



This project is part of the PRIMA programme supported by the European Union.

Handbook

Water-Energy-Food-Ecosystems Framework 2.0

Guidelines to implement WEFFe Nexus in practice

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BONEX consortium



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1. Introduction

As the **world's population grows and environmental challenges become more complex**, it becomes increasingly important to understand and manage the **interdependencies of natural resources**, in particular where resource use in one area can have unintended consequences in another.

Some examples include:



Intensive agricultural practices secure food production but have led to the depletion of water resources and degrading ecosystems in many parts of the world.



The need for **energy production**, especially from hydroelectric or biofuel sources, has put pressure on water and land resources, and thereby negatively affected food security and ecosystem health.



Climate change exacerbates these challenges by altering precipitation patterns and increasing the frequency of extreme weather events, thereby changing the balance between water availability, food security, energy production and ecosystem sustainability.



In the context of these interrelated challenges, the concept of the **Water-Energy-Food-Ecosystems (WEFe) nexus** has gained increasing attention over the last decade as a way to understand the interconnection between the use of water and energy resources, the production of food, and protection of ecosystems. Adopting such a WEFe nexus perspective helps to reflect how decisions taken and resources used in one sector may significantly impact other natural resources, possibly leading to unsustainable outcomes.

1.1 Purpose of the WEFeF 2.0

Despite the broad interest of the scientific and policy community on the WEFe nexus, and the various different methods and tools that have been developed to study the WEFe nexus, many approaches focus on analysing the WEFe nexus without offering tools to develop solutions to the identified problem. Furthermore, existing frameworks, such as those developed under the United Nations Economic Commission for Europe (UNECE) Water Convention or the FAO WEF Nexus Approach tend to focus on the national level.

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Frameworks that take a **context-sensitive approach** seem to be lacking. To address these gaps, the WEFef Framework 2.0 (WEFef 2.0) has been developed as a practical guide for different types of stakeholders, to collaboratively identify and assess interventions, or solutions, that solve WEFef nexus problems and thereby enhance sustainability at local and regional levels – i.e., reducing water, energy or land use, protecting ecosystems and/or maintaining food production – and develop corresponding implementation pathways.

The focus of the WEFef 2.0 is on technical and/or organizational interventions, that are implemented at the local level, and that aim to improve the WEFef nexus:



Technical interventions

For example, they include solar irrigation, wastewater reuse, nature-based solutions (NBS), or energy-exporting solar greenhouses.



Organizational interventions

For example, they include payments for ecosystem services or command and control measures.



One intervention can have multiple impacts

The use of solar-pumped irrigation systems instead of grid electricity for water pumping can, for example, help farmers reduce greenhouse gas emissions or cope with energy shortages. On the other hand, by reducing energy costs and alleviating constraints of energy availability, solar irrigation can also lead to over-abstraction of surface and groundwater resources and negative impacts on associated ecosystems

The WEFef 2.0 allows us to identify these positive as well as negative impacts (i.e., trade-offs and synergies) that interventions may have on the WEFef nexus in a given area, and to develop additional policy measures that enable actors to manage and ultimately avoid or reduce these negative side effects.

1.2. Structure of the WEFef 2.0

The WEFef 2.0 is a conceptual and methodological framework to identify and assess interventions in a context-specific manner.

The framework has been iteratively developed and tested by researchers and practitioners from various Mediterranean countries within the **BONEX project** (Boosting Nexus Framework Implementation in the Mediterranean).

The WEFef 2.0 is structured in five phases:

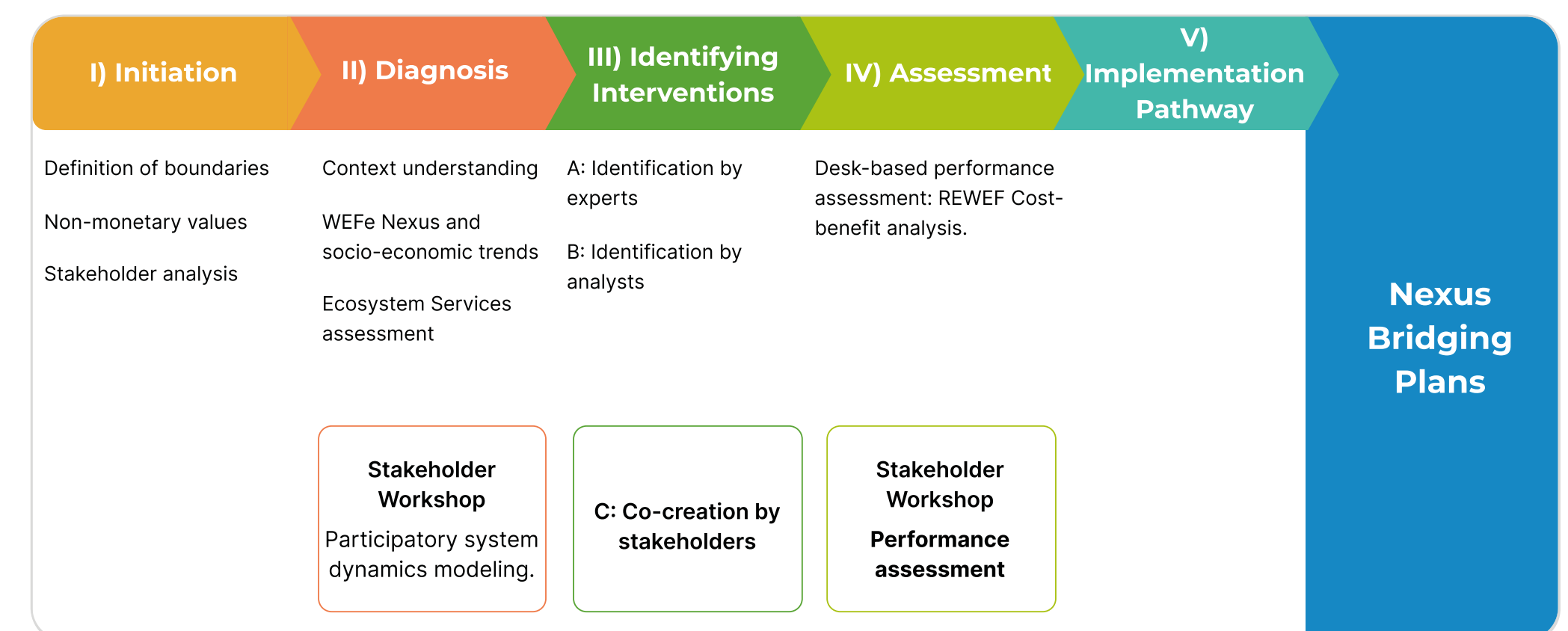


Figure 1.2: WEFef concept

Initiation Phase

i

Initiating the implementation of the WEFef Framework 2.0. by conducting three main methodological steps: Defining the boundaries of the system under study, analysing stakeholders, and optionally evaluating non-monetary values tied to ecosystem services.

1. Introduction

Diagnosis phase

Identifying, understanding and “diagnosing” the underlying causes of WEFe nexus challenges within the system. The WEFe nexus problem can encompass the biophysical and ecological, as well as the socio-economic dimensions of the focal area. Methodological steps include a context scan, assessing the WEFe nexus and socio-economic trends, conducting a stakeholder workshop for participatory system mapping, and if necessary, reconsidering system boundaries.

ii

Identifying interventions phase

Identifying possible solutions, whether technical, organizational, or governance-related, to address diagnosed problems. To identify and shortlist different interventions, three different methodological approaches can be selected: Identifying interventions by regional and/or local experts, by analysts, or by stakeholders through a co-creation process.

iii

Assessment phase

Evaluating the different interventions by assessing their potential performance, including impacts on Ecosystems Services, identifying barriers and facilitators to the implementation of the intervention, and analysing the facilitation of the implementation.

iv

Implementation pathway phase

This phase shall define specific actions, responsibilities, key actors and resources needed to implement the selected intervention. It may also identify other initiatives to align with or build upon them as well as the necessary alliances to tap into identified opportunities and reduce conflicts.

v

An important outcome of implementing the WEFeF 2.0 will be a context-specific implementation pathway, called **Nexus Bridging Plan (NBP)**.

These NPB summarise:

- the main insights and conclusions obtained from conducting the different WEFeF methods
- outline the steps, resources and actors that are required for a successful future implementation of the intervention
- corresponding policy measures in the area, with the overarching aim to improve problems related to the WEFe nexus in the area.

Conceptually, the WEFeF 2.0 adopts a:



Multi-scalar social-ecological-technological systems approach

Addressing the interlinked nature of human and natural systems. It builds on the Social-Ecological Systems (SES) Framework, developed by Elinor Ostrom (2007), which allows researchers to analyse how ecological and social systems interact within specific contexts, and shape system performance.

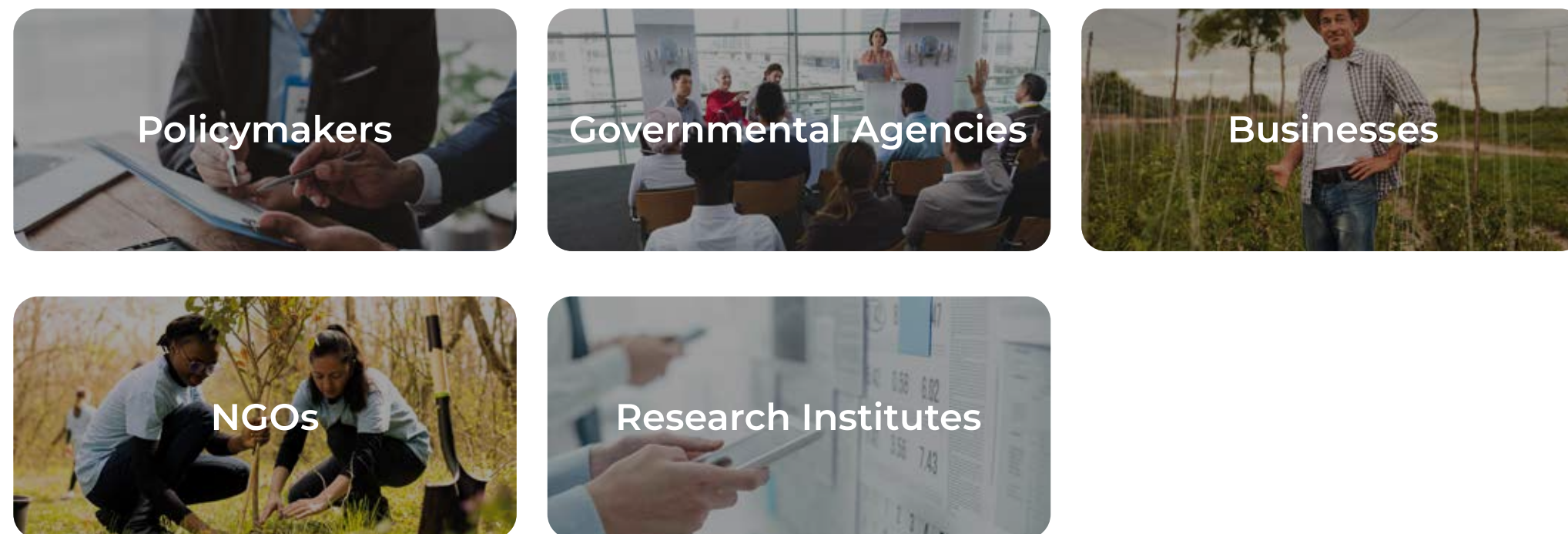


Systems thinking

Which serves as a holistic tool for addressing complex societal challenges. Systems are understood as interconnected elements that generate distinct behavioural patterns over time (Meadows 2009). This approach helps in understanding the dynamic interrelationships between system components and their drivers. In the WEFeF 2.0, systems thinking guides the identification and analysis of system components and their interactions. It helps in studying feedback loops, which shape the overall behaviour of a particular system, and identifying interventions to improve WEFe nexus problems (Antunes et al. 2015).

1.3. Guidance to use the handbook

The handbook is designed for different types of stakeholders:



The WEFef 2.0 is location-specific and thus area-based, meaning that it starts from the diagnosis of a problem in a specific geographic area. Key questions that the framework helps to address are:

- What are the best local organisational and/ or technical interventions for enhancing WEFef performance, thereby minimizing trade-offs and improving synergies within the WEFef nexus?
- How can these interventions be embedded into an overall solution approach to facilitate their implementation in a particular social-ecological context?

The handbook is structured into five distinct phases (see 1.2) and contains different qualitative and quantitative methods.

To implement them, the handbook provides detailed explanations in the form of “method protocols”. Analysts have the flexibility to select the most appropriate methods from the handbook based on various factors such as available resources, existing knowledge, stakeholder relationships, the nature of the problem being addressed or the accessibility of

information.

To implement the WEFef 2.0, it is therefore important either to already have well-established contacts with stakeholders in the field or to invest in developing such relationships.

The underlying rationale is that stakeholder engagement will:

- 1st** Improve the understanding of the WEFef nexus;
- 2nd** Legitimize the outcomes (i.e., the selected interventions and their implementation pathways of the framework implementation).

1.4. Getting familiar with the WEFef Nexus approach

The WEFef nexus approach is a concept that highlights the interconnections and interdependencies between four nexus components: water, energy, food, and ecosystems.

It emphasizes that these systems are deeply linked, and changes or decisions in one component can have significant impacts on the others.

The WEFef Nexus concept, originating in Western policy frameworks, offers a systems-based approach to managing interconnected resources.

However, it is top-down, and its technical nature often overlooks local knowledge, socio-cultural contexts, and stakeholder perceptions. In many regions, the WEFef nexus is not understood by

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key actors and local communities in the same way, thus challenging the operability of the WEFe nexus thinking and application (Albrecht et al. 2018, McGrane et al. 2018). This highlights the need for more inclusive, context-sensitive approaches that integrate local perspectives and knowledge in WEFe decision-making.

The WEFe nexus approach is designed to guide integrated management and policy-making to address challenges related to WEFe sustainability, resource use, and environmental protection. Here's a breakdown of what the WEFe nexus thinking is about (see also Figure 12):



Ecosystem is the most crucial WEFe component as it supports the other three components:

- Helps regulate water cycles, maintain biodiversity, and contribute to soil fertility (all of which are essential for food production).
- They also provide additional ecosystem services that energy systems may depend on, such as hydrological cycles that support hydroelectric power generation.



Water is essential for:

- Food production, energy generation, as well as for ecosystems.
- Agriculture and energy systems, such as hydropower or cooling in thermal power plants, rely heavily on water resources.

Note: Efficient management of the WEFe water resources is crucial for ensuring that all WEFe sectors have enough access to this vital resource.



Energy is required to extract, process, and distribute both water and food:

- 1st: The production of food often involves significant energy input (e.g., for irrigation, processing, and transportation).
- 2nd: In turn, energy systems themselves rely on water resources (e.g., for cooling in power plants or for hydropower generation).
- 3rd: Thus, optimising energy use and shifting to sustainable energy sources is essential to minimising negative impacts on water resources.



