Stakeholders' co-creation approach for WEFE nexus governance

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Abstract

The purpose of Deliverable 1.1 (D1.1) is to explain the NEXOGENESIS stakeholders´ co-creation approach for water-energy-food-ecosystem (WEFE) nexus governance, which will be implemented in the five case studies throughout the four years of the project. The implementation of the approach in the five NEXOGENESIS case studies will depend on the local context. Part II of the report function as a guideline for the case studies to select from and adapt the approach to local needs. The target audience of this report is any organisation at all scales in the WEFE nexus domains that would like to initiate a bottom-up stakeholders' co-creation process for improving policy integration and foster transition towards WEFE nexus governance, with a particular focus on water management organisations such as river basin organisations, including transboundary ones, water and environment ministries and water utilities. The science-led co-creation process that involves relevant stakeholders from the five (transboundary) river basins is mainly organised by Work Package (WP) 1 and WP 5.

Keywords

Nexus , governance, stakeholder, co-creation, water , river basin, river contract, energy, food, ecosystems

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Executive summary

This Deliverable 1.1 illustrates the NEXOGENESIS stakeholders´ co-creation approach for water-energy-food-ecosystem (WEFE) nexus governance, which will be implemented in the five project case studies throughout the four years of the project. The implementation of the approach in the case studies will depend on the local context. This means that the steps and building blocks of the approach are intended as a guideline for the case studies to select from and adapt according to local needs.

The target audience of this report are actors and institutions at all scales in the WEFE nexus domains who are interested in and have the power and capacity to initiate a bottom-up stakeholders' co-creation process for improving policy integration and foster transition towards WEFE nexus governance, with a particular focus on water management organisations such as river basin organisations, including transboundary ones, water and environment ministries and water utilities.

The NEXOGENESIS stakeholders´ co-creation approach for WEFE nexus governance aims at supporting stakeholders in a certain region (e.g. a river basin) to co-create and commit to implementing WEFE nexus goals and policies through a stakeholder agreement, built around the concept of non-binding river contracts. Ultimately, this approach paves the way towards effective WEFE nexus governance in the region in which it is implemented, depending on the local context, For the purposes of this report WEFE nexus governance is the final goal, i.e. the aim to achieve in the case study regions, and the NEXOGENESIS stakeholders' co-creation approach is the means the stakeholders in the case study regions have to support the transition towards nexus governance, which in turns contributes to improving sustainability in their region.

The NEXOGENESIS stakeholders´ co-creation approach for WEFE nexus governance to be applied in each case study was developed based on the NEXOGENESIS research questions and is organised in 2 main steps:

- **Nexus governance problem identification** via assessment of the performance of the existing governance system in the case studies to identify barriers, leverage and entry points for governance change (Chapter 7), and assessment of policy coherence in the case study to identify policy gaps related to nexus interlinkages (Chapter 8);
- **Stakeholders' co-creation of WEFE goals and policies and commitment to implementation** through a stakeholder agreement (Chapter 9). The stakeholders' co-creation process includes 5 building blocks:
    - **Preparing** the stakeholders' co-creation process: stakeholder identification and analysis (Section 9.2.1);
    - **Initiating** the stakeholders' co-creation process: interaction between the stakeholders of different sectors, awareness raising, setting the stage and data collection (Section 9.2.2);
    - **Facilitating** the stakeholders' co-creation process: stakeholder engagement, management and sustainment for trust building and social learning (Section 9.2.3);

- **Developing** the stakeholders' co-creation **content**: designing an action plan and ensuring coordination with existing policies (Section 9.2.4);
- **Implementing** the stakeholders´ agreement: fostering stakeholders´ ownership of the action plan, and monitoring of the planned implementation (Section 9.2.5).

For the assessment of the governance system in the case studies (step 1), WP 1 developed a Nexus Governance Assessment Tool (NXGAT), specifically targeting the characteristics and challenges of WEFE nexus governance. NXGAT assesses five dimensions (levels and scales; actors and networks; problem perspectives and goal ambitions; strategies and instruments; and responsibilities and resources) and five qualities (extent, coherence, flexibility, intensity of action, and fit) of the governance system. It will be used in the project to assess the performance of the existing WEFE nexus governance systems in the case studies.

For the policy coherence assessment (step 1), a policy inventory template was created where case studies can list all relevant nexus policies and score the level of coherence of each policy with other nexus policies using a 4-point scoring system (not applicable; no coherence; moderate coherence and strong coherence). The coherence is assessed by checking to what extent sectoral policy documents account for expected cross-sectoral interactions with provisions to reduce negative impacts or exploit synergies (no provisions = no coherence; potential impacts/synergies are only mentioned = moderate coherence; mandatory provisions = strong coherence).

The stakeholders' co-creation of goals and policies (step 2) was operationalised in five building blocks as listed above. These building blocks build on one another. However, depending on the specific local circumstances, the stakeholders' co-creation process and its success may look different in each case study (e.g. reaching an agreement on data sharing can be already a success in one case, whereas agreeing on a set of policies and an action plan can be the outcome in another case). The ambition of the NEXOGENESIS case studies is to implement one or more of the building blocks depending on the starting conditions in the case study region.

This report is organised in two parts. Part I presents the literature used as the necessary foundation for the development of the NEXOGENESIS approach. The reader can use part I as source of relevant literature on governance and the nexus for in-depth understanding of the rationale of the co-creation approach. Part II illustrates the NEXOGENESIS stakeholders' co-creation approach for WEFE nexus governance and constitutes the guideline for the cases to select from and adjust based on local needs to implement the approach in their region.

The stakeholders' co-creation approach for WEFE nexus governance will be consolidated by the end of the project, and recommendations for wider use in other contexts and for other nexus domains will be provided. Specifically, we will evaluate the results of this implementation in project year 4 (Task 1.5 and Deliverable 1.5). This evaluation will result in an user- and decision-oriented roadmap for policymakers and practitioners for effective nexus governance in other contexts and for other nexus domains. However, this report could already be used as reference for application of the approach in other WEFE nexus contexts.

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Acronyms

AI	Artificial Intelligence
CS	Case study
D1.1, D1.2, etc.	Deliverable 1.1, Deliverable 1.2, etc.
DROP	Benefit of Governance in **Dro**ught Ada**p**tation
DSS	Decision support system
GAT	Governance assessment tool
NXGAT	Nexus Governance Assessment Tool
SDM	System Dynamic Modelling
SLNAE	Self-Learning Nexus Assessment Engine
T1.1, T1.2, etc.	Task 1.1, Task 1.2, etc.
WEFE	Water-energy-food-ecosystem
WP	Work Package
WS1, WS2, etc.	Workshop 1, workshop 2, etc.

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Introduction

The purpose of Deliverable 1.1 (D1.1) is to explain the NEXOGENESIS stakeholders´ co-creation approach for water-energy-food-ecosystem (WEFE) nexus governance, which will be implemented in the five case studies throughout the four years of the project. The implementation of the approach in the case studies will depend on the local context. This means that the steps and building blocks of the approach are intended as a guideline for the case studies to select from and adapt to local needs.

The target audience of this report is any organisation at all scales in the WEFE nexus domains that would like to initiate a bottom-up stakeholders' co-creation process for improving policy integration and foster transition towards WEFE nexus governance, with a particular focus on water management organisations such as river basin organisations, including transboundary ones, water and environment ministries and water utilities. The science-led co-creation process that involves relevant stakeholders from the five (transboundary) river basins is mainly organised by Work Package (WP) 1 and WP 5.

The NEXOGENESIS stakeholders´ co-creation approach for WEFE nexus governance supports stakeholders in a certain region (e.g. a river basin) to co-create and commit to implementing WEFE nexus goals and policies through stakeholder agreement, built around the non-binding concept of river contracts. Ultimately, this approach supports the transition towards nexus governance, which in turns contributes to improving sustainability in the region in which it is implemented, depending on the local context.

For the purposes of this report WEFE nexus governance is the final goal, the aim to achieve in the case study regions, and the NEXOGESIS stakeholders' co-creation approach is the means the stakeholders in the case study regions can use to help the transition towards nexus governance.

The NEXOGENESIS stakeholders´ co-creation approach for WEFE nexus governance to be applied in each case study was developed based on the NEXOGENESIS research questions and is organised in two main steps:

1) **Nexus governance problem identification** via assessment of the quality of the existing governance system in the case study to identify barriers, leverage and entry points for governance and policy change (Chapter 7), and assessment of policy coherence in the case study to identify policy gaps related to nexus interlinkages (Chapter 8);
2) Stakeholders' co-creation of WEFE goals and policies and commitment to implementation through a stakeholder agreement (Chapter 9). The stakeholders' co-creation process includes 5 building blocks:
    - **Preparing** the stakeholders' co-creation process: stakeholder identification and analysis (Section 9.2.1);
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- **Facilitating** the stakeholders' co-creation process: stakeholder engagement, management and sustainment for trust building and social learning (Section 9.2.3);
- **Developing** the stakeholders' co-creation **content**: designing an action plan and ensuring coordination with existing policies (Section 9.2.4);
- **Implementing** the stakeholders´ agreement: fostering stakeholders´ ownership of the action plan, and monitoring of the planned implementation (Section 9.2.5).

For the assessment of the governance system in the case studies (step 1), WP 1 developed a Nexus Governance Assessment Tool (NXGAT), specifically targeting the characteristics and challenges of WEFE nexus governance. NXGAT assesses five dimensions (levels and scales; actors and networks; problem perspectives and goal ambitions; strategies and instruments; and responsibilities and resources) and five qualities (extent, coherence, flexibility, intensity of action, and fit) of the existing governance system. It will be used in the project to assess and describe the quality of the existing WEFE nexus governance systems in the five case studies (whether or not it is nexus oriented).

For the policy coherence assessment (step 1), a policy inventory template was created where case studies can list all policies perceived as relevant for nexus governance and score the level of coherence of each policy with other nexus policies using a 4-point scoring system (not applicable; no coherence; moderate coherence and strong coherence). The coherence is assesses by checking to what extent sectoral policy documents account for expected cross-sectoral interactions with provisions to reduce negative impacts or exploit synergies (no provisions = no coherence; potential impacts/synergies are only mentioned = moderate coherence; mandatory provisions = strong coherence).

The stakeholders' co-creation of goals and policies (step 2) was operationalised in five building blocks as listed above. These blocks build on one another. However, depending on the specific local circumstances, the stakeholder process in each case study may be different. The ambition of the NEXOGENESIS case studies is to implement one or more of the building blocks depending on the starting conditions in the case study region. This means that depending on the initial conditions, success of the co-creation process may look different for the different cases. Where good initial conditions are present (e.g. existing good collaboration and trust), the expectation is that by the end of the project the foundation of a stakeholder agreement is laid out. In cases where, for example, there is no data available or little discussion about cross-sectoral collaboration in place, the co-creation process would be already successful if, by the end of the project, the local stakeholders were able to come to an agreement with clearly allocated responsibilities for data collection and sharing.

The NEXOGENESIS project distinguishes two forms of co-creation addressed by different project tasks: internal, consortium co-creation and external, stakeholders´ co-creation. The internal co-creation (Task 1.3, Milestone 4) concerns the interaction, exchanges, knowledge development, learning processes and decisions occurring among the project partners during the 4 years of the project. These exchanges are laid out in a consortium co-creation plan that includes regular 3-weekly meetings and moments of consortium reflection (every 6 months) on the development of the project content. The external co-creation refers to the interaction, exchanges, knowledge development, learning processes and decisions occurring among the stakeholders in the case study regions. Such exchanges are facilitated by the project

partners, and in particular by the case study leads. These exchanges concern different topics, including understanding of bio-physical WEFE nexus interlinkages, modelling data and validation, nexus indicators, Self-Learning Nexus Assessment Engine (SLNAE) interface preferences, policy preferences, governance mechanisms, etc. Depending on the topic of exchange, different WPs will engage with case study stakeholders. Although separated in different tasks, the internal and external co-creation are part of the same process and both project partners and local communities (scientific, policy, civil, business) are all stakeholders for the purposes of NEXOGENESIS. This means that the exchanges that each WP will have with the stakeholders serve the purposes also of the other WPs. Specifically, the exchanges of WP2,3,4 with case study stakeholders serve the purposes of the stakeholders' co-creation for WEFE nexus governance conducted within WP 1. To ensure coordination of all exchanges of WPs with case study stakeholders and to support the work of case study leads, WP 5 – Case studies coordination (the WP responsible for supporting the case studies work in the project) developed an overarching stakeholders´ engagement plan, which guides case studies in organising and conducting stakeholder engagement throughout the duration of the project, across all WPs and based on the case studies specificities (Milestone 6 and D5.1).

Within the context outlined above, this report addresses the external stakeholders' co-creation for the specific purpose of supporting a transition towards WEFE nexus governance in the case study regions. In particular, it focusses on how to assess the governance and policy system and how to organise and conduct local stakeholders' interaction for the purposes of designing and adopting integrated policies that would help the transition towards WEFE nexus governance in the case study regions. The reason for this narrower approach is that this report and its future update at the end of the project are meant to be used by any stakeholder who aims to initiate a bottom-up stakeholders' co-creation process for WEFE nexus governance (e.g. policy makers, NGOs) and not only by researchers in the context of funded projects.

Finally, this report is organised in two parts. Part I presents the literature used as foundation for the development of our NEXOGENESIS approach for co-creation of Water-Energy-Food-Ecosystems nexus governance in (transboundary) river basins. The reader can use part I as source of relevant literature on governance and the nexus for in-depth understanding of the rationale of the co-creation approach. Part II illustrates the NEXOGENESIS stakeholders' co-creation approach for WEFE nexus governance and constitutes the guideline for case studies to select form and adjust based on local needs to implement the approach in their region.

In details, part I illustrates: the methodology of our literature reviews (Chapter 1); and the relevant (social) science literature on nexus governance and policy (Chapter 2), on governance and policy assessment frameworks (Chapter 3), on the role of artificial intelligence and decision support tools for nexus governance (Chapter 4) and on river contracts as potential outcomes of stakeholder engagement processes (Chapter 5). Part II of this report provides an in-depth explanation of the NEXOGENESIS stakeholders' co-creation approach for nexus governance and implementation in the case studies. We first describe the rationale of the approach (Chapter 6). Second, we present one of the core elements of our approach, the novel NXGAT (Chapter 7). We explain how we developed NXGAT and how the tool will be implemented in the case studies. Chapter 8 presents the nexus policy inventory and coherence assessment and describes how this will feed into WEFE policy packages. In Chapter 9, we explain the NEXOGENESIS stakeholders' co-creation approach

for a river contract for WEFE nexus governance. Moreover, we outline how this can be implemented in the five case studies. This report closes with some concluding remarks in Chapter 10.

The stakeholders' co-creation approach for WEFE nexus governance will be consolidated by the end of the project, and recommendations for wider use in other contexts and for other nexus domains will be provided. Specifically, we will evaluate the results of this implementation in project year 4 (Task 1.5 and D1.5). This evaluation will result in a roadmap for policymakers and practitioners for effective nexus governance in other contexts and for other nexus domains. However, this report could already be used as reference for application of the approach in other WEFE nexus contexts.

PART I – REVIEW OF THE RELEVANT LITERATURE TO DESIGN THE NEXOGENESIS APPROACH

1 Methodology

Methodology for the literature reviews on nexus governance and policy and governance assessment tools and governance co-creation approaches

Our co-creation approach for nexus governance builds on a comprehensive literature review. The reviewed publications comprise scientific articles on (WEFE) nexus management, governance and policy, as well as publications on governance assessment tools (GATs) and governance co-creation approaches. We conducted the first two literature reviews over a period of 8 month, from September 2021 up to April 2022. To ensure coherence, the core team working in WP 1 (KWR, UFZ, Université de Tours, IHE Delft) defined search terms for each topic beforehand, based on the problem context and objectives of NEXOGENESIS (see introduction). The search terms used can be found in Table 1.

Our literature search resulted in 200 relevant publications in total. Thereof, 68 publications were prioritised by the researchers to be explored in more detail and subsequently considered for the co-creation approach and NXGAT. We collected and stored all 200 publications on the NEXOGENESIS Surfdrive, which can be accessed by project partners via WP1 > T1.1 Nexus governance co-creation approach > Milestone 9 - Literature to access.

Table 1: Pre-defined search terms used for the literature review on nexus governance, governance assessment tools and co-creation approaches

Literature review topic	Search terms
Nexus governance	WEF nexus governance; nexus governance; (WEF) nexus transboundary governance; WEF nexus management; nexus management; Integrated Water Resource Management / IWRM; institutional change; transboundary river basin governance / management; power relations in resource governance / management
Governance assessment tools and co-creation approaches	Water / nexus governance assessment frameworks / tools/ approaches; (WEF) nexus governance assessment; water governance assessment; transboundary / integrated river governance assessment; Water / WEF nexus governance capacity framework / assessment

We searched SCOPUS and Google Scholar and extracted the ten most cited and ten most recent publications. In doing so, we took into account different forms of publications and deleted duplicates. For each search term, we prioritised publications for closer examination in accordance with the purposes of the project. Subsequently, we analysed the prioritised literature along the reading questions the core team developed. The reading questions can be found in Table 2.

Table 2: Guiding questions used for the literature review on nexus governance, governance assessment tools and co-creation approach

Literature review topic	Guiding questions
Nexus governance	• What are key definitions? • What are key elements of nexus governance / policy? • How can nexus governance be developed? • What are differences with other approaches, e.g. IWRM? • What are critiques to nexus approaches? • What are different perspectives on nexus governance and management? • What are pre-conditions for nexus governance to be successful?
Governance assessment tools and co-creation approaches	• How can key elements of the WEFE nexus governance assessment approach be defined? • How are assessment methods defined? • What are indicators used (e.g. qualitative, matrix reporting, graphs etc.)? • What are data collection methods (e.g. interviews, focus groups etc.)? • What are critiques to this approach?

