear. There is no or few specifications on deadlines in terms of dates. Due to inexperience with active stakeholder engagement, decisions are taken too early in the process leading to the exclusion of argument and solutions. Hence, decisions may not be fully supported
0	**Consultation or short active involvement**	There is a clear procedure for consultation or short active involvement of stakeholders, but the opportunities to consider all relevant alternatives are insufficient. Decisions are therefore still largely unilateral and solutions suboptimal. The suboptimal character of a solution can be observed from evaluations or difference in opinions
-	**Rigid procedures limit the scope**	Informative and consultative approaches are applied, according to rigid procedures with low flexibility. The period of decision-making is short with a low level of stakeholder engagement. These unilateral decision-making processes may lead to slow and ineffective implementation. The latter can be observed from critique via public channels
--	**Lack of procedures limit engagement and progress**	The lack of clear procedures hinders stakeholder engagement. This unilateral decision-making limit progress and effectiveness of both decision-making and implementation. It might result in conflicting situations. Often, much resistance can be found online, and implementation may be obstructed

Unit

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

Data Disaggregation

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Reference Values

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

Suggested Supplementary Metrics

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References

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7.5.3.4 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 Section 5.2 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	**Agents 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

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Reference Values

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

Suggested Supplementary Metrics

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References

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7.5.4 AC E.4 “Capacity building”

Description: capacity building and social learning is essential to make water-smart governance more effective. The level of capacity building differs from refining current management, critical investigation of fundamental beliefs or questioning underlying norms and values.

7.5.4.1 Metric “E.4.1” 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 Section 5.2 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

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Reference Values

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

Suggested Supplementary Metrics

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References

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7.5.4.2 Metric “E.4.2” Evaluation

Metric Name

Evaluation (EV)

Definition and Rationale

Definition: Answer the following question: To what extent are current policy and implementation continuously assessed and improved, based on the quality of evaluation methods, the frequency of their application, and the level of learning?

Concepts: The extent that current policy and implementation practices are continuously assessed and improved. Such improvements depend on the quality of evaluation methods, the frequency of their application and the level of learning.

Rationale and Interpretation: Evaluation of existing policy and practices is the basis for amendments and new policies and management practices that can support water-smart solutions.

Data Sources and Collection Method

See Section 5.2 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 current policy and implementation continuously assessed and improved, based on the quality of evaluation methods, the frequency of their application, and the level of learning?

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

++	**Exploring the fitness of the paradigm**	Frequent and high-quality evaluation procedures fully recognize long-term processes. Assumptions are continuously tested by research and monitoring. Evidence for this is found in sources (primarily online documents) that report on the learning process andprogress. Uncertainties are explicitly communicated. Also, the current dominant perspective on governance and its guiding principles are
+	**Changing assumptions**	There is continuous evaluation, hence continuous improvements of technical and policy measures and implementation. Innovative evaluation criteria are used. This is evidenced by reports containing recommendations to review assumptions or explicitly indicating the innovative character of the approach
0	**Improving routines**	The identified problems and solutions are evaluated based on conventional (technical) criteria. Current practices are improved. This becomes clear from information of the used and existing criteria, the small changes recommended in reports and short-term character

-	**Non-directional evaluation**	Evaluation is limited regarding both frequency and quality. Evaluation occurs sometimes, using inconsistent and even ad-hoc criteria. Also, the evaluation is not systematic. There is no policy on the performance of evaluations, only the evaluation(s) itself are reported
--	**Insufficient evaluation**	There is no evaluation of technical or policy measures regarding water challenges. Otherwise, it is not documented

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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7.5.4.3 Metric “E.4.3” 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 Section 5.2 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

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References

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7.5.5 AC E.5 “Information and knowledge sharing”

Description: this assessment criterion describes the qualities of information with which actors have to engage in water-smart decision-making.

7.5.5.1 Metric “E.5.1” 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 Section 5.2 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. Furthermore, progress reports on effective implementation can be found. 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

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Reference Values

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

Suggested Supplementary Metrics

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References

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7.5.5.2 Metric “E.5.2” Information transparency and sharing

Metric Name

Information transparency and sharing (ITS)

Definition and Rationale

Definition: Answer the following question: To what extent is information on water challenges accessible, being shared and understandable for experts and non-experts, including decision-makers?

Concepts: Extent to which information on water smartness is accessible, being shared and understandable for experts and non-experts, including decision-makers.

Rationale and Interpretation: The extent that information is available, transparent and is being shared is critical for citizen engagement, learning and boosting a transformation towards a water-smart society.

Data Sources and Collection Method

See Section 5.2 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 accessible, being shared and understandable for experts and non-experts, including decision-makers?

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

++	**Easy access to cohesive knowledge**	Information is easily accessible on open-source information platforms. There are multiple ways of accessing and sharing information. Information is often provided by multiple sources and is understandable for non-experts
+	**Sharing of partly cohesive knowledge**	All interested stakeholders can access information. Action has been taken to make knowledge increasingly understandable. Still, it is a time-consuming search through a maze of organizations, protocols, and databases to abstract cohesive knowledge and insights
0	**Sharing of very technical knowledge**	There are protocols for accessing information; however, it is not readily available. Although information is openly available, it is difficult to access and comprehend because it is very technical. Water challenges are reported on local websites and reports

-	**Low sharing of fragmentized knowledge**	Information is sometimes shared with other stakeholders. However, information is inaccessible for most stakeholders. Furthermore, knowledge is often technical and difficult to understand for non-experts. Water challenges may be addressed on local websites
--	**Not transparent and inaccessible knowledge**	Information is limitedly available and shared. Sharing may be discouraged. The information that is available is difficult to understand. Water challenges are not addressed on local websites

Unit

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

Data Disaggregation

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Reference Values

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

Suggested Supplementary Metrics

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References

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7.5.5.3 Metric “E.5.3” Knowledge cohesion

Metric Name

Knowledge cohesion (KC)

Definition and Rationale

Definition: Answer the following question: To what extent is information cohesive in terms of using, producing, and sharing different kinds of information, usage of different methods and integration of short-term targets and long-term goals amongst different policy fields and stakeholders in order to enable water-smart solutions.

Concepts: The extent that information is cohesive in terms of using, producing and sharing different kinds of information, usage of different methods and integration of short-term targets and long-term goals amongst different policy fields and stakeholders in order to enable water-smart solutions.

Rationale and Interpretation: Since water-smart solutions require an integrated approach covering various sectors, stakeholders and policy fields, the extent to which available knowledge is cohesive and can function as a shared knowledge base is a precondition for learning and achieving a water-smart society.

Data Sources and Collection Method

See Section 5.2 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 cohesive in terms of using, producing, and sharing different kinds of information, usage of different methods and integration of short-term targets and long-term goals amongst different policy fields and stakeholders in order to enable water-smart solutions

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

++	**Implementation of cohesive knowledge**	Stakeholders are engaged in long-term and integrated strategies. Information can be found that is co-created knowledge and will contain multiple sources of information, multiple and mixed methods considering the socio, ecological and economic aspects of water challenges
+	**Substantial cohesive knowledge**	Sectors cooperate in a multidisciplinary way, resulting in complete information regarding water challenges. Besides multiple actors, multiple methods are involved to support information. Too many stakeholders are involved, sometimes in an unbalanced way. Knowledge about effective implementation is often limited

0	**Insufficient cohesion between sectors**	Data collection within sectors is consistent and is sustained in multiple projects for about two to three election periods. Knowledge on water challenges, however, is still fragmented. This becomes clear from different foci of the stakeholders as stated in their organization's strategies and goal setting
-	**Low-cohesive knowledge within sectors**	Information that is found is sector specific and information is inconsistent within and between sectors
--	**Non-cohesive and contradicting knowledge**	A lack of data strongly limits the cohesion between sectors. Information that is found can even be contradictory

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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8 Revised interview process and lessons learnt

Evaluative questions have been asked to the LLs representatives who have been interviewed and have acquainted themselves with the metrics. The questions relate to how they experienced the interview, whether this way of assessing metrics is helpful and supports strategic decision-making to enhance water-smartness. Moreover, experiences and feedback from both the interviewers and interviewees (*i.e.,* LL representatives) have been provided through the online tool through writing and personal communication via the interviewers. In this chapter, the four lessons learnt from the test phase 1 are outlined and discussed.

8.1 Main observations

LLs indicate that the interviews have been considered as a convenient way of monitoring water-smartness. One LL pointed to the importance of the validation phase 2 to adapt the metrics, test them and choose the structure in order to identify the gaps that will raise according to the demands of different locations. They also highlight the relevance of identifying additional aspects to be considered for the assessment framework to achieve the objectives in question. One LL explains that such interviews by an independent researcher provide more objective results as compared to a self-assessment and that this can save time and resources. Another LL points out that considering the limited number of interviews in this testing phase, it is difficult to produce unbiased score justifications. The importance of supporting interview statements with available public surveys and opinions of other stakeholders with different interests and perspectives will be necessary to ensure unbiased results in phase 2 of the B-WaterSmart framework's application. Another LL points out that the connection between the interview questions and the concept of water-smartness was loose and suggested that the reason for that might have been the fact that the metrics were divided over three interviews explaining that dividing the metrics in three interviews might have been the reason. For getting acquainted with the metrics, the relation with water-smartness could have been made more explicit. One of the LL highlighted the importance of a scope on the concept of water smartness and the project itself. For them, there was a lack of specific contextualization of the concept of water-smartness related to their LL. More specifically, the LL pointed out that it was at times ambiguous if the metrics relates to LL/company strategy or to a regional and national policy level. This feedback is critical for improving the applicability of the metrics and relates to the framework applications as a whole.

8.2 Lesson 1: Scope

The scope of supporting strategic decision-making towards a water-smartness society covers in essence two highly interlinked scales.

1. **Water-smart living labs** - How individual organizations and the LLs improve their direct processes and services by experimentation and innovation to become water-smart.
2. **Water-smart societal embedding** - How transferrable innovations - developed in these real-life, safe, and temporary environments of the LLs - can be endorsed

> beyond experimentation within the wider region. To support strategic decision-making towards this goal, the broader social-institutional, geographical, and infrastructural setting is essential in understanding and exploiting the potential of the innovations and optimizing the innovation process.

LLs across Europe are established to actively shape their innovations by forming innovation alliances and do real-life experimentation with new schemes, technologies, and designs to develop their innovations to a point where they become applicable beyond the favorable conditions within the LL and can benefit society. Monitoring levels of water-smartness of an organization and LL is critical for strategic decision-making (one could frame this as 'leading by example'). However important, this in itself is not sufficient for contributing effectively to a water-smart society. For that, developed water-smart innovations need to become embedded in society. Hence, a significant number of metrics of the B-WaterSmart framework are focused on assessing the conditions for getting these schemes, technologies, and designs from an experimental level into full-scale application at a more regional context. These metrics are not assessing performances of a LL but rather assess critical conditions that enable the developed innovations to progress beyond the experimental phase. Consequently, various metrics in the interviews account for aspects such as local, regional, and national policies, knowledge or awareness and assess whether they form a barrier or enabler for regional adoption of LL innovations that enhance water-smartness. The scope of the B-WaterSmart framework - and consequently also the way metrics results can be used by the LL – can be further specified and communicated through, amongst others, the interview process. A distinction between metrics assessing water-smartness of LL and metrics assessing water-smart societal embedding can provide more clarity of what is assessed and how it supports strategic decision-making.

8.3 Lesson 2: The relation with water-smartness

For this initial testing phase, it was important that the LLs understood on a basic level the relation with water-smartness. In many interviews this was the case. Sporadically, this link was not instantly obvious. Hence, more attention to the relation of the metrics with water-smartness could have been helpful at times. For phase 2 however, a larger number of interviews with different stakeholder will be conducted. For these stakeholder interviews, the connection with water-smartness can be briefly explained during individual interviews but should not form the focus. The reasons are practical. It would take too much time and sending this information would deviate from the main objective of getting formation from interviewees. When stakeholders are asked for feedback, the concept of water-smartness can be introduced more prominently as a way of directing stakeholders' feedback on the preliminary score justification. The final score and score justification that are closely linked to the concept of water-smartness - through examples and place-based information – can be shared with the interviewees. Key lessons of the interview process are summarized below.

8.4 Lesson 3: Reducing the number of metrics in phase 2

One interviewee perceived some ambiguity in metrics and experienced difficulty answering each question. To address this, one could think of only using a subset of the metrics that is more tailored the specific context. For this, a broader inclusion of the perspectives of more stakeholder in phase 2 is considered critical. It is important to set a baseline scoring in phase 2 to provide a better shared insight of the resource demands necessary to annually update these baselines. In this way, a well-informed decision can be made about the subset of metrics that are deemed eligible to be monitored. In addition, further metric simplifications and the use of proxies can enable its continuous use in monitoring water-smartness. Accordingly, another LL pointed out that monitoring all metrics is likely to be overly time-consuming and unfeasible. This highlights the importance of experience interviewers that are even more familiar with the metrics. Multiple LLs pointed out that the number of metrics is too large. Beyond the 25 metrics addressed in the interviews, this point applies to the framework as a whole. The time, resources and data required to populate all metrics might be too large, particularly when considering the framework to be applicable for long-term monitoring. One LL points out that the number of metrics under SO E is too great compared to other SOs although this observation is not necessarily shared by all LLs.

After the completion of the stakeholder interviews in phase 2, it is essential for individual LLs to distill a subset of metrics that apply most to the LL context and are feasible to monitoring over time. Here basic guidelines in the selection of indicators are useful. Two particular guidelines are proposed.

1. A relatively equal balance between the number of metrics dedicated to water-smart LL and water-smart societal embedding (*e.g.,* one of the two should have a minimum of 40% of the metrics).
2. 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 divided over each SO.

In this way, a well-considered and content-based choices for continued tailored monitoring are encouraged without losing key elements of water-smartness.

8.5 Lesson 4: Apply a number of metric-level methodological clarifications

Two LLs point out that they perceive some ambiguity in some metrics. This point was raised specifically in relation to metrics **A.3.1** and **A.3.2** which respectively assess the consumer willingness to pay and affordability of water services. What these water services exactly are is not defined in the metric description (hence the perceived ambiguity). Water-smartness is a broad concept that translates in many water-related services varying between LLs. It is therefore recommended to define the water services that have been considered in scoring this metric explicitly in the justification of the metric. This can be done by the interviewer with the support of the interviewees, particularly the LL representatives. In essence, the formulation of these metrics is deliberately unspecific about the water service in order to leave room for the LLs to tailor this to their specific context. A methodological guidance on this point will be provided at the relevant metrics.