Food production is heavily dependent on water, energy, and ecosystems:

- 1st: Irrigation systems, fertilizers, and machinery all require water and energy.
- 2nd: Moreover, land and ecosystems provide the natural resources for growing food.
- 3rd: Agriculture must be managed in ways that conserve these resources and minimize environmental damage (such as reducing the impact on water quality or ecosystems).

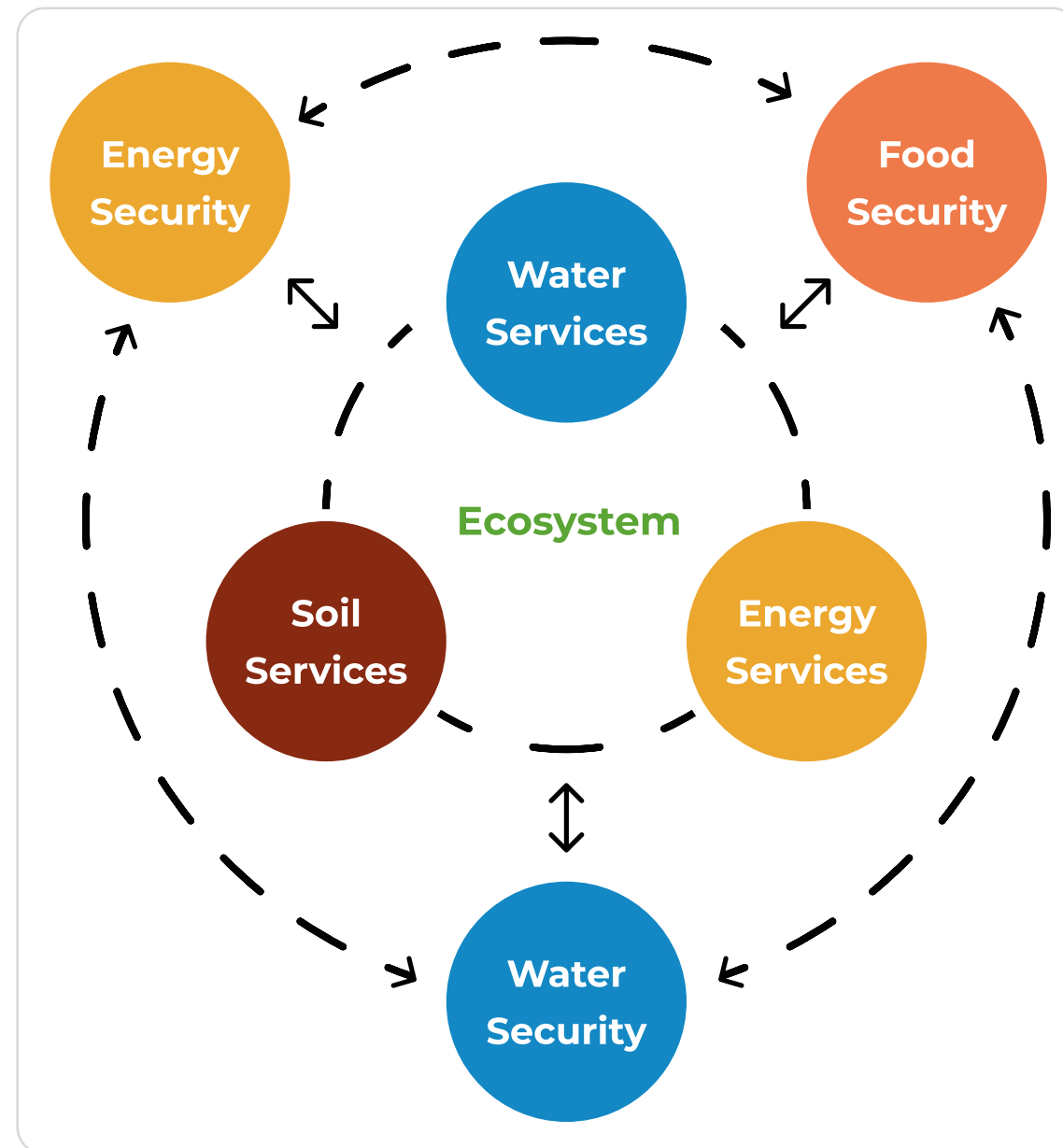


Figure 1.2: WEFe concept

The WEFe nexus thinking is thus an integrated approach to managing the interconnections among water, food, energy, and ecosystems to optimize resource use, minimize trade-offs and identify mismatch to ensure WEFe nexus sustainability. It emphasizes holistic decision-making by recognizing that actions in one component impact the others. Despite its complexity and governance challenges, WEFe nexus thinking is crucial for creating resilient and sustainable systems that balance human and environmental needs.

Analysing WEFe nexus trade-offs and mismatches for sustainability

The analysis of trade-offs and mismatches within the WEFe nexus (water, energy, food, ecosystems) is crucial for sustainability, as it helps balance competing demands and limited resources across sectors. Understanding these impacts allows for more sustainable solutions.

Examples of trade-offs include:



- Irrigation for agriculture competing with potable water or industrial needs.
- The growing demand for biofuels competing with food production for land and water.
- Thermal power plants and hydropower that consume large amounts of water, competing with agricultural needs.
- Ecosystem degradation, which affects all sectors (water, energy, food).

Many mismatches occur:

- Because stakeholders often overlook the importance of ecosystems (Albrecht, Crootof, and Scott 2018)
- Have a limited understanding of the water cycle (Bidoglio et al. 2019)

Note: This leads to conflicts and inefficiencies in resource management.

Protecting ecosystems is critical, as they provide essential services like water regulation, soil fertility and biodiversity. Which support the other three components of the WEFe nexus. By addressing these trade-offs and mismatches, more integrated and sustainable resource management approaches can be developed.

2. First phase: Initiation

Definitions WEFe nexus

The Water-Energy-Food-Ecosystems (WEFe) Nexus refers to the biophysical interdependencies (i.e., trade-offs and synergies) between the use and production of water, energy, and land resources, the production of food and protection of ecosystems. These interdependencies are associated with a particular practice of resource users (e.g., use of desalinated water which has implications for water, energy, and ecosystems) and are a fact of life. The nexus as such does not tell us how to govern or address them best.

WEFe nexus Trade-offs refer to situations where an action targeting one component of the WEFe nexus—water, energy, food, or ecosystems—has a direct impact on another component, either decreasing (trade-off) or increasing (synergy) the benefits it provides. These trade-offs arise from the interdependencies and interactions between the four systems, highlighting the challenge of optimizing one without causing adverse effects on the others.

A WEFe mismatch occurs when the interconnected demands and supplies of the WEFe components (water, food, energy, and ecosystem) are misaligned with the perceptions and preferences of actors involved in decision making, leading to inefficiencies, resource conflicts, and environmental degradation. This concept reflects the challenges of managing the WEFe components in an integrated and sustainable way, especially in the face of growing populations, climate change, and competing land use demands.

The framework addresses

Public, private, and civil society actors, such as policymakers, administrators, farmers, private companies, NGOs, or donors who are interested in improving the WEFe nexus.



The initiation phase, which is described in this chapter, involves three main methodological steps:

- i Defining system boundaries
- ii Conducting a stakeholder analysis
- iii Assessing non-monetary values associated with ecosystem services (optionally)

2.1. Definition of social and territorial boundaries

Why define boundaries

Defining the boundaries of the focal area is an essential initial step in analysing the WEF nexus and identifying potential solutions. This process involves determining the limits within which the study will be conducted (i.e., specifying who and what will be included, and who and what will be excluded from the study). The establishment of clear boundaries is therefore critical to clarify the scope and scale of the analysis, ensuring that the study remains focused and manageable.

Definitions: Boundaries

In the WEF Framework 2.0, the focal area is the main area under assessment where a solution approach to WEF nexus issues will be identified and implemented. The focal area is delimited by the social and/or territorial boundaries identified in this task and thus the outcome of this task. It can be a watershed, a specific landscape, an administrative region, or a farming community.

How to define boundaries in the WEF Framework 2.0?

The WEF Framework 2.0 applies to a specific geographic area, starting with the identification of a problem in that region. The boundaries are defined using guiding questions, without requiring data collection at this stage. The decision is made by the analyst or decision-maker based on their prior knowledge of the problem and the local context.

Guiding questions for reflecting system boundaries: What is in, and what is out?

- What is the broad WEF nexus problem to be addressed, and in what area? Does this area include all relevant natural resources that shape the WEF nexus or are affected by it, as well as the interconnections between the resources? Or are important resources and interconnections missing and the focal area should be expanded?
- Who are the actors that are directly or indirectly shaping the WEF nexus problems? Where are these actors located and/or operating?
- In which area and between which actors should the WEF nexus problem be improved?
- To what extent do the biophysical boundaries of the focal area (i.e., the boundaries that are defined by the WEF nexus problem) overlap with the socio-economic and administrative boundaries (i.e., the actors that are shaping the WEF nexus problem)?
- What are the institutional linkages that need to be considered? What are the implications for the boundaries of the focal area?

Expected output

The outcome of this first step is a brief description of the boundaries of the focal area where the WEF Framework 2.0 will be applied to improve WEF nexus issues. It should include a map highlighting the boundaries and explain the relationship of this area with other administrative or biophysical boundaries, such as watersheds or habitats.

2.2. Stakeholder analysis

Stakeholder analysis is a tool used to identify and classify stakeholders relevant to a specific organization, project, policy, etc.

It involves collecting information about groups or individuals affected by decisions, categorizing that information, and explaining the potential conflicts and synergies that may exist between important actor groups.

2.2.1 Why conduct a stakeholder analysis?

In the context of the WEFfe Framework 2.0, stakeholder analysis is an important tool to support the systematic and constructive involvement of stakeholders throughout and beyond the application of the framework in the focal area.

Stakeholder analysis helps:



- Identify the key actors in the focal area, ensuring that important stakeholders are not overlooked or insufficiently engaged.
- Supports the design of tailored strategies for meaningful and effective stakeholder participation.
- Further minimise disputes between different target groups and help resolve conflicts by creating room for dialogue among them.

In the context of the WEFfe nexus, important stakeholders include:

- Farmers, water managers and utilities (water and wastewater treatment and reuse)
- Energy producers and providers
- Ecosystem managers
- Public sector agencies, government, agri-businesses, distribution chains, civil society organisations and researchers/experts.

Note: Identifying which stakeholders need to be involved also strongly depends on the boundaries that are drawn of the focal area.

Identifying key stakeholders in the WEFfe Framework 2.0 also has its risks and limitations:

- If the stakeholder analysis is incomplete, such as missing key actors or over-representing certain groups, there is a risk that the entire research process, including its outcomes (i.e.,

the identified intervention), may become biased or unacceptable to some stakeholders.

- The process can be time-consuming and resource-intensive, potentially delaying the progress in the framework implementation.

2.2.2 How to do a stakeholder analysis for the WEFfe Framework 2.0?

Different approaches to stakeholder analysis exist, but in the context of the WEFfe Framework 2.0, the focus will be on identifying key stakeholders and their interests, and categorising them (Reed et al., 2009). This process provides a systematic and organised basis of information, helping to understand their agendas, interests, behaviour, and commitment. However, stakeholder analysis is dynamic, meaning stakeholders' positions may change over time, and new relevant actors may emerge during the process.



Step 1 - Identifying stakeholders

Identifying stakeholders is an iterative process, where new stakeholders are added as interviews progress. Snowball sampling is used to start with an initial set of stakeholders, interviewing individuals from these categories to identify new ones to include. The analysis begins with a list of potential stakeholders, based on prior knowledge of the area or a literature review, and should include at least one representative from each relevant sector. Interviews should be repeated until a comprehensive list is formed, and they should not be limited to experts but include a diverse sample of stakeholders.

Interview questions to identify stakeholders

When identifying stakeholders, please think about public, private and civil society actors from different sectors (water, energy, food, and nature conservation) as well as from different jurisdictional levels.

- Who is involved in, or affected by WEFe nexus problem in the focal area?
- Who could be interested in solving the WEFe nexus problems in the area? Who has specific knowledge or access to important resources?
- Who could hinder the solution of the WEFe nexus problems due to conflicting interests?
- Who can raise important questions regarding the WEFe nexus in the focal area? Who can have a refreshing perspective? Who could contribute to mitigate conflictive situations?
- To which sector (water, energy, food, ecosystems) do the stakeholders belong, at what jurisdictional level do they operate (local, regional, national), and what type of stakeholder are they (governmental, private, civil society, research) (see table below)?
- Which stakeholders are particularly important, because they either have a high degree of influence on WEFe nexus issues or are particularly dependent on it?

Optional pathways

If the region and the respective stakeholders involved in and affected by the WEFe nexus are already known, or if time or resources are limited, it may be decided to undertake a desk-based research and ask key actors (1–3) to validate and complete the stakeholder list.



Step 2 - Categorizing stakeholders

After the identification of stakeholders, each stakeholder should be classified according to the WEFe nexus:

- Sector(s) of interest (water, energy, food, ecosystems)
- The level (local, regional, national)
- The type (governmental, private, civil society, research) and their relation to the WEFe nexus, i.e., how actors uses a particular resource.

The information required can either be collected during the interview (see above), or through online research.

WEFe nexus sector	Name of entity/ organization	Level (Local, Regional, National)	Type (Governmental, private, civil society/NGO, research, other)	Relation with WEFe nexus (e.g., use or management of resource)	Importance (high, medium, low)
Water					
Energy					
Food					
Ecosystems/ nature conservation					

Table 2.1: Exemplary table for the categorization of stakeholders

Expected output

The main result of the stakeholder analysis is the completed table 2.1 in 2.2.2.

The table will be crucial for the next phases of the WEFe Framework 2.0: identified stakeholders will be invited to the different stakeholder workshops, or approached for other types of data collection. If many stakeholders are identified, the focus will be on the most important ones (right column). Depending on how the application of the WEFe Framework 2.0 evolves, new stakeholders may be added to the list, or some actors may be considered to be dropped.

Stakeholder analysis serves as the foundation for the next steps to come. Missing key stakeholders may have important implications for the legitimacy of next steps and the whole framework implementation.

2.3 Non-monetary values

The non-monetary value method aims to identify and assess the values generated by the WEF Nexus (water, energy, food, ecosystems) that do not have market prices but are important to individuals, communities, and organizations due to their connections with nature.

Optional pathways

This method is not mandatory but provides a broader understanding of the social, cultural, and ecological values of the WEF nexus. Identifying them early ensures a holistic approach to decision-making and aligns interventions with local community priorities

This method combines two analytical frameworks:

1. Type of values or multiple values (instrumental value, intrinsic values, and relational values) (Chan et al. 2016)
2. The Human Nature Connectedness (HNC) framework (Ives et al. 2018)

Definitions non-monetary values

Stakeholder, any person, group or organisation

Instrumental and commercial values
These values are rooted in market principles and monetary assessments within a tangible market context. They are embedded in market-centric ideologies and conservation programs that often involve some degree of commodifying nature and privatizing rights.