Methodology for the literature review on the use of artificial intelligence tools and decision support systems for nexus governance

As one key element of NEXOGENESIS is to create the SLNAE, we conducted the literature review on the use of artificial intelligence (AI) tools and decision support systems (DSS) for nexus governance. We used a similar approach to the previous literature reviews. This literature review was mainly conducted by UFZ and supported by KWR from February to August 2022. We developed search categories and defined search terms to ensure coherence of our approach. The search categories and terms can be found in Table 3.

Table 3: Search categories and search terms that guided the literature review on the use of AI tools and DSS for nexus governance

Search categories and search terms
• **AI/DSS + sustainable resource management** (11): AI + sustainability + resource; DSS + sustainability + resource; AI + sustainability + resource + management; DSS + sustainability + resource + management
• **AI/DSS and questions of justice and** bias (35): AI + bias; AI + empowerment; AI + fairness; AI + inclusiveness; AI + inequality; AI + justice; AI + power; AI + transparency; DSS + bias; DSS + empowerment; DSS + fairness; DSS + inclusiveness; DSS + inequality; DSS + justice; DSS + power; DSS + transparency
• **AI/DSS and risks and opportunities** (9): AI + opportunity + sustainability + resource; AI + risk + sustainability + resource; DSS + opportunity + sustainability + resource; DSS + risk + sustainability + resource

• **AI/DSS and governance/policy** (33): AI + policy + coherence; AI + policy + design; AI + policy impact; AI + policy + integration; DSS + policy + coherence; DSS + policy + design; DSS + policy impact; DSS + policy + integration
• **AI/DSS and nexus management** (10): AI + resource + nexus; AI + sustainability + resource; AI + nexus + complexity; AI + nexus + coherence; DSS + resource + nexus; DSS + sustainability + resource; DSS + nexus + complexity; DSS + nexus + coherence

In total, our search yielded 98 publications of which 25 were prioritised for an in-depth review. We searched SCOPUS and Google Scholar by filtering the most relevant and most recent publications. In total, we filtered four combinations for each search term: 1. Most relevant: AI + search term, 2. Most recent: AI + search term, 3. Most relevant: DSS + search term and 4. Most recent DSS + search term.

Methodology for the literature review on water-related stakeholder agreements and river contracts

The initial keyword that drove the literature analysis was “river contracts” in Google Scholar. With this term, we found few references consisting of some scientific articles, but mainly references from book chapters with cases describing and analysing chiefly in francophone Europe. Therefore, we decided to expand the literature review by searching for the term of stakeholder agreements. This term yielded more substantial results and most papers included references to public participation, and collaborative and adaptive water management. We then extended the review to these bodies of literature. In total, we analysed 21 texts, 7 of which made explicit reference to river contracts, and 14 to different forms of collaborative and adaptive water management involving various forms of stakeholder agreements. We analysed the texts by comparing the definition of the agreements, characteristics of the agreements, level of commitment of the agreements, reasons for success and failure of the agreements, the motivation and willingness of stakeholders to take part and remain in the agreements, and the main characteristics of the stakeholders. This literature review was mainly conducted by IHE Delft between March and July 2022. The guiding questions can be found in Table 4.

Table 4: Guiding questions used for the literature review on river contracts

Guiding questions
• What is the definition of the agreement?
• What are the characteristics of the type of agreement (toolbox)
• What is the level of commitment of the stakeholders on the agreement (legally binding or not?)?
• What is the level of institutionalization of the agreement?
• What was the reason for success of the agreement?
• What was the reason for failure of the agreement? (What are its weaknesses?)
• Was the process of the agreement more bottom-up or top-down?
• Are countries/ sectors equally represented in the agreement?

- What was the motivation of stakeholders to enter in the agreement (to prevent or solve problems)?
- What was the willingness of the stakeholders to participate in the agreement?
- What was the willingness of the stakeholders to remain in the agreement?
- Characteristics of the stakeholders?

2 Nexus governance and policy

The sustainable management of natural resources faces many challenges due to complex functioning of resource systems and inherent interlinkages between them (Pahl-Wostl et al., 2018). In fact, to manage water resources sustainably, it is necessary to take into account decisions made by other sectors, such as the energy or agricultural sector, as they have a significant effect on the availability and quality of water. For instance, irrigation needs of agriculture affect regional water availability, while policies regulating fertiliser use aim at protecting water quality. Likewise, growing energy crops to produce biofuels can impact the amount of food production, as they are competing for arable land (Pahl-Wostl et al., 2021). Furthermore, protection of ecosystems can limit both short-term food and energy crop production rates. Stricter nature conservation laws can positively impact water quality without the water sector itself has adopted any specific policies. It becomes clear that management of natural resources is usually fragmented, potentially resulting in sub-optimal social-ecological outcomes (Kurian et al., 2018).

General benefits of nexus thinking

To address the challenges resulting from lacking cross-sectoral coordination and to emphasise the need for integrated resource governance, which cannot be provided by sectoral policies in isolation, the nexus emerged as a systemic concept (Hoff, 2011). Nexus thinking aims to provide a more holistic perspective on sustainable management of natural resources and focus on amplifying synergies between resource systems and reducing trade-offs among different sectors involved (Pahl-Wostl et al., 2021).

Why the WEFE nexus?

Throughout the last years, various nexus concepts, including different resource combinations, have evolved (Bleischwitz et al., 2018). The water-energy-food (WEF) nexus gained particular attention, as it was promoted in a run-up conference after the Rio + 20 sustainability summit (Hoff, 2011; Pahl-Wostl et al., 2018). In other studies, the WEF nexus was expanded to include a land component, the water-energy-food-land (WEFL) nexus. It aims to more effectively account for trade-offs related to biofuel production (Lazaro et al., 2021). The European Union Horizon2020 project SIM4Nexus put the water-energy-food-land-climate (WEFLC) nexus at centre to include complexity and feedback resulting from climate dynamics (Sušnik et al., 2018). The Routledge Handbook of the Resource Nexus (2018) proposes a five-node nexus including water, energy, food, land, and materials (WEFLM nexus).

As a response to challenges resulting from the highly complex and poorly understood WEF nexus and lacking integration of ecosystems therein, while the ecosystem is strongly affected by the water, energy and food sector, the Water-Energy-Food-Ecosystem (WEFE) nexus is at the core of NEXOGENESIS. The nexus concept addresses isolated policy development of the WEFE sectors by focusing on complex functioning and interconnectedness of natural resource systems. The WEFE nexus aims to better account for trade-offs between resource systems and users and to foster synergies among those. A better understanding of the current state of the WEFE nexus in case studies investigated in NEXOGENSIS is expected to be supportive of more coherent water-related policy design that effectively exploits synergies and reduces trade-offs. This can foster more efficient resource use, identify

leverage points for more nexus-oriented decision-making and promote cross-sectoral cooperation.

Nexus governance characteristics

To identify characteristics of the WEFE nexus, we conducted a broad literature review on nexus governance and management. To describe the WEFE nexus characteristics in more detail, we used the governance dimensions suggested by the DROP Governance assessment Tool (GAT) by Bressers et al. 2015, namely “levels and scales”, “actors and networks”, “problem perspectives and goal ambitions”, “strategies and instruments” and "responsibilities and resources”. Thus, the DROP GAT, hereafter called GAT, provides the basis for the co-creation approach for nexus governance in NEXOGENESIS (for a detailed description of these frameworks, see Table 1 in Appendix 1). The reasons for using the GAT are explained in part II (section 7.1).

With respect to levels and scales, nexus governance is characterised by cross-sectoral interactions, which can be of cooperation at different scales, carried out by multiple actors (de Andrade Guerra et al., 2021). Thus, multiple interactions result from integration of different sectors, at different levels of governance and different scales. This increases uncertainty of legitimate actions and effective policy outcomes, representing one major nexus component (Pahl-Wostl et al., 2021). Nexus governance aims to identify and trigger synergies between sectors and scales (de Andrade Guerra et al., 2021; Salmoral et al., 2019). As processes in water, energy, food and ecosystems operate on different levels and scales, the biophysical dynamics do not necessarily fit to the structural levels of governance at which they are currently dealt with (Pahl-Wostl et al., 2021). By adopting a nexus approach, the ideal goal is a fit between governance regime and resource dynamics in terms of policy outputs. Moreover, strategies and problem perceptions of stakeholders determine levels and scales on which they act. This can have an impact on power dynamics and constellations in nexus governance (Margerum, 2008).

In terms of actors and networks, nexus governance is characterised by uncertainty resulting from cross-sectoral and cross-scale interactions (Pahl-Wostl et al., 2021). Powerful actors and networks have a higher ability of dealing with nexus governance challenges (Kurian et al., 2018). However, nexus governance dynamics can challenge prevailing power constellations and redistribute knowledge by cross-scale cooperation (Crona and Parker, 2012; Margerum, 2008). Key actors in nexus governance can act strategically in how they engage with issues on different levels and scales, reflecting interests and competency and opportunities to exercise power (Pahl-Wostl et al., 2021). Moreover, stakeholders and actors in nexus governance can develop a joint perspective on a specific resource or environmental problem, e.g. water resources (Link et al., 2016; Salmoral et al., 2019). This allows to gather and integrate all actors involved in order to identify synergies between actors and networks (Roidt and Avellán, 2019).

Looking at problem perspectives and goal ambitions, nexus governance approaches move away from “sectorally” developed policies and resource-centric views (Roidt and Avellán, 2019). Furthermore, adopting a nexus approach to achieve sectoral synergy enhances resilience of social-ecological systems in face of climate change (WWF and SAB Miller, 2014) and will contributes to the achievement of the Sustainable Development Goals (SDGs) (Liu et al., 2018; van Zanten and van Tulder, 2021). Moreover, nexus approaches aim to reduce trade-offs (Roidt and Avellán, 2019; Sušnik et al., 2021) and when necessary facilitate institutional change (Märker et al., 2018). Nexus governance focuses on

redistributing environmental risks, externalities and sectoral and institutional responsibilities and resources (Kurian et al., 2018) by identifying interlinkages between sectors in resource management (Benson et al., 2015; Pahl-Wostl et al., 2018; Salmoral et al., 2019). Lastly, social environment and social interactions affect knowledge utilisation to frame nexus governance problems and goals (Crona and Parker, 2012).

Regarding strategies and instruments, nexus governance requires strategic timing and innovative strategies to effectively manage power differentials and conflicting demands (Crona and Parker, 2012). Having the purpose of creating coherent policies (Roidt and Avellán, 2019), nexus governance has the potential to trigger transformative change (Hagemann and Kirschke, 2017; Pahl-Wostl, 2019). Prominent nexus governance instruments are cross-sectoral approaches for water management issues (Lawford et al., 2013; Sušnik et al., 2021), (collaborative) transboundary river basin management (Salmoral et al., 2019) and transboundary cooperation (De Strasser et al., 2016). Governing a resource nexus is political and clearly aiming at addressing governance-related issues and policy aspects (Roidt and Avellán, 2019). Instruments of nexus governance can be described as system tools to characterise problems and provide solutions to cross-sectoral issues (Grigg, 2019) and as an indicator-based approach to assess and monitor resource interactions (Giupponi and Gain, 2017). Moreover, nexus governance concepts can be a multi-centric tool for integrated resource management (Liu et al., 2015; Wen et al., 2022) and represents a systemic and iterative approach (Albrecht et al., 2018; Pahl-Wostl, 2019). It promotes utilisation of strategies to sustainably manage nexus interlinkages and can include a combined approach by linking nexus assessments to decision-making via computational models (Albrecht et al., 2018).

With respect to responsibilities and resources, nexus governance is about institutional interplay. Key institutions in nexus sectors may respond to, or drive cross-scale or cross-sectoral changes (Pahl-Wostl et al., 2021). Therefore, nexus governance includes managing complexity (Harwood, 2018), increasing institutional capacity (Kurian et al., 2018) and informing decision-making in all nexus sectors (Roidt and Avellán, 2019). Moreover, nexus concepts can provide data for decision support and improve data accessibility (Albrecht et al., 2018). Power imbalances can be created by the economic value of resources and its distribution, risk exposure and by the degree of (in)dependence of stakeholders (Kuslits et al., 2021). The role of bridging organisations and their inclusion in nexus management can facilitate nexus governance (Crona and Parker, 2012).

3 Governance and policy assessment frameworks

3.1 Governance assessment frameworks

According to the scientific literature, there are many ways of assessing governance. Governance assessment frameworks are designed for different purposes (drought and water scarcity, land cover, flood risk, etc.), scales (from local to regional), have a different domain focus (water, climate change, environment, etc.), investigate different governance dimensions (knowledge, transparency, stakeholders' involvement, rules and instruments, etc.), and use different data collection methodologies (discussion group, interviews, desk study, etc.). This diversity naturally leads to equally different methodological developments. Therefore, this chapter aims to provide a synthesis of the state of the art of existing frameworks for assessing water governance, developed to meet objectives close to those of the NEXOGENESIS project (for detailed description of these frameworks, see Table 1 in Appendix 1). This preliminary stage of inventorying and analysing the literature made it possible to identify and select the framework likely to best meet the needs of the nexus: the GAT of Bressers et al. (2015).

Governance assessment tools: literature review

To meet the needs of the NEXOGENESIS project, this literature review mainly focuses on the tools that are designed for water. The tools that particularly deal with the role of water in waste water treatment (Koop et al. 2017), water scarcity and drought (Bressers et al., 2015; Koop et al. 2017), flood risk (Alexander et al., 2016; Koop et al. 2017; OECD, 2018; Williams et al., 2018; O'Riordan et al., 2021), water cooperation (Dai, 2021), water resources management and water services provisioning (OECD, 2018; O'Riordan et al., 2021).

Depending on their purpose, these tools are designed to be implemented at different scales. Thus, while some of them are developed to be applicable across all governance scales (local, basin, national, etc.), such as the OECD Water Governance Indicator Framework (OECD, 2018; O'Riordan et al., 2021), most of them are designed to be implemented on a specific scale. Locally, the Governance Capacity Framework can be applied at city scale (Koop et al. 2017), the Governance Assessment (combining the GAT and the Strategic Niche Management) is designed to be applied at the niche level (Jain et al., 2017) and the Capital Approach Framework focuses on the district scale or on the area liable to flooding (Williams et al., 2018). At an intermediate scale, the Adaptive Capacity Assessment Framework is developed to fit the federal river scale (Garrick and De Stefano, 2016) and the Transboundary (River) Basin Nexus Assessment focuses on the river basin and transboundary basin scales (Roidt and De Strasser, 2018; De Strasser et al., 2016; Dai, 2021). Finally, at a larger scale, the GAT is designed to take into account the regional context (for example a river basin or a region in a province) (Bressers et al., 2015), but can be adapted to fit local and intermediate scales.

In the same way that they differ in their purpose and scale, these tools also differ in their approach to water governance. This leads to more or less complex frameworks, depending on how many dimensions (also called principles or factors) they include in the analysis. Indeed, some of them focus on less than 5 dimensions (Koop et al. 2017; Asiama et al., 2017; Dai, 2021; Garrick and De Stefano, 2016), when others take into account 5 to 10 dimensions (e.g., Alexander et al., 2016; Bressers et al., 2015; Jain et al., 2017; Dore et al., 2012; Williams et al., 2018; Roidt and De Strasser, 2018; De Strasser et al., 2016) or even more than 10 (e.g., OECD, 2018; O'Riordan et al., 2021).

One of the last aspects these frameworks differ in, is the data collection method. The first step, common to all authors, is the document analysis (comprising the public policies and water management context of the case study) or desk study. For more specific information, a second step consists in collecting the views and expertise of the relevant stakeholders through interviews (Koop et al. 2017; Bressers et al., 2015), focus group discussion (Asiama et al., 2017) or dialogue (Roidt and De Strasser, 2018; De Strasser et al., 2016). To complete the analysis and to ensure that all key information has been properly considered, some authors also use the triangulation method, which consists of validating in a third step the governance score with stakeholders (Koop et al. 2017) or observers (Bressers et al., 2015).

As already mentioned, the GAT can be adapted to all governance scales and thus from local to more regional spatial scales, with the possibility to comply with the WEFE nexus limits. Also, even though it has been initially designer for water and then adapted to drought extreme, it can be adapted to other issues and contexts. Therefore, the flexibility proposed for the data collection during interviews offers different possibilities of implementation.

Moreover, if the GAT has been developed to provide not only a governance analysis and recommendation by experts, a user-guide has been developed for managers to assess the strengths and weaknesses of their governance themselves. The named "handbook" (Bressers at al., 2013) is thus an interesting document to provide a clear and simple description of the method initially designed for drought extreme preparedness, as described below.

The Governance Assessment Tool

The GAT was developed as a model for analysing governance systems regarding water management. Water governance is the combination of the relevant multiplicity of responsibilities and resources, instruments and strategies, awareness of problems and goal ambitions, actors and networks, levels and scales that forms a context that, to some degree, restricts and, to some degree, enables actions and interactions for any issue mainly related to water and / or climate change risks.

The theory at the origins of the GAT is a theory of policy implementation that is labelled Contextual Interaction Theory (Bressers and Kuks 2004; Bressers 2009; de Boer and Bressers 2011). It views implementation processes not top-down, as just the application of policy decisions, but as multi-actor interaction processes that are ultimately driven by the actors involved. The theory is based on a conceptual framework that aligns the motivations, cognitions, and resources of people to their contexts. It uses this to assess the likelihood of the governance instruments and structures in their ability to support implementation of given policies and achieve certain goals. Normally this framework (Contextual Interaction Theory) is used to produce academic studies of policy implementation whilst the GAT is aligned to the needs of practitioners who are interested in understanding their own contexts.