PART II – Insights towards the development of the dashboard module

9 The FAST application

9.1 High level description

To facilitate the validation phase process, WP6 has agreed in dialogue with Task 1.4 to convert, after the achievement of the MS16, the BWS AF V_0 from an excel based solution to a web-based application, by embedding all the content described in the excel version and in the supporting report into an *ad hoc* facilitating tool. The web-application:

- allowed a hands-on experience for the InAll
- facilitated the feedback process
- included simple features for visualization of the assessments
- provided only basic features to navigate through the different parts of the framework
- allowed the creation of an automatic 'pdf' report at the end of each assessment exercise.

The web-application, called **F.A.S.T.** (**F**ramework **AS**sessment **T**ool) not to be confused with the dashboard to be developed by Task 3.9, has been developed by SINTEF in the period March-April 2022.

It is worth to mention that the web-application is just a temporal solution which will be replaced by the dashboard (by Task 3.9) with early an release of the dashboard to be available at M36. The collaborative phases planned for the InAll, after the validation phase, will benefit from the use of a final version of the Framework content (the V_2) embedded in the FAST, but only the dashboard, delivered by Task 3.9, will be the actual final product to be defined as a management support tool combining the content delivered by WP6 and more advanced usability and visualization features.

9.1.1 General description

The **F**ramework **AS**sessment **T**ool (FAST) was developed with two main goals in mind:

1) Provide the BWS partners with a way to test the developed framework in WP6, in an interactive way. Participants should be able to visualize results "live".
2) Allow the partners to evaluate the framework while using it directly: the framework, as described in Chapter 7, consists of strategic objectives, assessment criteria, and metrics and for assessing them the user is expected to answer a set of questions. Using a sperate tool like google form or similar seemed to be a cumbersome task for both the team preparing the questionnaire and for participants having to answer (and thus having to switch tab and ensure they are answering the right questions for the right metric for instance). Collected feedback has been analyzed by Task 6.2 and either already addressed in the BWS AF V_1 or included in this document as input to Task 6.3 towards V_2.

FAST addresses those two points in a way that is as generic as possible: the tool is not tightly linked to the framework being evaluated and can in fact be used with any framework that uses the same metric "types".

FAST comes in the form of a web application, available at fast.b-watersmart.eu[8] and is supported by a “companion website” containing an extensive description and explanations of the framework, available at data.fast.b-watersmart.eu.

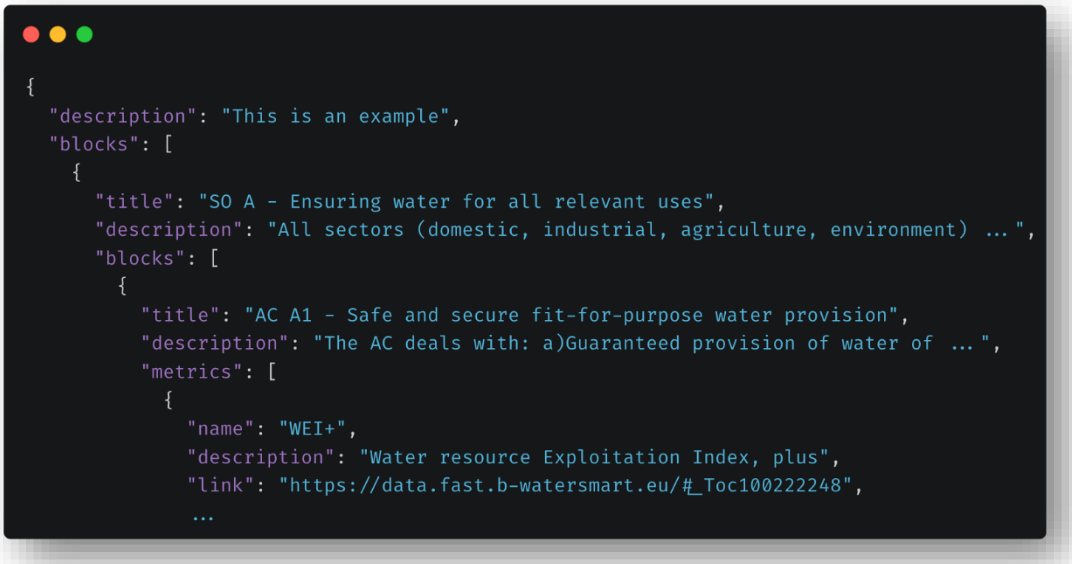
9.1.2 Main functionalities

9.1.2.1 User management

Accessing the application requires an account. Two roles exist: **admin** (given to all SINTEF’s users) and **assessor** (all other users). Admins can create other users and add frameworks to the tool. Assessors can only create/edit/delete assessments. Each user can only see (and edit) its own assessments. This is valid for all users, admins included.

9.1.2.2 Framework management

In FAST and from a user’s perspective, frameworks are described using JSON which “is a lightweight data-interchange format. It is easy for humans to read and write. It is easy for machines to parse and generate.”[9] An example of such a JSON file can be seen in Figure 11.



```
{
  "description": "This is an example",
  "blocks": [
    {
      "title": "SO A - Ensuring water for all relevant uses",
      "description": "All sectors (domestic, industrial, agriculture, environment) ... ",
      "blocks": [
        {
          "title": "AC A1 - Safe and secure fit-for-purpose water provision",
          "description": "The AC deals with: a)Guaranteed provision of water of ... ",
          "metrics": [
            {
              "name": "WEI+",
              "description": "Water resource Exploitation Index, plus",
              "link": "https://data.fast.b-watersmart.eu/#_Toc100222248",
              ...
```

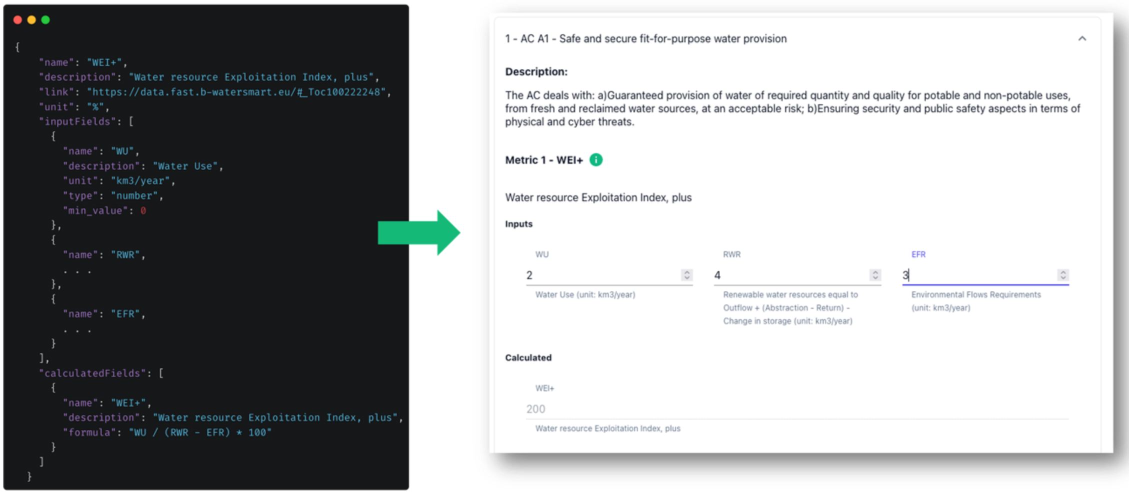
Figure 11 – A FAST framework described in JSON

The fields in the JSON file are used by the tool to generate the Framework UI “on the fly”. Figure 12 shows an example of how the metric WEI+ description in JSON is rendered by the tool.

---

[8] 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.

[9] https://www.json.org/json-en.html



```
{
    "name": "WEI+",
    "description": "Water resource Exploitation Index, plus",
    "link": "https://data.fast.b-watersmart.eu/#_Toc100222248",
    "unit": "%",
    "inputFields": [
      {
        "name": "WU",
        "description": "Water Use",
        "unit": "km3/year",
        "type": "number",
        "min_value": 0
      },
      {
        "name": "RWR",
        . . .
      },
      {
        "name": "EFR",
        . . .
      }
    ],
    "calculatedFields": [
      {
        "name": "WEI+",
        "description": "Water resource Exploitation Index, plus",
        "formula": "WU / (RWR - EFR) * 100"
      }
    ]
  }
```

1 - AC A1 - Safe and secure fit-for-purpose water provision

Description:

The AC deals with: a)Guaranteed provision of water of required quantity and quality for potable and non-potable uses, from fresh and reclaimed water sources, at an acceptable risk; b)Ensuring security and public safety aspects in terms of physical and cyber threats.

Metric 1 - WEI+

Water resource Exploitation Index, plus

Inputs

WU: 2
Water Use (unit: km3/year)

RWR: 4
Renewable water resources equal to Outflow + (Abstraction - Return) - Change in storage (unit: km3/year)

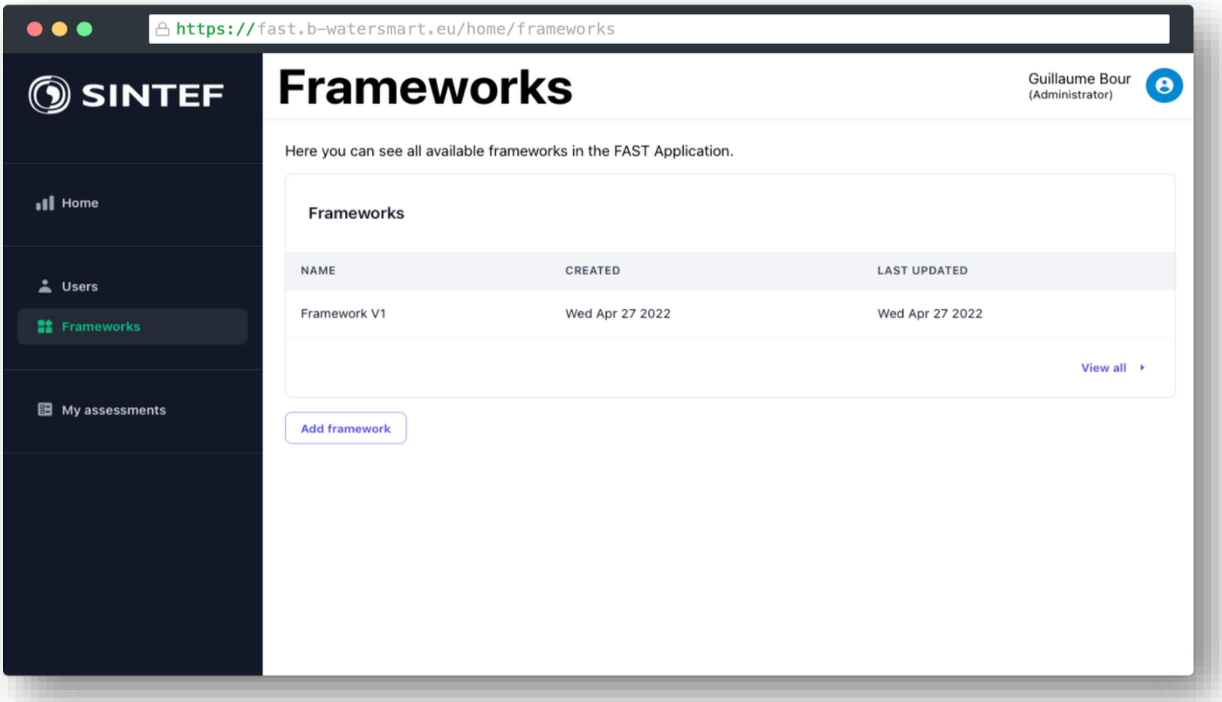
EFR: 3
Environmental Flows Requirements (unit: km3/year)

Calculated

WEI+: 200
Water resource Exploitation Index, plus

Figure 12 – WEI+ metric in JSON and as rendered by FAST

Frameworks in FAST are shared amongst all users and can be added to the application by any administrator. Figure 13 shows the framework management view in FAST.



Frameworks

Here you can see all available frameworks in the FAST Application.

Frameworks

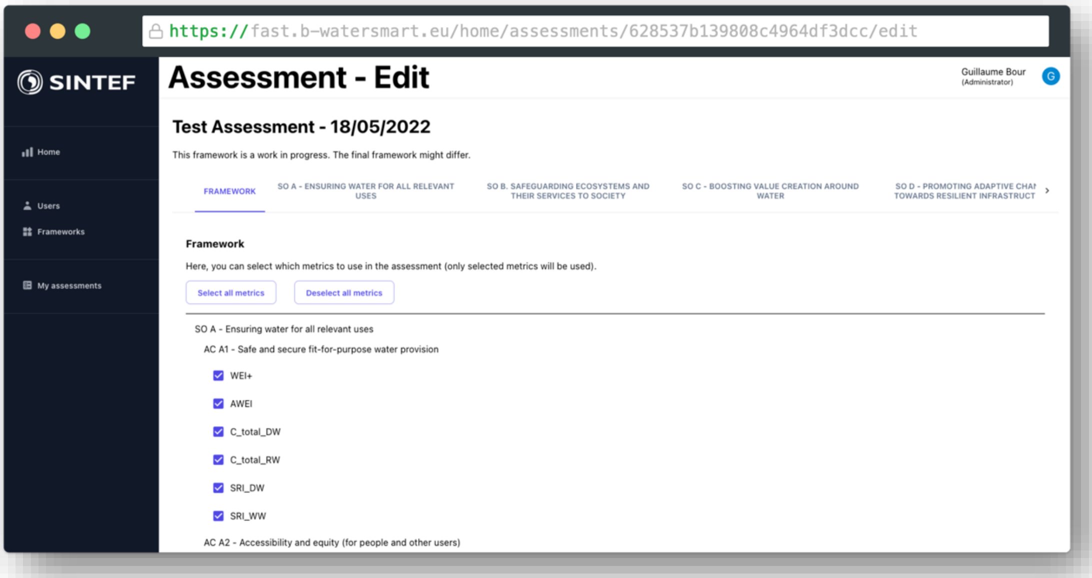
NAME	CREATED	LAST UPDATED
Framework V1	Wed Apr 27 2022	Wed Apr 27 2022

Figure 13 – Framework management view in FAST

9.1.2.3 Assessment management

Assessment’s management happens at the user level: each user can create as many assessments as she wishes. Those assessments are only accessible by this user. An assessment is based on a framework (selected at creation time, and which cannot be updated afterwards).