Intrinsic values

Intrinsic value pertains to the inherent moral rights of nature, biodiversity, and all species worldwide to simply exist. It emphasizes our recognition of nature's intrinsic right to exist.

Relational values

Relational values encompass preferences, experiences, and virtues associated with human-nature interactions and human relationships within the natural world (as defined by Chan et al. in 2016). Some examples of relational values arising from the connection between people and nature include stewardship of the landscape, cultural identity, adherence to local traditions, the symbolic significance of

the landscape, a sense of belonging, identity within the landscape, social ties etc. Relational approaches can inspire conservation efforts without ascribing a monetary "price tag" to nature, thereby sidestepping associated controversies and unintended consequences. on that has an influence on a policy, project or measure (including as an opponent) and is affected by it. These can be public, civil society or private actors.

Why use the non-monetary value method?

This method explores the multiple values that the WEF nexus holds for local communities, beyond traditional market valuations. It examines how people associate different types of values (instrumental, intrinsic, and relational) with WEF components (water, energy, food, ecosystems) and how these values shape human-nature relationships. The goal is to understand the importance of various dimensions of human-nature connections (material, experiential, cognitive, emotional, philosophical) in the socio-ecological context of the study area.



How to apply the non-monetary value method for the WEF_e Framework?

The methodological approach of the method is to conduct in-depth interviews with local stakeholders of the area of study. A sample of between 6-16 in-depth interviews is generally considered sufficient to perform a thematic analysis of this type.

Interview structure

The interview will be structured into different sections to collect information about:

- The multiple type of values that people associate with the WEF_e nexus
- The factors that explain the human-nature connection (material, experiential, cognitive, emotional and philosophical) within the WEF_e nexus
- Sociodemographic information (age, gender, educational level, type of occupation/work, etc.) of the study site

Dimensions of the Human-Nature Connectedness (HNC)

These dimensions can be at the individual or community level, and are ordered from least to greatest depth:

1. material, related to the extraction and use of resources;
2. experiential, associated with activities carried out in contact with nature;
3. cognitive, related to values and attitudes towards nature and knowledge about it;
4. emotional, relating to emotional ties and affective responses towards nature; and
5. philosophical, concerning the deep ideas of what nature is and why it matters (Ives et al. 2017, 2018).

The interview can be adapted to best suit the socio-ecological system that you are working in, some words may not be understood by all stakeholders and should be clear to everyone, so the data collection is as precise as possible for the future analysis.

3. Second phase: Diagnosis

The second phase of the WEF_e Framework 2.0, the diagnosis phase, is concerned with identifying, describing, and “diagnosing” the WEF_e nexus problem. The problem encompasses the biophysical and ecological, as well as the socio-economic dimensions of the focal area.

The diagnostic phase includes three (to four) methodological steps:

-  Context scan
-  Assessment of the WEF_e nexus and socio-economic trends
-  Conducting a stakeholder workshop for participatory system mapping
-  Reconsideration of system boundaries *(if necessary)*

3.1 Understanding the context

Why conduct a context scan?

The WEF_e Framework 2.0 aims to develop specific interventions to improve WEF_e nexus performance, considering local, regional, and national socio-ecological contexts. To achieve this, it conducts a context scan, which gathers socio-economic, environmental, and governance information relevant to the intervention.

Rather than providing a full description of the area, the scan focuses on key aspects influencing implementation (for example, if water scarcity is a concern, the analysis will examine water resources, consumption, regulations, and conflicts to ensure realistic and effective solutions).

Definitions context scan

Context refers to the external environment in which the case is embedded, which is assumed to be relatively stable over a longer period of time. The context is not amenable to change. It refers to the various conditions, circumstances, and environments that surround and influence actors, their interactions, and outcomes. It can encompass a wide range of factors, including social, cultural, economic, political, historical, and geographical elements

How to do a context scan?

The context scan is primarily based on desk research, including institutional reports and public statistics, and can be supplemented with key informant interviews if necessary. The depth of the analysis varies depending on available resources, but it is recommended to gain a broad understanding of the social and territorial aspects of the focal area.

The box below provides broad questions to facilitate data collection, ensuring a better understanding of the study area's context.

Guiding questions to understand the context of the focal area

Socio-economic context:

- What is the broader socio-economic context and related challenges of the region and/or state that could influence the WEFe Nexus and the implementation of WEFe nexus solutions? (e.g., economic situation, population growth, unemployment, corruption, perception of the severity of the WEFE nexus problems, ...)
- What are the main economic activities in the focal area in general, and the main agricultural activities in particular? What is the level of employment?
- What are the levels of education and income among different social groups? What are the levels of poverty and inequality in the region?
- Could these indicators influence the implementation of an intervention, and if so, how (e.g., high levels of poverty and low levels of education could hinder the implementation of an intervention that is very costly and requires high technical skills)?

Ecological setting:

- What are the most pressing issues in the focal area with regard to water resources, energy resources, food production, soil resources as well as ecosystems? Are there any significant environmental issues or challenges in the focal area (e.g., water scarcity, water pollution, soil degradation, deforestation, climate change, etc.)?
- What are the main trade-offs and interdependencies of the WEFe nexus in the focal area? (e.g. between water scarcity and food production; or water resources and CO₂ consumption?)

Governance context:

- What is the broader formal and informal governance and political context of the region or state that needs to be considered when implementing WEFe nexus solutions (e.g., state capacities, political stability, human security, political importance of addressing WEFe nexus problems, compliance with environmental regulations, etc.)?
- What are the existing policies related to the WEFe nexus problems reported above?

If it is not possible to obtain data that fully match the study area, information can be collected at a broader level. Understanding of the local context will improve throughout the implementation of the WEFe Framework 2.0. If different boundaries are used due to a lack of data, this should be indicated in the report/Nexus Bridging Plan.

Expected output

As the main output of the context scan, it is suggested to elaborate a context description that answers the questions outlined above in a precise and concise manner. This context description can be complemented during the process of implementing the WEFe Framework 2.0. It will be included in the final Nexus Bridging Plan.

3.2. WEFe nexus and socio-economic trends

Why analyze trends?

Trend analysis is important for understanding potential future scenarios impacting the WEFe nexus, especially in regions undergoing rapid socio-economic and environmental changes. While the context scan examines the current situation, trend analysis looks at future factors like population growth or urbanization, which can increase demand for water, energy, and food. These changes, along with the availability of natural resources and ecosystem quality, can affect the feasibility of interventions and should be assessed early in the WEFe Framework 2.0 implementation.

How to analyse WEF nexus and socio-economic trends?



Approach

A desk-based approach is used based on existing data, reports, and models that are readily accessible. The focus of the analysis should be on the main WEF nexus issues and socio-economic challenges, and the main aspects that shape WEF nexus problems that have been identified in the context scan. A clear connection to the WEF nexus issues in the focal area is needed to guarantee that the collected data are relevant for the next phases of the framework (i.e., the identification and assessment of specific interventions for the focal area).



Data sources

Databases (e.g. FAO, International Energy Agency, World Bank, or national statistics and databases), Reports (e.g., IPCC, EU, United Nations Environment Programme) and Country and Region-Specific Environmental Outlooks.



Scope

10 to 20 years to align with local, actionable interventions.



Boundaries

It may not be possible to collect data that completely overlap with the boundaries of the study area:

- In this case, information can be collected at the appropriate higher level of analysis.
- If different boundaries for data collection are chosen, it is important to indicate this in the report/Nexus Bridging Plan.

The box below provides broad questions that can be used as a guideline for collecting information on future WEF nexus and socio-economic trends. It is not necessary to answer all questions in detail. The focus should be on those natural resources or ecosystems that are most affected by the key WEF nexus challenges identified in the context scan.

Indicators to analyse current status quo and future trends of the WEF nexus and socio-economic factors

Water:

- What are the current levels of surface water and groundwater availability in the region, and what are the projected changes for the next 15–20 years (e.g. due to climate change, urbanization, and population growth)?
- What are the current rates of water consumption across different sectors (e.g. agriculture, industry, domestic), and what trends are projected for the next 15–20 years?
- How is water quality expected to change in the next 15–20 years, e.g. due to economic development and climate change?

Land use and food production:

- What are the current developments of land use change (e.g. urban expansion, deforestation, agricultural conversion), and what are projections for this development for the next 10–20 years?
- What are the current levels of agricultural productivity, and how may this change in the next 10–15 years, e.g. due to soil health, water availability or use of technology?
- What is the current status of soil health in agricultural areas, and how may this change in the next 10–15 years, e.g. due to agricultural practices and climate change?

Energy:

- What are the current levels of energy production and consumption, and what are the projected future trends considering factors like economic growth, or technological advancements in the next 10–15 years? What are the main energy sources (e.g., coals, oil, natural gas, renewables) in these trends?

Ecosystems:

- What are the current levels of ecosystem health, and what are the projected future trends (e.g., biodiversity, status of critical habitats), considering inter alia the influence of climate change and economic development?

Socio-Economic Drivers:

- What are the current and future demographic trends (e.g., population growth, urbanization, migration) in the region for the next 10–15 years that may impact the WEF nexus (e.g., resource use and ecosystem health)?
- What are the current and projected future economic growth rates, and how may these influence the WEF nexus?

3.3. Stakeholder workshop: Participatory system mapping

Participatory System Mapping (Lopes and Videira 2017; Sedlacko et al. 2014) is:

- Essential for analysing the WEF nexus as it provides a holistic view of the interconnections between the systems.
- Enables the identification of feedbacks, synergies, and trade-offs, facilitating more informed decision-making.
- Promotes the engagement of diverse stakeholders, integrating local knowledge into the analysis of WEF interlinkages.

Furthermore, PSM combines qualitative and quantitative data, offering a more robust analysis and helping to formulate effective, contextually tailored management strategies.

3.3.1. Why conduct participatory system mapping?

The aim of the PSM workshop in the diagnostic phase is to describe and diagnose the main WEF nexus problems in a participatory way. For this purpose, a stakeholder workshop should be conducted, using Participatory System Mapping, which involves designing a Causal Loop Diagram and undertaking a visioning exercise to discuss their vision for the region over the next 10 years. To develop a vision, all participants involved need to communicate their aims and develop a shared picture of the future.

**System**

Any group of interacting, interrelated, or interdependent parts that form a complex and unified whole that has a specific purpose.

**System Thinking**

Systems thinking is a way to approach issues by looking at them as systems. Rather than considering each element, or WEF dimension, in isolation systems thinking focuses on how these elements connect to make a whole.

**Participatory System Mapping (PSM)**

Is a collaborative method for visualising and analysing complex systems by engaging diverse stakeholders to co-create causal models. This approach helps visualise relationships in systems, supporting communication and collaboration between places and local communities. PSM typically involves creating network diagrams of factors and their causal connections, annotated with salient information from participants such as importance and potential changes.

**Causal Loop Diagram (CLD)**

CLDs are a tool to provide visual representations of dynamic relations of systems' components. This tool provides a language for articulating the understanding of the dynamic, interconnected nature of our world.

Visioning

Fundamental task in any strategic planning process, and it is fundamental to draw a vision (the destination) in order to be able to define a roadmap (strategic plan) of how to get there. Visioning leads people to focus on the end result (what success look like) rather than on the current difficulties and problems. By getting people to think about future aspirations, creative and out-of-the-box ideas are more likely to emerge.

The process of participatory system thinking and the visioning should be organized in a workshop setting, where relevant stakeholders are invited to collaborate in the creation of a common idea of concerns for the organization, area and/or context.

Who should be invited to participate in the workshop?

All relevant stakeholders identified through the stakeholder analysis (Section 1.2) should be invited to participate in this process. Given the complexity and interconnections within the WEF nexus, it is critical to involve a diverse range of participants. This includes representatives from the key sectors and stakeholder groups directly influencing or impacted by the nexus, such as:

- Farmers and Agricultural Cooperatives (including small and large-scale producers, irrigators, and those dependent on different water and energy sources);
- Public Administration (representatives from local, regional, and national levels, covering water management, agriculture, energy, and ecosystem protection);
- Energy, Water, and Agricultural Service Providers (private companies, utilities, and technology providers working on water efficiency, renewable energy, and sustainable agriculture);
- Knowledge Providers and Researchers (universities, research institutes, and technical experts involved in water, energy, agriculture, and ecosystems research);
- Civil Society and NGOs (organizations focused on environmental conservation, community development, and social equity);
- Ecosystem and Nature Conservation Actors (those involved in biodiversity conservation, land use planning, and ecosystem services management).

To ensure a balanced and inclusive dialogue, participants should represent a variety of characteristics within each group (e.g., large and small producers, local vs. central administration) and emphasize gender balance. Additionally, involving stakeholders from all

WEFe sectors and at different levels (local, regional, national) will promote comprehensive and innovative solutions to nexus challenges.

3.3.2. How should the workshop be organised?

The following stages involve carrying out two collaborative participation exercises, in which all stakeholders are invited and encouraged to share their ideas and perspectives of the territory.

Script for participatory system mapping workshop (3-4 hours)

Welcome and introduction

- Introduce the challenge of the WEF nexus
- Explain the purpose of the workshop and a brief introduction to the agenda and the exercises.

Visioning exercise

How should the vision exercise look like?

A vision exercise should be challenging by pushing beyond the status quo while remaining practical and realistic, desirable to generate enthusiasm among the group for the ideas presented, and positive by framing proposals in affirmative and constructive language.

The visions are described in a vision statement, summarizing the long-term goals and aspirations of a community/organizations. A suitable vision statement should:

- Be written in the present, not future tense. It must describe how stakeholders live/work/ manage/ operate in the focal area, as if they have already reached the vision.
- Describe an outcome, the best outcome stakeholders can imagine, without providing quantitative targets or measures of success.
- Be concise – 2-3 short sentences should be enough – and start with a powerful phrase that summarizes the main aspirations of the group.

Exercise steps:

1. Explain the concept of visioning and ask participants to imagine a future in 10 years from now.

The goal is to move beyond current problems and focus on what an ideal, sustainable future could look like (a vision statement may be written, usually in the present tense, conveying the future reality envisioned by participants).

2. Divide participants into groups of 4-6 people. Ask some questions to support participants' imagination. Questions always relate to the situation in 10 years:

- Water: how is water distributed and used?
- Energy: what sources of energy do we use?
- Agriculture/Production: what type/model of agriculture/animal production do we have?
- Biodiversity and Landscapes: what is the status of landscapes and biodiversity?
- Climate Adaptation: how do we secure climate adaptation and resilience?
- Technology: what is the role of technologies?
- Society: how does the society change? How are the communities engaged in decisions about water, energy, food, and ecosystem management?

Encourage participants to think creatively and positively, emphasizing that no idea is wrong. Record their suggestions on a flipchart, ensuring that all ideas are captured.

3. Share the group vision and discussion

Each group should choose a representative who will briefly share the group's vision and present the key ideas.

Systems thinking – Using Causal Loop Diagrams to understand the WEF nexus challenges

Participants should collaborate to identify and frame key issues and develop a Causal Loop Diagram to map system interactions.