To explain the process, it makes sense to place these actors and their main characteristics in the middle of the analytical model (Bressers et al.,2015).

This theoretical perspective on water governance recognises the prominent role of actors and their characteristics in implementing adaptation policy within a particular context. This context steers, but does not determine, the outcome of water management activities undertaken by relevant stakeholders.

The GAT is depicted as a matrix in which five governance dimensions are evaluated according to four qualitative governance criteria (Table 5). The criteria are supposed to evaluate the quality of the governance dimension in regard to sustainable resource management. The GAT explores whether all the dimensions of the governance system are 1) coherent (reinforcing not contradicting), 2) flexible (multiple pathways to adaptation outcomes are considered to increased resilience), 3) intense (there is some sense of urgency to change the status quo for adaptation processes), and 4) that all relevant elements described above are taken advantage of (extent) (Bressers et al., 2015).

An interdisciplinary team composed of international researchers (from geography, political sciences, public administration and hydrology) undertook two visits in 2013 and 2014 to each of the case study regions during the DROP project. A range of stakeholders (water authorities, environmental agencies, nongovernmental organisations and other stakeholders) were interviewed according to the matrix of questions summarised in Table 5. The interviews were supplemented by observations and site visits; field notes; focus groups with some participants; and a range of policy and documentary analyses which were incorporated into the six regional reports.

This tool has been used internationally to assess water governance settings and was expanded for DROP project to assess the particular problematic of D&WS governance, and to provide in depth descriptive and analytical details on each of the regional case studies.

These analyses are then developed to support the adaptation activities of the partner engaged in the project or those interviewed interested in staying in contact with the outputs of the project or to participate to further groups of discussion. Based on their answers and insights, a judgement can be reached on whether the governance circumstances investigated in the matrix box concerned are supportive, restrictive, or neutral for the adaptation of the issue the study consists in.

Table 5: Governance assessment tool matrix (Bressers et al., 2015)

Governance dimension	Quality of the governance regime			
	Extent	**Coherence**	**Flexibility**	**Intensity**
Levels and scales	How many levelscare involved and dealing with an issue? Are there any important gaps or missing levels?	Do these levels work together and do they trust each other between levels? To what degree is the mutual dependence among levels recognised?	Is it possible to move up and down levels (up scaling and downscaling) given the issue at stake?	Is there a strong impact from a certain level towards behavioural change or management reform?
Actors and networks	Are all relevant stakeholders involved? Are there any stakeholders not involved or even excluded?	What is the strength of interactions between stakeholders? In what ways are these interactions institutionalised in stable structures? Do the stakeholders have experience in working together? Do they trust and respect each other?	Is it possible that new actors are included or even that the lead shifts from one actor to another when there are pragmatic reasons for this? Do the actors share in 'social capital' allowing them to support each other's tasks?	Is there a strong pressure from an actor or actor coalition towards behavioural change or management reform?
Problem perspectives and goal ambitions	To what extent are the various problem perspectives taken into account?	To what extent do the various perspectives and goals support each other, or are they in competition or conflict?	Are there opportunities to re-assess goals? Can multiple goals be optimized in package deals?	How different are the goal ambitions from the status quo or business as usual?
Strategies and instruments	What types of instruments are included in the policy strategy? Are there any excluded types? Are monitoring and enforcement instruments included?	To what extent is the incentive system based on synergy? Are trade-offs in cost benefits and distributional effects considered? Are there any overlaps or conflicts of incentives created by the included policy instruments?	Are there opportunities to combine or make use of different types of instruments? Is there a choice?	What is the implied behavioural deviation from current practice and how strongly do the instru-ments require and enforce this?
Responsibilities and resources	Are all responsibilities clearly assigned and facilitated with resources?	To what extent do the assigned responsibilities create competence struggles or cooperation within or across institutions? Are they considered legitimate by the main stakeholders?	To what extent is it possible to pool the assigned responsibilities and resources as long as accountability and transparency are not compromised?	Is the amount of allocated resources wsufficient to implement the measures needed for the intended change?

3.2 Policy coherence assessment approaches

Policy coherence is a key aspect of nexus governance (Roidt and Avellán, 2019). Policy coherence is either an indicator for successful nexus governance, or a lack thereof, can pose as a barrier towards nexus governance (Nilsson and Weitz, 2019). Current policies are often sectoral oriented, and sometimes even address only a specific part of a certain problem (Briassoulis, 2004). Not accounting for other sectors in policies, could lead to unintended spill-over effects in other policy domains, and can increase their vulnerability (Rasul and Sharma, 2016). There is a lot of literature on policy coherence in which it often referred to as policy integration, and policy coordination (Nilsson et al., 2016; OECD, 2021). Despite the difference in terminology, there is consensus that sectoral policies are not sufficient to address WEFE nexus issues and coherence between sectoral policies should be ensured. This chapter presents a literature review on policy coherence, policy coordination, and policy integration assessment approaches.

Policy coherence

According to Nilsson et al. (2012) policy coherence can be defined as a characteristic of policy that aims to reduce contradictions and foster synergies both between (external coherence) and within (internal coherence) policy domains and ultimately aims to create policy goals that are agreed upon by both policy domains. In a later publication, Nilsson et al. (2017) distinguish different types of coherence: sectoral policy coherence, the coherence between two policy sectors; transnational coherence, the coherence between jurisdictions; governance coherence, the coherence between different sets of interventions; multilevel coherence, coherence between different policy levels e.g. national – local; and lastly implementation coherence, the coherence between instruments used and policy objectives. The OECD (2016) has a similar definition and stresses the importance of preventing negative (unintended) consequences in other policy domains. However, the OECD (2016) differently to Nilsson et al. (2016) only mentions vertical coherence (between different policy scales), and horizontal coherence, (between different policy levels). Papadopoulou et al. (2020) follow the definition of Nilsson and the OECD and view policy coherence as a characteristic of the policy content and process. Strambo et al. (2015) provide a more general definition in which they define policy coherence as interactions of reciprocal influence between policies. Giest and Mukherjee (2022) also follow the broader notion of policy coherence as presented by Nilsson et al. (2012) and the OECD (2016) by formulating coherence as mutual reinforcement between the entire policy cycle. I.e. process, outputs, and outcomes both horizontally and vertically.

Policy integration

There are several definitions of policy integration. Jordan and Lenschow (2010) state that the interpretation of integration is situational, depending on the context. Briassoulis (2004) defines policy integration as a process of connecting and coordinating policies between different levels (horizontally) and scales (vertically) of governance resulting in a policy system that contains synergies between policies. Meijers and Stead (2004) view policy integration as a way to manage cross-sectoral issues or cross-policy domains issues that do not fall under the responsibility of a single policy domain to horizontally and vertically integrate policies, resulting in a joint policy. Candel and Biesbroek (2016) view policy integration not as a goal on its own, but as a process of policy change driven by the interactions of actors.

Policy coordination

Policy coordination differs from policy integration in terms of results. Policy coordination aims to coordinate policies to not have conflicting goals, while policy integration aims for one policy that integrates different policy domains (Meijers and Stead, 2004). Peters (1998) views coordination slightly different, as an end goal in which policies are coherent. Metcalfe (1994) seems to be in the same line of thought as Meijers and Stead (2004) and views policy coordination as parts working together in a coordinated manner and do not negatively influence each other. This can be done with or without a coordinating entity.

Policy coordination, coherence and integration have some key elements in common but are slightly different. All three aim to create synergies and avoid conflicts between and within different policy domains at different levels and scales. However, their level of intensity differs. Policy coordination seems to be aimed more at the coordinating process itself (Meijers and Stead, 2004). Policy coherence aims to create synergies between two different policy domains (Nilsson et al., 2016). Policy integration takes it one step further and aims for jointly produced policy document between two different policy domains (Meijers and Stead, 2004). NEXOGENESIS aims to develop policy packages, a combination of policies from different domains selected by stakeholders. To ensure that these policies do not counteract each other, the influence of these policies on each other has to be known, i.e. whether these policies have contradicting goals or not. Therefore, a 'policy coherence' assessment is needed before creating the policy packages in the NEXOGENESIS case studies.

Approaches for policy coherence assessments

In the literature there are several approaches to assess policy coherence on several policy levels: SDG level, EU level, regional level, and national level.

There are approaches that have been applied at the level of the Sustainable Development Goals (SDG) or their targets level such as Nilsson et al. (2017) that assess policy coherence at the level of the SDGs or targets by measuring their interactions based on a 7-point scoring system ranging from cancelling (-3) to indivisible (+3). Weitz et al. (2017) perform a similar analysis between SDG targets but, their scoring were complemented with a network analysis to understand how targets that do not directly interact influence each other. The OECD (2016) has a focus on the SDG level as well. While the OECD (2016) does not so much provide a framework to assess policy coherence, but rather to monitor it. The approach is focused on monitoring policy coherence at the SDG level that includes an inventory of sectoral policy objectives at the national level that are relevant for the SDGs; an analysis of the interaction between these policy objectives; the identification of enabling conditions for policy coherence for sustainable development.

Other approaches have been applied on the EU level. Nilsson et al. (2012) developed a three step approach to assess the interaction between policies at the EU policy objectives, instruments and implementation practices in three steps: First, an inventory of policy objectives. Second, scoring of the interactions between the policy objectives and their coherence with EU environmental policy themes. Third, the strength of the interaction is scored based on expert judging on scale ranging from strong, neutral to weak. Strambo et al. (2015) analysed the policy coherence between climate change mitigation policy and energy security policies at the EU level. The policy interactions were qualified as inconsistent, consistent and in coherence by placing the policies in a simple matrix. The scoring was done based on expert workshops with academics and policy practitioners.

Giest and Mukherjee (2022) apply a policy coherence analysis on a regional level with a special focus on the coherence of policy instruments to design more effective policy toolkits. The authors conducted a content analysis of policy and technical reports in the Mediterranean region to investigate if the tools promote integration or coordination; the authors consider integration and coordination supporting factors for policy coherence.

Other approaches focus on the national level. Papadopoulou et al. (2020) conducted a policy coherence assessment on the Greek national level in the context of the Water-Food-Energy-Climate-Land Nexus. They analysed the interaction between nexus critical policy objectives; nexus critical policy objectives and their nexus critical instruments; and how nexus critical objectives and instruments should be regarded during the policy design process. Papadopoulou et al. (2020) used a five-step approach: First, the nexus problem identification. Second, Stakeholder identification. Third, inventorying relevant national policies. Fourth, identifying nexus critical objectives and instruments in collaboration with local stakeholders. Last, the policy coherence analysis based on the assessment of Nilsson et al. (2017) and validation by stakeholders.

In NEXOGENESIS we chose to adopt a simplified version of Nilsson et al. (2017) approach. We chose Nilsson approach because it has been implemented in multiple contexts, including by colleagues from 2 out of the 5 NEXOGENESIS case studies and one author of this deliverable (WP1 leader). This gives an advantage in the implementation, because 2 case studies and WP1 are already familiar with the approach and its implementation. However, because Nilsson approach has been reported as time consuming, we adopted a simplified version of it (more details in chapter 8).

4 The role of artificial intelligence tools and decision support systems for nexus governance

The use of artificial intelligence (AI) for sustainability gains increasing relevance. Overall, AI tools offer three main benefits: First, by automating repetitive and time-demanding tasks, AI technologies allow humans to focus on higher-value work (Gupta et al., 2021; Nishant et al., 2020). Second, AI technologies provide a novel opportunity to gain insights from large amounts of unstructured data, which would otherwise not be possible (D'amore et al., 2022; Leal Filho et al., 2022). Third, the very nature of AI allows for addressing complex problems and intertwined relationships (Strantzali & Aravossis, 2016; Tiyasha et al., 2020). Thus, AI tools can play a crucial role in promoting effective environmental governance (Nishant et al., 2020; Oliver et al., 2012). In face of the high complexity and multi-facetted nature of challenges involved in WEFE nexus governance, the use of AI has particular leverage (D'amore et al., 2022). Using AI can enhance governance capacities through detection, prediction and fostering data-driven decision-making (Margetts, 2022).

NEXOGENESIS exploits AI tools to enhance understanding of policy impacts on the WEFE nexus and promote sectoral synergies. The work of NEXOGENESIS WP 4 therefore focusses on a multi-agent architecture that implements a reinforcement learning (RL) approach. RL is a multi-agent approach where each „agent" (nexus sector) responds to new policies imposed on the nexus. It enables improvement and automation of existing systems, response to new events and fosters learning. Decision-making optimisation of each agent, driven by RL, will apply the most beneficial policies without impeding other nexus sectors in achieving their objectives. To perform this optimisation, NEXOGENESIS applies an environment that combines different biophysical simulation tools, stakeholder behavioural analysis and complexity science. Complexity science methodologies include but are not limited to Bayesian Network Analysis, Life Cycle Assessment, System Dynamics Modelling, Cellular Automata and Fuzzy Cognitive Mapping. In doing so, NEXOGENESIS offers disruptive transformation in nexus research by connecting the policy assessment context to nexus research using AI and RL.

This ambitious approach is accompanied by implications that require special attention. This literature review aims to contextualise the use of AI tools for policy streamlining and impact assessment from a social sciences perspective. In doing so, we aim to complement the work of WP4 and provide a broader perspective on the use of AI tools in this context.

The value of using AI and decision support systems (DSS) to inform environmental and natural resource management is increasingly acknowledged (McIntosh et al., 2011). DSS are computerised systems including databases and models that are used in decision-making processes. DSS are tools that support decisionmakers in choosing the best (environmental, social, or economic) alternative solution (Fotia et al., 2021; Manos et al., 2010). They can simulate different scenarios and policies and account for changing social, economic, and environmental parameters (e.g. different levels of fertiliser use or water consumption per

crop). Additionally, DSS can give an estimation of the economic, social, and environmental impacts of different policies (Manos et al., 2010). When introduced in an adequate way, DSS have the potential to add value to decision-making processes by providing scientific knowledge (van Delden et al. 2011).

Although the value of using AI and DSS is perceived high, actual use and adoption of the tools remains challenging. Key challenges in environmental DSS or AI tool development relate to engagement, adoption, business and evaluation challenges. The engagement challenge results from the extent, adequacy and quality of end user involvement in AI and DSS design (Barons et al., 2021; McIntosh et al., 2011). To ensure engagement, it is crucial that AI and DSS match the perceptions, operational procedures and experiences of policymakers. Additionally, it is important that the use of AI and DSS is perceived as an enhancement and useful addition to current, well-embedded practices, rather than a replacement (van Delden et al. 2011). Lacking adoption can be the result of uncertain or negative human behavioural responses towards the use of AI or DSS (Nishant et al., 2020; Oliver et al., 2012; van Delden et al. 2011).

As AI tools and DSS are not yet fully understood by many, it is seminal to discuss issues related to data ownership, confidentiality and motivation driving the use. Access to data must be carefully sought to protect privacy rights and ensure safety and ethical standards (Allam & Dhunny, 2019; Gupta et al., 2021; Leal Filho et al., 2022). To overcome the engagement and adoption challenges, it is crucial to employ participatory approaches in AI and DSS design and build stakeholder capacities. This includes building both individual and organisational capacities to align goals, promote the tools, enhance coordination and ensure accessible and inexpensive use of the technologies (McIntosh et al., 2011). Adopting a bottom-up co-design approach to designing AI tools and DSS is beneficial for creating a co-learning environment that reduces barriers to AI or DSS use Bottom-up co-design processes allow for taking into account ethical considerations and deliberate practices for transformation (Camaréna, 2021). Additionally, gaps in ethical and transparency standards call for regulatory mechanisms and adequate legislation frameworks to prevent unintended outcomes of DSS or AI use (Leal Filho et al., 2022). Especially when AI and data driven policies determine decision-making and societal development, it is fundamental to create awareness among policy-makers and take into account their perceptions and needs (Yigitcanlar et al., 2022). The business challenge refers to the costs of AI and DSS, which are often underestimated. High transaction costs can threaten longevity and financial sustainability, thus, the long-term use of AI and DSS. Therefore, careful planning, accounting for long-term costs and training and maintenance, is required. Business plans and scoping documents can help design AI tools and DSS that are robust, accurate and multi-facetted (McIntosh et al., 2011; Tiyasha et al., 2020). The evaluation challenge stems from the difficulty to measure success of the assessment, implementation and achievement of indented outcomes. To address this challenge, it is useful to ensure transparency, agree on targets and outcomes beforehand and deliberate on lessons that can be learnt (Gupta et al., 2021; McIntosh et al., 2011; van Delden et al. 2011).

Particularly with the aim to integrate AI and DSS use in decision-making, it is important to provide a clear, easy-to-access and user-friendly interface. This implies that using and taking advantage of the tools must be possible without specific modelling skills or technical knowledge (Candido et al., 2022; Oliver et al., 2012).

One major challenge related to the use of AI tools for environmental and resource governance refers to issues of fairness, bias and justice (Fletcher et al., 2021; Zou & Schiebinger, 2018). It is required to pay special attention to the data that AI tools or RL are based on. Algorithms that are flawed can easily amplify biases through feedback loops, for example, regarding the representation of specific groups of individuals, stakeholder interests, or resources (Yigitcanlar et al., 2022; Zou & Schiebinger, 2018). Data biases often show institutionalised and hidden imbalances in social power constellations. To avoid systematic discrimination against gender or specific populations, biased decision-making and unequal representation in data (e.g. lacking geodiversity), it is important to ensure transparency about data sources and use (Martínez & Fernández, 2019; Zou & Schiebinger, 2018). Therefore, it is useful to systematically label data, provide information on the context and data collection procedure and engage interdisciplinary research teams (Zou & Schiebinger, 2018). Engaging research teams that adopt an interdisciplinary lens on the use of AI is crucial to understand implications beyond one scientific discipline, so as to get a better understanding of broader environmental, economic and societal consequences (Gupta et al., 2021).