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). This is presented in Figure 14. The following tabs then vary based on the framework used. Finally, two additional tabs exist to collect feedback (see later).



https://fast.b-watersmart.eu/home/assessments/628537b139808c4964df3dcc/edit

Assessment - Edit

Test Assessment - 18/05/2022

This framework is a work in progress. The final framework might differ.

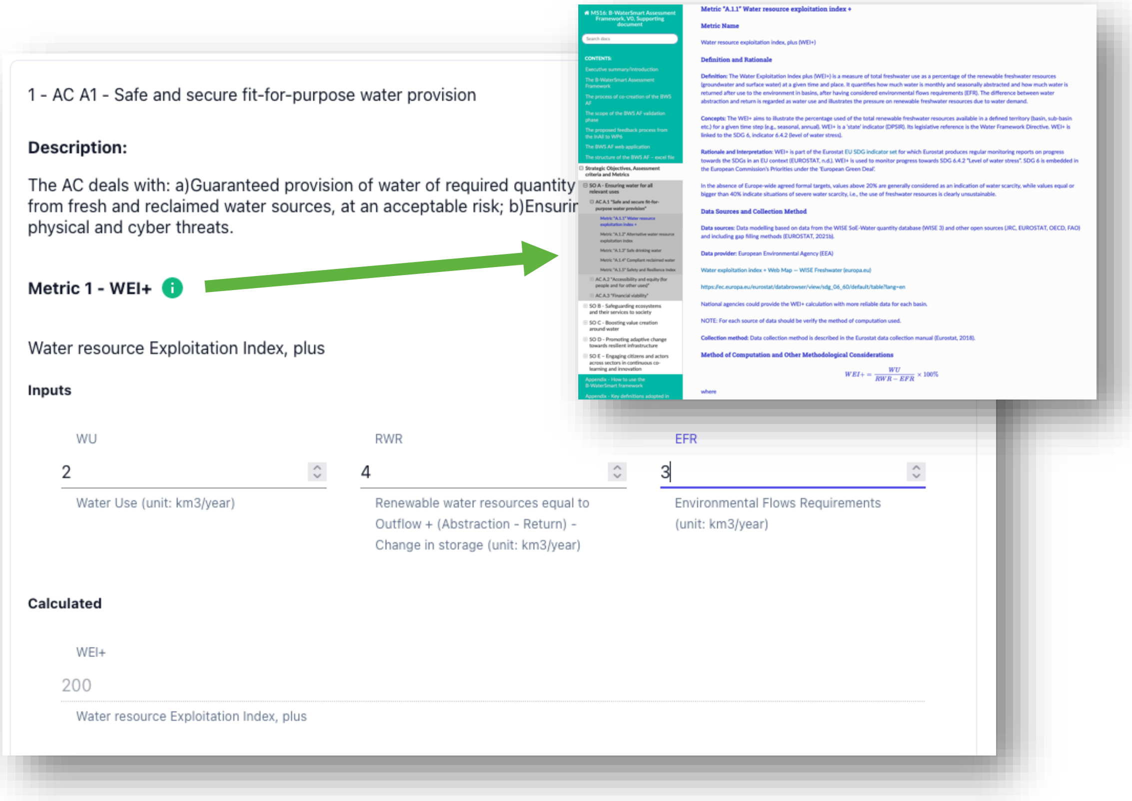
Framework

Here, you can select which metrics to use in the assessment (only selected metrics will be used).

SO A - Ensuring water for all relevant uses
  AC A1 - Safe and secure fit-for-purpose water provision
    ☑ WEI+
    ☑ AWEI
    ☑ C_total_DW
    ☑ C_total_RW
    ☑ SRI_DW
    ☑ SRI_WW
  AC A2 - Accessibility and equity (for people and other users)

Figure 14 – Filling an assessment in FAST

When filling an assessment, users are guided by the description of the metrics. Sometimes, they require more explanations. In order not to overload the interface with information, a companion website was developed with a description of the particular framework developed in BWS. In JSON, this additional information is indicated by a URL which can point to any resource (see Figure 15).



1 - AC A1 - Safe and secure fit-for-purpose water provision

Description:

The AC deals with: a)Guaranteed provision of water of required quantity
from fresh and reclaimed water sources, at an acceptable risk; b)Ensurir
physical and cyber threats.

Metric 1 - WEI+

Water resource Exploitation Index, plus

Inputs

WU: 2
Water Use (unit: km3/year)

RWR: 4
Renewable water resources equal to Outflow + (Abstraction - Return) - Change in storage (unit: km3/year)

EFR: 3
Environmental Flows Requirements (unit: km3/year)

Calculated

WEI+: 200
Water resource Exploitation Index, plus

Metric "A.1.1" Water resource exploitation index +

Metric Name

Water resource 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)

Water exploitation index + Web Map — WISE Freshwater (europa.eu)

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).

Method of Computation and Other Methodological Considerations

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

where

Figure 15 – Additional information provided for the metrics

9.1.2.4 Visualizing results

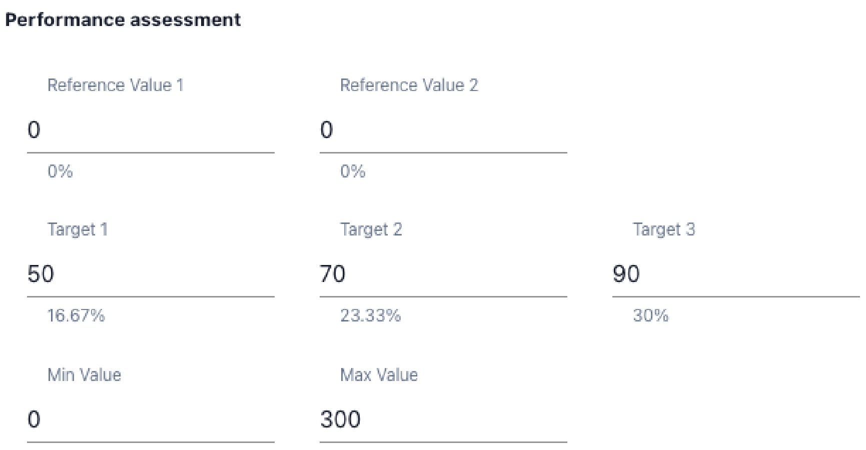
When filling in an assessment, results can be visualized live: as soon as all the required fields are filled, the metric's value will be calculated, and the "score" will be updated.

The required fields are (see Figure 16):

Reference values are the judgement of what good, fair and poor is for each metric. 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).

The metrics **Max value and the worst possible value.** Since the metrics are scored using different scales, each unit is converted to a common denominator which is in relation to the Max value (*e.g.,* the **M**ost **Am**bitious **O**bjective - MAMO) and its worst possible value (Most Unfeasible Value). In this way, you see to what extent the most ambitious goals are being achieved. This MAMO will be determined for each metric and could apply to all InAll in order to enable easy (visual) comparison between progress amongst the InAll.

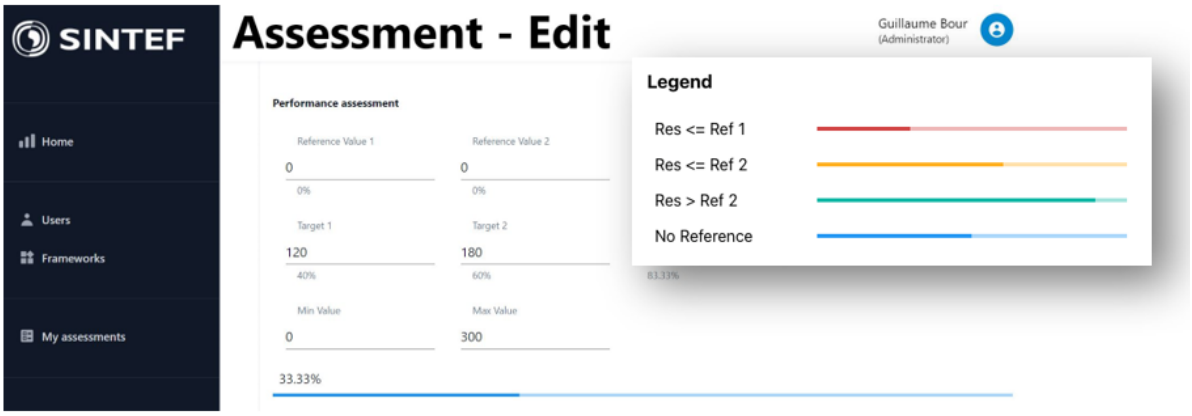


Performance assessment

Reference Value 1: 0 (0%)
Reference Value 2: 0 (0%)
Target 1: 50 (16.67%)
Target 2: 70 (23.33%)
Target 3: 90 (30%)
Min Value: 0
Max Value: 300

Figure 16 – Performance assessment in FAST

Once the values are entered, each metric result X will be normalized in relation to the Most Ambitious Objective (X_{max}) and its worst possible value (Most Unfeasible Value) (X_{min}). In this way, the user can see to what extent the most ambitious goals are being achieved (in % value). The FAST application adopts the traffic light approach for visualizing the calculated values against the reference values (Appendix D – Reference values) as illustrated in Figure 17 and Figure 18 below.

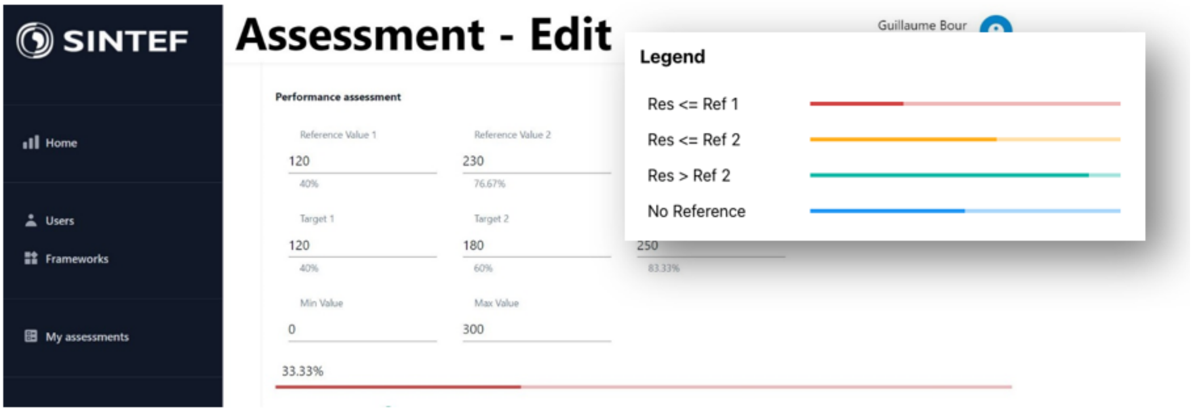


Assessment - Edit

Performance assessment

Reference Value 1: 0 (0%)
Reference Value 2: 0 (0%)
Target 1: 120 (40%)
Target 2: 180 (60%)
83.33%
Min Value: 0
Max Value: 300
33.33%

Figure 17 – Performance assessment if no reference values are entered (blue color)



Assessment - Edit

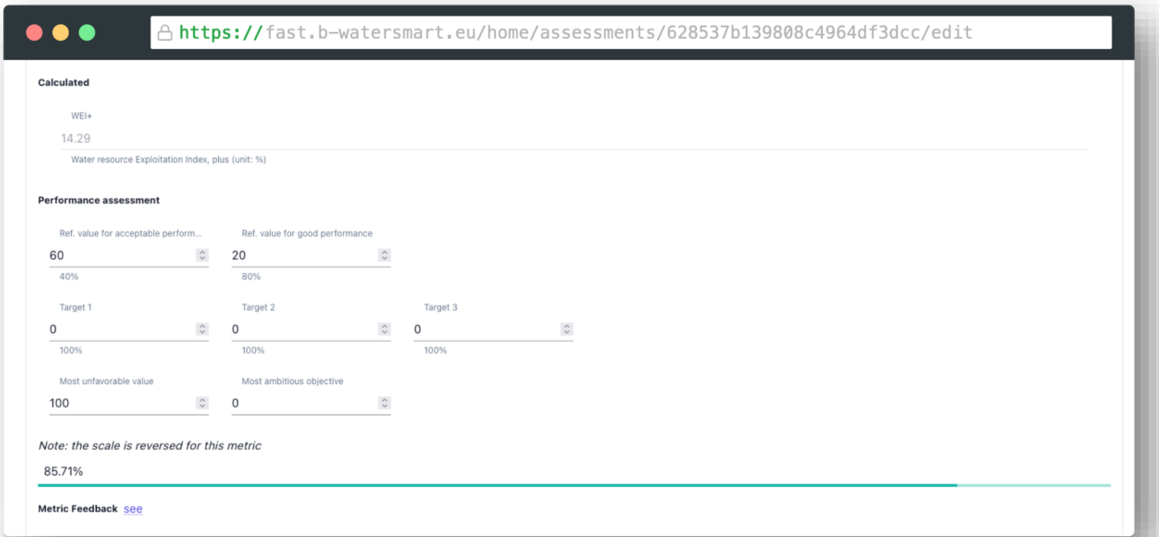
Performance assessment

Reference Value 1: 120 (40%)
Reference Value 2: 230 (76.67%)
Target 1: 120 (40%)
Target 2: 180 (60%)
250 (83.33%)
Min Value: 0
Max Value: 300
33.33%

Figure 18 – Performance assessment if reference values are entered (traffic light approach)

Reference values for each metric are given as a supporting feature in the FAST application, although the user can modify them depending on their objectives (see Appendix D – Reference values). Some of the metrics have a 'reversed scale', *i.e.,* a lower score indicates better condition/is preferable, vice versa. Hence, indication is given for such metrics as presented in Figure 19.