Divide participants into groups of 4-6 people distributed by Water, Energy, Food and Ecosystems (each table as a WEF nexus component) **and ask them to undertake the following activities.**

Provide a flipchart, post-it and pens to each group so that they can freely organize their ideas and design the CLD.

- **Identify Variables:** Participants shall start by listing all relevant variables that influence the system under study. These variables should capture essential aspects of the systems' dynamics, including both problem variables and causal factors. The variables should not be ambiguous, and have clear directionality, but not imply a behaviour (e.g. NOT "Increase of GHG emissions" BUT "GHG emissions"). The links between variables should be easy to trace in the model.
- **Define Relationships:** Participants are asked to establish the relationships between the variables, and to determine which variables influence others and how they do so. This involves identifying direct and indirect causal connections.
- **Indicate Causal Links:** Participants shall use arrows to connect variables, showing the direction of influence. An arrow from Variable A to Variable B indicates that A affects B.

Label Relationships: Participants shall annotate the arrows with symbols indicating the type of relationship:

1. A "+" (positive) sign means that an increase in Variable A leads to an increase in Variable B (or a decrease in A leads to a decrease in B).
2. A "-" (negative) sign indicates that an increase in Variable A leads to a decrease in Variable B (or vice versa).

- **Create feedback loops:** A feedback loop in a causal loop diagram (CLD) represents the circular cause-and-effect relationships between variables in a system. (See Figure 31 for an example of a feedback loop and its narrative.)

1. Reinforcing Loop (Positive Feedback Loop- R): Amplifies change, leading to exponential growth or decline. Represented by a loop with an even number of negative links (or none).
2. Balancing Loop (Negative Feedback Loop- B): Stabilizes the system by counteracting changes and promoting equilibrium. Represented by a loop with an odd number of negative links.

Presentation of each CLD by each group to the plenary

Each group explains the connections and feedback loops they identified, allowing everyone to see how different components of the WEF nexus interact, constructing a narrative of this system.

4. Closing of the workshop

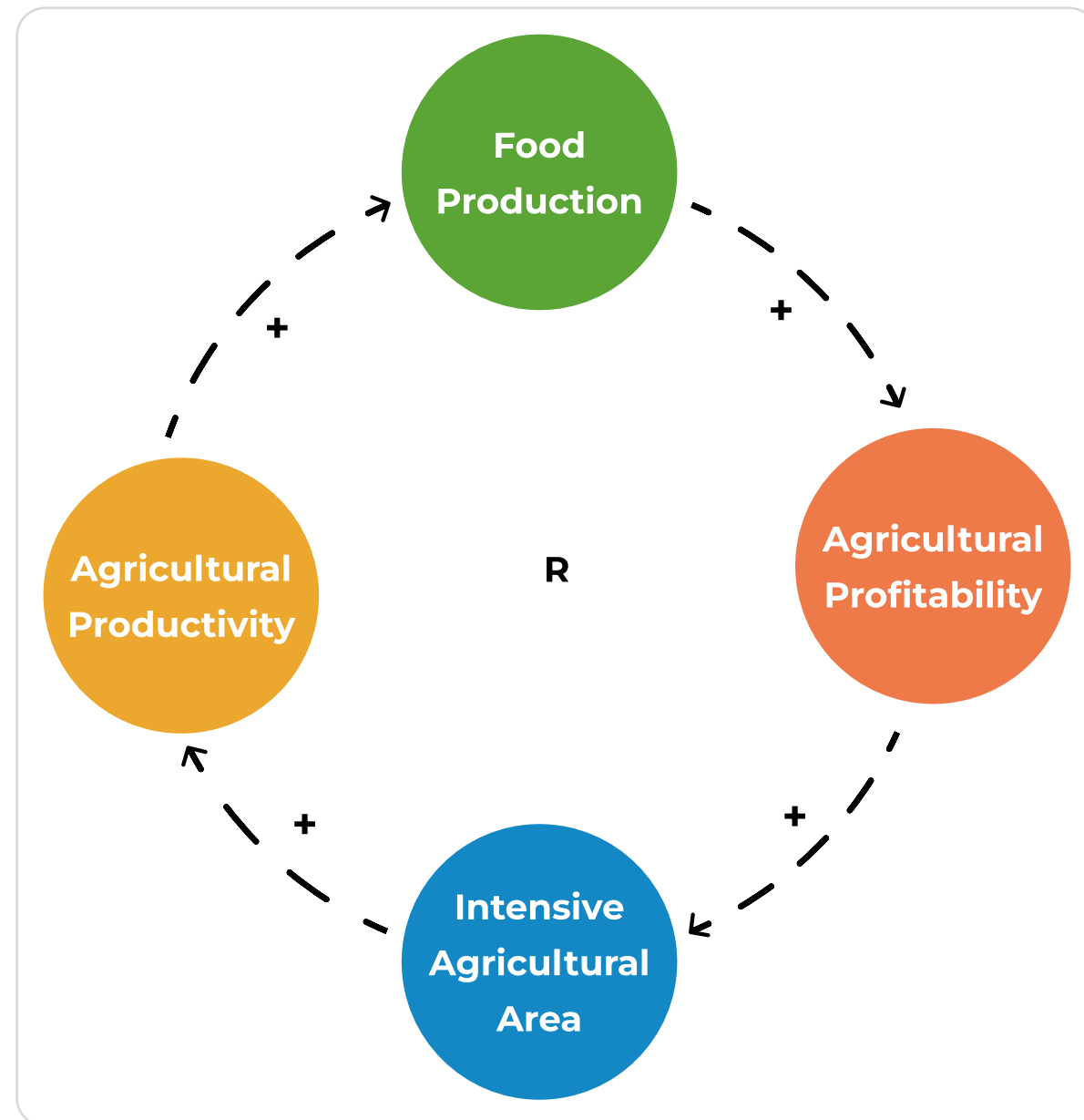


Figure 3.1. Causal Loop Diagram Loop Example

Narrative: This diagram illustrates a positive feedback loop (reinforcing loop) where the intensive agricultural area leads to agricultural productivity, which raises food production, causing more agricultural profitability and consequently increases the intensive agricultural area.

Tips for Effective CLD Design:

- **Simplicity:** Keep the diagram as simple as possible while capturing essential dynamics. Overly complex diagrams can be confusing.
- **Collaboration:** Involve participants from different backgrounds to gather diverse perspectives and insights.
- **Iterative Process:** Be open to revisiting and refining the CLD as new information or insights arise during discussions.

The Causal Loop Diagram should:

- Look at the big picture and consider multiple perspectives;
- Allow to understand the dynamic behaviour of a complex system
- Look for root causes of problems in the area;

- Challenge and change stakeholders' paradigms.

Causal Loop Diagram Post-production

After completing the Causal Loop Diagram during the stakeholders' workshop, it is essential to refine the diagram in a process understood as "post-production" (Lopes and Videira, 2015). This refinement aims to enhance the system map while preserving the core structure established by the participants. The post-production process enhances the initial CLDs by ensuring clarity, coherence, and scientific rigor. It transforms the CLD generated diagram developed by stakeholders in the workshop into a refined system map that:

- Strengthens logical connections, by ensuring all causal relationships are clear and meaningful, the refined CLD becomes a reliable analytical tool.
- Simplifies Complexity, by aggregating variables, resolving redundancies, and visually distinguishing relationships to make the diagram more accessible for future applications.
- Bridges knowledge sources, based on insights gathered from literature reviews. This information supports content modifications to the CLD, such as aggregating variables, formalizing causal links and feedback loops, and specifying variable names.

To simplify the diagram, different colors can be used to represent the relationships between the elements. The CLD should be conceptualized as sentences describing the key variables (nouns) and their causal relationships (verbs), expressed in the present tense. After refinement, the CLD serves as a tool for system analysis and should be validated with stakeholders in the "Interventions Assessment Workshop" (see phase 4). The diagram should be revisited as the project progresses and more data becomes available, to ensure its accuracy and relevance. The refined CLD helps identify leverage points, facilitates scenario analysis, and guides strategic planning.

Expected output

After the workshop, a brief report should be prepared outlining the process and outcomes, including the following elements:

- Venue, date, and agenda;
- A list of participants, detailing their gender, affiliation, and stakeholder group, based on the categories outlined in the section "Who should be invited to participate in the workshop?";

- A description of the activities conducted and the results achieved;
- The vision statement agreed upon by the participants;
- Finally, include the CLD designed by the stakeholders during the workshop and the post-production version created by the project team, and the narrative derived from the refined or enhanced CLDs.

Note: It would be helpful to include photos from the session and images of the materials developed by the groups to visually illustrate the process.

3.4. Ecosystem service assessment

The assessment of ecosystem services (ES) focuses on the characterization of the social-ecological context and broad understanding of the main ES provided by:

- The focal area (presence and importance of ES)
- Their associated values
- Potential existing trade-offs and synergies, associated with different social-ecological factors.

The ES assessment will be based on a social dimension (qualitative), integrating the importance that ES have for the different stakeholders involved in the focal area.

This method can serve as a complementary approach and can thus be integrated into the stakeholder workshop for participatory system mapping (see 2.3). It can provide insights into the complex relationships between ES and social-ecological factors, fostering a shared understanding among stakeholders.

? Definitions ecosystem services assessment

Social-ecological system

The term social-ecological system refers to the system that is being studied, formed by an ecological part and a social part that interact continuously.

Ecosystem services

Understood as a component of socio-ecological systems, they allow capturing, expressing, and visualizing the key role of ecosystems in providing multiple benefits to human beings, with the aim of contributing to the improvement of the current and future management of natural resources, in order to achieve an increasingly effective and sustainable management.

ES can be classified into three broad categories (Haines-Young and Potschin 2018):

- Provisioning: contributions or benefits to human well-being that are obtained directly from ecosystems (biotic and abiotic components), such as water, food, wood, materials, etc.
- Regulating: contributions or benefits that can modify and regulate the environment that affects human well-being, related to the regulation of the natural processes of ecosystems, such as climate regulation, water purification, flood control, etc.
- Cultural: intangible and immaterial contributions or benefits that can affect physical and mental well-being and that we obtain from ecosystems through our experience or interaction with them, such as aesthetic enjoyment, tourism, cultural heritage, etc.

ES Trade-offs – Synergies

Situations that arise when the use of one ES directly decreases (trade-off) or increases (synergy) the benefits provided by another. This may be due to a simultaneous response to the same driver of change or due to interactions between ES (Baró, Gómez-Baggethun, and Haase 2017).

Why use Ecosystem Service Assessment method?

In the context of the WEF nexus, understanding the socio-ecological system helps capture the values, preferences, and priorities of stakeholders. This approach also identifies key ecosystem services (ES) and their links to other social-ecological factors that may cause conflicts among actors.

Advantages, risks, and limitations include challenges in applying the academic ES concept to local contexts, time limitations associated with interviews and participatory activities, and difficulties in answering open-ended questions due to cultural differences.

Therefore, it is important to adapt the methodology to the specific case study.

3.4.1. How to do an assessment of ES for the WEFe Framework?

The assessment of ES is split into two steps:

-  Assessment of ES based on a survey
-  The validation of ES which will be done in a participatory activity (workshop/online meeting...). - *This step can be combined/integrated into the workshop for participatory system mapping (see 2.3).*

Assessment of ES

Description

The aim of this method is to get a broad understanding of the ecosystems and landscapes that are important to local stakeholders; the benefits they perceive and associate with these ecosystems and landscapes; the ecosystem services they associate with the WEFe components; the socio-environmental problems and challenges they perceive; and the possible links with other social, ecological, economic, political, and cultural factors in the focal area. This will be done by implementing detailed surveys to stakeholders.

Methods and Data Collection

Data will be collected through a survey. Ideally, this will be done before the stakeholder workshop. Depending on the possibilities and needs of the case study, the survey can be done:

-  Through a google form that is shared by email with participants of the stakeholder workshop, and which must be answered before this activity (see example of the ES survey) (preferred option). - *Alternatively, the survey can be conducted face-to-face with participants, depending on the case study needs.*
-  Face to face with the workshop participants.

ES survey template

Introduction

The purpose of this form is to gather the opinions and insights of key individuals and social agents in the “..... region” regarding the main environmental, social, and economic challenges facing the area. Please note that this form is completely anonymous, and there are no right or wrong answers—we are simply interested in your perspective.

Module 1. Benefits of the “..... region” to society

1. Do you think that the “.....region” offers any type of benefit for the people who live in this region? *With the term benefits we refer to the different types of social, cultural, economic or environmental benefits that the “.....region” offers to the people who live in or visit this region.

☐ Yes ☐ No

1.1. If yes, how many benefits do you think it offers people?

☐ A lot ☐ Enough ☐ Few ☐ Any ☐ I don't know

1.2. For example, which ones? Could you identify some examples of the benefits that the “.....region” offers? Identify as many benefits as come to mind.

1.
2.
3.

2. What do you think is the state or health of the environment or ecosystems that makes up the “.....region”?

☐ Optimum ☐ Good ☐ Bad ☐ Very bad ☐ I don't know

3. Do you think that any of the ecosystems (environment/ landscape) in the ...region are being over-exploited or have reached their limit or exhaustion?

☐ Yes ☐ No

4. If so, could you tell us what ecosystems or landscapes they are and what would be the main causes and possible solutions for them, in your opinion?

☐ Ecosystem/Landscape ☐ Causes ☐ Solution

Module 2. Water – Energy – Food in ...

5. In your opinion, what are the main benefits related to water resources in theregion? Please indicate a maximum of 5 examples of benefits. If possible, please also indicate which social groups or individuals benefit or are affected by each example.

Benefits	People/groups benefited	People/groups affected
----------	-------------------------	------------------------

2. What do you think is the state or health of the environment or ecosystems that makes up the “.....region”?

☐ Optimum ☐ Good ☐ Bad ☐ Very bad ☐ I don't know

3. Do you think that any of the ecosystems (environment/ landscape) in the ...region are being over-exploited or have reached their limit or exhaustion?

☐ Yes ☐ No

4. If so, could you tell us what ecosystems or landscapes they are and what would be the main causes and possible solutions for them, in your opinion?

☐ Ecosystem/Landscape ☐ Causes ☐ Solution

Module 2. Water – Energy – Food in ...

Water

5. In your opinion, what are the main benefits related to water resources in theregion? Please indicate a maximum of 5 examples of benefits. If possible, please also indicate which social groups or individuals benefit or are affected by each example.

Benefits	People/groups benefited	People/groups affected
----------	-------------------------	------------------------

Energy

6. In your opinion, what are the main related benefits associated with the production or consumption of energy in the “..... region” Please indicate a maximum of 5 examples of benefits. If possible, please also indicate which social groups or individuals benefit or are affected by each example.

Benefits	People/groups benefited	People/groups affected
----------	-------------------------	------------------------

Food production

7. In your opinion, what are the main benefits related to food production in the “..... region”? Please indicate a maximum of 5 examples of benefits. If possible, please also indicate which social groups or individuals benefit or are affected by each example.

Benefits	People/groups benefited	People/groups affected
----------	-------------------------	------------------------

Module 3. Challenges for “.....”