To address potential issues of fairness and bias, it is useful to employ the three criteria appropriateness, bias and fairness to evaluate and audit AI and machine-learning algorithms. Appropriateness refers to properly matching the model to the target problem and goal, bias refers to identifying, and mitigating bias and fairness metrics should consider individual, group and organisational levels (Fletcher et al., 2021). Fairness plays also a central role with respect to trade-offs in resource nexus management. For example, by weighing policy impacts that save (monetary) costs, for instance of the agricultural sector, but might harm the (non-monetary) value of ecosystems (Kalyanaraman et al., 2022).

Looking specifically at resource nexus management, the use of AI and DSS can be highly productive to address complexity and sectoral interrelations. It can promote efficient, data-based and citizen-oriented governance solutions and support finding optimal management solutions (Allam & Dhunny, 2019; Zhou et al., 2019). AI models and tools are able to efficiently analyse large data sets with complex interactions of thousands of variables and therefore bridge isolated sectoral management approaches. By dealing with high levels of complexity, AI tools can optimise resource use, provide an almost real-time snapshot, predict policy outcomes and assess policy impacts (D'amore et al., 2022; Udias et al., 2018). Additionally, the use of AI technologies positively influences nexus planning and risk management (Govindan & Al-Ansari, 2019). However, understanding of broader implications of AI use for environmental sustainability and society is currently fairly unexplored (D'amore et al., 2022).

5 River contracts and other water related stakeholder agreements in the literature

The river contract literature consistently refers to this governance instrument as voluntary agreements between stakeholders aiming at coming to a joint approach to manage a river basin (La Jeunesse et al., 2003; Rosillon, 2004; Rosillon et al. 2005; Bocchi et al. 2012; Brun, 2014; Berrutti and Moccia, 2016; Voghera, 2016; Cialdea and Cacucci, 2018; Pappalardo et al. 2018). Historical development of river contracts mostly originates from the European francophone area in 1980s and 1990s, specifically in France, Italy and Belgium. Similar forms of stakeholder agreements also exist in other parts of the world. They are named differently and use different elements and concepts but ultimately fulfil the same function. In general, agreements between stakeholders to manage a water system take different shapes and forms depending on the type of water system, specific contexts and the problem at hand. Accordingly, the scope of this literature review has been broadened from only river contracts to include other forms of voluntary stakeholder agreements on water systems management.

River contracts are defined differently in the literature. Some examples include:

1) “agreement between the largest possible number of water actors from both the public and the private sector (…) aims at harmonising the diverse uses and functions of the river, its banks and the water resources of the catchment” (La Jeunesse et al. 2003);
2) "a protocol of agreement between public and private actors in relation to objectives aimed at reconciling the multiple functions and uses of watercourses, their surroundings and the water resources of the basin " (Rosillon, 2004);
3) “voluntary agreement between local authorities and private people as a form of negotiated and shared planning procedure” (Bocchi et al. 2012);
4) "governance institutional process for water management at local level and aims to involve all the main actors of the area in the identification of integrated actions of river environmental policy intended to foster the river, considered as a value resource for the recovery and development of territories” (Berrutti and Moccia, 2016);
5) “an agreement between the state and volunteering local authorities” (Brun, 2014);
6) “Masterplan which orients the vast area territorial action and with the preparation of an action agreement, which guides local projects” (Voghera, 2016);
7) “voluntary agreement between local authorities and private people as a form of negotiated and shared planning procedure” (Cialdea and Cacucci, 2018).

These definitions reflect some common, but also some diverging elements. One element is the ‘who’ of the contracts. Some definitions explicitly describe agreements between public and private sectors. Public actors are defined as authorities, but it is also extended to environmental groups and university experts (Bocchi et al., 2012); while others expand the range of actors by mentioning all the main actors in the area of interest. However, this

element is not much present in the literature. Furthermore, “emphasis must also be placed on the equal representation and involvement of all relevant stakeholders from different sectors. All of them must have an opportunity to express their opinions and be listened to by others” (Polajnar Horvat and Smrekar, 2021).

A second element is the ‘what for’ of the contracts. Some seem to (implicitly) link river contracts to river basin management (RBM) cycles or even describe the development of a river contract along RBM cycles (La Jeunesse et al. 2003, Rosillon et al. 2005) or as a process rather than a document/instrument (Bocchi et al. 2012). This is interesting as the contract then becomes a process instead of an instrument. There also seems to be an understanding that river contracts are a way to implement a landscape (or maybe basin) approach (Pappalardo et al. 2018). Some go as far as considering it an instrument for developing a masterplan to structure and guide territorial actions of different stakeholders (Voguera, 2016).

A third aspect is the legal nature of these documents. The literature describes river contracts as semi-legal instruments. This is because river contract are not fully institutionalised as they are not mandated by law. At the same time, they find some sort of institutional foundation in the broad stakeholder group that stands behind them and the link they create with existing regulations. In particular, being them voluntary agreements, the foundation for their enforcement is found in the commitment of all signing stakeholder to its implementation.

The literature on stakeholder agreements on water systems revealed other elements relevant for characterising river contracts. Stakeholder agreements in the literature differ in many aspects. In particular, they are inspired by a variety of reasons that are strongly dependent on the type of water system they are designed for and the motivation to solve an existing problem or prevent one from happening. They are also driven either by top-down or bottom-up decision-making processes; they have different characteristics; they entail different level of commitment of the participating stakeholders as well as different level of institutionalisation. Reasons for success and failure of the agreement can be found in these differences as well as in the characteristics of the stakeholders and of the local contexts.

On the type of water systems for which stakeholder agreements are designed, it is worth notice that there are many examples of stakeholder agreements encompassing not only rivers, but also aquifers, wetlands, and lakes. Also, the type of issues addressed in each water system range from water pollution and ecosystem health in the case of rivers, to encroachment in the case of wetlands, overexploitation and reduced water quality in the case of aquifers, and preservation of pristine conditions for wetlands, aquifers and lakes.

The design and adoption of stakeholder agreements securing the stakeholders´ commitment to a long-term action plan to improve and protect water systems is a social process consisting of several building blocks. The literature review led to identify four key building blocks:

1. Initiating the stakeholder engagement process: interaction between stakeholders of the different – nowadays isolated - sectors, awareness raising, setting the stage and data collection;
2. Facilitating the stakeholder engagement process: social learning and trust building;
3. Developing the stakeholder agreement content: designing an action plan and ensuring coordination with existing policies;

4. Implementing the stakeholder agreement: fostering stakeholder ownership and stewardship of the action plan and monitoring of the planned implementation

In the following the building blocks of the stakeholder process are illustrated.

1) Initiating the stakeholder´ engagement process: interaction between the stakeholders of different sectors, awareness raising, setting the stage and data collection

The first building block consists of raising awareness in stakeholders of a socio-environmental problem in a water system or the need to protect the water system and setting the stage for the process initiation which include starting by stakeholders collaborating in data collection.

The stakeholder engagement process for the design of stakeholder agreements can be initiated in different ways. Often the process starts with government officials or research experts encouraging building a picture of the complexity of a water system and of a situation that needs change (Schulte, 2012). This analysis is undertaken by researchers that integrate technical and non-technical knowledge of the water system into a comprehensive illustration. Other times, the stakeholder process is triggered by major external events and subsequent demand for government action by grassroots movements. For example, in the case of the Rhine river stakeholder agreement, an industrial accident in the Rhine River that caused significant water pollution and ecological damage was a major trigger of a sudden urge to mobilise cooperation between different countries to tackle the river's pollution (Mostert, 2009). Grassroots movements of concerned citizens and environmental NGOs lobbied in their respective countries to create awareness about the severity of the problem and demanded governmental action (Mostert, 2009). In response to the accident and the social pressure, an initial agreement was drawn up which set up a commission, the International Commission for the Protection of the Rhine, to coordinate research among national governments to propose measures to address water pollution and preparing the basis for future agreements (Mostert, 2009). Eventually, this agreement was upheld by national and local governments, industries and NGOs, and it is considered as one of the most successful agreements in the Rhine basin that led to improve water quality of the river. Although the agreement was not legally binding, the social pressure forced all actors to participate to the agreement and stick to it.

Awareness raising paves the way to initiate the stakeholder process. The next step is setting the stage for the process to take place. When setting the stage for a stakeholder process, literature shows that it is important to evaluate and learn from past stakeholder engagement initiatives. Some of these stakeholder engagement initiatives may have failed in efficiently addressing the water system problems that motivated their initiation in the first place. New stakeholder engagement processes need to address the issues that hindered the success of past initiatives and persuade stakeholders to join a new stakeholder agreement initiative. In this context, Brun (2014) noted that river contracts motivated by political opportunism failed to involve key stakeholders who were important to implement crucial water management actions (e.g. land owners) and often included only short-term solutions.

An important first step when setting the stage is to collect data on water bodies socio-economic and ecological status (Mostert, 2009, Schulte, 2012; Sindico et al., 2018, Burchi, 2018). In the case of transboundary water bodies, stakeholders involved in these voluntary agreements often established intergovernmental water system commissions whose first action was to undertake joint fact-finding processes. The data collected later served as the basis for

undertaking the next steps of the stakeholder agreement process, namely negotiations, forums for information exchange, research coordination, design of solutions and dissemination of results.

Some instruments that have been applied in these contexts include joint fact finding to enhance understanding and acceptance of knowledge among participants (Taylor et al., 2013) and integrated cognitive analysis of the river basin which builds evidence using a multidisciplinary perspective (Galassi et al., 2020).

2) Facilitating the stakeholder engagement process: social learning and trust building

The second building block consists of building trust and enabling social learning about the water system where key stakeholders negotiate shared criteria to search for effective solutions.

The process towards a stakeholder agreement on water systems is based on iterated negotiations between key stakeholders to manage the many trade-offs that emerge when having to decide between different kind of solutions and strategies (Berruti and Moccia, 2016; Polajnar Horvat and Smrekar, 2021). The negotiation includes:

1. Design clear and shared rules of the stakeholders´ decision-making process together with all relevant stakeholders (Berruti and Moccia, 2016);
2. Agree on the criteria that will be used to search for strategic solutions; criteria should capture the different values underpinning the diversity of stakeholders' interests and objectives (Polajnar Horvat and Smrekar, 2021);
3. Jointly identify integrated actions to enhance socio-environmental quality of water systems (Berruti and Moccia, 2016).

Ultimately the stakeholder negotiation process aims to ensure that stakeholders will take responsibility to carry out any agreed commitment (Mostert, 2009, Sindico et al., 2018, Burchi, 2018).

The negotiation in the stakeholder agreement process, if conducted with clear rules of decision-making, in a transparent manner, and based on agreed criteria reflecting stakeholder values, fosters trust building and mutual learning amongst stakeholders. As a result, by making stakeholders aware and respectful of their respective perspectives and legitimate views, the process elicits civic trust and engagement and ultimately creates the space for the emergence of new ideas (Taylor et al., 2013). However, stakeholders could consider the additional responsibilities coming from the agreement as a loss if the potential gains are not deemed sufficient (Wehn et al., 2018). Therefore, special attention needs to be placed at the start of the process to understand what are the perceived gains and losses from the perspective of each stakeholder and to highlight the mutual gains over the losses.

Four instruments were identified in the literature to foster social learning in the stakeholder negotiation process for the design of stakeholder agreements: participatory modelling, deliberative visioning, scenario workshops and community mapping coupled with expert mapping. Participatory modelling contributes to dialogue about the trade-offs of different scenarios and reveals the shared responsibility among stakeholders (Basco Carrera et al., 2018; Godinez Madrigal et al., 2022). This allows for a complementarity between stakeholders, since communities can share local knowledge, and authorities and university experts can contribute to a bigger picture through modelling (Molle and Closas, 2019). Deliberative visioning allows local stakeholders to share a future that is desirable by all and

discuss common planning actions. This tool accounts for multiple values, uncertainty in information and asymmetries among individuals (Bocchi et al., 2012). Scenarios workshops, involve local groups of actors who assess technical and social strategies to problems and develop proposals for realising a collective vision, which can be established through a memorandum of intentions that include goals, measures, initiatives, and risks (Galassi et al., 2020, Polajnar Horvat and Smrekar, 2021). Finally, community mapping coupled with expert mapping of landscape units show the nexus of interactions between humans and nature (Pappalardo et al., 2018).

3) Developing the stakeholder agreement content: designing an action plan and ensuring coordination with existing policies

The third building block consists of designing an action plan with clearly allocated responsibilities, tasks and allocated human and financial resources among stakeholders based on their respective roles and competences and timing. The actions need to be coordinated with the larger legislative and regulatory framework as well as integrated with other actions for the management of the same resources addressed by the plan.

This building block of the process towards a stakeholder agreement is characterised by strategic, negotiated activities to develop an action plan (Galassi et al., 2020). To develop an action plan the process facilitator needs to place special emphasis on communication with stakeholders to ensure they are clearly informed about the entire process (Polajnar Horvat and Smrekar, 2021). At this stage of the process it is often useful to develop a document that includes the criteria agreed by the stakeholders to search for shared solutions. These criteria are defined by stakeholders based on their prioritise and can be related to public utility, economic return, social value, and environmental sustainability (Polajnar Horvat and Smrekar, 2021).

Another important aim of this building block is to come to an agreement on the distribution of clear responsibilities and coordinating roles to a large set of actors, including citizens, and allocation of human and financial resources for each agreed action and a timetable of implementation (Berruti and Moccia, 2016; Polajnar Horvat and Smrekar, 2021). This mobilisation of human capital and related resources (expertise, financial and organisational resources) increases the chance to make plans more effective (Berruti and Moccia, 2016; Polajnar Horvat and Smrekar, 2021). This is one of the most felt requirements considered necessary to overcome the weak results of past planning exercises. Something always important to consider is to put “emphasis on the equal representation and involvement of all relevant stakeholders from different sectors. All of them must have an opportunity to express their opinions and be listened to by others” (Polajnar Horvat and Smrekar, 2021).

Albeit action plans are usually essential in stakeholder agreements, sometimes the lack of commitment between parties can block or at least slow down a pathway towards a concrete action plan. Cases like this are abundant in the literature. Sometimes the result of the stakeholder agreement process stagnates and only legal frameworks or memorandums of intentions are achieved (Voghera, 2016; Burchi, 2018; Sindico et al., 2018; Polajnar Horvat and Smrekar, 2021). Other times action plans with conflict of interest and a lack of real local stakeholder commitment are undertaken (Suhardiman et al,. 2012; Schulte, 2012). In cases of transboundary water systems, these setbacks are sometimes caused by politicisation of the action plan due to sovereignty issues (Schulte, 2012; Suhardiman et al., 2012; Sindico et al., 2018), excessive sectorial nature of the actions or lack of clear financial resources to implement the action plan (Voghera, 2016; Polajnar Horvat and Smrekar, 2021), and

disregard of the inputs of local stakeholders (Wehn et al., 2018; Molle and Closas, 2019; Villada-Canela et al., 2021).

Despite the many obstacles to sign and implement action plans in stakeholder agreements, it is worth notice that once they have been signed, stakeholder agreements tend to be resilient and follow an iterative process of evaluation and revision. As such, “agreements evolve over time through periods of testing and learning: stakeholder networks of state and non-state actors may help introduce and foster new institutional priorities, policies, and practices within and among water management institutions” over the courses of decades (Wilder et al., 2020). And as noted by Mostert (2009), iterative stakeholder agreements can foster negotiations, forums for information exchange, coordinating research and propose and disseminate solutions. Therefore, stakeholder agreements have a great potential to overcome (temporal) lack of commitment of some stakeholders and continuously adapt new action plans according to changing dynamics of water systems. Moreover, there are examples where a lack of action plan at the international scale did not prevent the design and implementation of an action plan at the local level between cities in different countries (Sindico et al., 2018).

Stakeholder agreements are not intended to replace laws and regulations; instead, they are meant to support implementation of existing regulation (Brun, 2014). Since river contracts or stakeholder agreements are meant to be an “operational instrument able to provide operative and checkable outcomes in the short/average period finalised to solve concrete problems of a specific area”, these actions need to be coordinated with existing plans and programs at a larger scale as well as with the local interests in a smaller scale (Berruti and Moccia, 2016). In practice, this sometimes does not happen and especially coordination between actions taken at different levels of government is not always ensured (Galassi et al., 2020). When this happens or when agreed actions fail to be implemented or are only partially implemented, stakeholder agreements might lose their value and turn into a disappointment for the involved stakeholders with negative impact on stakeholders´ collaboration due to loss of trust..

As for the instruments used at this step of the process, the programmatic document is sometimes used to design action plans (Galassi et al., 2020). The programmatic document is a preparatory document of the stakeholder agreement meant to provide verifiable and operational results to solve concrete problems in specific areas in the short and medium term, and to prevent problems in the long-term in the water system as a whole (Berruti and Moccia, 2016; Brun, 2014). It also aims to ensure coherence with the existing policy framework. As for the type of actions included in water system contracts, these are often policies based on "sticks and carrots” approach such as increasing fees for water use or providing subsidies for drip irrigation (Molle and Closas, 2019). Concerning financing the action plan, there voluntary and decentralised financial schemes to promote watershed conservation are often used (Villada-Canela, 2021).

A frequent instrument used to ensure the coordination of action plans with the large and small scale policy frameworks and plans, especially in transboundary contexts, are intergovernmental river basin commissions (Mostert, 2009). Other instruments are compensation measures whereby stakeholders´ negotiate compensations of different kinds in order to accept actions for the benefit of most stakeholders in the river basin (Mokorosi and van der Zaag, 2007).The level of participation might differ per case study depending on their contexts. The context influence determined what level of participation is possible.