Aggregated results are also calculated (at assessment criteria and strategic objective level) and can be visualized on the assessment main page. This is presented in Figure 20.



https://fast.b-watersmart.eu/home/assessments/628537b139808c4964df3dcc/edit

Calculated

WEI+: 14.29

Water resource Exploitation Index, plus (unit: %)

Performance assessment

Ref. value for acceptable perform...: 60 (40%)

Ref. value for good performance: 20 (80%)

Target 1: 0 (100%)

Target 2: 0 (100%)

Target 3: 0 (100%)

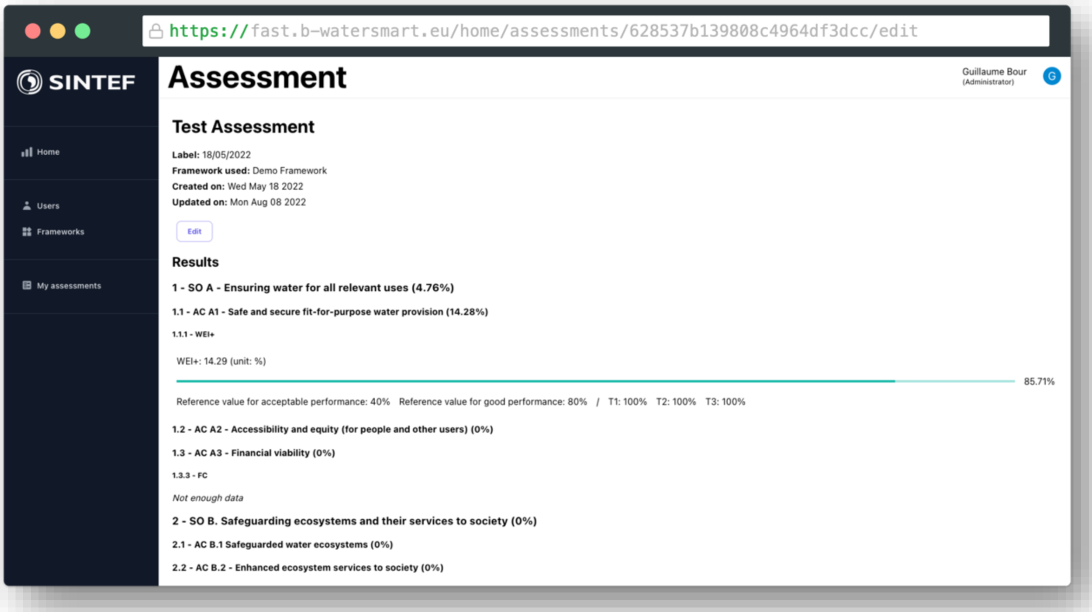
Most unfavorable value: 100

Most ambitious objective: 0

Note: the scale is reversed for this metric

85.71%

Figure 19 – Example of WEI+ being filled in



https://fast.b-watersmart.eu/home/assessments/628537b139808c4964df3dcc/edit

Test Assessment

Label: 18/05/2022
Framework used: Demo Framework
Created on: Wed May 18 2022
Updated on: Mon Aug 08 2022

Results

1 - SO A - Ensuring water for all relevant uses (4.76%)

1.1 - AC A1 - Safe and secure fit-for-purpose water provision (14.28%)

1.1.1 - WEI+

WEI+: 14.29 (unit: %)

85.71%

Reference value for acceptable performance: 40% Reference value for good performance: 80% / T1: 100% T2: 100% T3: 100%

1.2 - AC A2 - Accessibility and equity (for people and other users) (0%)

1.3 - AC A3 - Financial viability (0%)

1.3.3 - FC

Not enough data

2 - SO B. Safeguarding ecosystems and their services to society (0%)

2.1 - AC B.1 Safeguarded water ecosystems (0%)

2.2 - AC B.2 - Enhanced ecosystem services to society (0%)

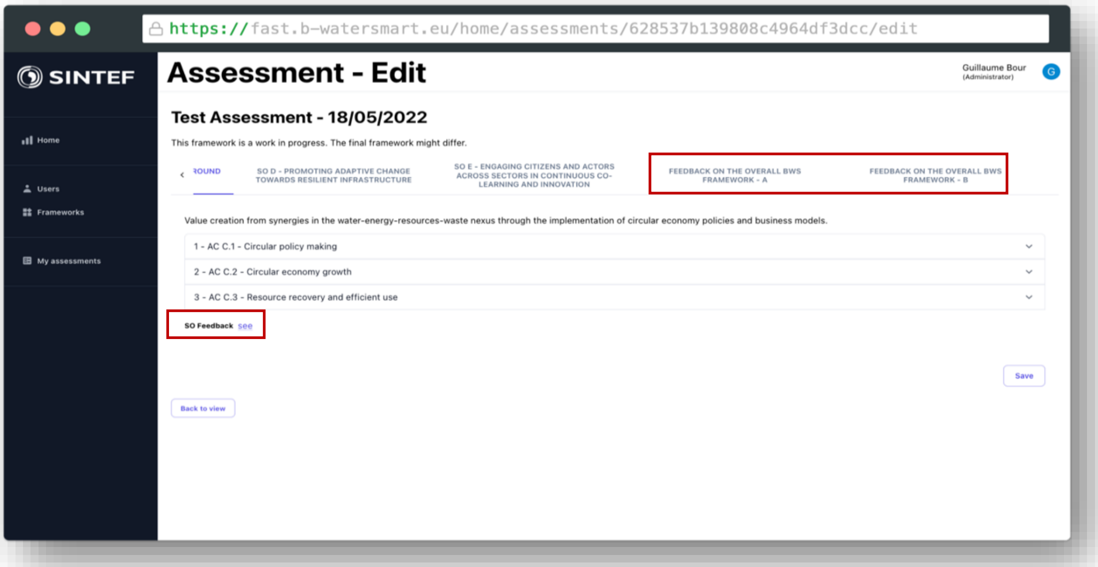
Figure 20 – Visualizing aggregated results

The application also has a way to export the results as a PDF report or downloaded as JSON if one wants to further process the data.

9.1.3 Collecting feedbacks

9.1.3.1 Feedback collection at different levels

Feedback on the framework needed to be collected at all levels *i.e.,* framework level (in two rounds, as described in Chapter 4), strategic objectives (SO), assessment criteria (AC), and metrics. Such a feedback questionnaire would have been cumbersome to both create and complete. The FAST application solves this by embedding the questionnaire directly into the assessment form. The feedback questions are hidden by default to not overwhelm the user. Figure 21 and Figure 22 provide examples of how the feedback collection was integrated to the assessment.



https://fast.b-watersmart.eu/home/assessments/628537b139808c4964df3dcc/edit

Assessment - Edit

Test Assessment - 18/05/2022

This framework is a work in progress. The final framework might differ.

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

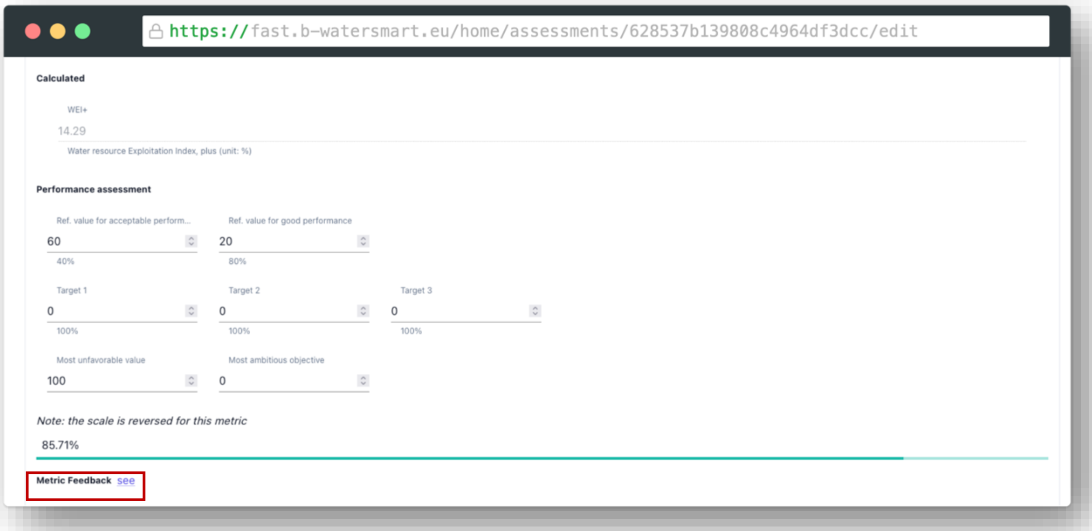
1 - AC C.1 - Circular policy making

2 - AC C.2 - Circular economy growth

3 - AC C.3 - Resource recovery and efficient use

SO Feedback see

Figure 21 – Overall BWS Feedback Tabs


https://fast.b-watersmart.eu/home/assessments/628537b139808c4964df3dcc/edit

Calculated

WEI+
14.29
Water resource Exploitation Index, plus (unit: %)

Performance assessment

Ref. value for acceptable perform...
60
40%

Ref. value for good performance
20
80%

Target 1
0
100%

Target 2
0
100%

Target 3
0
100%

Most unfavorable value
100

Most ambitious objective
0

Note: the scale is reversed for this metric

85.71%

Metric Feedback see

Figure 22 – Feedback questions for a given metric

9.1.3.2 Feedback visualization

There are two ways to visualize the collected feedback: a user can see the feedback she provided on the “assessment page” (also included in the report), or an administrator can extract the feedback for all users. This is not done via the user interface but with a script. The output can be collected for each user and gathered in a folder containing all the assessments’ feedbacks. Two files are generated for each assessment: *feedback.txt*, which contains all the questions/answers of the feedback, and *feedback.xlsx* which contains the answers only, to be copy-pasted in another Excel file to compare answers between responders.

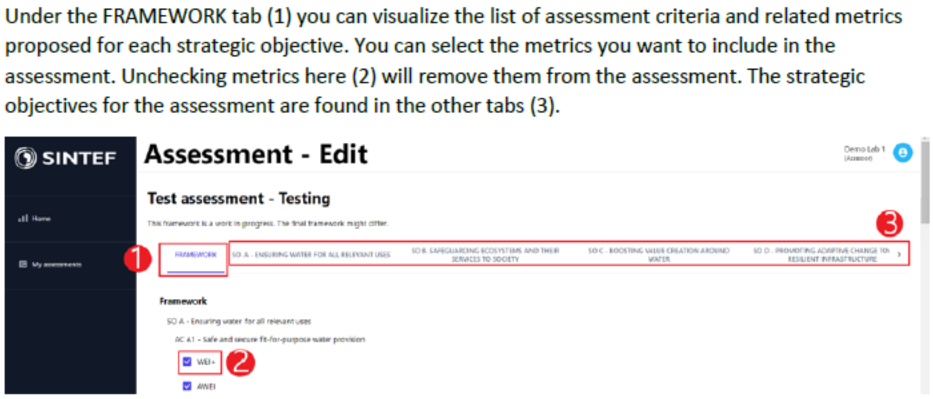
9.1.4 Users on-boarding

9.1.4.1 Access to the application

Once the application was deployed (see details below), one account was created for each of the Living Labs and the credentials were shared with the main contact person for each LL. On need, some credentials were also shared with other members of the same LL so they could split the work. For confidentiality reasons, accounts were never shared between participants of different organizations.

9.1.4.2 Tutorial

To help participants use the application, a tutorial was made available to them. Through screenshots and a descriptive text, the tutorial simulates a real interaction with the application. The user is guided from the login page to the creation and filling of assessments, and finally how to export the generated data to either .pdf or .json format. Red boxes and enumeration are some places added to the screenshots to support the textual description where necessary (Figure 23). Green note boxes (Figure 24) are used throughout the tutorial to highlight important aspects that the user must be aware of when using the application.



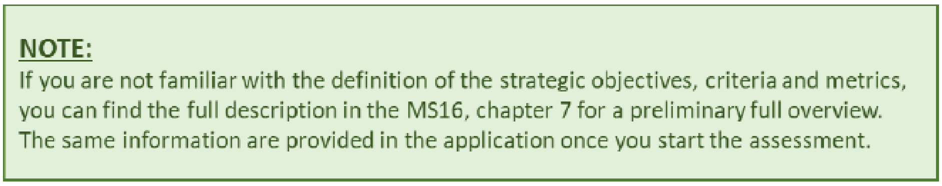
Under the FRAMEWORK tab (1) you can visualize the list of assessment criteria and related metrics proposed for each strategic objective. You can select the metrics you want to include in the assessment. Unchecking metrics here (2) will remove them from the assessment. The strategic objectives for the assessment are found in the other tabs (3).

Assessment - Edit

Test assessment - Testing

This framework is a work in progress. The final framework might differ.

Figure 23 – Textual description of the features in FAST application



NOTE:

If you are not familiar with the definition of the strategic objectives, criteria and metrics, you can find the full description in the MS16, chapter 7 for a preliminary full overview. The same information are provided in the application once you start the assessment.

Figure 24 – An excerpt of a note box showing an important information

After reading the tutorial, users should know how to interact with the application and how the application features work.

9.2 Technical description

9.2.1 Technology stack

The FAST application consists of a frontend application (SPA) developed in React (React 17) and of a backend developed in Golang (go1.18). The data is stored in a NoSQL database (MongoDB). A REST API is used for the communication between the frontend and the backend. JSON Web Token (JWT) is used for user authentication and authorization.

9.2.2 Deployment setup

The FAST application is deployed on a Virtual Private Server (VPS) owned by SINTEF and hosted in OVH, in France. The different components are deployed as containers (docker). A reverse proxy (nginx) manages the TLS termination and serves both the frontend and the backend. The infrastructure is represented in Figure 25.