8. In your opinion, what are the main environmental, social and/or ecological challenges in the “..... region”? Could you identify the 3 main challenges and possible solutions?

Challenge	Solution
-----------	----------

[illegible]

The results of the ES survey need to be revised and summarized for validation in the next step. Based on these results, the aim is to identify the key conclusions regarding the ecosystem services, possible conflicts or synergies, and the social-ecological context of the area. The results will be used as background material to conduct the participatory activity with stakeholders.

Validation of ES assessment

This method validates the Ecosystem Services (ES) assessment by integrating stakeholders' knowledge, refining the socio-ecological characterization of the focal area. The goal is to identify and validate the WEF nexus and related ES, highlighting their interactions, trade-offs, and synergies, with a focus on local perspectives and including both visible and less obvious ES.

Proposed methodology for the participatory activity (Validation ES)

Step 1

Introduction & Framing The session begins with a brief introduction to the concept of Ecosystem Services (ES), using examples that are directly relevant to the focal area. Facilitators explain how ES contribute to human well-being and their connection to the Water-Energy-Food-ecosystem (WEFe) Nexus. The goal is to ensure that all participants, regardless of their background, have a common understanding of ES and their role in the socio-ecological system. Following this, the preliminary results from the ES assessment (based on surveys and initial stakeholder input) are presented, highlighting key ES and their perceived importance.

Step 1

Introduction & Framing The session begins with a brief introduction to the concept of Ecosystem Services (ES), using examples that are directly relevant to the focal area. Facilitators explain how ES contribute to human well-being and their connection to the Water-Energy-Food-ecosystem (WEFe) Nexus. The goal is to ensure that all participants, regardless of their background, have a common understanding of ES and their role in the socio-ecological system. Following this, the preliminary results from the ES assessment (based on surveys and initial stakeholder input) are presented, highlighting key ES and their perceived importance.

Step 2

Stakeholder input using CLD: Participants review the initial structure of the Causal Loop Diagram (CLD) to ensure it accurately represents key interactions within the system. At this stage, they are encouraged to refine or add missing elements based on their knowledge and experience. To facilitate engagement, a sticker-based ES integration is introduced. Each participant receives color-coded stickers representing different ES categories: Provisioning (e.g., food, water, raw materials), regulating (e.g., climate regulation, water purification), and cultural (e.g., tourism, cultural heritage, recreation). Participants place stickers on the CLD components where they perceive relevant ecosystem benefits, effectively linking ES to specific system elements. A discussion follows, allowing participants to reflect on trade-offs, synergies, and overlooked ES in the system.

Step 3

Discussion & Co-Creation of the Narrative A guided discussion follows the sticker activity to help interpret the emerging patterns. Facilitators ask questions to encourage reflection: Which ES are most important in this system? How do they interact with key social, economic, and political factors? Are there ES that have been overlooked? What trade-offs and synergies exist? Participants debate and refine the causal relationships within the system, identifying how ES influence and are influenced by social-ecological dynamics.

Stakeholder input using CLD: Participants review the initial structure of the Causal Loop Diagram (CLD) to ensure it accurately represents key interactions within the system. At this stage, they are encouraged to refine or add missing elements based on their knowledge and experience. To facilitate engagement, a sticker-based ES integration is introduced. Each participant receives color-coded stickers representing different ES categories: Provisioning (e.g., food, water, raw materials), regulating (e.g., climate regulation, water purification), and cultural (e.g., tourism, cultural heritage, recreation). Participants place stickers on the CLD components where they perceive relevant ecosystem benefits, effectively linking ES to specific system elements. A discussion follows, allowing participants to reflect on trade-offs, synergies, and overlooked ES in the system.

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3.5. Reconsidering system boundaries at later stages

During the initial phase of the WEF_e Framework 2.0, the boundaries of the focal area were defined, but they may need to be adjusted as the understanding of the WEF_e nexus problem evolves. This is because the problem may turn out to be different from what was initially assumed, requiring changes in the biophysical and/or socio-economic boundaries of the focal area. The box below provides questions to help consider these possible changes.

Guiding questions for reconsidering system boundaries

Considering the results of the stakeholder workshop (i.e., the main problem statement of the Causal Loop Diagram), ...

- i. Do the system boundaries decided at the beginning of the framework implementation correspond to the main WEF nexus problem that the stakeholders want to work on?
- ii. Do the initial boundaries include all relevant natural resources that shape or are affected by the WEF nexus, or are important resources missing?
- iii. Do the initial boundaries include all relevant actors that directly or indirectly shape the WEF nexus problems?
- iv. What are the implications for the boundaries of the focal area, does it need to be enlarged or reduced?

If the boundaries of the focal area change from those originally defined, the description of the boundaries (see output above) needs to be adapted. This includes an update of the map and of the description how the system boundaries relate to (other) administrative and/or biophysical boundaries.

4. Third phase: Identifying interventions

The third phase of the WEFFe Framework 2.0, the identifying intervention phase, is focused on identifying technical, organizational and/or governance-related interventions to address the WEFFe nexus problem diagnosed in previous phases (i.e., the undesirable state of water, energy, ecosystems, and/ or food production). As one of the main tasks of the WEFFe Framework 2.0, this phase is crucial for developing actionable solutions.

There are three different methodological approaches to identify and shortlist interventions, which can be selected depending on personnel and financial resources, time, risk of stakeholder fatigue, etc. These approaches are:



A. Co-creation of interventions by stakeholders



B. Identifying interventions by local experts



C. Identification by analysts.

Note: Option A is the most time- and resource-intensive, but it has the advantage of the highest stakeholder legitimacy, followed by Option B, and finally Option C.



Definitions interventions

In the context of the WEFFe Framework, interventions are understood as local technical or organizational intervention, or a combination of both, aimed at improving the WEFFe nexus.

Technical interventions include, for example, solar irrigation, wastewater reuse, nature-based solutions (NBS), or energy-exporting solar greenhouses. Organizational interventions include, for example, payments for ecosystem services or command and control measures.

Interventions for agricultural water use: drip irrigation, treatment of wastewater, desalination, rainwater harvesting, hydroponics, energy efficiency technology, solar irrigation systems, ecological pond management, fertigation, solar-driven on-farm desalination plant for saline groundwater, constructed wetlands, ...

Interventions for energy use in agriculture: photovoltaics, energy storage, geothermal energy production, ...

Innovative farming practices: fertilizer reduction, no-tillage, crop rotation, cover crops, integrated pest management, fertilization with sewage sludge, integrating livestock and crops, agroforestry, soil conservation measures, integrating livestock and crops, or sharecropping arrangements.

How many interventions are to be identified?

If time and resources permit, 2-4 interventions should be identified to address the WEFFe nexus problem, which can be either complementary or alternative to each other.

Note: Due to the complexity of the issue, it is unlikely that a single intervention will fully resolve the problem. For example, to address water scarcity, the use of treated wastewater may be combined with solar energy; or, in the case of soil degradation, sustainable farming practices may be combined with rainwater harvesting.



Social-ecological context: Interventions should be suitable for the specific social and ecological context, considering factors like financial constraints or land access. Interventions that are sensitive to the local context are more likely to be adopted successfully.



Trade-offs and synergies: Evaluate the potential benefits, trade-offs, and synergies of interventions. For example, desalination might reduce freshwater consumption but increase energy use and CO₂ emissions. A systemic perspective on interdependencies and impacts should be considered.



Informed decision-making: While detailed analysis isn't required at this stage, interventions should be based on available stakeholder and expert knowledge. The next phase will further assess their feasibility and performance. Unfeasible interventions may be discarded later.

4.1. Option A: Co-creation of interventions by stakeholders

This option involves a co-creation focus group with national, regional, and/or local stakeholders to identify interventions in a collaborative session. The co-creation session should focus on

active participation, creativity, and a sense of shared ownership to identify and analyse their potential to contribute to solving WEF_e Nexus challenges.

Why co-create interventions?

1. Allows members of a community to interact on an equal footing, encouraging the participation of all stakeholders without leaving anyone on the outside
2. Opens a space for dialogue, where ideas are debated and the best alternative for local development is determined by consensus;
3. It is a learning community: people learn from each other and vice versa, allowing them to understand the dynamics of local development;
4. Provides relevant information on the local situation, which will be used for present and future evaluations;
5. Respects local knowledge as a starting point: affirming the group's identity with its culture, traditions, and landscape;
6. Favours the democratisation of decision-making;
7. It is used as a tool for disseminating information to the community members involved;
8. It helps to create appropriate, effective, and efficient policies;
9. Allows the use of its own resources in the solution of priority problems affecting the population.

Who should be invited to participate in the co-creation process?

The same participants from the Participatory System Mapping workshop (Section 2.4) can join the focus group, but in smaller numbers. These should include key sector and stakeholder representatives directly influencing or impacted by the WEF_e nexus. For details on the stakeholders and their inclusion rationale, refer to Section 2.4.

How to run a co-creation intervention exercise by stakeholders?

The “Script for Co-creation of Interventions by Stakeholders” outlines a suggested format for this exercise within the WEF_e 2.0 framework. The goal is to define interventions that address the problems identified in the Causal Loop Diagram (CLD). This exercise will take about 1 hour and ideally should be organized in an in-person focus group with stakeholders, but an online focus group could work too. The exercise should be done after the post-production of the CLD has been finalised.

4. Third Phase: Identifying interventions

Script for co-creation of interventions by stakeholders

1. Introduction to the exercise (5 minutes)

The facilitator gives a brief review of the CLD exercise from the Participatory System Mapping workshop and the post-produced CLD (2.4).

The facilitator explains the leading question for the task, which will guide the overall discussion with the groups: *“In your opinion, what solutions do you think should be implemented in this area that could contribute to tackle the problem discussed? Please consider potential trade-offs that the intervention could have”*

2. Identification of interventions in the CLD (25 minutes)

Divide participants into groups of 4 people

Provide a printout of the post-produced CLD, Post-it and pens to each group so they can freely organize their ideas in the CLD.

Starting from the CLD, participants should identify the main solutions and place them in the CLD (linked to a variable or to an arrow between variables).

3. Presentation of the interventions identified (15 minutes)

The representative of each group presents the interventions they have collected in their group to the participants.

4. Selection of the most promising interventions (15 minutes)

1. Facilitator(s) collect the post-its from the tables and place them on the wall, whiteboard or flipchart, so that they can be seen by all participants. The facilitator reads out all the post-its and groups them according to themes and characteristics. This will avoid repeating ideas and reading all the interventions.
2. The facilitator gives two stickers to each participant. The participants stand up and vote for three of the interventions.
3. The facilitator reviews the votes by reading out the most voted-for interventions from the post-its. In the end, the three interventions with the most votes are chosen.
4. The facilitator reads the variables that interact with each intervention in the CLD.

5. Closing of the workshop

After the meeting, a report can be prepared that summarizes the interventions identified by participants in the CLD. Share that document with participants and ask for validation.

Expected output

List of interventions and the most promising solutions from the participants' perspective.

4.2. Option B: Identifying interventions by local experts

This option involves conducting 2-3 interviews with regional or local experts who are familiar with the WEF nexus and potential interventions. Experts should be independent and objective, with no vested interests in specific technologies. Experts can be local, but also technical or general experts.

How to identify interventions by local experts?

Start the interview by presenting the main WEF nexus problem from the Causal Loop Diagram (CLD) and, if necessary, provide a brief overview of the diagnostic phase (context scan, socio-economic trends) to give experts relevant background for identifying interventions.

Interview questions to identify interventions to WEF nexus problems

Considering the main WEF nexus problem (*i.e., undesirable state of water, energy, ecosystems, and/or food production*) presented in the Causal Loop Diagram, and the socio-economic and biophysical context-specificities of the focal area,...

- What could be interventions that can be implemented at the local level to address these issues? What are appropriate...
 - technologies/techniques for agricultural water use?
 - techniques for the production and use of energy?
 - innovative and/or sustainable farming practices?

- To what extent can these interventions be expected to improve the WEF nexus problem and what trade-offs could arise (e.g., intervention could reduce water consumption but lead to higher energy consumption, or it could enhance protection of ecosystems but reduce land availability for farmers)?
- Do actors in the focal area have sufficient personal, financial and time resources to implement such an intervention?
- What is the role of governance to implement this intervention? Are additional, complementary measures needed to ensure a successful implementation and operation of the intervention, and avoid that trade-offs occur? (e.g., changes in water allocation, subsidies, capacity building measures, etc.)
- Does the intervention fit to the economic, political and social context, or are there any context-specific constraints that could impede the implementation of the intervention? (e.g., lack of financial resources, unstable political environment, etc.)
- Are the interventions alternatives or complementary to each other?
- If several interventions are identified, how would you prioritize them in light of the previously discussed topics (i.e., potential to solve WEF nexus problems, required resources, need for complementary measures, context-specific constraints)?

Expected output

Based on the results of the expert interviews, a bundle of interventions should be identified and briefly described in terms of their:

-  Potential to solve WEF nexus problems
-  Required resources
-  Fit to the socio-ecological context of the focal area.

4.3. Option C: Identifying interventions by analysts

How to identify interventions by analysts?

This option involves gathering information on interventions for the WEF nexus using expert knowledge, online databases, grey literature, policy reports, and scientific literature. The interview questions (Section 1.1) can help assess whether identified interventions are suitable for the focal area, with a focus on potential trade-offs. For example, expanding energy infrastructure may impact water resources and food production, or efficient irrigation may increase water consumption due to rebound effects. This reflection should be conducted within the analyst team.

Online sources and databases on WEF nexus interventions

Water, Energy & Food Security Platform: <https://www.water-energy-food.org/>

Global Database on Sustainable Land Management: <https://wocat.net/en/global-slm-database/>

Water Data Portal by the International Water Management Institute:
<https://www.iwmi.cgiar.org/news/water-data-portal/>

This option is appropriate when resources are limited and there's enough local knowledge. It may lack stakeholder legitimacy, so experts should consult stakeholders or research their solutions to mitigate this risk. It's the least preferred option.

Expected output

Based on the results of the data collection, a bundle of interventions should be identified and briefly described in terms of their:

4. Third Phase: Identifying interventions

- i Potential to solve WEF nexus problems
- ii Required resources
- iii Fit to the socio-ecological context of the focal area
- iv Recommended complementary measures



[Additional tool content](#)

More detailed information and supporting materials on how the tool works

5. Fourth phase: Assessment phase

The fourth phase of the WEF_e Framework 2.0, the assessment phase, is the most extensive phase, offering an in-depth analysis of the interventions that have been identified in the previous phase. In this phase, the interventions and their potential to improve the nexus will be evaluated first using a desk-based analysis and then through a participatory approach.

Optional pathways

The WEF_e Framework 2.0 offers two methods to evaluate the potential performance of the selected interventions. If time or personnel resources are limited, these two methods can be further complemented with more sector-specific tools to assess certain processes and impacts in more detail.