4) Implementing the stakeholder agreement: fostering stakeholder ownership and stewardship of the action plan and monitoring of the planned implementation

Finally, the action plan needs to be owned by stakeholders and continuously monitored to ensure its efficacy.

Pappalardo et al. (2018) highlight the importance of the feeling of ownership in stakeholders to contribute to the efficacy of the stakeholder agreement. A recurring obstacle to stakeholder ownership is the lack of transparency in monitoring the action plan implementation. Such monitoring, especially if conducted by stakeholders themselves, contribute to create a sense of progress from an initial baseline, which nurtures the sense of ownership and supports stewardship (Brun, 2014). Finally, to build a sense of ownership among stakeholders it is necessary to empower them to undertake the stewardship function. This implies strong delegation of management power to users of the water resource. If this does not happen, there is strong evidence suggesting that stakeholder agreements of water systems will fail (Molle and Closas, 2019).

An instrument sometimes used in this context could potentially be Citizen Observatories where citizens along with scientists and professionals contribute to data collection, thus establishing a two-way communication paradigm between citizens and authorities (Wehn et al., 2018). However, the establishment of this kind of instrument entails changing the role of citizens in resource management and the “potential for changing the role of citizens is highly dependent on the room that citizens are granted by authorities – but also on that claimed by citizens” (When et al., 2018).

PART II – NEXOGENESIS STAKEHOLDERS' CO-CREATION APPROACH FOR NEXUS GOVERNANCE AND IMPLEMENTATION IN THE CASE STUDIES

6 Rationale of the NEXOGENESIS stakeholders' co-creation approach for WEFE nexus governance

Part II of this report illustrates the NEXOGENESIS stakeholders' co-creation approach for WEFE nexus governance and outlines the planned implementation in the case studies. The implementation of the approach in the case studies will depend on the local context. This means that the two steps and five building blocks of the approach illustrated below are intended as a guideline for the case studies to select from and adapt according to local needs.

The literature reviews presented in part I of this report provided the basis for development of the NEXOGENESIS approach. The approach aims at supporting stakeholders in a certain region (e.g. a river basin) to co-create and commit to implementing WEFE nexus goals and policies through a stakeholder agreement, built around the concept of non-binding river contracts. Ultimately, the approach facilitates the transition towards WEFE nexus governance in the region in which it is implemented. The NEXOGENESIS approach for stakeholders' co-creation for WEFE nexus governance includes two main steps:

1) Nexus governance problem identification via assessment of the performance of the existing governance system to identify barriers, leverages and entry points for governance and policy change (Chapter 7), and assessment of policy coherence to identify policy gaps related to nexus interlinkages (Chapter 8);
2) Stakeholders' co-creation of WEFE goals and policies and commitment to implementation through a stakeholder agreement (Chapter 9). The stakeholders' co-creation process is operationalised in five building blocks:
    - Preparing the stakeholders' co-creation process: stakeholder identification and analysis (Section 9.2.1);
    - Initiating the stakeholders' co-creation process: interaction between the stakeholders of different sectors, awareness raising, setting the stage and data collection (Section 9.2.2);
    - Facilitating the stakeholders' co-creation process: stakeholder engagement, management and sustainment for trust building and social learning throughout the project (Section 9.2.3);
    - Developing the stakeholders' co-creation content: designing an action plan and ensuring coordination with existing policies (Section 9.2.4);
    - Implementing the stakeholders´ agreement: fostering stakeholders´ ownership of the action plan, and monitoring of the planned implementation (Section 9.2.5).

7 The Nexus Governance Assessment Tool (NXGAT)

7.1 Development of NXGAT

NXGAT in NEXOGENESIS has a twofold aim:

1) Understanding the extent to which the current governance system and stakeholder interactions in each case study region are nexus-oriented (cross-sectoral);
2) Identifying enablers, barriers and entry points for the governance system to change towards more nexus-oriented governance.

NXGAT adopts a holistic nexus perspective to identify enablers and barriers and assess the governance capacity to change. To do so, it is required that NXGAT is truly nexus-oriented and focusses on specific WEFE nexus governance characteristics and challenges. Currently, there is no GAT that is tailored to the needs of the nexus. Therefore we developed NXGAT.

Based on the literature reviews described in part I, the GAT of Bressers et al. (2015) was selected as the basis for NXGAT. We selected this specific tool, as it is a broad framework that encompasses most relevant governance dimensions and quality criteria, also with regard to nexus governance characteristics and challenges. However, the original framework is not able to address all nexus governance challenges, such as issues related to fit, policy coherence, power imbalances and multiple views and perspectives. Especially the governance quality criteria fit was added to the tool to be able to account for governance challenges related to scalar fit and scalar strategies as identified in the literature (see chapter 2 and Pahl-Wostl (2021)).

To adapt the GAT of Bressers et al. (2015) in a way that it accounts for the needs of WEFE nexus governance, we took four steps:

1) We conducted a literature review on WEFE nexus interlinkages and governance challenges associated with these interlinkages;
2) We conducted a literature review on nexus governance literature to identify nexus governance characteristics and allocate them under the governance dimensions and quality criteria in the GAT matrix of Bressers et al. (2015);
3) We adapted the existing GAT questions of Bressers et al. (2015) into more nexus-fitting questions. Additionally, we included additional questions in the GAT for newly identified nexus governance characteristics;
4) We organised six intensive working sessions that involved the core research team of WP1 to consolidate the NXGAT, its governance dimensions, quality criteria and questions. The outcome of this process is the final version of the NXGAT, which is presented in Table 6.

Table 6: Nexus Governance Assessment Tool (NXGAT)

Governance dimension	Quality of WEFE nexus governance system				
	Extent	**Coherence**	**Flexibility**	**Intensity of action undertaken**	**Fit**
Levels and scales	**Are all relevant WEFE domains across** institutional levels and scales represented and involved in nexus governance? (Bressers et al.,2015, de Andrade Guerra et al., 2021) To what extent can the **WEFE nexus governance system** be characterised as **polycentric**? (Pahl-Wostl et al., 2021; Märker et al. 2018; Lockwood, 2010)	Do WEFE domains **work together across governance levels and scales** in a coordinated manner, which fosters coherence? (Bressers et al., 2015, Salmoral et al., 2019; de Andrade Guerra et al., 2021; Albrecht, 2018; De Strasser et al. 2016; OECD, 2018) To what extent are **vertical and horizontal synergies** and mutual **dependencies** across levels and scales recognised? (Bressers et al., 2015; Salmoral et al., 2019)	Is it possible to address WEFE nexus governance issues at different levels and scales (**upscaling** and **downscaling**)? (Bressers et al., 2015)	Is there a **strong drive or action undertaken** from a certain level or domain to urge WEFE nexus governance change on other levels and scales? (Bressers et al., 2015)	To what extent do the **nexus interlinkages correspond to the structural levels** of **governance** at which they are currently dealt with? (Pahl-Wostl, 2021; Finger at al. 2006; Liu et al., 2015)

Governance dimension	Quality of WEFE nexus governance system				
	Extent	**Coherence**	**Flexibility**	**Intensity of action undertaken**	**Fit**
Actors and networks	To what extent are **relevant actors and networks** from the **WEFE** domains **involved equally and meaningfully** in the governance of the WEFE nexus? (Bressers et al., 2015 Zeitoun et al., 2013) Who are key actors and networks in the governance of the WEFE nexus? Who is not involved or **excluded**? (Bressers et al., 2015; Dai, 2021; Asiama et al., 2017; Koop et al., 2017, Corbera and Schroeder, 2011)	How **cooperative** and **how strong are interactions** between actors and networks across the WEFE nexus? (Bressers et al., 2015) Do **actors and networks trust** and **respect** each other and have established collaboration they can build on to foster WEFE nexus synergies and manage trade-offs? (Bressers et al., 2015; Raadgever et al. 2008, Armitage et al., 2015)	To what extent **can WEFE power constellations or leadership shift**, and is it possible to include new actors and networks if useful? (Bressers et al., 2015) To what extent is the governance of the WEFE nexus **contested and negotiated by actors and networks?** Can key actors or networks (like bridging organisations) act meaningfully in support of the WEFE nexus governance? (Bressers et al., 2015; Zeitoun et al., 2013, Koop et al., 2017)	How do certain **actors or networks urge change of the WEFE nexus governance regime** effectively and continuously? (Bressers et al., 2015; Koop et al., 2017) Are there any actors or networks able to exert influence unilaterally? (Bressers et al., 2015; Koop et al., 2017)	To what extent are the current **WEFE actors** the **most appropriate** to deal with the nexus interlinkages?

Governance dimension	Quality of WEFE nexus governance system				
	Extent	**Coherence**	**Flexibility**	**Intensity of action undertaken**	**Fit**
Problem perspectives and goal ambitions	To what extent are **different perspectives** about WEFE nexus **interlinkages and related problems and ambitions** taken into account in the single WEFE domain and in the WEFE nexus decision-making? (Bressers et al., 2015; Benson et al., 2015) To what extent are the WEFE nexus **actors aware of the vertical and horizontal inter-dependencies** (synergies and trade-offs) across WEFE nexus domains? (Williams et al., 2018; Bressers et al., 2015; Salmoral et al., 2019)	To what extent do the various actors' policy goals and perspectives across WEFE nexus support each other (**synergies**) or are in competition or conflict with one another (**trade-offs**) (Bressers et al., 2015; Link et al., 2016; Roidt and Avellan, 2019, Susnik et al., 2021; Salmoral et al., 2019 Dai, 2021)	Are there opportunities to **re-assess priority of WEFE domain goals**? Where are these opportunities located in the WEFE nexus? (Bressers et al., 2015) Can multiple WEFE policy goals be **optimised** and perceived problems be solved in nexus governance **packages deals**? (Bressers et al., 2015)	To what extent are the goal ambitions and the problems perceived **moving away from a single resource centric view** towards a perspective on nexus governance which effectively urges change? (Bresser et al. 2016; Roidt and Avallan, 2019) What is the **perceived urgency** of WEFE nexus problems by actors across the WEFE nexus? (Jager 2016; Koop et al., 2017)	Do the perceived **problem perspectives and goal ambitions account for the nexus interlinkages**?

Governance dimension	Quality of WEFE nexus governance system				
	Extent	**Coherence**	**Flexibility**	**Intensity of action undertaken**	**Fit**
Strategies and instruments	What types **of measures and instruments (including monitoring and enforcement instruments)** are included in the policy strategy of each WEFE nexus domains? What is missing? (Bressers et al., 2015; Giupponi and Gain 2017) What different strategies and instruments exist to **prevent and manage power imbalances** and **conflicts** among the WEFE nexus actors? (Crona and Parker 2012; Margerum 2008; Dai, 2021)	To what extent are measures and instruments **cross-domain and reinforcing each other**? (Lawford et al., 2013, Sušnik et al. 2021, OECD, 2018) To what extent is the **incentive system based on synergies** across WEFE nexus domains? Are there any overlaps or conflicts of incentives created by the policy instrument across the nexus domains? (Bressers et al., 2015) Are **trade-offs** related to **costs and benefits** and to distributional effects across the WEFE nexus domains considered? (Bressers et al., 2015)	Are there opportunities to **combine or make use of different types of (legal, policy, economic, etc.) instruments** across WEFE nexus domains? Are there alternative choices? (Bressers et al., 2015) Are legal frameworks, policy instruments and measures robust and **flexible, i.e. adjustments are possible and relatively easy to implement** (including financing systems)? (Zeitoun et al. 2013; Raadgever et al. 2008)	To what extent do policy instruments **stimulate desired behaviour** and deviate from current practices? (Koop et al., 2017; Bressers et al., 2015) To what extent WEFE nexus strategies and instruments foster **sustainable and integrated WEFE nexus** management? (Albrecht, 2018; Bressers et al., 2015)	To what extent do **policies** and **instruments match the nexus interlinkages**?

Governance dimension	Quality of WEFE nexus governance system				
	Extent	**Coherence**	**Flexibility**	**Intensity of action undertaken**	**Fit**
Responsibil-ities and resources	To what extent are **responsibilities** about WEFE nexus issues **clearly assigned and facilitated** with resources and organisational structures? (Bressers et al., 2015; Koop et al., 2017, OECD, 2018; Crona and Parker 2012) Are actors with the **right expertise and capacity** involved in the WEFE nexus management decisions? Which expertise is missing or even excluded? (de Andrade Guerra et al., 2021; Gerlak and Schmeier 2018; Raadgever et al. 2008) To what extent are there **power imbalances** and **conflicts** among the WEFE nexus actors regarding responsibilities and resources? (Crona and Parker 2012; Margerum 2008; Dai, 2021)	To what extent do the assigned responsibilities for integrated WEFE nexus management create struggles or cooperation within or across institutions and domains? (Bressers et al., 2015) How do the functional differences of WEFE actors affect **power distribution, legitimacy and exercise** in the WEFE nexus decision-making? Could one actor act alone as a result of power allocation? (Armitage et al., 2015; Margerum 2008 Bressers et al., 2015; Kuslits et al. 2021) Are there any allocated responsibilities and resources to manage WEFE nexus issues in an integrated manner? What are they? Are they **legitimate**? (Roidt and Avellan, 2019)	To what extent is it possible **to pool the assigned responsibilities** and **resources** without compromising accountability and transparency? (Bressers et al., 2015)	Is the amount of **allocated resources sufficient** to implement the measures needed for the intended change across nexus domains? In which domains are resources more scarce for implementing change? (Bressers et al., 2015) To what extent do the **key institutions** in the WEFE nexus **drive changes** to other institutions in the nexus toward more nexus integration? (Pahl-Wostl, 2021; Albrecht, 2018) To what extent are the **entrepreneurial agents of change** enabled to gain access to resources, seek and seize opportunities, and have **meaningful influence** on the nexus governance regime? (Koop et al., 2017)	To what extent do the **allocated responsi-bilities and resources match the scale of the nexus interlinkages**?
Overall integration of WEFE Nexus domains in the governance system (score 0-3):					

Similar to the GAT of Bressers et al. (2015), the NXGAT assesses five governance dimensions: (1) Levels and scales, (2) Actors and networks, (3) Problem perspectives and goal ambitions, (4) Strategies and instruments, and (5) Responsibilities and resources. The definitions are based on Bressers et al. (2016).

(1) Levels and scales: The administrative levels and the biophysical scales involved in the WEFE nexus domains and their interdependencies.

(2) Actors and networks: The involved actors and networks in the WEFE nexus governance system, their roles, potential conflicts and power relations.

(3) Problem perspectives and goal ambition: The various perspectives, ambitions and levels of awareness of WEFE nexus stakeholders about nexus issues.

(4) Strategies and instruments: The policy instruments and strategies available to address WEFE nexus issues.

(5) Responsibilities and resources: The available resources and responsibilities and their distribution to address WEFE nexus issues.

The governance dimensions are assessed based on five governance quality criteria: extent, coherence, flexibility, intensity of action undertaken and fit. The definitions are based on Bressers et al. (2015) except for the fit quality criteria, which was defined for the purposes of this study.

(1) Extent: The degree to which all relevant elements of the WEFE nexus are taken into account in each of the governance dimensions.

(2) Coherence: The level of contradiction or reinforcement of the relevant WEFE elements in each of the five governance dimensions.

(3) Flexibility: The presence of alternative opportunities to achieve the WEFE nexus goals and if this flexibility is supported by the governance system.

(4) Intensity of the action undertaken: The level of action taken towards a more WEFE nexus-oriented governance regime in each of the five governance dimensions.

(5) Fit: The degree to which WEFE institutional levels (local, regional, national and transnational), stakeholders´ priorities, social interactions, policy instruments and responsibilities correspond to the bio-physical scales and dynamics of the WEFE nexus issues (Pahl-Wostl et al., 2021; Vatn and Vedeld, 2012).

Nexus domain: We distinguish in this matrix nexus domain from nexus sector, mainly to reflect that water, energy and food are commonly understood as sectors, but the fourth domain of the WEFE nexus, ecosystems, is not a sector in this sense.

Each NXGAT question will be operationalised into interview questions tailored to the specificities of each case study. Semi-structured interviews with relevant stakeholders across nexus domains will be conducted by a multi-disciplinary team of experts. The matrix cells will be scored based on expert judgement using the scoring system presented in Table 7. The stakeholders will also be asked to give an overall score of level of integration of the WEFE nexus domains as presented in Table 8.

Table 7: Likert-type scoring scale used in the NXGAT to assess the governance system

++ **Nexus oriented governance system**	The current governance system is nexus governance oriented
+ **Governance system supportive towards nexus governance**	The current governance system supports transition towards nexus governance
- **Governance system restrictive to nexus governance**	The current governance system does not support nexus governance
-- **Sectoral oriented governance system**	The current governance system hinders and steers against nexus governance

0	Silo approach; no substantial integration between domains
1	Two nexus domains have good level of integration
2	Three nexus domains have good level of integration
3	All nexus domains have good level of integration

Table 8: Scoring of the overall WEFE nexus integration

7.2 Implementation of the NXGAT in the case studies

This section presents how the NXGAT is implemented in each case study. The main objective is to adapt the tool to the context of each case study and to each stakeholder (group) interviewed, while respecting the tool and methodology developed to ensure cross-case comparison and generalisation.

Composition of the governance assessment team

- A minimum of three people, if possible from different backgrounds in social sciences and natural sciences.
- At least one member of the case study, if possible from social sciences that can support with local knowledge and translation, when necessary. This person is invited to participate in the debriefing to provide additional information and can propose additional interviews.