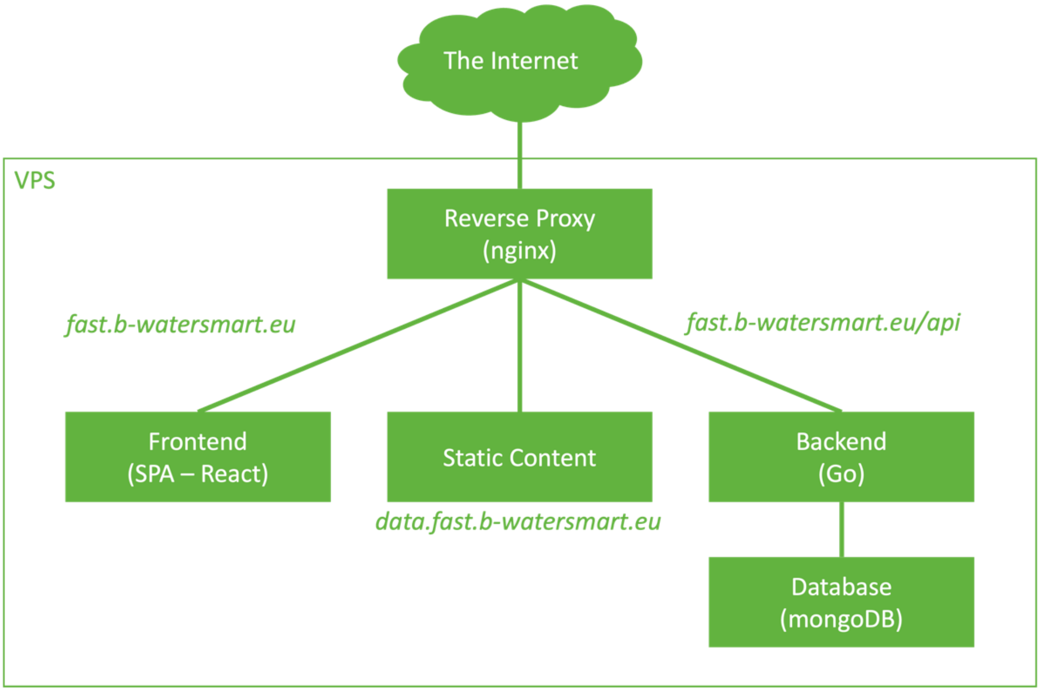


Figure 25 – Architecture Diagram of the Deployed Application

9.2.3 Security considerations

The VPS where the application was deployed is owned and managed by SINTEF. It was hardened from a security perspective and only two persons have access to it.

9.3 Lessons learned

The FAST application was developed as a prototype for the process of framework development and evaluation as of WP6, and not as an early version of the dashboard. It is however possible to take away some lessons learned from its development. The learnings' points are split between positive and negative.

9.3.1 Positive points

The findings of the development and the use of the current platform are expected to be useful for the development of the T3.9 dashboard. For instance, the results from an assessment being stored in JSON make it easy to exchange data between services and applications.

Despite being programmed in a typed language, the backend remains flexible and modifications to the framework models are either transparent (due to the use of *interface{}* or restricted to the model itself). The CRUD logic is never impacted.

Because of how the frontend application works, it is easy to extend it. One can easily add new metric types (that could use sliders, or any other UI components). It would also be simple to implement a "framework editor" to the application, preventing the users to have to create frameworks by editing a big JSON file, which can be cumbersome and prone to errors. In addition, rendering a framework is already implemented when filling an assessment, and the component can thus just be reused.

Having a way to visualize additional information about parts of the framework (metrics in that case) proved to be useful, especially since this information could be maintained separately. Currently the information opens in a new tab, but it is possible to improve the user experience by opening it in a modal window on the current page (using an *iframe* for instance).

9.3.2 Negative points

There is one major negative point to the current application, and that is the data model. Currently, frameworks and assessments are stored separately, allowing a 1..* relationship (one framework can be used by many assessments). The way the results were stored in an assessment is based on the structure of the framework, meaning that any modification in the framework (for instance switching two metrics) would render the data inconsistent. To prevent this, updating a framework was forbidden. Not all the use cases were known until late in the development which made it difficult to change afterwards. For the real application, a solution could be to use a versioning pattern, but also to “strongly” link one answer to one question (using for instance UUIDs).

Another negative point of the application is the lack of support for simultaneous editing: if two people sharing the same account were connected and editing the same assessment at the same time, they would overwrite each other changes. Given the short amount of time to develop the application, we decided not to implement this feature, but it could be needed for the dashboard. Another possibility is to prevent simultaneous editing of the same assessment and/or field.

10 Key conclusions and next steps

D6.2 is the second deliverable of WP6 and it has 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.

The V_1 of the framework mainly consists of a revised version of the V_0, which was shared with the Innovation Alliance (InAll) for testing and validation for the period April-August. To facilitate the validation phase process, SINTEF has developed a web-application, named FAST (not planned as for the description of work), embedding V_0, originally planned as excel-based. The FAST application is a temporal solution and as such it provides 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.

Thanks to the web-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 that are 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.

Comments addressed in V_1:

V_1 consists of 5 strategic Objectives, 17 assessment criteria and 72 metrics. The main differences between V_0 and V_1 entails an extensive work in revising the metrics in terms of their definition, in adding examples supporting the computation methods and potential sources of data, in enriching the literature references and in providing the list of reference values for each metric. These changes have been discussed in Section 6.4 and addressed both in this document (Chapter 7) and in the FAST application.

Comments to be addressed in V_2 (by task 6.3)

Task 6.3 will have to focus on the usability of the framework and mostly work in the following directions:

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.

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).
3. **Revise the interview process based on the lessons learnt provided in Chapter 8**. Task 6.3 should complement D6.3 with a guide for conducting interviews that takes into account the improvements proposed here, 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.

Comments shared with the dashboard developers (Task 3.9)

The FAST should not be confused with the dashboard that is to be developed under the responsibility of T3.9. Nevertheless, the developers of FAST believe that some elements of the software design could already inform the developers of the dashboard in terms of lessons learnt. In this direction, Chapter 9 provides a critical assessment by the developers of the positive and negative features of FAST. FAST could also be used by T3.9 as the foundation to create the dashboard.

In addition to the developer perspective, the most relevant insights of the FAST user experience have been extracted by Task 6.2 from the feedback forms and were shared with Task 1.4 as inputs to D1.3 (as internal decision of collaboration between Task 6.2 and Task 1.4). The user experience in engaging with FAST is a useful information for Task 3.9, given that FAST has been designed on purpose as a simple application with limited features. It is in the scope of Task 3.9 to “develop advanced visualization techniques, providing a gamified, immersive environment for users to interact with the framework, provide information and visualize suggestions in user friendly, intuitive ways, suitable for multiple, collaborating stakeholders and decision makers”.

Overall, although the BWS AF V_1 is a transitional step between V_0 and the final version V_2 (by Task 6.3), the work performed by the Task 6.2 team has been extremely intense and preparatory for both the finalization of WP6 and the start of Task 3.9. Specifically, the team has:

1) developed the V_0 of the BWS AF, based on in depth literature and interaction with the LLs;
2) developed the FAST tool;
3) developed a tutorial to support the use of FAST;
4) provided reference values for each of the 73 metrics based on extensive literature review and shared it with the InAll via T1.4;
5) guided and trained the InAll, under the coordination of T1.4;
6) reviewed the feedback of the InAll for a total of more than 4800 answers addressed;
7) categorized the feedbacks in order of priority and related task (Task 6.2 - V_1 and the interview process, Task 6.3 - V_2, T3.9 - dashboard);
8) enriched and improved the description of the metrics both in this document and in FAST, also including the reference values not included in V_0;
9) provided clear overview of the feedbacks received as part of this document for future reference;
10) provided clear recommendation for further work in Task 6.2 and suggestions for Task 3.9.

Much work is still ahead, but Task 6.2 has now set a strong basis to support the process of refinement of the framework (Task 6.3) until M30 (Prototype V_2).

Appendix A – How to use the B-WaterSmart framework

This section presents the proposed deployment "Methodology". The definitions of the terms applied ("reference value", "target", "milestone", "scenario" and "alternative") are provided in Appendix B – Key definitions adopted in the B-WaterSmart Assessment Framework. Furthermore, instructions on how to set reference values and targets, mentioned in the description below, are provided in Section 6.8 of D6.1 (Ugarelli et al., 2021).

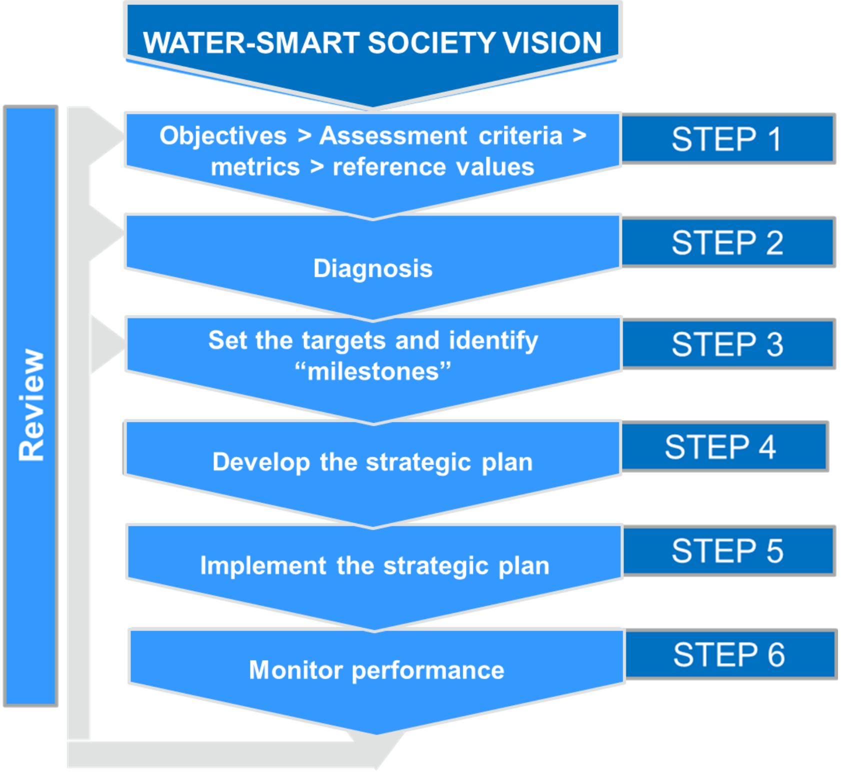


Figure 26 – The iterative six-step process to meet the water-smart vision proposed for the deployment of the B-WaterSmart framework.

As depicted in Figure 26, an iterative six-step process for continuously improving the transition process to a water - smart society is proposed as deployment methodology, and it comprises, at the current stage of development, the following steps:

STEP1 – Selection of strategic objectives, assessment criteria, metrics and reference values

Step 1 is a crucial stage to 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 clear objectives, assessment criteria, metrics to assess them, and finally, reference values for every metric. The strategic objectives are grounded on the water-smart society vision and their definition requires proficient knowledge of the context.

Once the metrics have been selected, it is important to identify their measurement details, such as definitions, measurement units, 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 to include these in the metrics sets. It is also important to narrow the selection of the relevant metrics instead of using an overly large set.

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 metrics. This step usually includes the collection and evaluation of relevant information (on the external context - global and stakeholder-specific - and on the internal context) 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 assessments performed over time (*e.g.,* on regular yearly basis) or to assess the effectiveness of alternative solutions (see step 4). The diagnosis should also include scenarios (see Appendix 0 in Ugarelli et al. (2022) for further explanation about the scenarios) to enhance anticipatory capacity; scenarios are due to factors (isolated and/or combined) that may influence the analysis and should therefore be considered (*e.g.,* demographic trends, regulatory changes).

STEP 3 - Set the targets and identify “milestones”

The diagnosis allows to identify 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 for 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.

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 organization/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 should contain a summary of the diagnosis and of the selected alternative solutions. The alternative solutions are not limited to alternative technological solutions, but to any change of practice related to the multiple dimensions of the framework (*e.g.,* alternative solutions to achieve set targets in awareness creation, under the Governance dimension).

STEP 5 - Implement the strategic plan

It consists of the actual implementation of the plan produced. The implementation involves executing the selected alternatives in the timeframe defined in the plan. It is outside the scope of the framework to guide the user on how to implement the plan, which has to be tailored on each specific case. However, it is encouraged to include in the plan the period in time at which the effects of the alternatives should be perceived, so to schedule when to monitor the effectiveness of the plan, leading to the next step.

STEP 6 - Monitor performance

Monitoring and reviewing are critical for the continuous improvement process. To perform this step, users should develop a monitoring plan for monitoring and reporting metrics during the plan implementation – by whom, how often, quality assurance methods, and format for reporting.

The iterative six-step process here proposed, and the description of each STEP, will be further revised and detailed as results of the validation phase performed by the InAll along the work to be performed in Task 1.4.

Appendix B – Key definitions adopted in the B-WaterSmart Assessment Framework

B.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.,* excellent, good, fair, poor).

B.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:

Data elements: A basic datum from the system that can either be measured from the field or is easily obtainable. Depending on their nature and role within the system, data elements can be considered variables, context information or simply explanatory factors.

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.

Explanatory factors: An explanatory factor is any element of the system of performance indicators (PI) that can be used to explain PI values, *i.e.,* the level of performance at the analysis stage. This includes PI, variables, context information and other data elements not playing an active role before the analysis stage.

B.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).

Milestones are significant intermediate actions to be accomplished at a given time in the process of achieving the strategic objectives.