Desk-based performance assessment

The bundle(s) of interventions identified in the previous phase will be assessed in terms of their potential to solve the WEF_e nexus problems of the focal area. Thereby, it shall be ensured that the selected interventions are able to address the specific problem, i.e., that they help to reduce the use of water, energy or land and protect ecosystems, while ensuring that food production and local livelihoods are maintained or improved. This also means that trade-offs and synergies need to be considered. These two tools analyze “what if” scenarios, showing the potential impact of the interventions, combinations of interventions, or different implementation levels.



To undertake this desk-based assessment, two methods can be used:

1st

First, the REWEFe (Rapid Evaluation of the Water, Energy, Food and ecosystem) will be used to model scenarios on the impact of interventions on the WEF_e nexus.

2nd

Second, the Cost-Benefit Analysis allows evaluation of the economic advantages and disadvantages of the selected intervention.



Definition performance assessment

In the context of the WEF_e Framework, the performance of an intervention relates to how well it contributes to solving the WEF_e nexus problem. This means whether the intervention helps to balance the use of water, energy and land, and protect ecosystems, while ensuring that food production and local livelihoods are maintained or improved (i.e., creating synergies). The performance refers to the ability of an intervention to achieve improvements across multiple interrelated indicators, considering the complexity of managing the interconnected resources, and ecosystem boundaries.

5.1. REWEFe: Rapid Evaluation of the Water-Energy-Food-ecosystem nexus



Why doing the REWEFe analysis?

The REWEFe tool is developed to fill the gap in scenario analysis tools for the WEF nexus, which are often location-specific, data-intensive, or sector-focused. It provides a standardized, easy-to-use, Excel-based method for analyzing interlinkages between water, food, energy, and ecosystems. The tool helps users model and evaluate different scenarios, offering a comprehensive view of the WEF system to support informed decision-making and prioritise interventions. The REWEFe tool can be used by accessing the following link: <https://www.futurewater.eu/tools/rewefe/>

Strengths

The REWEFe tool is the first of its kind, allowing users to generate scenarios and quantitatively assess the synergies and trade-offs among the four sectors. Its key strengths include:

- **User-friendliness:** REWEFe is a macro-enabled Excel-based tool that requires only a basic understanding of MS Excel to operate.
- **Easy terminologies:** The variables in the Input sheet have been named in a self-explanatory manner. Each variable is clearly defined with units to guide users in entering data in the correct format. If further clarification is required, users can also refer to the user guide which

provides brief descriptions for each variable.

- **Open access:** The tool is publicly available and does not require any licence or subscription for use.
- **Flexibility:** As REWEFe is an Excel-based tool, users can easily add new variables or modify the quantitative relationships between existing variables, as per need.
- **Wide applicability:** The tool is not configured or optimised for any specific geographical region, making it versatile for assessing the WEF nexus in any context globally.

Limitations

While REWEFe aims to incorporate the most relevant inter- and intra-sectoral dependencies, it should be noted that it does not provide a high level of detail. This is because the purpose of the tool is to provide a holistic assessment of the WEF domain without being too data-intensive or too limited in terms of applicability to various contexts. Therefore, it is important for users to consider the following limitations:

- **Temporal dynamics:** REWEFe provides a snapshot of the WEF nexus at a specific moment and does not track changes over time. While users can model scenarios to reflect future changes, the tool does not allow for time-based trend analysis or visualization.
- **Spatial disaggregation:** Once the nexus unit (or focal area) is defined, the calculations run for the entire area. The users, therefore, cannot zoom in on specific aspects within the area but they can run separate analyses for different nexus units if needed.
- **Level of detail:** Although REWEFe covers major subcomponents of the WEF nexus, it does not take into account details such as specific crop varieties, local biodiversity, water quality, or the impacts of ecosystems on water, energy, and food production.
- **Background knowledge of users:** users should have a technical background (e.g. physical sciences or engineering), and a minimum understanding of the physical processes and data they are working with (e.g. water, land and energy data).
- **Simplification:** Some of the inter- and intra-sectoral quantitative linkages are based on empirical formulas. While more sophisticated expressions may exist for certain linkages in some countries, they are not included in the tool to maintain its universal applicability. Moreover, certain variables, such as return flows from the domestic and industrial sectors, may also need to be estimated by the user in the Input sheet.

5.1.1. How to do the REWEFe analysis

The REWEFe tool can be used by accessing the following link: <https://www.futurewater.eu/tools/rewefe/>

Effective data collection relies on two key elements:



Main data sources

The Input sheet of the REWEFe tool requires users to insert data related to land use, water demands and flows, energy demands and production as well as the monetary values of the ecosystem components. The data can either be obtained through primary sources such as field surveys and ground measurements or can be collected from secondary sources such as national official statistics, technical reports, literature studies and remote sensing.

Note: Users are encouraged to explore platforms such as [EarthMap](#), [Google Earth Engine](#), [AQUASTAT](#) and [WaPOR](#) to extract certain data inputs (e.g. precipitation, land use, evapotranspiration, population, etc.) for their own focal area. More technical guidance can be found in the manual.



Scenario definition

The user can define several scenarios. The first scenario is always the baseline scenario, meaning the no-intervention scenario. Scenarios 1–5 are the intervention scenarios. The number of scenarios can be selected through the tick box (Figure 5.1). The user is free to decide whether each scenario (S1 – S5) refers to:

- Each a different intervention: to compare different interventions in one single display of the result tab, or
- Different levels of implementation of the same intervention: to compare how increasing the implementation level of an intervention impacts the various indicators in the result tab.



Scenario definition

The user can define several scenarios. The first scenario is always the baseline scenario, meaning the no-intervention scenario. Scenarios 1–5 are the intervention scenarios. The number of scenarios can be selected through the tick box (Figure 5.1). The user is free to decide whether each scenario (S1 – S5) refers to:

- Each a different intervention: to compare different interventions in one single display of the result tab, or
- Different levels of implementation of the same intervention: to compare how increasing the implementation level of an intervention impacts the various indicators in the result tab.

REWEFe allows users to easily check if an input parameter value of a scenario varies from the baseline parameter value, because only if it is different, the cell is highlighted in blue (as shown in Figure 5.2). This allows users to easily identify the differences between the scenarios and the baseline.

Scenario	Description	Show results
Baseline (B)		
Scenario 1 (S1)		☒
Scenario 2 (S2)		☒
Scenario 3 (S3)		☒
Scenario 4 (S4)		☐
Scenario 5 (S5)		☐

Figure 3.1. Causal Loop Diagram Loop Example

Land Use		B	S1	S2
Total	(Km2)	1,024	1,024	1,024
Nature	(%)	13%	13%	13%
Other	(%)	26%	26%	26%
Rainfed	(%)	45%	45%	45%
Irrigated	(%)	16%	16%	16%
Irrigated pressurized (% of irrigated)	(%)	50%	50%	50%
Greenhouse area	(%)	0%	0%	0%
Total (check)	(%)	100%	100%	100%

Population				
Total	(cap)	216,720	260,064	312,077
Domestic water demand	(m3/p/y)	74	74	74
Return flow urban	(%)	80%	80%	80%
Food demand	(kCal/p/d)	2,100	2,100	2,100
Energy demand urban	(kWh/p/y)	71	71	71

Industry				
Units	(-)	507	507	507
Industrial water demand	(m3/u/d)	4	4	4
Return flow industry	(%)	85%	85%	85%
Energy demand industry	(MWh/u/y)	23	23	23

Water				
Precipitation	(mm/y)	500	1,000	200
ETpot	(mm/y)	1,289	1,289	1,289
Irrifation requirement	(mm/y)	733	733	733
Greenhouse requirement	(mm/y)	0	0	0
Runoof fraction	(-)	0.2	0.2	0.2
Recharge fraction	(-)	0.0	0.0	0.0
Reclaimed fraction	(%)	100%	100%	100%

 Optional pathways

Even though users can independently operate the REWEFe tool to generate an analysis, it is recommended to work in a team of two to speed up the data collection process. Depending on data availability, team size and the technical expertise of the users, it can take 2-4 weeks to develop a REWEFe analysis.

Data Analysis

The REWEFe tool presents results in two tabs: Results and Sector Details.

-The Results tab provides a quick overview with bar graphs showing absolute and relative changes (compared to the baseline) in production, consumption, import, and export across the four sectors. It allows users to compare scenarios (S1-S3) with the baseline (B) to assess the impact of interventions.

-The tab also indicates resource balances: if production and consumption are imbalanced, it must be balanced by imports or exports. For the ecosystem sector, the tool shows "produced" versus "consumed" impacts, expressed in monetary terms.

Figure 5-2: Snippet of the required input variables

5. Fourth Phase: Assessment phase

The second result tab (Sector Details) provides the users with a detailed breakdown of each sector, providing values for all the subcomponents considered.

-This allows users to view the absolute values as well as the percentage changes (negative or positive).

-The table also includes additional indicators such as blue water stress, nutrient stress, and groundwater storage change, among others, enabling users to further assess the sector through multiple lenses.

Note: For interpreting these detailed results, the user is referred to the REWEFe manual.



Figure 5-2: Snippet of the required input variables

5. Fourth Phase: Assessment phase

Water				Energy				Food				Ecosystem				
(MCM/y)				(GWh/y)				(Mkg/y)				(mEUR/y)				
B	S1	S2	S3	B	S1	S2	S3	B	S1	S2	S3	B	S1	S2	S3	
Results																
Produced	525	1,008	246	249	40	40	40	40	0	90	30	31	2	2,051	1	1
Consumed	535	938	246	249	38	38	48	52	1,661	1,661	1,993	2,392	1	14	26	27
Import	10	0	0	0	0	0	8	12	1,661	1,572	1,963	2,361				
Export	0	71	0	0	2	2	0	0	0	0	0	0				
Balance (check)	0	0	0	0	0	0	0	0	0	0	0	0				
Change compared to balesine																
Produced	483	-280	-276		0	0	0		90	30	31		2,049	-1	-1	
Consumed	402	-290	-286		0	9	14		0	332	731		13	25	26	
Import	-10	-10	-10		0	8	12		-90	302	700					
Export	71	0	0		0	-2	-2		0	0	0					
Change (%)compared to balesine																
Produced	92%	-53%	-53%		0%	0%	0%		infinite	infinite	infinite		112216%	-35%	-35%	
Consumed	75%	-54%	-53%		-1%	24%	36%		0%	20%	44%		1146%	2197%	2332%	
Import	-100%	-100%	-100%		infinite	infinite	infinite		-5%	18%	42%					
Export	infinite	infinite	infinite		12%	-100%	-100%		infinite	infinite	infinite					

Fig 5.4 Optional tabulated results available for viewing Communication Pathway

 Optional pathways

Users can easily extract REWEFe outputs, including graphs and tables, for direct inclusion in reports and presentations. If desired, users can also create custom graphs by copying the data from the Results tab. The Sectoral Details tab can be used to provide additional quantitative insights to strengthen the analysis. It is crucial to highlight the synergies and trade-offs between water, energy, food, and ecosystems when presenting scenarios, ensuring that the decision-making process is scientifically grounded.

Water	Water	Water	Water	Water
(MCM/y)				
Produced	525	1,008	246	259
Rainfall	512	1,024	205	205
Desalination	0	0	0	0
Groundwater Delta	-1	31	-22	-22
Consumed	535	938	246	259
Evapotranspiration	399	798	160	160
Irrigation	120	120	72	75
Greenhouse	0	0	0	0
Domestic	16	19	14	25
Industry	0	0	0	0
Import/Export				
Inflow	10	0	0	0
Evapotranspiration	0	71	0	0

Water	Water	Water	Water	Water
Change (%)				
Produced	0%	92%	-53%	-51%
Rainfall	0%	100%	-60%	-60%
Desalination	0%	0%	0%	0%
Reclaimed	0%	20%	44%	149%
Groundwater Delta	0%	-5065%	3531%	3531%
Consumed	0%	75%	-54%	-52%
Evapotranspiration	0%	100%	-60%	-60%
Irrigation	0%	0%	-40%	-38&
Greenhouse	0%	0%	0%	0%
Domestic	0%	20%	-13%	55%
Industry	0%	0%	-40%	-38&
Import/Export				
Inflow	0%	-100%	-100%	-100%
Evapotranspiration	0%	0%	0%	0%
Other relevant factors				
Groundwater Recharge (MCM/y)	15	31	6	6
Groundwater Pumping (MCM/y)	16	0	29	29
Green Water Shortage (MCM/y)	920	521	1,160	1,160
Blue Water Shortage (MCM/y)	0	0	57	60
Green Water Stress (%)	70%	39%	88%	88%
Blue Water Stress (&)	0%	0%	40%	38%

Figure 5-5: Breakdown provided for each of the four WEF components

5.2. Cost-Benefit Analysis

Cost-Benefit Analysis (CBA) is a systematic process used to evaluate the economic advantages and disadvantages of a project or decision – or in the case of the WEFef 2.0, an intervention – by comparing its costs and benefits (Pearce, Atkinson, and Mourato 2006). In this method, all relevant costs and benefits associated with an activity are identified, quantified, and converted to monetary values. The goal in the context of the WEFef 2.0 is to determine whether the benefits of implementing an intervention outweigh the costs, and by how much, helping decision-makers understand the overall economic value of the intervention. CBA has been used frequently for the analysis of interventions on water quality and supply.

Why doing a cost-benefit analysis?

- To determine the total costs associated with the implementation of the intervention.
- To evaluate the economic benefits arising from the intervention.
- To determine whether the benefits outweigh the costs, and by how much.

5.2.1. How to do a cost-benefit analysis?

The approach to CBA in the WEFef 2.0 is similar to the method described by Borrego-Marín and Berbel (2019) but consisting of four phases:

- i definition of the scenario, boundaries of the system, and indicators;
- ii estimation of costs;
- iii estimation of benefits;

- iv estimation of the benefit-to-cost ratio.

Phase 1: Definition of the Scenario, Boundaries of the System, and Indicators

In the first phase of the Cost-Benefit Analysis (CBA), the scenario for evaluating the intervention is defined, alongside the system boundaries. This involves identifying the geographical, temporal, and sectoral scope, and determining the baseline conditions, such as the status of water resources, agricultural practices, and economic factors prior to the intervention.