Planning of the agenda of the visit with case study leaders

- Planning the visit starts at least 2 months before the visit.
- Minimum duration of the visit is at least of one week when two countries are involved.
- A detailed agenda outlining the visits schedule and its goals is provided by the CS leads.
- 12 to 15 stakeholders across all nexus domains are to be interviewed per country (in case of transboundary case study).
- At least one interview with a representative of each level/scale of each domain; this number is multiplied by the number of countries involved in the river basin area.
- Stakeholders can be divided into groups of 2 or max 3 people of the same or different domains or institutions. They can be familiar with each other or not; the exchange will provide different, but in any case interesting information.

Conducting the interviews

- Face-to-face interviews, as much as possible
- 90 minutes per interview, 120 minutes when translation is needed
- One researcher is leading but all members of the governance assessment team are invited to ask additional questions and complement
- All members of the governance assessment team take notes
- The interviews are recorded to clarify different interpretations of the data among members of the governance assessment team
- First step: signing of consent form and explaining the interview purpose to the stakeholders; managed by the local, case study project partners and the assessment team (10 minutes).

- Presentation of NEXOGENESIS and objectives of the governance assessment (2 minutes).
- The interview is framed as a discussion and provides a snapshot of WEFE cross-sectoral management. The text is adapted to each stakeholder, depending on their expertise, function and activity.
- The stakeholders' self-assessment of the integration of the WEFE nexus domains takes place at the end of the interview.

The agenda of the debriefing

- During the visit, whenever possible, the data is coded after each day of interviews and assigned to each cell of the matrix
- At the end of the visit, all dimensions and quality criteria are scored
- If needed, the governance assessment team discusses further steps with the case study leaders (e.g. need for additional interviews either in person or on-line)
- Additional information, when pertinent, is used to consolidate the scoring and synthesis of the results
- The completed matrix and score justifications are presented to the WP1 team before writing the report for the case study.

The validation of the main outputs

- When the scoring is finalised, an exchange is planned with the case study leaders. The goal is to discuss the presentation of the results to the stakeholders interviewed. This can be done during a workshop or in a second round of interviews, if needed, to specify certain aspects.
- The governance assessment team is then engaged in an analysis process to identify enablers, barriers and entry points for governance change towards more nexus-oriented governance.

Towards a transboundary collaboration (for transboundary cases)

As far as the case study does not have any transnational collaboration in force for river management, the NXGAT is implemented in each individual country. In this case, a comparison of the two assessments is done by the governance assessment team to provide a transboundary analysis on synergies, trade-offs, opportunities, difficulties and tensions to support transnational collaboration. The aim is to pave the way towards transboundary nexus collaboration. Whatever initial state of the case study, the NEXOGENESIS work will support a step forward in this process to improve collaboration across scales and sectors.

8 Nexus policy inventory and coherence assessment: towards WEFE policy packages

8.1 Development of the policy inventory and coherence assessment tool

The policy coherence analysis in NEXOGENESIS aims to assess the level of coherence between different WEFE nexus policies relevant to the (transboundary) river basin case studies. To assess policy coherence in the case studies, NEXOGENESIS adopts a simplified version of the tool adopted by Papadopoulou et al. (2020), which was developed by Nilsson et al. (2017).

There are two main differences between the NEXOGENESIS policy coherence assessment and the approach adopted by Papadopoulou et al. (2020) after Nilsson et al. (2017): the complexity of the scoring system and the object of assessment. The original tool of Nilsson et al. (2017) measures the interaction between pairs of policy goals through a 7-point scoring scale ranging from cancelling (-3) to indivisible (+3). Papadopoulou et al. (2020) indicate that this tool is complex and time intensive to use. Therefore, we simplified the coherence analysis. Instead of a 7-point scale, we opted for a 4-point scale (Table 9): “no coherence”, “weak coherence”, “strong coherence”, and “not applicable”. Furthermore, while Nilsson et al. (2017) assess coherence between pairs of policy goals, the NEXOGENESIS approach assesses coherence by checking to what extent sectoral policy documents (e.g. water policy documents) account for expected cross-sectoral interactions (e.g. interactions between water and energy, water and agriculture, water and ecosystems).

Table 9: Scoring system in the NEXOGENESIS policy coherence analysis

	Not applicable	**No coherence**	**Weak coherence**	**Strong coherence**
DEFINITION	The policy document **is not expected to refer** to other sectors or sectors’ policies.	The policy document **does not refer** to other sectors or sectors’ policies although impacts and/or potential synergies exist.	The policy document **only mentions/ acknowledges** possible impacts/ synergies with other sectors or sectors’ policies but there are no mandatory measures.	The policy document **prescribes specific measures** to ensure that impacts on other sectors are managed and/or synergies exploited.

To help case studies to conduct the policy coherence analysis, WP1 developed a policy inventory tool (see Figure 1 and 2) that includes:

- Instructions to fill in the policy inventory: including instructions on how to find policies and populate the database;
- The scoring system: an explanation of how to score the level of policy coherence;
- A List of policy instruments: an overview of existing policy instruments and their definitions;
- Policy data: under this tab, all relevant policies will be stored, summarised and their level of coherence will be provided.

The next section will describe how to populate the policy inventory and conduct the policy coherence assessment in detail.

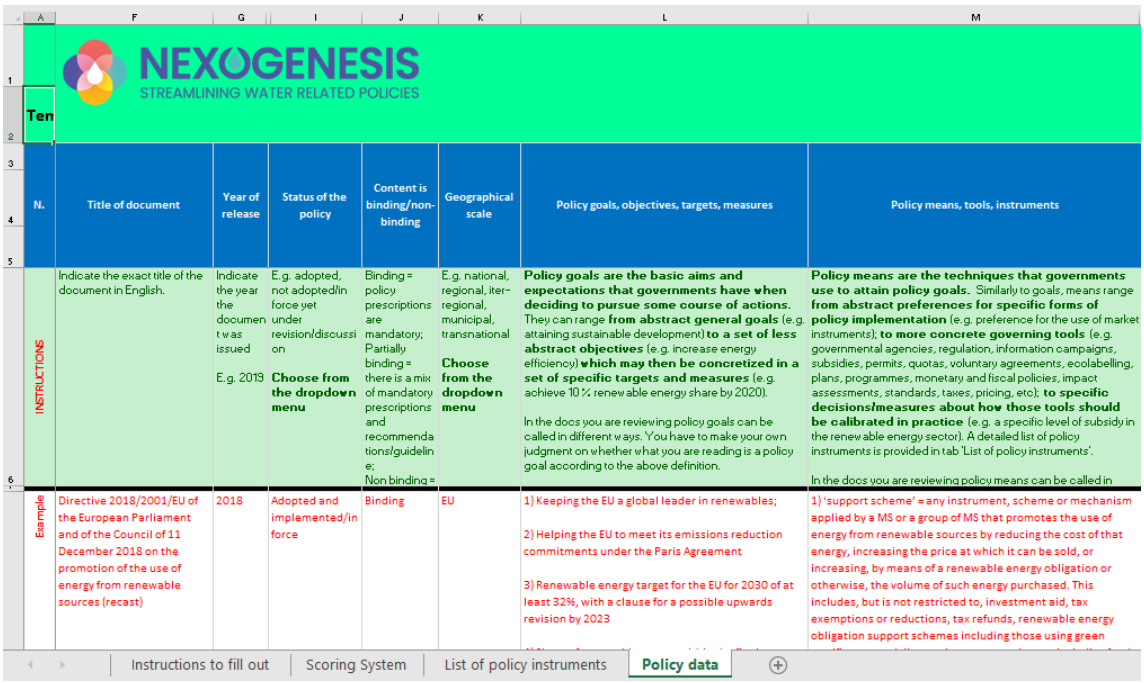


Figure 1: Example of Policy inventory

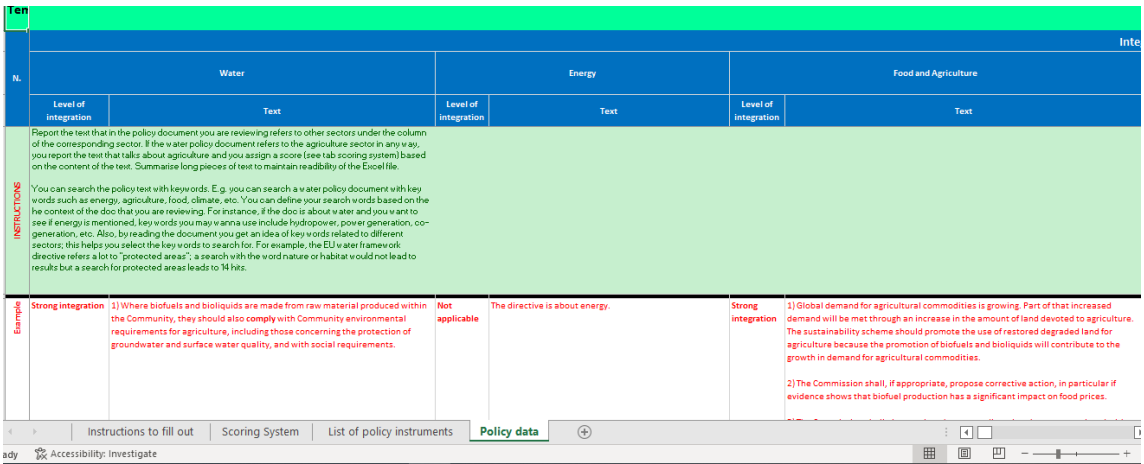


Figure 2: Example of Policy coherence analysis in the policy inventory

8.2 Implementation of the policy inventory and coherence assessment tool in the case studies

The policy coherence assessment comprises three steps. First, identification of relevant policies at different levels: EU, national, regional and local level. Second, analysis of the policy documents and populating the policy inventory. Third, assessment of policy coherence based on expected policy interaction. The steps are described in detail in the following paragraphs.

Step 1: Identifying relevant policies

The aim of this step is to identify – based on the knowledge of our lead case study partners - the most up-to-date policies and legislation for the relevant WEFE nexus sectors in the case study region and store it in the database. It is the responsibility of the case study owner to identify relevant policy documents (plans, programs, strategies, roadmaps, etc.) from governmental and intergovernmental authorities at transnational, national, state, federal, regional, provincial, municipal scale and legislations (both binding and non-binding). Documents for all WEFE nexus sectors need to be included, and other sectors when relevant to the case study (climate, land use, tourism, etc.). It is impossible to cover all existing policies and legislations. Therefore it is important to select the policies relevant to the case study based on identified nexus problems, the current political debate and the needs of the project. It is possible to discuss project needs with WP1, WP2, WP3, and WP4. WP1 set up one-on-one meetings with the CS to explain the process. This step needs to be conducted for all countries involved in the transboundary case studies.

Step 2: Analysis of the policies and building the policy inventory

In this step, the policy documents are stored in the policy inventory and analysed based on their content. To populate the policy data tab, CS owners will first do a quick scan of the document to become familiar with its structure and content. The second step is to read the document in detail to identify the policy goals and instruments. In this step, the following information is stored: the country to which the policy document applies; the policy area; the type of document; the name of the organisation that released the document; the title of the document; the year of release; the time horizon of the policy document; the status of the policy; the level of legally binding; the geographical scale of the document; the policy goals, objectives, targets and measures; the policy tools and instruments; and the expected revision of the policy.

Step 3: Analysis of policy coherence

The policy coherence analysis will be conducted on the selected policy documents in the transboundary case studies. The scoring is based on the scoring scale illustrated in Table 9. To ensure robustness of the assessment, an approach including triangulation of the results is used. Associated local researchers with nexus expertise (case study project partners) score coherence between the policies individually. The local researchers substantiate their score with examples from the policy documents that show the level of policy coherence. This is done per policy document per WEFE sector. Researchers from the NEXOGENESIS team, with expertise in environmental policy and governance, review the policy coherence scores in the policy

inventory based on evidence provided by the local researchers. If the NEXOGENESIS team interprets the policy coherence scores differently than the local researchers, the local researchers and NEXOGENESIS team will then discuss the score together until consensus is reached. The policy coherence analysis results are presented to local stakeholders during a workshop with the aim to validate the results.

8.3 Designing policy packages for the SLNAE using the policy inventory and coherence assessment tool

The case studies will choose among all identified WEFE policies listed in the policy inventory the ones that will be integrated in the Self-Learning Nexus Assessment Engine (SLNAE). The selection of the WEFE policies, their goals, targets and instruments will be done by the case studies with their respective stakeholders. This section illustrates the process step-by-step.

Similarly to the approach adopted in SIM4NEXUS, a **template** was developed to list all policies selected to be included in the SLNAE (Figure 3). The selected policies per each case study, called policy scenarios in SIM4NEXUS, are called **policy packages** in NEXOGENESIS, in line with the grant agreement language, and will be presented in D1.3 due by month 23. The list of policies in the template for each case study constitute the policy package of the case study. The SLNAE will allow the user to assess the impact of one or a combination of policies among those included in the policy packages and will display the effect of these policies in terms of progress towards the policy targets. Based on the assessment, the SLNAE will also recommend an optimal combination of policies among those included in the policy packages that would improve all WEFE nexus sectors and minimize trade-offs.

The policy input data for the SLNAE that the case studies need to provide to WP3 and WP4 include: policy goals, policy targets, policy instruments, entry point of the policy in the nexus, assumptions for the models, and variables/parameters to include policies into the models. All this information is included in the policy packages template.

The list of policy goals, targets and instruments will be provided by case studies in dialogue with stakeholders and with support of WP1. Case studies will then identify entry points of the policies into the nexus. Finally, case studies together with WP3 and WP4 will identify assumptions, parameters for the models and functions/equations for the models. It may happen that not all policies indicated by the stakeholders can be integrated in the SLNAE. In that case, case study leads, with the support of WP2, 3 and 4 will have to be clear with stakeholders on what is and what is not feasible to avoid disappointing stakeholders' expectations.

The following paragraphs illustrate the process for case studies to select and validate with stakeholders´ policies for the SLNAE (case study policy package).

Rationale for selecting the policies for the SLNAE from the policy inventory

The policies to be included in the SLNAE are the ones that have or are expected to have a substantial positive or negative impact on one or multiple WEFE sectors in the case study region (e.g. subsidies for biofuel production have an impact on water quality and quantity, food production, land use, energy; this policy may be important in one case study but not in others depending on local conditions).

The number of policies to include in the SLNAE is not fixed. However, case studies shall be aware of the fact that the more policies the more work to translate them into parameters and functions for the SLNAE. Hence, it is recommended to start with a limited number of policies per nexus sector (2-3) to understand the workload and then eventually add more policies, considering the timeframe of the project and the expectations of the stakeholders.

Policy packages selection process (Figure 4)

First, case studies will identify critical cross-sectoral interactions/issues (e.g. water-energy interaction concerning hydropower production; water-food interaction concerning water pollution; water-food interaction concerning water supply; etc.) based on:

1) their knowledge of the main nexus issues and potential cross-sectoral synergies in their region;
2) the initial discussion with stakeholders about WEFE cross-sectoral interactions and problems in their region (outcomes of stakeholder workshop 1);
3) the draft conceptual maps (developed by case studies with WP3).

Once case studies have identified the critical cross-sectoral interactions/issues, the policy inventory and the policy coherence assessment help them to:

1) identify the existing policy instruments and related goals and targets, that the legislation adopted to address the selected cross-sectoral interactions; most likely there are multiple policy instruments; the case studies will have to select which ones to include in the SLNAE (one or two) based on their understanding of expected impact of these instruments on the nexus;
2) identify for which selected cross-sectoral interactions there is no consideration in policy documents, meaning there is a policy gaps for which policy is needed/desirable. For these policy gaps, case studies may want to suggest new policies (goals, targets, instruments) to be included in the SLNAE.
3) identify entry points of the policies in the nexus; e.g. subsidies to farmers to adopt more water efficient irrigation techniques is a water policy that enter the nexus via the agriculture sector.

The above mentioned information is collected in the template for policy packages (Figure 3). The draft policy packages will be discussed with stakeholders. In line with the project plans (see Milestone 2 for the planning of all workshops and case study activities), during workshop 2 all case studies will validate their policy coherence assessment and present a preliminary list of policy instruments to include in the SLNAE. Front runner case studies should reach agreement with stakeholders to at least one policy instrument per nexus sector in workshop 2 and finalise the validation of the policies for the SLNAE in workshop 3. This

way, WP3 and WP4, together with front runners, will be able to start translating the policies into model parameters right after workshop 2. As for follower case studies, they should aim to advance as much as possible the discussion about policy instruments to include in the SLNAE in workshop 2 and finalise policy package at workshop 3. The discussion with stakeholders will be prepared by case studies with support of WP1 and WP5.