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 C – List of variables adopted in BWS AF, V_1

Variable	Definition
$A_{Connect}$	Area of agricultural land with access to irrigation
AFF_{WSW}	Affordability
AP	Number of people from the catchment area using the water system for recreational activities each year
AP_{with}	Affected people by a flood event with flood protection by the ecosystem
$AP_{without}$	Affected people by a flood event without flood protection by the ecosystem
Area	Area considered (area to be specified by the user) in which identify points for water public consumption
A_t	Area of the considered territory
A_{Total}	Total agricultural area (area to be specified by the user)
A_{Total}	Total area of identified potential stormwater pollution areas
$A_{Treatment}$	Area of identified potential stormwater pollution areas where suitable treatment is implemented
AU	Authority
BM_C	Number of new and modified business models put into practice
BM_{CE}	Circular economy business models in practice
BM_{tot}	Number of total business models (new and existing)
BPR	By-products recovery revenues
CA	Collaborative agent
C_{AS}	Number of customers covered by infrastructure dependent on other services with autonomy (back-up) solutions
CDR	Clear division of responsibility
CES	People enjoying cultural ecosystem services
CFP_D	Carbon Footprint for drinking water
CFP_{dw}	Carbon footprint in the drinking water systems
CFP_W	Carbon Footprint for wastewater
CFP_{ww}	Carbon footprint in the wastewater collection, treatment and reclaimed water system
C_{OS}	Number of customers covered by infrastructure dependent on other services
C_{RS}	Number of customers covered by infrastructure with redundant solutions
C-SL	Cross-stakeholders learning
CSO	Combined sewer overflow
CSO_r	Yearly total number of registered CSOs of the considered organization
C_{TOT}	Total number of customers served by infrastructure
$C_{totalDW}$	Percentage of total compliance for safe drinking water
$C_{totalRW}$	Percentage of total compliance for safe reclaimed water

Variable	**Definition**
CWP	Consumer willingness to pay
DE	Discourse embedding
DWC	Volume of the drinking water consumption
DWC_{PC}	Drinking water consumption per capita
DWP	Annual drinking water production
E_{eff}	Energy consumption (total)
EFR	Environmental flows requirement component
EFR_{CR}	EFR Compliance Rate
EP	Energy production
E_{re}	Energy produced from waste recovered
E_{total}	Total energy used in the whole system (all processes)
EV	Evaluation
FC	Financial continuation
FDP	Regulation of extreme events
FPA	Fertilizer production avoided
GJ	Green jobs
GPP_{C}	Green public procurement in terms of the number of contracts
$H_{<EFR}$	Amount of time (hours) during a year in which EFR is not achieved
H_{annual}	Total number of hours per year
HCZ	Hydrocitizenship
I	Inhabitants living in the catchment area
IAU	Information availability and use
ICV	Infrastructure current (fair) value
III_{AC}	Infrastructure Implementation Index for Adaptive Change
IO	Incident occurrences in the system
IPI_{AC}	Infrastructure Planning Index for Adaptive Change
IRC	Infrastructure replacement cost
ITS	Information transparency and sharing
IVI	Infrastructure Value Index
KC	Knowledge cohesion
K-E	Knowledge and education
LA	Level of ambition
L_{net}	Total length of the supply and distribution pipelines
LoA	Level of autonomy
LoR	Level of redundancy
LS (1-5)	Likert style scoring with five categories
LSU	Local sense of urgency
LWL	Linear water losses
NC	Network cohesion

Variable	**Definition**
$N_{conflict}$	The sum of the identified potential conflicts
N_{CSO}	The number of active CSO devices in the assessment year
N_{CSO}	Number of active CSO devices of the organisation
$ne_{totalDW}$	Total number of samples with exceedance, *i.e.,* sum of samples with microbial, chemical and indicator parameter exceedance
$n_{totalDW}$	Total number of samples analyzed in assessment period
$ne_{totalRW}$	Total number of samples with exceedance, *i.e.,* sum of samples with microbial, chemical or indicator parameter exceedance
$n_{totalRW}$	Total number of samples analyzed in assessment period
N_{GJ}	Number of new created, converted, maintained green jobs on a yearly basis
N_{J}	Total number of created, converted, maintained jobs
$NH_{Connect}$	Number of households (and / or small business) that are connected to the waterworks
NH_{Total}	Total number of households (and / or small business) in the area (area to be specified by the user)
$N_{i,in}$	Total nutrient used as a fertilizer
$N_{i,re}$	Nutrient recovered used as a fertilizer
$NI_{Connect}$	Number of industries that are connected to the waterworks
NI_{Total}	Total number of industries in the area (area to be specified by the user)
$NPC_{entry/a}$	Sum of N, P and C entry in tons per year
$NPC_{250etention/a}$	Sum of N, P and C retention capacity in tons per year
NRW	Non-Revenue Water
$n_{totalDW}$	Total number of samples analyzed in assessment period
$n_{totalRW}$	Total number of samples analyzed in assessment period
N_{WAP}	Number of operational fountains and other points of public consumption in public spaces
N_{y}	Considered number of years
$PA_{Connect}$	Agriculture area with access to water for irrigation
$P_{conflict}$	Number of potential conflicts of use related to water availability in a basin
PCV	Protection of core values
$P_{Hconnect}$	Physical access to water supply (households and small businesses)
PI	Policy instrument
$PI_{Connect}$	Physical access to water supply (industrial use)
PP_{GC}	Number of green public procurement contracts
$PP_{tot\text{-}C}$	Total number of public procurement contracts, including non-green contracts
PREP	Preparedness
P_{Total}	Total population
$P_{Treatment}$	Number of customers complying with wastewater treatment requirements

Variable	**Definition**
PVO	Progress and variety of options
PWA	Physical access to water supply in public spaces for quality of life
QA.1.1-DW	Questionnaire for Metric A.1.5 DW (BWS_METRIC_A1.5_SRI_WS_WW.xlsx)
QA.1.1-WW	Questionnaire for Metric A.1.6 WW(BWS_METRIC_A1.6_SRI_WS_WW.xlxs)
$QD.1.1\text{-}IPI_{AC}$	Questionnaire for Metric D.1.1 – IPIAC (BWS_METRIC D1.1_IPI_AC.docx)
$QD.2.2\text{-}III_{AC}$	Questionnaire for Metric D.2.2 – IIIAC (BWS_METRIC D2.2_III_AC.docx)
$Q_{max\text{-}30}$	Daily average water flow of the 30 consecutive days with highest inflows
Q_s	Yearly average inflow entering the considered system
Q_{TC}	Daily treatment capacity
R_{BP}	Yearly revenue generated from by-products recovery
R_i	Number of registered incidents in a given timeframe
RM	Room to maneuver
R_{tot}	Yearly total revenue generated within the organisation
RW	Volume of reclaimed water utilized by the organization for different scopes
RWP	Reclaimed water production
RWR	Renewable water resources = Outflow + (Abstraction-Return)-change in storage
RWU	Reclaimed water use
SBU	Sludge beneficial use
SC	Statutory compliance
SI	Stakeholder inclusiveness
SM	Smart monitoring
SPR_{NPC}	Benefits from regulating services (water quality)
SRI-DW	Safety and Resilience Index for drinking water
SRI-WW	Safety and Resilience Index for wastewater
SWT_{eff}	Effective stormwater treatment
TCU	Treatment capacity utilization
TCW	Total water volume consumption from all the different sources, including the reclaimed water used
$TR_{i,j}$	Time of restoration (out-of-service duration + recovery time)
TR_{max}	Time for restoration
TWW	Volume of wastewater treated and the reclaimed water systems
V_{other}	Total volume of water consumed from alternative sources
V_{OU}	Annual water consumptions for other use than domestic use (public, industrial, etc.)
V_r	Total retained volume from alternative non-conventional sources with the purpose of additional water supply
$V_{reclaimed}$	Volume of reclaimed water produced in a reclamation facility transferred to other entities

Variable	**Definition**
V_t	Total operational volume of storage tanks for the considered system
V_{Total}	Total volume of wastewater generated
$V_{Treatment}$	Volume of treated wastewater complying with legal requirements
V_w	Volume of water produced/treated
$V_{ww,treated}$	Total volume of wastewater treated in wastewater treatment plants under the responsibility of the utility
$W_{Available}$	Water provision by ecosystem
WA	Overall water area of the whole catchment
$WA_{\geq good}$	Water area with at least a good ecological status or better
WC_{os}	Water consumption from other sources
W_E	Maintaining nursery populations and habitats
WEI+	Water resource exploitation index, plus
WFD	Water footprint for drinking water
WF_{dw}	Water footprint in drinking water system
WFW	Water footprint for wastewater
WF_{ww}	Water footprint in the wastewater collection, treatment and reclaimed water
$W_{i,in}$	Total waste of the same type entering the treatment process or activity
$W_{i,re}$	Waste of the same type recovered
WR	Water-related materials recovery
WR	Water retention
WSC	Water Storage Capacity
W_t	Water available for abstraction from the ecosystem in year t
W_{t-1}	Water available for abstraction from the ecosystem in the previous year t-1
WU	Water use = Abstraction - Return
WWT_{eff}	Effective wastewater treatment
X_{re}	Sludge recovered and suitable for its reuse
X_{tot}	Total sludge produced

Appendix D – Reference values

D.1 Applied analysis framework to derive 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 of their legislation and strategic plans.

While the indicators require reference values to judge the performance, for indices the judgement are intrinsic to the calculation.

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 should be established with an integrated analysis of these several sources (Figure 27). During InAll validation period, the reference values provided by Task 6.2 may be adapted based on i) proposal for an easy, moderate, and ambitious joint reference value based on expert judgment of researchers and LL experts for each metric and ii) joint choice for easy, moderate or ambitious reference value for each metric by strategic level representatives of the LLs. Figure 28 below demonstrates this rational and exemplifies for the metric energy production.

The reference values proposed for each metric are presented afterwards, as well as the detailed information justifying the ranges proposed.

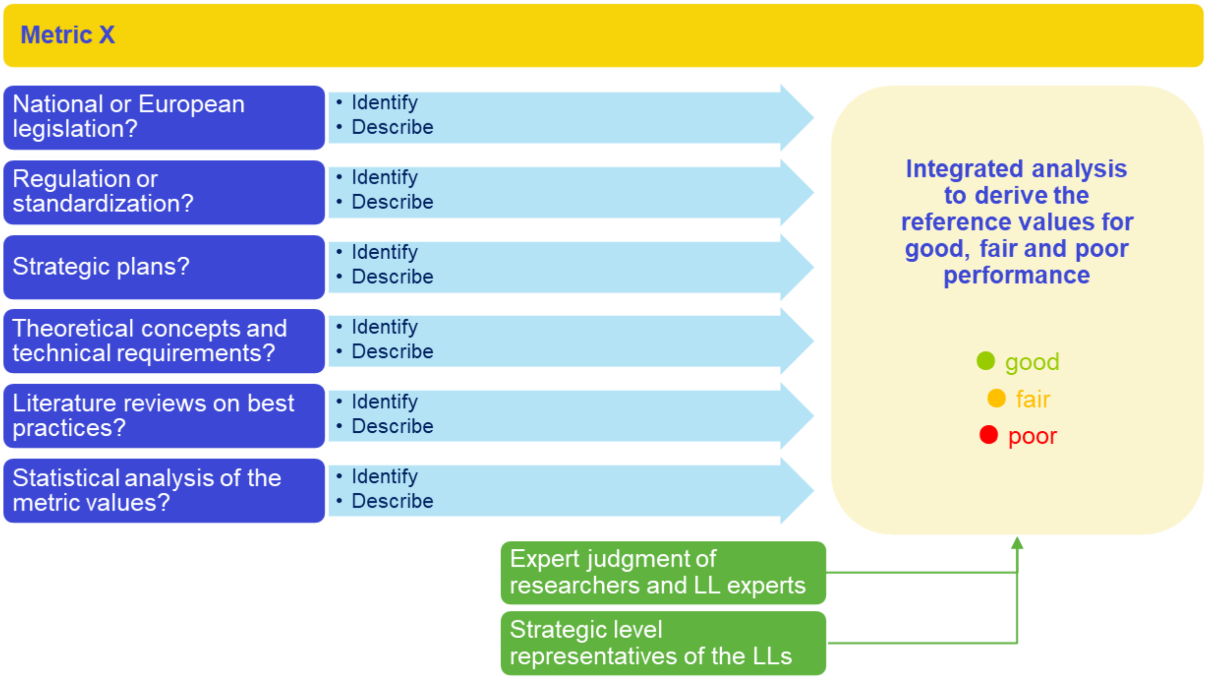
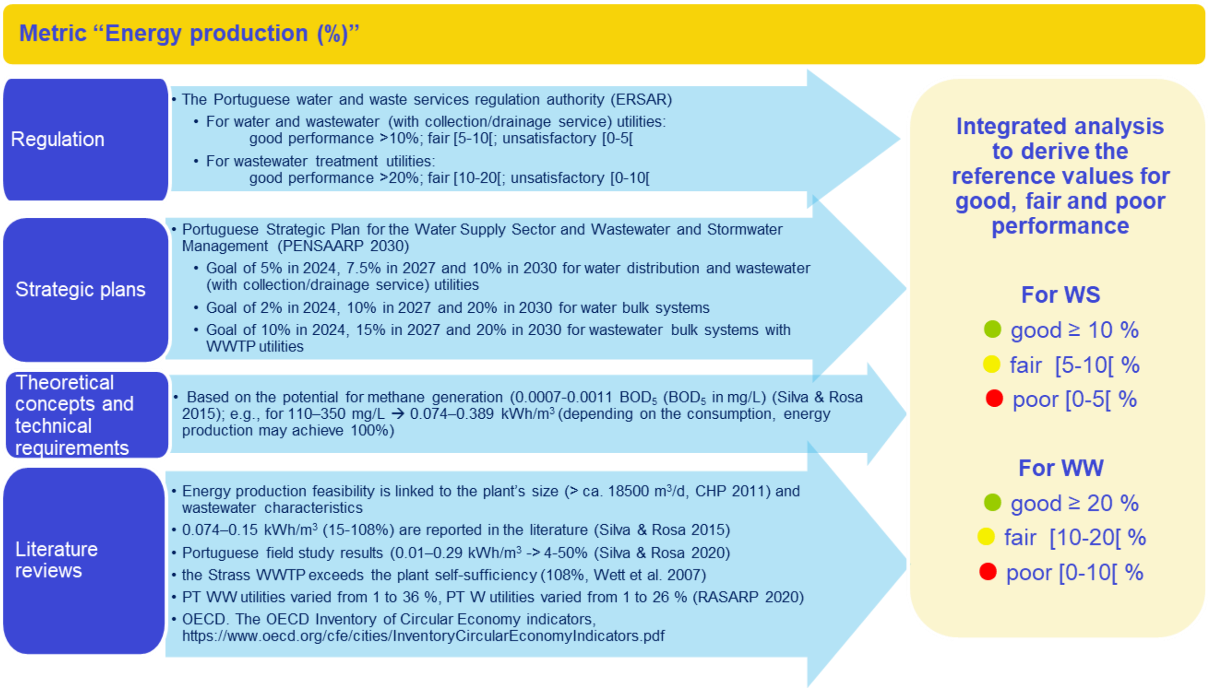


Figure 27 – Applied framework to derive reference values for a metric.



- The Portuguese water and waste services regulation authority (ERSAR)
  - For water and wastewater (with collection/drainage service) utilities:
    good performance >10%; fair [5-10[; unsatisfactory [0-5[
  - For wastewater treatment utilities:
    good performance >20%; fair [10-20[; unsatisfactory [0-10[

- 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

- 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%)

- 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 %, PT W utilities varied from 1 to 26 % (RASARP 2020)
- OECD. The OECD Inventory of Circular Economy indicators, https://www.oecd.org/cfe/cities/InventoryCircularEconomyIndicators.pdf

Figure 28 – Example of reference values formulation using the framework.