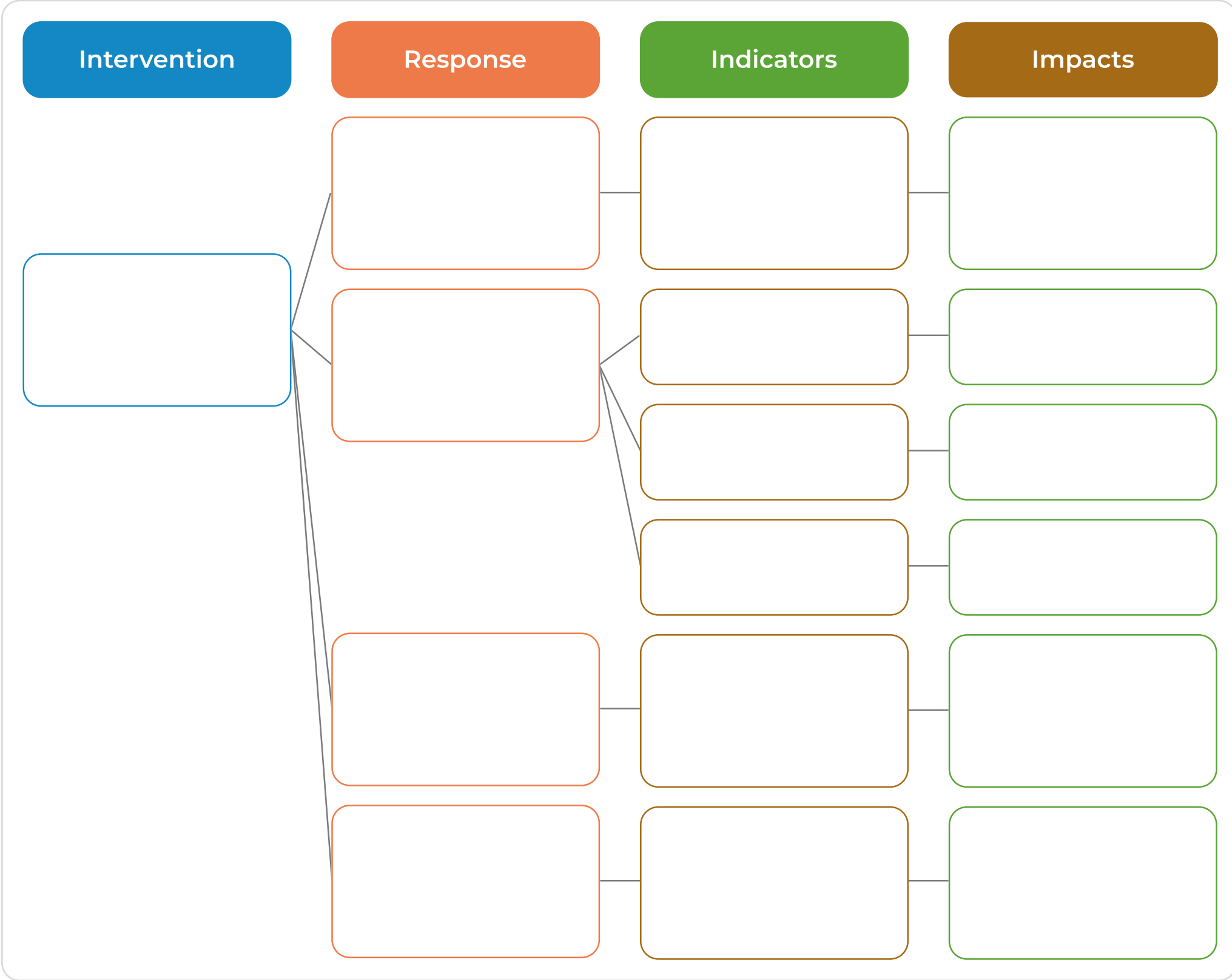


Figure 5-5: Breakdown provided for each of the four WEFef components

5. Fourth Phase: Assessment phase

The phase follows four steps:

1.

Intervention Definition

A clear, concise description of the proposed technological solution (e.g. water reclamation plant, solar PV infrastructure).

2.

Identification of Responses

Recognizing how different sectors or stakeholders might respond to the intervention, such as changes in farming practices or energy use.

3.

Identification of Impacts

Assessing broader consequences, including socio-economic effects (job creation, agricultural productivity) and environmental changes (water supply, carbon emissions reduction).

4.

Selection of Indicators

Choosing appropriate economic, environmental, and social indicators to measure both costs and benefits (e.g. expenses, savings, agricultural output, CO2 capture).

Note: This phase ensures that the analysis focuses on factors directly relevant to the intervention, using measurable, objective criteria. Sectoral expertise is needed to determine appropriate boundaries and select meaningful indicators to ensure the analysis is scientifically robust and contextually grounded.

Phase 2: Estimation of Costs

The second phase involves the detailed estimation of all costs associated with the intervention, including capital, operations and maintenance costs, as well as finance costs (debt service).

Costs used in the CBA should be marginal, not average costs. However, when there is no detailed cost accounting, average costs are frequently used as an alternative.

Capital costs include, but are not limited to:

- Infrastructure development (e.g. construction of dams, reservoirs, or irrigation systems in water management projects; building treatment plants for wastewater or pollution control; installing renewable energy systems, such as solar panels or wind turbines).
- Equipment and machinery (e.g. purchase of agricultural equipment, such as precision farming tools or irrigation machinery; installation of air or water quality monitoring systems;

acquisition of vehicles for project implementation or logistics).

- Land acquisition and preparation (e.g. purchasing land for project facilities or conservation areas; site preparation, including land leveling, clearing, or landscaping).
- Technology investments (e.g. development or procurement of software for modeling, monitoring, or management; acquisition of advanced technologies for carbon capture or waste recycling).
- Construction materials and supplies (e.g. materials for building infrastructure, such as cement, steel, pipes, and wiring; supplies needed for specific interventions, like filters for water purification).
- Consulting and professional services (e.g. testing costs, feasibility analyses; design, permitting, and supervision of the system's design, installation, and connection).

Operation and maintenance costs include:

- Regular maintenance, cleaning, and periodic inspections.
- Repairs or parts replacements.
- Energy costs (e.g. electricity or fuel required for running equipment, machinery, or facilities; energy consumption for processes like water pumping, purification, or heating).



Definitions cost-benefit analysis

Marginal costs: the additional costs incurred by producing one more unit of a good or service.

Average costs: the total costs of production divided by the number of units produced, representing the cost per unit.

Capital costs: fixed, one-time expenses incurred during the design and construction of the intervention.

Once the costs to be included in the estimation for the intervention have been identified, the next step involves calculating the financial costs using the Annual Equivalent Cost (AEC) method. This approach distributes the capital costs of construction, equipment, and other initial investments, along with the ongoing operating and maintenance expenses, into equal annual amounts over the project's lifetime, thus providing a clear estimate of the annual financial commitment required for the intervention.

5. Fourth Phase: Assessment phase

The AEC is calculated using the formula which has been applied for water economics by Berbel et al (2011):

$$AEC = \frac{r \cdot (1+r)^n}{(1+r)^n - 1} \cdot K + OMC$$

Where:

- K represents the investment costs;
- OMC are the operational and maintenance costs;
- r is the discount rate;
- n is the useful life of the intervention.

In this phase, external costs, such as environmental impacts or opportunity costs associated with land use, should be incorporated to capture the total economic burden of the intervention. This will enable a balanced comparison with the projected benefits in subsequent stages. For example, the costs of CO₂ emissions and other greenhouse gases should be considered, reflecting their impact on climate change and associated societal costs, such as public health impacts and damage to infrastructure. The estimation of these costs can be done through tools like the Social Cost of Carbon Explorer or secondary sources such as existing studies and databases.

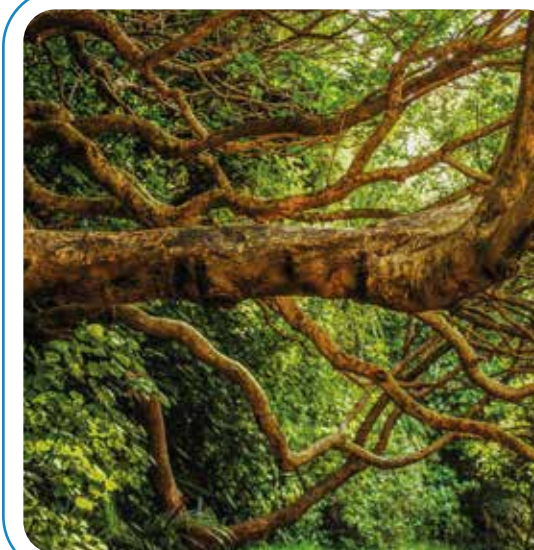
The data for cost estimation can be obtained from primary sources, such as field surveys, or secondary sources like national statistics, technical reports, and case studies. Expert consultations, stakeholder inputs, and market surveys can also provide valuable insights to refine cost estimates.

Depending on the intervention, the required data may include various types of information

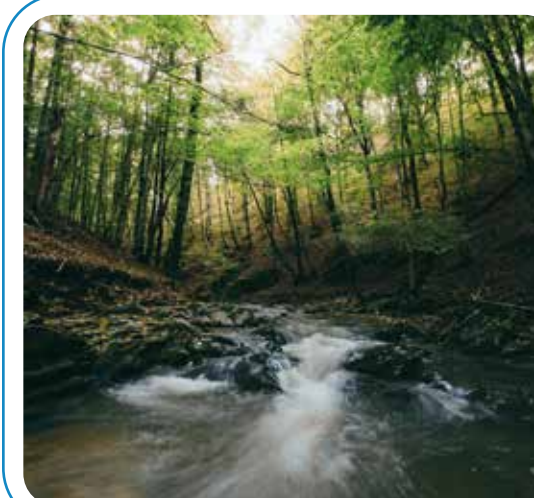
-
- Gross value added per worker in other sectors
- Economic multiplier of the agricultural sector
- Concentration of nitrogen in treated wastewater
- Average purchasing price of energy
- Average selling price of energy
- Average price of diesel
- Average price of CO₂
- Average price of nitrogen
- Cost of nitrogen pollution
- Rate of CO₂ capture by tree crops per unit area and/or time
- Average CO₂ emitted for energy generation

Phase 3: Estimation of Benefits (Direct and Indirect Benefits)

In this phase, both direct and indirect benefits of the project are quantified to understand its positive outcomes.



Direct benefits include measurable economic gains such as increased agricultural productivity, job creation, reduced pollution, lower CO₂ emissions, and improved CO₂ capture. These are easier to quantify and often linked to tangible changes, like improved crop yields or reduced healthcare costs. Gross Value Added (GVA) is a key indicator of benefits, as it measures the economic contribution of a project by indicating the value added to the economy, after deducting input costs.



Indirect benefits are broader and less direct, including spillover effects on the economy, job creation in adjacent sectors, improved social welfare, and increased community resilience. While harder to quantify, these benefits are critical in assessing the full impact of the intervention.

Depending on the intervention, the required data may include various types of information

- Extension of land cultivated with each crop in the irrigated area (crop mix)
- % of land with tree crops in the irrigated area
- Volume of water required for crop irrigation (per ha) (irrigation dose per crop)
- Annual income per crop cultivated (per ha)
- Average annual salary in agriculture
- Average annual salary in other sectors
- Gross value added per worker in agriculture

Data for benefits can be collected through primary sources (e.g. field surveys) or secondary sources (e.g. studies, reports). The challenge lies in valuing indirect or non-market benefits, such as improved air quality or enhanced biodiversity, which require specialized methods like contingent valuation or input-output models. Secondary data from government sources, research, or industry reports can help estimate these benefits, allowing for a more comprehensive and cost-effective approach to quantification.

Converting all benefits into a common monetary metric enables comparison with costs, aiding in a clearer understanding of the project's overall economic impact.

Phase 4: Estimation of Benefit-Cost Ratio (BCR)

In the final phase of the Cost-Benefit Analysis (CBA), the benefit-cost ratio (BCR) is calculated to assess the economic viability of the intervention. The BCR is determined by dividing the total monetized benefits by the total costs. A BCR greater than 1 indicates economic benefit, while a ratio below 1 means the costs exceed the benefits. This ratio simplifies decision-making by providing a clear assessment of the intervention's value.

The interpretation of the BCR depends on factors such as: discount rate applied, time horizon, context & assumptions.

It is important to consider other qualitative factors alongside the BCR for a more comprehensive evaluation. CBA is context-specific, and the methodology should be adapted to the project's objectives, sector, and context. Users are encouraged to consult the European Commission's Guide to Cost-benefit Analysis for detailed guidance.

The CBA method also involves trade-offs, including balancing economic and non-economic factors, short-term versus long-term impacts, local versus global effects, and sustainability versus economic growth. Selecting a discount rate and addressing uncertainties in future estimates also introduce trade-offs that must be carefully considered.

5.3. Performance assessment in stakeholder workshop

The interventions selected in phase three will be assessed through a participatory stakeholder workshop, consisting of four key exercises:

-  Contextualisation and presentation of the results of the previous phases
-  Validation of the CLD and analyse the effects of interventions on the system
-  Assessment of barriers and facilitators to the intervention
-  Assessment of perceived impacts of the intervention on ecosystem services.

Workshop Overview

The workshop begins with an introduction to the WEF nexus challenges and selected interventions, followed by a brief overview of the agenda and exercises. The session requires a moderator, facilitators, and a group representative. The moderator ensures smooth facilitation and time management, while facilitators support subgroup activities and record notes.

The group representative acts as a spokesperson for each subgroup. These exercises encourage active participation from all stakeholders to collaboratively assess and validate the interventions.

5.3.1. Validation and analysis of interventions in the Causal Loop Diagram

How to run a CLD validation and analyse interventions exercise?

After presenting the CLD to the participants, it will be validated (i.e., feedback shall be received from the participants on the variables and the links between the variables).

CLD validation example

Purpose of the session: Validation of the post-produced CLD

Time: approx. 90 minutes total

Roles and People Needed:

- Facilitator(s): Guide plenary tasks and support group rapporteurs.
- Recorder: Take notes on questions and discussions by stakeholders
- Group Rapporteurs: Nominated participants to lead each subgroup.
- Group Participants: Invited stakeholders to engage in group activities.

Steps:

- Plenary: Facilitator presents the CLD, a systemic map of the problems encountered in the region through a narrative, which is the starting point for discussion. (10 minutes)
- Group Formation: Create 3 subgroups (approx. 4-6 participants each), with each subgroup nominating a rapporteur. Ideally, groups are composed of diverse stakeholders representing each WEF nexus sector (5 minutes)
- Group work (60 minutes):

Groups, guided by moderators familiar with the CLD, discuss and include new variables, links, and issues in the CLD. e.g. Do causal relationships hold? Do feedback loops make sense? Are any key variables missing inside or outside a loop? Are causal relationships oversimplified and need more specification?

Script for stakeholders' assessment workshop

1. Welcome and introduction (15 minutes)

Introduce the challenge of WEF nexus in the focal area.

Explain the purpose of the workshop and provide an overview of the agenda and the exercises.

2. Presentation of the CLD, intervention(s), REWEFe and Ecosystem Services assessment (15 minutes)

This presentation should be organised in the follow steps:

1. CLD
2. Interventions identified in the third phase (through co-creation, by local experts, or by analysts).
When presenting interventions, it is crucial to emphasize that these are not the only solution.
3. REWEFe scenarios
4. Ecosystem Services assessment from the Participatory System Mapping workshop

3. Validation of the Causal Loop Diagram (CLD) post-produced and analyse interventions in the CLD (90 minutes)

This exercise presents a comprehensive diagnosis of the region's challenges, serving as a foundation for discussion and collaborative exploration of the issues, the performance assessment results, and the relationships between the interventions and the CLD variables will be established.

Divide participants into groups of 4-6 people.

Provide a flipchart, Post-it and pens to each group so that they can freely organize their ideas and revise the CLD.

4. Assessing barriers and facilitators (around 40 minutes)

Participants will analyse barriers and facilitating factors related to the interventions that have been selected.