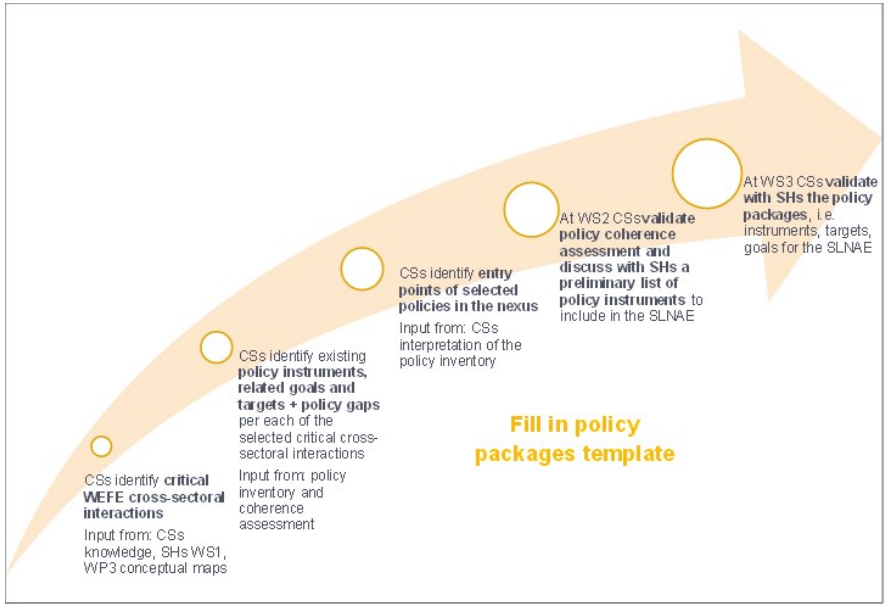
Figure 3: Policy packages template (draft version)

NEXOGENESIS
STREAMLINING WATER RELATED POLICIES

Template for policy packages: from policies to models

	TO BE DISCUSSED WITH STAKEHOLDERS IN WORKSHOP 2 AND 3 (CSs WITH SUPPORT WP1, WP3)							TO BE DEVELOPED BY CSs WITH WP3, WP4, WP2						
	Sector that adopt/implement the policy (WEFE, others)	Existing vs. desired policy	Poligy goal	Target associated to goal	Specific policy objective	Target associated to objective	Policy instrument	Entry sector of the policy in the conceptual model (WEFE, others)	Assumptions to be made to translate policy into models	Modulation of the instrument (either mandated by law or defined by CSs)	Specific assumptions on the changes triggered by the policy instrument in the model variables	Input variables used in models to implement policy	Data	link to other sectors
Example	Agriculture	Existing	Sustainable management of water resources in agriculture	no numerical target; Target: maintain and whenever possible improve surface water flows and aquifers levels	Increase water efficiency in agriculture	no target mandated by law; we define a target of 10% increase in water efficiency	Subsidies to farmers for adoption of efficient irrigation technology	water	Assumptions about the replacement of low efficient with high efficient water tech	20M Euro/yr for 10 years subsidies to farmers for adoption of efficient irrigation technology	it is assumed that with this money there is a water saving of **X** m3/yr in yr1 untill **Y** m3/yr in yr10	from X to Y m3 decrease of yearly water demand by agriculture	Total area (ha) irrigated with sprinkle irrigation Total area (ha) irrigated with drip irrigation Total area (ha)	Energy: drip irrigation uses more energy than sprinkle; sprinkle use more energy than surface irrigation Agriculture: more revenues for farmers Ecosystem: more water
	Agriculture	Existing				target mandated by law is 100.000 hectars converted to less water demanding crops	Subsidies to farmers to switch to low water demand crops	water	Assumptions about the replacement of crops with high water demands by crops with lower water demands OR assumptions about the replacement of irrigated crops by non-irrigated crops. Contribution to the GDP,	10M Euro/yr for 10 years subsidies to farmers for switching to low water demand crop	it is assumed that with this money there is a water saving of X m3/yr in yr1 till Y m3/yr in yr10	from X to Y m3 decrease of yearly water demand by agriculture	Yearly (monthly) water demand by irrigated crops (m^3) Total area (ha) of irrigated crops Decrease of	Energy: ?? Agriculture: change in income of farmers Ecosystem: depending on the new crop, it may negatively affect the ecosystem Water: less water
	Agriculture	Desired			Reduce water losses in agriculture	no target mandated by law; we define a target of 40% reduction of water loss in agriculture by 2050	Investments to (repair) renovate water infrastructures	water	Assumptions about existing and future water losses in agriculture. Water saving when infrastructures' renovation will be completed. Assumptions about the irrigation practices and efficiency of agricultural	60M Euro/yr for 20 years investment to renovate water infrastructure in agriculture	it is assumed that with this money there is a water saving of X m3/yr in yr1 till Y m3/yr in yr11	from X to Y m3 decrease of yearly water demand by agriculture	Water demand by the agricultural sector (m^3) % of total agricultural area by type of	Energy:?? Agriculture: Ecosystem: water loss is a way to recharge aquifers; if this is gone there may be a negative effect on ecosystems

Figure 4: Policy packages selection process



9 Stakeholders' co-creation process

9.1 Development of the stakeholders' co-creation process

In this chapter we illustrate the development of the stakeholders' co-creation process for the design of WEFE goals and policies and ultimately commitment to implementation through a stakeholder agreement.

As the literature review in chapter 5 shows, there are different types of stakeholder agreements designed for different purposes. The river contract is a type of stakeholder agreement designed for water governance in a specific region. Building on the river contract concept, in NEXOGENESIS we choose the term stakeholder agreement for WEFE nexus governance and define it as follows:

> A **stakeholder agreement for WEFE nexus governance** is a **voluntary, negotiated action plan** developed through a bottom-up stakeholders' co-creation process where relevant stakeholders across the WEFE nexus domains identify integrated solutions for the management of the WEFE nexus resources. The stakeholders involved in the process **commit** and take **responsibility,** each within their respective frame of roles and competences, for the adoption and implementation of a set of agreed **actions and tasks** for the integrated management of the WEFE nexus resources as well as for the **monitoring** of the planned implementation. Actions and tasks can be of different nature, depending on the local conditions, and can range from technical/infrastructural measures to financing mechanisms, knowledge development and data collection.

We operationalised the NEXOGENESIS stakeholders' co-creation process into five building blocks:

1) Preparing the stakeholders´ co-creation process: stakeholder identification and analysis;
2) Initiating the stakeholders´ co-creation process: awareness raising, setting the stage and data collection;
3) Facilitating the stakeholders´ co-creation process: stakeholder engagement plan, management and sustainment for trust building and social learning throughout the project;
4) Developing the stakeholders´ co-creation content: designing an action plan and ensuring coordination with existing policies;

5) Implementing the stakeholders´ agreement: fostering stakeholders´ ownership of the action plan, and monitoring of the planned implementation.

The implementation of the five building blocks in the case studies will depend on the local context. This means that the building blocks are intended as a guideline for the case studies to select from and adapt to local needs. Specifically, the ambition of the NEXOGENESIS case studies will be to implement one or more of the building blocks depending on the starting conditions in the case study region. Building blocks build on one another. However, depending on the specific local circumstances, the stakeholder process in each case study may be different. For example, in one case study there may be already an organized group of stakeholders with good collaboration and trust, and/or existing cross-sectoral collaboration arrangements to build on. In other cases, there may be nothing of that sort and the entire co-creation process needs to be built from scratch. Furthermore, depending on the initial conditions, success of the co-creation process may look different for the different cases. Where good initial conditions are present, the expectation is that by the end of the project the foundation of a stakeholder agreement is laid out (building block 3). In cases where, for example, there is no data available or little discussion about cross-sectoral collaboration in place, the co-creation process would be already successful if, by the end of the project, the local stakeholders were able to come to an agreement with clearly allocated responsibilities for data collection and sharing (building block 1).

In light of the above, Table 10 illustrates the building blocks and the NEXOGENESIS instruments that case studies can use during the NEXOGENESIS co-creation process with stakeholders.

Table 10: Building blocks of the NEXOGENESIS stakeholders' co-creation process

Building blocks	Instruments
Preparing: stakeholder identification and analysis (CSs, WP5)	• Stakeholder register • Stakeholders´ power-interest assessment • Regular meetings WPs and CSs • Snowballing method to identify additional stakeholders
Initiating: awareness raising, setting the stage and data collection (WP1, WP2, WP3, WP4, CSs with support of WP5)	• NXGAT • Policy inventory and coherence assessment tool • Conceptual maps of nexus interlinkages • Stakeholder collaborative/participatory modelling for conceptual maps • Expert mapping for causal loops maps and SDMs • Stakeholder workshops for visioning and goal setting • Interviews • Bilateral exchanges CSs and stakeholders (meetings, emails, phone calls, etc.) • Regular meetings WPs and CSs

<u>Facilitating</u>: social learning and trust building throughout the project (CSs, WP1, WP2, WP3, WP4 and support of WP5)	• Stakeholders´ power-interest assessment • Stakeholders´ actor-linkage assessment • Stakeholders´ engagement plan • Stakeholders´ evaluation (throughout the entire process) • NXGAT • Policy inventory and coherence assessment • Conceptual maps of nexus interlinkages • Nexus footprint[1] • SLNAE • Stakeholder workshops • Interviews • Bilateral exchanges CSs and stakeholders (meetings, emails, phone calls, etc.) • Regular meetings WPs and CSs
<u>Developing content</u>: action plan and coordination with existing policies (CSs, WP1, WP3, WP4 and support of WP5)	• SLNAE • Nexus footprint • Policy packages template for translating policy into modelling variables • Governance roadmap for implementation of action plans • Stakeholder workshops • Interviews • Bilateral exchanges CSs and stakeholders (meetings, emails, phone calls, etc.) • Regular meetings WPs and CSs
<u>Implementing</u>: Stakeholders´ ownership and stewardship, and monitoring of the action plan **(CSs with support of WP1)**	• Nexus footprint • Governance roadmap for implementation of action plans • Stakeholder workshops • Interviews • Bilateral exchanges CSs and stakeholders (meetings, emails, phone calls, etc.) • Regular meetings WPs and CSs

The sections below illustrate the implementation of each building block of the stakeholders' co-creation process in the case studies.

[1] WP3, Task 3.5 will develop a WEFE nexus footprint for the assessment of the case studies' baselines and the different scenarios and policies implemented in the SLNAE. This process will involve expert review and stakeholder engagement, both in the selection of constituent indicators and in their normalisation, treatment, weighting, and aggregation.

9.2 Implementation of the stakeholders' co-creation process in the case studies

9.2.1 Preparing the stakeholders' co-creation process: stakeholder identification and analysis

In this first stage, the main tasks are: (1) developing the stakeholder engagement aim; (2) identifying stakeholders; and (3) analysing the stakeholder pool. CSs, with the support of WP5, describe their case study context and develop aims for the stakeholder engagement. With the stakeholder data, WP5 carries out the stakeholder analysis with feedback from the CSs. The approach and templates for this stage are designed by WP5 and implemented by the case studies with the support of WP5. The list of actions to take for preparing the stakeholders' co-creation process is presented in Table 11 below.

Stakeholder engagement aim: This aim is developed individually for each CS and adapted to their context and interests. A clear aim supports identifying the required stakeholders as well as communicating their role in the co-creation process.

Stakeholder identification: The preliminary identification of stakeholders is a process of listing, collecting, and storing basic information about individuals, entities or organisations that are affected by or affect the project. The CSs list is based on their perception and best knowledge of the stakeholders who should be involved in the project. This list is expanded and regularly revised and updated throughout the duration of the project (suggestion: update every 6 months) including the stakeholders identified via a snowballing approach in which preliminary stakeholders are contacted to help identify new stakeholders.

Stakeholder analysis: During the identification, stakeholders are differentiated and categorised according to their level of engagement in the co-creation process (directly engaged, interest in results and products, general interest), their activity (e.g., civil society, policymakers, authorities and representatives, private enterprises), and their level of power and interest on the project, to find a group of key stakeholders that should be engaged. Furthermore, stakeholder relationships are identified and analysed to adjust the facilitation activities (Section 9.2.3).

Table 11: Actions that project partners need to take to prepare the stakeholders' co-creation process

When	What	How	Who
Before WS1	Elaborate Privacy Policy Consent Form and stakeholder register template	EU Survey platform Stakeholder register database (Excel template)	WP5
	Develop stakeholder engagement aims	Knowledge types approach (system, target, and transformation)	CSs supported by WP5
	Identify stakeholders to confirm the preliminary stakeholder list	Stakeholder register database (Excel file) Stakeholder differentiation and categorisation (3 tiers and 12 categories)	CSs
	Reach out to stakeholders to check interest to the project and identify new stakeholders	Phone calls, emails, informal talks, interviews	CSs
	Provide instructions (via e-mail, online-meetings, etc.) to CS on how to organize a workshop and specifically on stakeholder engagement [5.4]; Activity C.2 in Milestone 2	Meetings, emails Workshop checklist document	WP5
	Preparations Workshop 1: Communication about stakeholder engagement and how to organise the workshop [C.2]	Meetings	CS and WP5
WS1	Register of stakeholders attending the workshop	Stakeholder register database (Excel file)	CSs
	Identification of missing stakeholders	Stakeholders facilitated discussion	CSs and WPs supported by WP5
	Request filling the Privacy Policy Consent Form and update the stakeholder register accordingly	Stakeholder register database (Excel file)	CSs
Between WS1 and WS2	Keep open communication with stakeholders to: identify more stakeholders, obtain their consent to be engaged, and share PPCF (e.g., thanking participation in WS1 and reminding of the consent form)	Emails Phone calls, meetings, interviews	CSs supported by WP5
	Determine group of key stakeholders for the engagement process	Power-interest map	WP5 supported by CSs
	Map and understand relationships between the stakeholders	Actor-linkage matrix	WP5 (template and analysis), CS (content)

9.2.2 Initiating the stakeholders' co-creation process: interaction between the stakeholders of different sectors, awareness raising, setting the stage and data collection

At this stage of the process, all WPs and CSs contribute to raise awareness among stakeholders about the project and its ambitions, set the stage for the collaboration between the project and the stakeholders and collect the relevant data for the project work and the co-creation process. Table 12 below illustrates the process, with particular focus to WP1 activities. More details to other WPs activities can be found in Milestone 2.

Table 12: Actions that project partners need to take to initiate the stakeholders' co-creation process

When	What	How	Who
Before WS1	Policy inventory and coherence assessment	Policy inventory, coherence assessment tool	CSs, WP1
	Start mapping nexus interlinkages (conceptual maps)	Expert mapping	CSs, WP3
	Reach out to stakeholders to check interest to the project	Phone calls, emails, informal talks, interviews	CSs
	Inventory of data available and needed: which stakeholders have them and what is missing	Data inventory	CSs, WP2, WP3
WS1	Present the NEXOGENESIS project and the tools that will be develop Discuss expectations of stakeholders, interest in the project tools and capacity to contribute Preliminary discussion of main perceived WEFE nexus problems, WEFE nexus interlinkages and knowledge gaps (initial conceptual maps) Stakeholders to fill in survey on expectations, interest on project, capacity to contribute and discussion of results Discuss data availability and willingness to share Definition of next steps for the collaboration between the project and stakeholders	Stakeholder collaborative/participatory modelling Stakeholders facilitated discussion Survey on expectations, interest on project, capacity to contribute	CSs, WPs when asked to contribute to WS1, Stakeholders
Between WS1 and WS2	Start/continue developing the conceptual maps with WP3 and collect data for WP2: this may entail reaching out to the stakeholders to have access to data they may have	Expert mapping Phone calls, emails, informal talks	CSs, WP1, WP2, WP3
	Conduct governance assessment in the case study regions	Interviews for governance assessment (field work of the governance assessment team)	CSs, WP1
	Continue data inventory and data collection for WP3 and WP2 as needed	Data inventory	CSs, WP2, WP3

9.2.3 Facilitating the stakeholders' co-creation process: stakeholders´ engagement, management and sustainment for trust building and social learning

Stakeholders need to be engaged in the co-creation according to their interest and capacity to contribute, and the relationship of the project with them needs to be managed and sustained throughout the co-creation process. Here below is an overview of how stakeholder engagement, management and sustainment is done in NEXOGENESIS. The stakeholder engagement, management and sustainment are designed by WP5 and are conducted by the case studies with the support of WP5 (further details will be provided in Deliverable 5.1).

Stakeholder engagement plan: This plan elucidates who (which stakeholder) is engaged where (in which stage of the project – information, co-creation) and how (via which activities). The information on the CS's aims and context and the stakeholder identification and analysis helps locate stakeholders at different levels of interaction, from co-exploration to co-development, while specifying CS-specific focus activities and directions (see Table 13).

As stated in section 9.1, these plans may differ across CS; depending on their initial conditions and aims, some CS may focus on trust-building while others on generating data or awareness raising.

Table 13: Different interactions with stakeholders based on their categorisation

	Co-exploration	**Co-design**		**Co-development**	
	Information	**Consultation**	**Involvement**	**Collaboration**	**Empowerment**
Stakeholder category (expected - given NXG aim)	All categories	E.g., civil society, public initiatives, businesses, authorities, media	E.g., civil society, public initiatives, authorities	E.g., authorities and policymakers	E.g., authorities; and e.g., civil society, small enterprises
Power and Interest (PI)	Low PI	Low to medium PI	Medium PI	Medium to high PI	High PI and medium to low P with high I
CS focus (e.g., building trust)	Informing about results on held meetings and WS (e.g., email, newsletter)	Consult about perception of trust context (e.g., survey)	Involve in framing trust issues (e.g., survey, focus group, interview)	Engage in framing the issue and developing solution pathways (e.g., focus groups, interviews, workshops)	Engage in framing and finding solution pathways by themselves (e.g., focus groups, workshops, training/capacity building)

Management and sustainment: The main purpose of stakeholder management is to reduce the risk of stakeholder fatigue and maximising the gains of the stakeholder engagement for the project outcomes. It is about implementing the plan throughout the project to co-create content, as seen in the activities in Table 15 of section 9.2.4. Sustainment focuses on a longer-term view of stakeholder engagement to foster the use of the project's outputs and avoid a backlash once the project has ended. Table 14 below illustrates the activities that project partners will conduct to manage and sustain stakeholder's engagement.