D.2 Justification of reference values for each metric

A.1.1 Water resource 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 < 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 and A.1.5 Security and resilience index for drinking water and wastewater (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 water supply (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 water supply in public spaces for quality of life (#/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

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.

Integrated analysis to derive the reference values for good, fair and poor performance

- ● **good >=1**
- ● **fair [0.2-1[**
- ● **poor < 0.2**

A.2.3 Physical access to water supply (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 Agriculture area with 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 >50** ● **fair [30-50[** ● **poor [0-30[**
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.2.5 Number of points with potential conflicts of water 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	WFD	**Integrated analysis to derive the reference values for good, fair and poor performance** **n.A.**
Regulation or standardization	- 2012 Blueprint for Europe's Waters (EC 2012): re-labelling water quantity as an environmental quality issue; recognises the interlinkages between quality and quantity, considering the latter as an important factor in the achievement of good water status. - "Ecological flows in the implementation of the Water Framework Directive" (EC 2015). Acknowledgement of the ecological flow concept , but no relation to water demand of sectors other than the natural environment and transboundary water allocation issues (from https://waterquality.danube-region.eu/wp-content/uploads/sites/13/sites/13/2019/09/BG_Transboundary_Water_Cooperation_CONF_BY_DANUBE_STRAT.pdf)	
Strategic plans		
Theoretical concepts and technical requirements	- T7 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)	
Literature reviews on best practices	- https://wbwaterdata.org/dataset/transboundary-freshwater-spatial-database - https://www.worldwater.org/conflict/map/ - Levy & Sidel 2011 (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3076402/) - Hooper 2006 (https://www.iwr.usace.army.mil/Portals/70/docs/iwrreports/2006-VSP-01.pdf) - Bertule et al. 2017 (https://www.unepdhi.org/wp-content/uploads/sites/2/2020/05/Using_Indicators_for_Improved_WRM_Sept17.pdf)	
Statistical analysis of the metric values		

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%.	

B.1.1 EFR 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 <=40** ● **fair]40-60]** ● **poor >60** **Southern Europe** ● **good <=20** ● **fair]20-40]** ● **poor >40**
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 Benefits from regulating services (water quality) (%)

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		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values		

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	
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	
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 Regulation of extreme events (%)

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 [40-100]** ● **fair [10-40[** ● **poor [0-10[**
Regulation or standardization	Different ratified national laws and institutions caring for implementation	
Strategic plans	In Germany: "Hochwasserrisikomanagementpläne"	
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 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		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices		
Statistical analysis of the metric values		

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		**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		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices	https://ec.europa.eu/environment/water/flood_risk/better_options.htm	
Statistical analysis of the metric values		

B.3.1 and B.3.2 Water Footprint for drinking water and wastewater (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 1.45m3/m3 average	

B.3.3 and B.3.4 Carbon Footprint for drinking water and wastewater (kgCO_{2eq}/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** ● **good <= 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 mediasn 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 RO 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 wastewater treated: Baseline for kg CO_{2eq}/$m^3$of wastewater treated – 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.3.5 Energy consumption (Total) (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."	**Integrated analysis to derive the reference values for good, fair and poor performance** **For WS** ● **good <=0.5** ● **fair [0.5-0.8[** ● **poor >0.8** **For WW** ● **good <= 0.6** ● **fair [0.6-0.9[** ● **poor >0.9**
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	

B.3.4 Drinking water consumption (L/pe/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 [100-150]** ● **fair]150-175]** ● **poor]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

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.1.3 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** ● **fair]10-50[** ● **poor <=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

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.2.1 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** ● **fair [3-6[** ● **poor < 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** ● **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 efficient use

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** ● **good >= 15** ● **fair [10-15[** ● **poor < 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).	
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 efficient use

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** ● **good >= 30** ● **fair [5-30[** ● **poor < 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 Sludge beneficial use (%)

Strategic objective: C. Boosting value creation around water

Assessment criteria: C.3 Resource recovery and efficient use

National or European legislation	European list of wastes (LoW) considers sludge from treatment (WT, WWT). https://ec.europa.eu/eurostat/documents/342366/351806/Guidance-on-EWCStat-categories-2010.pdf/0e7cd3fc-c05c-47a7-818f-1c2421e55604	**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) defined 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 >= 99% in 2024, 2027 and 2030	
Theoretical concepts and technical requirements		
Literature reviews on best practices	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		

C.3.4 Water consumption from other sources (%)

Strategic objective: C. Boosting value creation around water
Assessment criteria: C.3 Resource recovery and efficient use

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** ● **good >40** ● **fair [10-40[** ● **poor < 10**
Regulation or standardization		
Strategic plans		
Theoretical concepts and technical requirements		
Literature reviews on best practices	Agriculture accounts for around 40 % of the total water used per year in Europe.	
Statistical analysis of the metric values		

C.3.5 Reclaimed water use (%)

Strategic objective: C. Boosting value creation around water

Assessment criteria: C.3 Resource recovery and efficient 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 >=15** ● **fair [1-15[** ● **poor < 1**
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	

C.3.6 Reclaimed water production (%)

Strategic objective: C. Boosting value creation around water

Assessment criteria: C.3 Resource recovery and efficient 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** ● **fair [0.5-5[** ● **poor < 0.5** **WEI+ [10-30[** ● **good >=10** ● **fair [5-10[** ● **poor < 5** **WEI+ [30-70[** ● **good >=20** ● **fair [10-20[** ● **poor < 10** **WEI+ >=70** ● **good >=30** ● **fair [15-30[** ● **poor < 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.3.7 Energy production (%)

Strategic objective: C. Boosting value creation around water
Assessment criteria: C.3 Resource recovery and efficient 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

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 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[and]0.6-0.8]** ● **poor [0.0-0.2[and]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[and]0.6-0.8] Unsatisfactory perofrmance [0.0-0.2[and]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; 1095]** ● **fair]1095; 1825]** ● **poor]1825; +∞[** **For bulk systems** ● **good [0; 1825]** ● **fair]1825; 2738]** ● **poor]2738; +∞[**
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** **● good [1; 2]** **● fair]0.5; 1] and [2; 4]** **● poor]0; 0.5[and [4; +∞[**
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		
Statistical analysis of the metric values		

D.3.3 Water retention (L/(m^2 . 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	UN Sustainable Development Goal on Water (SDG 6) targets a substantial increase in rain harvesting and safe reuse globally by 2030
Regulation or standardization	Maximization of water reuse is a specific objective in the Communication Blueprint to safeguard Europe's water resources
Strategic plans	Water from alternative sources is a top priority area in the Strategic Implementation Plan of the European Innovation Partnership on Water
Theoretical concepts and technical requirements	Reuse of treated wastewater can be considered a reliable water supply, quite independent from seasonal drought and weather variability and able to cover peaks of water demand. This can be very beneficial to farming activities that can rely on reliable con
Literature reviews on best practices	Agriculture accounts for around 40 % of the total water used per year in Europe. Despite efficiency gains in the sector since the 1990s, agriculture will continue to be the largest consumer for years to come, adding to water stress in Europe. This is because more and more farmland needs to be irrigated, especially in southern European countries. While only around 9 % of Europe's total farmland is irrigated, these areas still account for more than 40% of the total water use in Europe. Giving that 40.4% of 243,000,000,000 cubic meters (total water use in EU, as shown in Figure 2) is used for agriculture, reference values of the analyzed metric can be derived from a share of this quantity, equal to 98,172,000,000,000 liters. By considering the shares of 10% and 5%, respectively for Reference 1 and 2, the following values are suggested: -Reference value 1 [L/(m^2 year)]: 9,817,200,000,000/143,207,000,000 = 68.55 L/(m2 year) -Reference value 2 [L/(m^2 year)]: 4,908,600,000,000/143,207,000,000 = 34.28 L/(m2 year) If all the agricultural land is considered in the computation, instead of taking into account only the irrigated area, Reference value 1 and Reference value 2 calculated with the latter approach are the following: -Reference value 1 [L/(m^2 year)]: 9,817,200,000,000/1,591,185,000,000 = 6.17 L/(m2 year) -Reference value 2 [L/(m^2 year)]: 4,908,600,000,000/1,591,185,000,000 = 3.08 L/(m2 year) Giving that 45.5% of 243,000,000,000 cubic meters (total water use in EU, is used for production industries, reference values of the analyzed metric can be derived from a share of this quantity, equal to 110,565,000,000,000 liters. By considering the shares of 10% and 5%, respectively for Reference 1 and 2, the following values are suggested: -Reference value 1 [L/(m^2 year)]: 11,056,500,000,000/163,198,000,000 = 67.75 L/(m2 year) -Reference value 2 [L/(m^2 year)]: 5,528,250,000,000/163,198,000,000 = 33.87 L/(m2 year) Giving that 14.1% (11.6% + 2.5%) of 243,000,000,000 cubic meters (total water use in EU, as shown in Figure 2) is used for households and service industries, reference values of the analyzed metric can be derived from a share of this quantity, equal to 34,263,000,000,000 liters. By considering the shares of 10% and 5%, respectively for Reference 1 and 2, the following values are suggested: -Reference value 1 [L/(m^2 year)]: 3,426,300,000,000/244,798,000,000 = 14.00 L/(m2 year) -Reference value 2 [L/(m^2 year)]: 1,409,400,000,000/244,798,000,000 = 7.00 L/(m2 year)
Statistical analysis of the metric values	

Integrated analysis to derive the reference values for good, fair and poor performance

Agriculture

● **good >=68**
● **fair [34-68[**
● **poor <34**

Industrial consumptions

● **good >=68**
● **fair [34-68[**
● **poor <34**

Urban consumptions

● **good >=14**
● **fair [7-14[**
● **poor <7**

D.3.4 Incident occurences (#/year/100 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** **burst in distribution** ● **good [0-30]** ● **fair [30-60[** ● **poor [60-+∞[** **flooding** ● **good [0-0.5]** ● **fair [0.5-2[** ● **poor [2-+∞[** **collapse** ● **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.3.5 Combined sewer overflows (#/device)

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** **Non sensitive** ● **good [0-30]** ● **fair]30-60]** ● **poor]60-+∞[** **Non sensitive and recreational uses** ● **good [0-5]** ● **fair]5-10]** ● **poor]10-+∞[** **Sensitive** ● **good [0-6]** ● **fair]6-12]** ● **poor]12-+∞[** **Bathing waters** ● **good [0-2]** ● **fair]2-3]** ● **poor]3-+∞[**
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		

D.3.6 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)

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** ● **good [0.0-0.25]** ● **fair]0.25-1]** ● **poor >= 1**
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.3.7 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** ● **fair [70-80[** ● **poor <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 unsatisfatory.	
Statistical analysis of the metric values		

D.3.8 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** ● **fair [80-90[** ● **poor <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.3.9 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)

National or European legislation		**Integrated analysis to derive the reference values for good, fair and poor performance** **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

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.1.2 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

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 Hydrocitizenship (5-point Likert scales)

Strategic objective: E. Engaging citizens and actors across sectors in continuous co-learning and innovation

Assessment criteria: E.1 Awareness

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.1.4 Discourse embedding (5-point Likert scales)

Strategic objective: E. Engaging citizens and actors across sectors in continuous co-learning and innovation

Assessment criteria: E.1 Awareness

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 Network Cohesion (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 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.2.4 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

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.3.2 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 Progress and variety of options (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.3.4. 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%.	

E.4.1 Smart monitoring (5-point Likert scales)

Strategic objective: E. Engaging citizens and actors across sectors in continuous co-learning and innovation

Assessment criteria: E.4 Capacity building

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.4.2 Evaluation (5-point Likert scales)

Strategic objective: E. Engaging citizens and actors across sectors in continuous co-learning and innovation

Assessment criteria: E.4 Capacity building

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.4.3. 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.4 Capacity building

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.5.1. 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.5 Information and knowledge sharing

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.5.2. Information transparency and sharing (5-point Likert scales)

Strategic objective: E. Engaging citizens and actors across sectors in continuous co-learning and innovation

Assessment criteria: E.5 Information and knowledge sharing

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.5.3. Knowledge cohesion (5-point Likert scales)

Strategic objective: E. Engaging citizens and actors across sectors in continuous co-learning and innovation

Assessment criteria: E.5 Information and knowledge sharing

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 Summary table of reference values

The reference values proposed for each metric are presented below.

Strategic Objective (SO)	Assessment criteria (AC)	Metric short title	Unit	Reference values
A. Ensuring water for all relevant uses	A.1 Safe and secure fit-for-purpose water provision	Metric “A.1.1” Water resource exploitation index +	%	● good < 20 ● fair [20-40[● poor ≥ 40
		Metric "A.1.2" Safe drinking water	%	● good [98.5-100] ● fair [94.5-98.5[● poor [0-94.5[
		Metric “A.1.3” Compliant reclaimed water	%	● good [95-100] ● fair [90-95[● poor [0-90[
		Metric "A.1.4" Safety and Resilience Index - DW	Score (1-200)	● good [140-200] ● fair [75-140[● poor [0-75[
		Metric "A.1.5" Safety and Resilience Index - WW	Score (1-200)	● good [140-200] ● fair [75-140[● poor [0-75[
	A.2 Accessibility and equity (for people and for other uses)	Metric "A.2.1" Physical access to water supply (households and small business)	%	Predominantly urban areas ● good [95-100] ● fair [80-95[● poor [0-80[Intermediately urban areas ● good [90-100] ● fair [80-90[● poor [0-80[Predominantly rural areas ● good [80-100] ● fair [70-80[● poor [0-70[
		Metric "A.2.2" Physical access to water supply in public spaces for quality of life	#/km^2	● good >=1 ● fair [0.2-1[● poor < 0.2
		Metric "A.2.3" Physical access to water supply (industrial use)	%	● good [95-100] ● fair [80-95[● poor [0-80[
		Metric "A.2.4" Agriculture area with access to water for irrigation	%	● good >50 ● fair [30-50[● poor [0-30[
		Metric "A.2.5" Number of points with potential conflicts of water use	#	n.A.

Strategic Objective (SO)	Assessment criteria (AC)	Metric short title	Unit	Reference values
	A.3 Financial viability	Metric “A.3.1” Consumer willingness to pay	5-point Likert scales	🟢 good + or ++ 🟡 fair 0 🔴 poor - or --
		Metric “A.3.2” Affordability	5-point Likert scales	🟢 good + or ++ 🟡 fair 0 🔴 poor - or --
		Metric “A.3.3” Financial continuation	5-point Likert scales	🟢 good + or ++ 🟡 fair 0 🔴 poor - or --
B. Safeguarding ecosystems and their services to society	B.1 Safeguarded water ecosystems	Metric "B.1.1" EFR Compliance Rate	%	Northern Europe 🟢 good <=40 🟡 fair]40-60] 🔴 poor >60 Southern Europe 🟢 good <=20 🟡 fair]20-40] 🔴 poor >40
		Metric "B.1.2" Effective stormwater treatment	%	🟢 good [95-100] 🟡 fair [90-95[🔴 poor [0-90]
		Metric "B.1.3" Effective wastewater treatment	%	🟢 good 100 🟡 fair [95-100[🔴 poor [0-95[
	B.2 Enhanced ecosystem services to society	Metric “B.2.1” Benefits from regulating services (water quality)	%	🟢 good [40-100] 🟡 fair [10-40[🔴 poor [0-10[
		Metric “B.2.2” Maintaining nursery populations and habitats	%	🟢 good [40-100] 🟡 fair [10-40[🔴 poor [0-10[
		Metric “B.2.3” Regulation of extreme events	%	🟢 good [40-100] 🟡 fair [10-40[🔴 poor [0-10[
		Metric “B.2.4” Water provision by ecosystem	%	🟢 good [40-100] 🟡 fair [10-40[🔴 poor [0-10[
		Metric “B.2.5” People enjoying cultural ecosystem services	%	🟢 good [40-100] 🟡 fair [10-40[🔴 poor [0-10[
	B.3 Resource efficiency	Metric "B.3.1" Water Footprint for drinking water	m^3/m^3	🟢 good [0.0; 1.0[🟡 fair [1.0; 1.5[🔴 poor [1.5; +∞[
		Metric "B.3.2" Water Footprint for wastewater	m^3/m^3	🟢 good [0.0; 1.0[🟡 fair [1.0; 2.0[🔴 poor [2.0; +∞[
		Metric "B.3.3" Carbon Footprint for drinking water	kgCO$_2$eq/m^3	🟢 good <= 0.3 🟡 fair [0.3-0.7[🔴 poor >0.7
		Metric "B.3.4" Carbon Footprint for wastewater	kgCO$_2$eq/m^3	🟢 good <= 0.3 🟡 fair [0.3-0.7[🔴 poor >0.7

Strategic Objective (SO)	Assessment criteria (AC)	Metric short title	Unit	Reference values
		Metric "B.3.5" Energy consumption	kWh/m^3	For WS ● good <=0.5 ● fair [0.5-0.8[● poor >0.8 For WW ● good <= 0.6 ● fair [0.6-0.9[● poor >0.9
		Metric "B.3.6" Drinking water consumption	L/(pe.day)	● good [100-150] ● fair]150-175] ● poor]175-+¥[
C. Boosting value creation around water	C.1 Circular policy making	Metric “C.1.1" Statutory compliance	5-point Likert scales	● good + or ++ ● fair 0 ● poor - or --
		Metric “C.1.2" Preparedness	5-point Likert scales	● good + or ++ ● fair 0 ● poor - or --
		Metric “C.1.3" Policy instruments	5-point Likert scales	● good + or ++ ● fair 0 ● poor - or --
		Metric “C.1.4" Green public procurement	%	● good >=50 ● fair]10-50[● poor <=10
		Metric “C.1.5" Level of ambition	5-point Likert scales	● good + or ++ ● fair 0 ● poor - or --
	C.2 Circular economy growth	Metric “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
		Metric “C.2.2” Green jobs	%	● good >= 6 ● fair [3-6[● poor < 3
		Metric “C.2.3” Circular economy business models in practice	%	● good >= 50 ● fair]0-50[● poor 0
	C.3 Resource recovery and efficient use	Metric “C.3.1" Water-related materials recovery	%	● good >= 15 ● fair [10-15[● poor < 10
		Metric “C.3.2" Fertilizer production avoided	%	● good >= 30 ● fair [5-30[● poor < 5
		Metric “C.3.3" Sludge beneficial use	%	● good 100 ● fair [95-100[● poor [0-95[
		Metric “C 3.4" Water consumption from other sources	%	● good >40 ● fair [10-40[● poor < 10

Strategic Objective (SO)	Assessment criteria (AC)	Metric short title	Unit	Reference values
		Metric “C.3.5” Reclaimed water use	%	● good >=15 ● fair [1-15[● poor < 1
		Metric “C.3.6” Reclaimed water production	%	WEI+ < 10 ● good >=5 ● fair [0.5-5[● poor < 0.5 WEI+ [10-30[● good >=10 ● fair [5-10[● poor < 5 WEI+ [30-70[● good >=20 ● fair [10-20[● poor < 10 WEI+ >=70 ● good >=30 ● fair [15-30[● poor < 15
		Metric “C.3.7" Energy production	%	For WS ● good >=10 ● fair [5-10[● poor [0-5[For WW ● good >=20 ● fair [10-20[● poor [0-10[For solid 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	Metric “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	Metric “D.2.1” Infrastructure Value Index	%	● good [0.4-0.6] ● fair [0.2-0.4[and]0.6-0.8] ● poor [0.0-0.2[and]0.8-1.0]
		Metric “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)	Metric “D.3.1” Linear water losses	m^3/(year km)	For distribution ● good [0; 1095] ● fair]1095; 1825] ● poor]1825; +∞[For bulk systems ● good [0; 1825] ● fair]1825; 2738] ● poor]2738; +∞[

Strategic Objective (SO)	Assessment criteria (AC)	Metric short title	Unit	Reference values
		Metric “D.3.2” Water Storage Capacity	Days	For WS ● good [1; 2] ● fair]0.5; 1] and [2; 4] ● poor]0; 0.5[and [4; +∞[
		Metric “D.3.3” Water retention	L/(m^2 year)	Agriculture ● good >=68 ● fair [34-68[● poor <34 Industrial consumptions ● good >=68 ● fair [34-68[● poor <34 Urban consumptions ● good >=14 ● fair [7-14[● poor <7
		Metric “D.3.4” Incident occurrences	#/year/100 km	burst in distribution ● good [0-30] ● fair [30-60[● poor [60-+∞[flooding ● good [0-0.5] ● fair [0.5-2[● poor [2-+∞[collapse ● good [0-1.0] ● fair [1.0-2.0[● poor [2.0-+∞[
		Metric “D.3.5” Combined Sewer Overflows	#/device	Non sensitive ● good [0-30] ● fair]30-60] ● poor]60-+∞[Non sensitive and recreational uses ● good [0-5] ● fair]5-10] ● poor]10-+∞[Sensitive ● good [0-6] ● fair]6-12] ● poor]12-+∞[Bathing waters ● good [0-2] ● fair]2-3] ● poor]3-+∞[
		Metric “D.3.6” Time for restoration	Days	● good [0.0-0.25] ● fair]0.25-1] ● poor >= 1
		Metric “D.3.7” Level of autonomy (of infrastructure)	%	● good >=80 ● fair [70-80[● poor <70

Strategic Objective (SO)	Assessment criteria (AC)	Metric short title	Unit	Reference values
		Metric “D.3.8” Level of redundancy	%	🟢 good >=90 🟡 fair [80-90[🔴 poor <80
		Metric “D.3.9” 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	Metric “E.1.1” Knowledge and education	5-point Likert scales	🟢 good + or ++ 🟡 fair 0 🔴 poor - or --
		Metric “E.1.2” Local sense of urgency	5-point Likert scales	🟢 good + or ++ 🟡 fair 0 🔴 poor - or --
		Metric “E.1.3” Hydrocitizenship	5-point Likert scales	🟢 good + or ++ 🟡 fair 0 🔴 poor - or --
		Metric “E.1.4” Discourse embedding	5-point Likert scales	🟢 good + or ++ 🟡 fair 0 🔴 poor - or --
	E.2 Multi-sector network potential	Metric “E.2.1” Clear division of responsibility	5-point Likert scales	🟢 good + or ++ 🟡 fair 0 🔴 poor - or --
		Metric “E.2.2” Network Cohesion	5-point Likert scales	🟢 good + or ++ 🟡 fair 0 🔴 poor - or --
		Metric “E.2.3” Authority	5-point Likert scales	🟢 good + or ++ 🟡 fair 0 🔴 poor - or --
		Metric “E.3.4” Collaborative agents	5-point Likert scales	🟢 good + or ++ 🟡 fair 0 🔴 poor - or --
	E.3 Stakeholder Engagement processes	Metric “C.3.2" Fertilizer production avoided	5-point Likert scales	🟢 good + or ++ 🟡 fair 0 🔴 poor - or --
		Metric “E.3.2” Protection of core values	5-point Likert scales	🟢 good + or ++ 🟡 fair 0 🔴 poor - or --
		Metric “E.3.3” Progress and variety of options	5-point Likert scales	🟢 good + or ++ 🟡 fair 0 🔴 poor - or --
		Metric “E.3.4” Collaborative agents	5-point Likert scales	🟢 good + or ++ 🟡 fair 0 🔴 poor - or --
	E.4 Capacity building	Metric “E.4.1” Smart Monitoring	5-point Likert scales	🟢 good + or ++ 🟡 fair 0 🔴 poor - or --

Strategic Objective (SO)	Assessment criteria (AC)	Metric short title	Unit	Reference values
		Metric “E.4.2” Evaluation	5-point Likert scales	● good + or ++ ● fair 0 ● poor - or --
		Metric “E.4.3” Cross-stakeholders Learning	5-point Likert scales	● good + or ++ ● fair 0 ● poor - or --
	E.5 Information and knowledge sharing	Metric “E.5.1” Information availability and use	5-point Likert scales	● good + or ++ ● fair 0 ● poor - or --
		Metric “E.5.2” Information transparency and sharing	5-point Likert scales	● good + or ++ ● fair 0 ● poor - or --
		Metric “E.5.3” Knowledge cohesion	5-point Likert scales	● good + or ++ ● fair 0 ● poor - or --

Appendix E – Feedback forms

Questions for Feedback Form A:

Q1) Question: Is it feasible to use the AF for strategic planning and decision-making process? If not, explain why

Q2) Question: Does the AF fit its purpose to support strategic planning and decision – making process? If not, explain why

Q3) Question: Is the AF useful for developing new strategic plans? If not, explain why

Q4) Question: Is the AF useful for revising and monitoring implementation of existing strategic plans? If not, explain why

Q5) Question: Is the AF useful for diagnosis and identification of improvement opportunities? If not, explain why

Q6) Question: Is the AF useful for exploring alternative water smartness strategic paths? If not, explain why

Q7) Question: Is there any other feedback/comment you would like to provide for the AF?

Questions for Feedback Form B:

Q1) Question: "In case you decided to conduct an assessment with some of the metrics (without including all the metrics of the AF), please select the main reasons for excluding these metrics

Q2) Question: How useful did you find the current version of the AF taking into account the main goals the LL organization wants to achieve in the B-WaterSmart project?

Q3) Question: Is there any other general or specific comment you think it will be useful for us to take it into account for the next version?

Q4) Question: The following three questions apply if you have been interviewed as part of the scoring of a few metrics.

Q5) Question: Was the interview convenient as a way of populating the B-WaterSmart framework and its purpose to monitor water-smartness?

Q6) Question: In the feedback form, metric justifications have been provided based on the information provided in your interview. Are the metrics relevant to support strategic decision-making in your Living Lab?

Q7) Question: We aim to develop a baseline score justification of 24 metrics through interviews like the one you have had. This baseline can be used in the future to evaluate and update through a workshop or a few interviews. Do you think this approach is feasible and meaningful to maintain the active use of the framework in supporting strategic decision-making in your Living Lab?

Questions for Feedback at Strategic Objective (SO) level:

Q1) Question: After having a quick look at the AC, please indicate if there is any AC which is not clear. If yes, mention which these points are

Q2) Question: Please indicate if there is any AC which needs to be revised. If yes, mention which AC must be revised along with the suggested revision

Q3) Question: Considering the complete list of AC proposed for this SO, do you consider all the points of view that allow for the assessment of the objectives are covered? If not, please mention which they are and give a brief description.

Questions for Feedback at Assessment Criteria (AC) level:

Q1) Question: After having a look at the relevant metrics and their detailed descriptions, please indicate if there is any vague information that makes the evaluation difficult. If yes, mention which these points are

Q2) Question: Are there other (missing) related metrics that need to be included in the AC? If yes, what is your suggested feedback?

Q3) Question: Are there metrics which are misplaced (they are placed to the wrong AC)? If yes, please specify which is the AC they fit better. If yes, please specify

Questions for Feedback at Metric level:

Q1) Question: Is there any vague information or unclear points as for the metrics short title and description? If yes, please elaborate on this.

Q2) Question: Is there any vague information as for the method of computation? If yes, please refer to it.

Q3) Question: Select the feasibility (1, 2 or 3) of calculation for this metric. If the answer is '3-impossible to calculate', please state the reason why

Q4) Question: State if this metric is relevant for planning at the strategic level. If yes, state if it is relevant for planning at tactical or operational level

Q5) Question: State if all necessary data are available for evaluating the metric. If not available, please indicate which are the missing data and if there is any possible way of acquiring them.

Q6) Question: Is there alternative way (*e.g.,* formula/tool) you need to calculate this metric? If yes, describe the alternative method of computation

Q7) Question: How the necessary data for calculating the metric were collected (data collection methods)? Multiple answers can be selected. If other, specify

Q8) Question: For the available data of this metric, please state the data source. Multiple answers can be selected. Based on your response, please specify (e.g if the answer is Online data, mention the website; if the answer is Output data, describe the process/tool; if the answer is Other, describe the method, etc.)

Q9) Question: Do you believe it is important for this metric to be calculated for different levels of disaggregation (*e.g.,* different areas/sub-areas, spatial levels, water sectors, alternative water resources, different water demands, categories of users etc.)? If yes, please specify

Q10) Question: Are the reference values adequate in your context? If not, explain why

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