Table 14: Actions that project partners need to take to manage and sustain stakeholders´ engagement

When	What	How	Who
Between WS1 and WS2	Present preliminary results of the stakeholder identification and analysis, discuss lessons learnt, and co-create case-specific stakeholder engagement plans	Facilitated discussion with CS and WPs	WP5
WS2	Present stakeholder engagement plans	Facilitated stakeholder discussion conducted by local project partners with support of WP5 for preparation	CSs, WP5
After WS2	Regularly check stakeholder's interests, expectations and perceptions of the project's advancements	Surveys, meetings	CS, WP5
	Regularly share updates with stakeholders (suggestion: at least once between workshops)	Emails (primarily). Other options are calls, meetings, informal talks	CS
	Share needs/requests of CS and WP for an aligned and coordinated communication with stakeholders avoiding their fatigue	Meetings	CS and WPs supported by WP5
	Ensure a channel for open communication with stakeholders	Email, calls, meetings	CS supported by WP5
Before ending the project	Identify target topics (e.g., SLNAE technical support) and set contact points for further interaction Find means and responsible stakeholders to: • Maintain the website of the project • Ensure accessibility to the developed tools (SLNAE and WEFE Footprint)	Survey to stakeholders Stakeholder engagement evaluation results Collaboration with stakeholders, link with existing or planned projects/initiatives	WPs with support of CSs

9.2.4 Developing the stakeholders' co-creation content: designing an action plan and ensuring coordination with existing policies

The stakeholders´ co-creation process in NEXOGENESIS aims to gather existing and develop new knowledge on a number of topics related to policy and governance, bio-physical WEFE nexus interlinkages, models and data, indicators, etc. Specifically, the content developed through the stakeholders' co-creation process includes:

- **Policy packages**: this is a list of policy instruments, related goals and targets to be included in the SLNAE;
- **Action plan (stakeholder agreement):** the action plan includes one validated policy package and one governance roadmap for the implementation of the plan. These are:
- **validated policy package** is a set of policies the stakeholders agree would be necessary to implement in their region;
- **governance roadmap for action plan implementation** is a document illustrating the actions and tasks per each involved stakeholders, including roles, responsibilities, financial instruments for governing and monitoring the implementation of the action plan.
- Input to define indicators to measure progress towards policy targets and indicators to report policy assessment results;
- Input to conceptual maps (WP3): stakeholders´ knowledge about the local context will be useful input information to WP3 to design the conceptual maps and the causal loops maps;
- Input concerning the SLNAE user interface features (WP4): stakeholders´ preferences will be elicited to ensure that the SLNAE is user friendly for the purposes of the case studies
- Input data for WP2: WP2 data sets will be validated and, if needed, integrated with stakeholders´ knowledge and data.

Table 15 below illustrates the actions to be taken during the co-creation process for developing the project content with a focus on WP1 activities. For details of other WPs activities with stakeholders see Milestone 2.

Table 15: Actions that project partners need to take for the co-creation of the project content

When	What	How	Who
WS2	Visioning exercise to define common goals of the project Validate policy inventory and coherence assessment Discuss preliminary results of governance assessment if and when relevant Discuss preliminary ideas of policy packages (i.e. policy instruments, targets and goals to include in the SLNAE); draft to be prepared in advance Discuss data: what is missing, who holds which data, willingness to share, etc. Discuss final version of conceptual maps of nexus interlinkages Discuss initial ideas of SLNAE features	Facilitated stakeholders´ discussion by CS partners with support of WPs for preparation Stakeholder collaborative/participatory modelling	CSs, WP1, WP2, WP3, WP4, WP5
Between WS2 and WS3	Complete governance assessment: identify barriers, leverages and entry points for governance change	Interviews for governance assessment (field work of the governance assessment team)	CSs, WP1
	Prepare a consolidated draft of policy packages and share it with invited stakeholders ahead of WS3	Fill in policy package template (Excel) and either share that or an extract of it in word	CSs, WP1
	Activities related to WP2, WP3 and WP4 (see project Milestone 2)	Regular, bilateral exchanges CSs, WPs	CSs, WP2, WP3, WP4
WS3	Validate policy packages (i.e. final list of policy instruments, targets and goals to include in the SLNAE) Discuss indicators to assess progress of policies towards their targets Discussion related to WP2, WP3 and WP4	Facilitated stakeholders´ discussion	CSs, WP1, WP2, WP3, WP4
WS4	Preliminary discussion with stakeholders of action plan and governance roadmap (based on the policy packages and governance assessment only) and feasibility of stakeholder agreement Discussion related to WP2, WP3 and WP4	Facilitated stakeholders´ discussion	CSs, WP1, WP2, WP3, WP4
Between WS3 and	Development of SLNAE Assessment of impact of policy packages for front runner cases: analyse results and	Regular, bilateral exchanges CSs, WPs Phone calls, emails,	CSs, WP1, WP2, WP3, WP4

WS5	prepare ideas for action plan + governance roadmap to be discussed with stakeholders	informal talks with stakeholders	
WS5	Front runners: discuss results of SLNAE impact assessment; present ideas of action plan and governance roadmap; identify policies for second run of SLNAE Followers: continue discussion of action plan, governance roadmap and stakeholder agreement Actions related to WP3, WP4, WP6 (see Milestone 2)	Facilitated stakeholders´ discussion	CSs, WP1, WP3, WP4, WP6
Between WS5 and WS6	SLNAE impact assessment for front runners (round 2): analyse results and prepare draft action plan + governance roadmap to be discussed with stakeholders SLNAE impact assessment for followers (round 1): analyse results and prepare ideas for action plan + governance roadmap to be discussed with stakeholders	Regular, bilateral exchanges CSs, WPs Phone calls, emails, informal talks with stakeholders	CSs, WP1, WP2, WP3, WP4, WP6
WS6	Front runners: validate policy packages, action plan and governance roadmap as basis for stakeholder agreement Followers: validate policy packages, converge on a draft action plan and governance road map as basis for stakeholder agreement	Facilitated stakeholders´ discussion	CSs, WP1, WP3, WP4, WP6

9.2.5 Implementing the stakeholder agreement: fostering stakeholders´ ownership of and commitment to the action plan

Once a stakeholder agreement is reached and signed, implementation in practice needs to occur. This means that each signing party has to take action to execute the tasks they committed to. It is not a reasonable expectation for the NEXOGENESIS case studies to reach this stage of the co-creation process within the timeframe of the project. However, the project considers lessons-learned from other projects to improve implementation by including accountability mechanisms into the governance roadmap.

In general, at the implementation stage challenges are expected to emerge such as delays in implementing measures due to technical, political or financial reasons but also stakeholders withdrawing from the agreement if they do not see real commitment in practice from all parties. To avoid stakeholders to withdraw from the agreement, the governance roadmap has to include a clear governing structure of the agreement designed to foster a sense of ownership, with stakeholders taking responsibility for the management of the agreement themselves. Such governing structure has to include rules, responsibilities and actions for governing and monitoring the action plan implementation (see also section 9.2.4). In particular, there has to be a clear coordinating body (organisation and person) of the planned implementation and resources for executing the coordinating function appointed at the start of the action plan implementation. Regular evaluation of the progress towards the agreed goals is also important for the implementation of the action plan and should receive adequate resources and planning.

Finally, to encourage stakeholders' ownership of the agreement, the case studies, depending on the specific context and content of the stakeholder agreement, could discuss the option of establishing citizen observatories as way to monitor progress of the plan. Citizen observatories are community-based environmental monitoring and information systems in which citizens collect data, typically via mobile phone or the web, and are empowered by the information generated from these data to support public authorities in environmental management. Citizens supporting the implementation of the stakeholder agreement could be a way to maintain commitment of the signing stakeholders when the local context is supportive of such form of citizen engagement.

10 Concluding remarks

This report illustrated the NEXOGENESIS stakeholders´ co-creation approach for WEFE nexus governance, which will be implemented in the five project case studies throughout the four years of the project.

The approach aims at supporting stakeholders in a certain region to co-create and commit to implementing WEFE nexus goals and policies through a stakeholder agreement, built around the concept of non-binding river contracts. Ultimately, this approach paves the way towards effective WEFE nexus governance in the region in which it can be implemented, provided that relevant stakeholders with the necessary capacity and power are involved and support the process. The implementation of the approach in the NEXOGENESIS case studies, but also in any other area, depends on the local context. This means that the steps and building blocks of the approach are intended as a guideline for the case studies to select from and adapt according to local needs.

The NEXOGENESIS stakeholders´ co-creation approach for WEFE nexus governance is organised in two main steps: 1) Nexus governance problem identification via governance and policy assessment in each case study to identify barriers, leverages and entry points for governance and policy change; 2) Stakeholders' co-creation of WEFE goals and policies and commitment to implementation through a stakeholder agreement. The stakeholders' co-creation process includes 5 building blocks: preparing the stakeholders' co-creation process; initiating the stakeholders' co-creation process; facilitating the stakeholders' co-creation process; developing the stakeholders' co-creation content; and implementing the stakeholders´ agreement.

In year four of NEXOGENESIS, experiences and lessons learned with the implementation of the approach in the five case studies will lead to a consolidated stakeholders' co-creation approach for nexus governance and a guidance for replication of the process in other contexts and across other nexus domains (D1.5 due by month 48). Specifically, Task 1.5 will compare the implementation of the stakeholders' co-creation approach in the CSs, draw conclusions and revise the initial approach accordingly.

The target audience of the final guidance will be any organisation at all scales across different nexus domains that have to initiate a bottom-up stakeholders' co-creation process for improving policy integration and foster transition towards nexus governance, with a particular focus on water management organisations such as river basin organisations, including transboundary ones, water and environment ministries and water utilities. The guidance will be design professionally in collaboration with WP6 (dissemination and exploitation) in a way that these stakeholders will be able to autonomously use it to design and implement their own stakeholders' co-creation for nexus governance. The project partners that developed and implemented the approach could advise stakeholders on the design and implementation of the approach based on the NEXOGENESIS experience.

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APPENDIX 1 – Overview of governance assessment frameworks in the literature

Name of the governance assessment framework	Purpose and main governance focus (actors, institutions, etc.)	Domain focus (water, nexus, transboundary, etc.)	Scale of implementation	Governance dimensions investigated	Data collection method	Key references
Governance capacity framework	Assessment of governance regime to help cities understand how to improve it	Applied in 5 areas of sustainable governance of cities with focus on the role of water in it: water scarcity, flood risk, waste water treatment, solid urban waste treatment, urban heat island	Applied at city scale	3 dimensions, articulated each in 3 conditions, each operationalised in indicators: Knowing: • Awareness • Useful knowledge • Continuous learning Wanting • Stakeholder engagement process • Management of ambition	Triangulation method: • Document analysis on 27 indicators • Interviews • Validation of scores with stakeholders	Koop et al. 2017

				• Agents of change Enabling: • Multilevel network potential • Financial viability • Implementing capacity		
The Transboundary (River) Basin Nexus Assessment	Enables stakeholders to identify positive and negative linkages, benefits and trade-offs between relevant sectors, while allowing the possibility to account for potential climatic and socioeconomic changes A way to identify solutions and concrete actions to create more sustainable and collaborative management of resources and to reduce tensions between sectors and countries.	Provides for a progression from the overall socioeconomic context of a basin and its surrounding region to a zooming in on the specific **intersectoral issues** at play (Water-Energy-Food nexus and Water-Energy-Food-Ecosystem nexus)	Applied at the river basin scale and transboundary basin scale	Based on 7 principles: • Participatory process • Knowledge mobilisation • Sound scientific analysis • Capacity building • Collective effort • Benefits and opportunities	6 steps: • Desk study or factual questionnaire • Stakeholder assessment • Key sectors analysis, with help of local authorities • Intersectoral and transboundary dialogue • Stakeholder dialogue and nexus dialogue • Issues and solutions/benefits	Roidt and De Strasser, 2018 De Strasser et al., 2016

NEXOGENESIS STREAMLINING WATER RELATED POLICIES

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					analysis	
The capital approach framework	Assesses the strengths and weaknesses of the governance for water management	Tries to understand the embeddedness of social values which is important for integrative and the transdisciplinary management of flood risk management	Applied at the district scale, area liable to flooding (residents or communities exposed to climate-induced risk (flood risk))	5 capitals: Social capital: • Social networks • Trust in the decision-making • Trust in policy-planning process Human capital: • Preparedness • Knowledge Political capital: • Transparency • Trust in political actions Financial capital: • Disaster funds allocated to provide assistance to affected people/communities Environmental capital:		Williams et al., 2018

NEXOGENESIS STREAMLINING WATER RELATED POLICIES

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				• Measures taken by society to help the environment regenerate		
The good governance framework	A governance assessment framework based on good governance principles and providing specific indicators	Designed for land resettlement		4 dimensions: Transparency: • Access to information • Openness of process Public participation and inclusiveness: • Actors involved • Decision-making process Equity and rule of law: • Fair and adequate compensation • Tenure security • Livelihood, equal treatment of parties and rule of law Accountability:	2 steps: Primary data collection tools: • Focus Group Discussions (FGD) • Structured and semi-structured interviews Secondary data collected: • Statutes • Regulations • Resettlement Planning Framework (RPF) • Claims made during the interviews	Asiama et al., 2017

NEXOGENESIS STREAMLINING WATER RELATED POLICIES

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				• Assignment of responsibilities • Accountability arrangement		
The water governance assessment framework	Develops a diagnostic and multidisciplinary water governance assessment framework, based on the 10 building blocks framework The aim is to identify the strengths and weaknesses in water governance capacity from a holistic perspective	Examines the main factors influencing water cooperation	Applied to a shared aquifer (transboundary basin)	Consists of 3 dimensions and 10 relevant elements generated from diverse disciplines: Content: • Water system knowledge • Values • Policy discourses Organisation: • Regulations and agreements • Responsibility • Authority • Means • Stakeholder involvement • Trade-offs between social objectives	3 steps: Desk research/ literature analysis: • Governmental and non-governmental reports • Political agendas • Policy documents • News • Academic publications Discussions held at a conference Additional perspectives from water experts	Dai, 2021

NEXOGENESIS STREAMLINING WATER RELATED POLICIES

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				Implementation: • Financing • Engineering • Enforcement • Conflict • Prevention • Resolution		
The water governance complexes assessment	Analyses transboundary water governance complexes and focus on nexus related issues	Focusses on the impacts of decisions in terms of the fairness and sustainability of water allocation, that reshapes the water governance context	Transboundary river basin	6 dimensions: Context: • Geo- and biophysical • Water resources • Socio-economic Drivers: • Interests • Discourses • Institutions Tools: • Deliberation • Technical		Dore et al., 2012

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				• Advocacy Arenas : • Actors • Power • Politics Decisions: • Framing • Supply • Demand Impacts • Fairness • Sustainability • Allocation		
The adaptive capacity assessment framework	Identifies the influencing factors for the adaptive capacity		Federal rivers	3 types of factors: Institutions • Division of powers and functions • Inter-governmental water allocation • Decision-making venue...		Garrick and de Stefano, 2016

NEXOGENESIS STREAMLINING WATER RELATED POLICIES

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				Infrastructure: • Financing • Planning • Operations Information: • Data monitoring • Joint monitoring • River system modelling		
The governance assessment tool	Assesses a governance context in a specific domain concerning a specific issue. Identifies governance conditions that can hinder or facilitate adaptation measures to solve the specific issue.	Assesses the governance setting of a specific region for the planning and realising of drought adaptation measures. The tool was also implemented before on water.	Regional context and also at the catchment scale or relevant scale of the issue.	5 dimensions of governance: • Levels and scales • Actors and networks • Perception of problem and goal ambitions • Strategy and instruments • Responsibilities and resources	Triangulation method: • Interviews with key informant • Document review on public policies and context of issues • Validation of scores with at least two observers	Bressers et al., 2015

NEXOGENESIS STREAMLINING WATER RELATED POLICIES

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				4 quality criteria: • Extent • Coherence • Flexibility • Intensity		
The Governance Assessment combining GAT and Strategic Niche Management (SNM)	Identifies governance conditions that can hinder or facilitate adaptation measures and studies the introduction and diffusion of new sustainable technologies through societal experiments that contribute to forming a niche	Provides insight into fostering technological and social change and at the same time initiates sustainable innovations	Niche level	See GAT	4 steps: • Stakeholder analysis • Semi structured interviews based on the GAT questions combined with quality criteria and key elements from SNM • Secondary document analysis • Meeting with researchers	Jain et al., 2017
The flood risk governance arrangement (FRGA)	Evaluates the extent to which flood risk governance arrangements support societal resilience, and demonstrate efficiency and legitimacy	Within this overarching arrangement, sub-governance arrangements		A Flood Risk Governance Arrangement can be defined as: • Actor networks	Benchmarking for: • Efficient flood risk governance • Legitimate FRG	Alexander et al., 2016

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		(subFRGAs) are discernible according to distinct goals within Flood Risk Management (e.g. spatial planning aims to minimise exposure, whereas defence reduces the likelihood of hazard occurrence)		• Rules • Resources • Discourses • Multi-level coordination mechanisms	• FRG supporting societal resilience	
The OECD Water Governance Indicator Framework	Provides a synthesised version of the OECD Water Governance Indicator Framework. A tool supporting the implementation of the OECD Principles on Water Governance, adopted by the OECD Regional Development Committee in 2015	Conceived as a voluntary self-assessment tool to assess the state of play of water governance policy frameworks (what), institutions (who) and instruments	Intended to be applicable across governance scales (local, basin, national, etc.) and water functions (water resources management, water services provisioning and water disaster	12 principles: • Clear roles and responsibilities • Appropriate scales within basin systems • Policy coherence • Capacity • Data and information		OECD, 2018 O'Riordan et al., 2021

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		(how), and their needed improvements over time	risk reduction)	• Financing • Regulatory frameworks • Innovative governance • Integrity and transparency • Stakeholder engagement • Trade-offs across users, rural and urban areas, and generations • Monitoring and evaluation Clustered around 3 dimensions: • Effectiveness • Efficiency and trust • Engagement		

NEXOGENESIS STREAMLINING WATER RELATED POLICIES

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