5. Impact Assessment on WEF Components (around 40 minutes)

The goal is to gather insights from local stakeholders regarding the perceived positive or negative impacts (benefits or threats) that the selected interventions may have on the WEF nexus and associated local ecosystems.

6. Closing of the workshop

After the meeting, a report can be prepared that summarizes the results.

5. Fourth Phase: Assessment phase

Are causal relationships excessively detailed and need simplification?

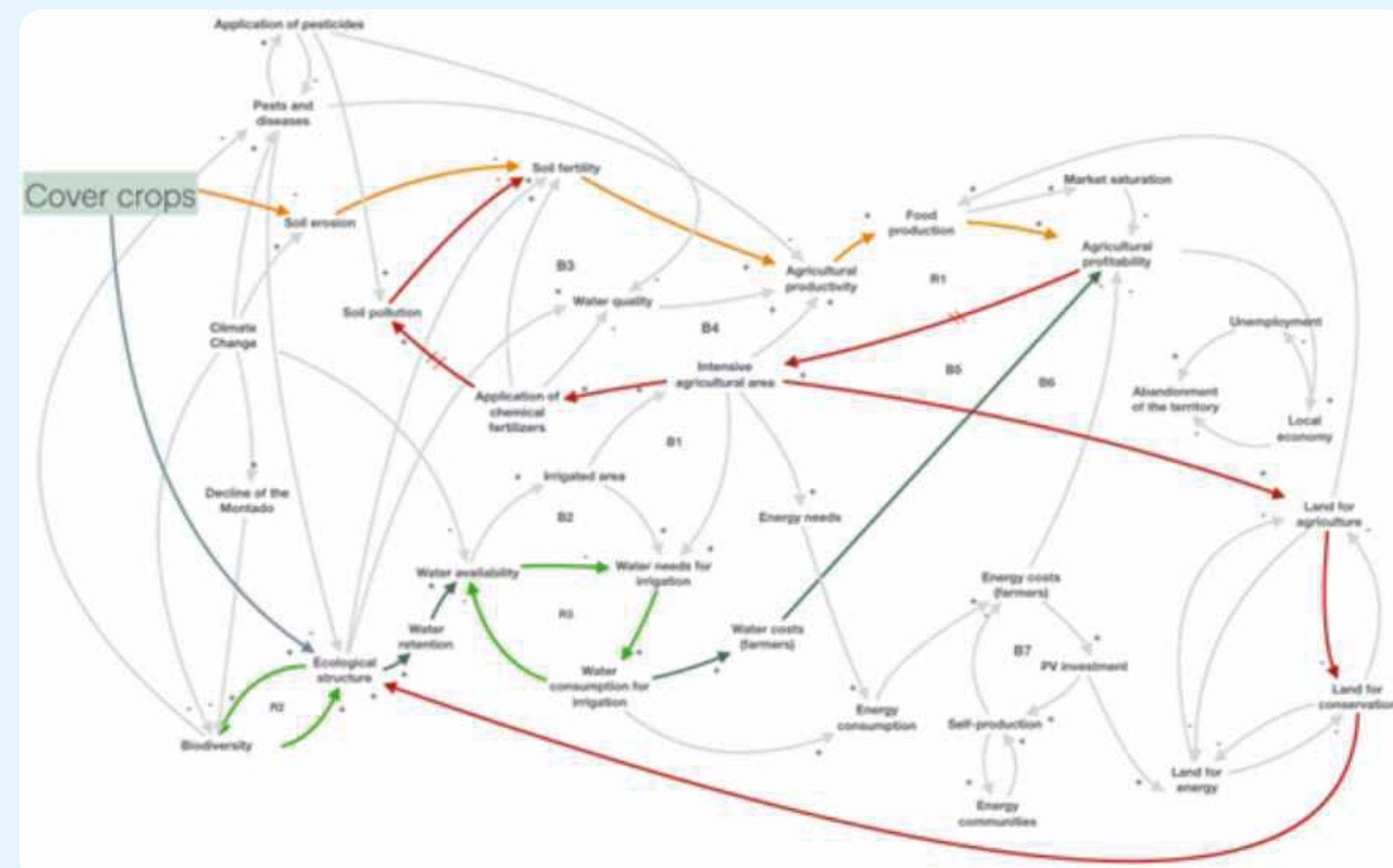
The CLD can be used to model and discuss the impacts of the interventions on the system, and possibly identify unanticipated effects generated by the feedback loops underlying the dynamic behaviour of the system. In the same group, the participants shall integrate the different interventions in the CLD. Using the CLD for this task should support the understanding of the impact of the proposed interventions and the different interconnections among the variables.

With the introduction of the interventions in the CLD, attention must be paid to the signs (+ and -), i.e. if they have to change with the introduction of these new variables.

At the end of the exercise, the group may discuss the consequences and the improvements caused by the proposed interventions.

See example below

Plenary: At the end of this exercise, the facilitator presents the results of each group, which are discussed with all stakeholders (15 minutes).



In this example, the identified intervention relates to cover crops, a Nature Based Solutions (NbS) in an intensive agricultural area. Cover crops are non-cash crops grown primarily to provide seasonal cover for soil, enhancing its health and stability. They play a crucial role in sustainable agriculture by offering various environmental and agronomic benefits (Yosefi, M. et al., 2024). This intervention was identified as a solution for the problem of intensive agriculture.

The introduction of cover crops creates or strengthens several feedback loops: cover crops enhance the ecological structure, increasing water retention, thereby improving water availability, reducing irrigation requirements, lowering water consumption, which results in higher water availability in a reinforcing loop (loop R3). Improvement of the ecological structure also contributes to increased biodiversity, which further reinforces the positive effects on ecological structure (loop R2).

The CLD also shows that the increase in agricultural profitability may lead to a desire from farmers to increase the area for intensive agriculture, which leads to an increase in the application of fertilizers and growing water needs for irrigation, counteracting the initial benefits from the implementation of nature-based solutions (illustrated by the red arrows in the diagram). The concrete outcome of all these interactions in each case will depend on the relative strength of the different relations and feedback loops operating in the system, which can only be assessed with a quantitative system dynamics model. The main conclusion in this case is that NbS can constitute an important solution to tackle some of the WEF challenges, but they must be part of a wider transformation of agricultural systems.

Assessing barriers and facilitators

Why assessing barriers and facilitators?

An important objective of the stakeholder workshop is to critically evaluate the selected interventions by examining both the barriers and facilitators to their implementation, operation, and maintenance.

The goal is to identify the conditions that foster the successful adoption of an intervention and to anticipate the obstacles that could prevent its success. This process helps stakeholders predict challenges, assess whether the intervention is feasible within the current context, and determine if adjustments are needed. Identifying barriers early on can also lead to rejecting interventions if they are deemed too difficult to implement or maintain successfully.

5. Fourth Phase: Assessment phase

How to analyse barriers and facilitators?

The analysis focuses on three main types of barriers and facilitators to the selected WEF nexus interventions:



Financial

This aspect examines whether stakeholders have sufficient financial resources to implement and operate the intervention. Barriers could include high initial costs, limited access to financing, or uncertain returns. Facilitators might include public grants, subsidies, green bonds, and economic incentives that emphasize long-term cost savings.



Physical

This dimension addresses whether stakeholders have the required knowledge, space, and technology to implement the intervention. Barriers might involve technical complexity, infrastructure limitations, or maintenance challenges, while facilitators include advancements in technology or successful pilot projects that demonstrate feasibility.



Social, Political, and Administrative

This category focuses on legal, political, and community-related factors. Barriers could involve regulatory hurdles, lack of awareness, or political instability, while facilitators might include supportive policies, public engagement, capacity-building efforts, and strong stakeholder collaboration.

Workshop facilitation

During the workshop, stakeholders will discuss the barriers and facilitators for each intervention, considering the specific context. If a bundle of interventions has been identified, the potential for additional barriers due to the combination of multiple interventions will also

be evaluated.

Workshop set-up and logistics

Purpose of the session: Identify and discuss barriers and facilitating factors for adopting and operating 3–4 interventions to address WEF nexus problems in the focal area.

Time: approx. 60 minutes total (see below)

Roles and People Needed:

- Facilitator(s): Guide plenary tasks and support group rapporteurs.
- Recorder: Take notes on questions and discussions by stakeholders
- Group Rapporteurs: Nominated participants to lead each subgroup.
- Group Participants: Invited stakeholders to engage in group activities.

Steps:

- Plenary: Facilitator presents interventions, and outlines the session's purpose (10 minutes)
- Group Formation: Create 3 subgroups (approx. 10 participants each), with each subgroup nominating a rapporteur. Groups should ideally focus on different interventions. Ideally, groups are composed of diverse stakeholders and each WEF nexus sector is represented (5 minutes)
- Group work: Groups, guided by moderators familiar with the interventions, discuss barriers and facilitators for their assigned interventions (30 minutes)
- Plenary: Discussions and findings are reported to the plenary and discussed with all stakeholders (15 minutes)

Assessing perceived impacts on flows of Ecosystem Services

Why assess perceived impacts?

The goal is to evaluate local stakeholders' perceptions of threats and benefits to ecosystem services, and how these impacts affect ecosystem service flows, which may increase, decrease, or remain unchanged before and after the intervention.

5. Fourth Phase: Assessment phase

How to analyze perceived impacts?

This exercise analyzes stakeholder perceptions in terms of:

- Current and future threats linked to the intervention.
- Ecosystem service (ES) flows, including trade-offs and synergies.
- Impacts on ES in both present and future scenarios.

Two scenarios are used:



Scenario 1: Current scenario

Identifies current impacts on ecosystem services, assessing whether they are increasing, decreasing, or stable.



Scenario 2: Intervention scenario

Evaluates how the intervention affects threats and ecosystem service flows in the future. If multiple interventions are considered, each is assessed separately.

Exercise to analyse perceived impacts on flows of Ecosystem Services

Discussing financial barriers and facilitators (I)

Understanding the financing of an intervention

- What are the short- and long-term costs associated with the intervention?
- Who is responsible for funding the different steps of the intervention?
- How often are investment costs paid?
- What is the investment mainly about?
- Who benefits from the intervention?

Financial barriers and facilitators

- Do the actors financing the intervention have the necessary financial capacities for both the initial construction/implementation of the intervention, and its long-term operation and maintenance?
- What are the main funding sources for the implementation, operation and maintenance of the intervention? Are these sources accessible to all under any conditions?

- Are there specific actor groups that could potentially support the financing of these interventions?
- Are there any risks to funding the intervention in both the short and long-term?
- Does the combination of several interventions (i.e., the bundle of intervention) pose additional barriers in terms of financing?

Discussing barriers and facilitating factors to the physical implementation of an intervention (II)

Identifying the actors involved in the implementation

- Which actors are involved in and affected by the implementation, operation, and maintenance of the intervention? Consider actors from all sectors of the WEF nexus including agriculture, water, energy, and environment.
- At what levels do these actors operate? Are they based within the community, or do they operate at local, regional, or national levels?

Barriers and facilitating factors to implementation

- What human resources are needed to build and run the intervention (knowledge, labour, etc.)?
- Is suitable land or space available for the intervention?
- Is the physical infrastructure (e.g., materials) needed to implement, operate and maintain the intervention available at reasonable costs?
- Is a detailed, long-term planning needed for running and maintaining the intervention?
- Are climatic and geographical factors (e.g., extreme weather events, such as floods or droughts) likely to impact the functioning of the intervention?
- Does the combination of several interventions (i.e., the bundle of intervention) pose additional barriers in terms of their physical implementation?

Discussing social, administrative and political barriers and facilitators (III)

- Do actors have land rights and permits to implement the intervention (e.g. water rights, environmental permits)?
- Is there a need for coordination or collective action with other actors (public, private, and civil society) within and outside the community, and how does this impact the implementation and operation of the intervention?

- Are there likely to be legal and administrative aspects that will hinder or facilitate the implementation and operation of the intervention (e.g. specific rules or regulations)?
- Does the combination of several interventions (i.e., the bundle of intervention) pose additional social, administrative and political barriers?

Synthesising the findings (IV)

To identify the most important barriers to an intervention, participants can either openly discuss this and/or do a “dot voting” exercise.

- **(A) Discussion:**

Considering the barriers and facilitators identified in the previous discussion, what are the most important barriers for each intervention that you have identified?

- **(B) Dot voting:**

Each participant is given a number of dot stickers, and they allocate these dots to the barriers they believe are most significant. The barriers with the most votes are deemed to be the highest priority. Participants can then also discuss why they voted for particular barriers.

Based on the weighting exercise:

- What are the implications: Could these barriers seriously hinder the successful implementation and operation of an intervention, or are they simply aspects that need to be considered during the implementation, and if so, how?
- Should certain interventions be abandoned? Or are there conditions under which the intervention could still be pursued?

Expected outcomes

The outcomes of this workshop are a final CLD validated by participants, a preliminary list of barriers and opportunities associated with different solutions, and the perceived impacts on WEF components and ecosystems that support them. Furthermore, the CLD allows to gain insight into how the solutions affect the problem.

6. Fifth phase: Implementation pathway

The fifth and final phase of the WEFe Framework 2.0 is the implementation pathway. The phase consists of undertaking a participatory workshop.

Stakeholder workshop on the implementation pathway

After the evaluation of the intervention has been carried out, the next steps for the widespread adoption of the intervention in the focal area are to be planned. By considering the identified barriers and the key actors involved in implementation, practical strategies can be developed to overcome the challenges and promote a transformation of the focal area. The aim of holding a participatory workshop at this stage is to consolidate understanding and promote collaboration within the WEFe nexus, reflecting on the barriers, opportunities, and how the intervention can be integrated into the focal area and into more general relevant policy-making.

How should the workshop be organised?

The stakeholders from previous phases should also participate in this one to sustain and consolidate the reflection on the WEFe nexus. To widen the scope of the discussion and align it with the specific objectives of each case, it may be beneficial to expand the group by including stakeholders from under-represented elements of the nexus, particularly emphasising the diverse knowledge.

The workshop involves a collaborative exercise, divided into three parts, in which all interested parties are invited and encouraged to share their ideas and perspectives on the territory.



Script for implementation pathway workshop

1. Welcome and introduction (25 minutes)

Introduce the challenge of WEFe nexus in the focal area.

Presentation of the main results from the previous phases

Explain the purpose of the workshop and provide an overview of the agenda and the exercises.

2. Implementation pathway exercise (World café) (2 hours and 15 minutes)

Divide participants into groups of 4-6 people, according to the number of barriers to be analysed, depending also on the number of participants.

Provide a flipchart, Post-it and pens to each group so that they can freely organize their ideas.

Each group should nominate a group representative, i.e. a participant who coordinates each subgroup.

This exercise is divided in three parts:

Part 1: This exercise builds on the barriers identified in the stakeholder's assessment workshop, as well as other barriers identified in the literature and/or by experts. The barriers should be presented in the beginning of the exercise to the participants, clustered along **i) financial barriers, ii) political, social and administrative barriers, and iii) barriers to the physical implementation**. Each group discusses one category of barriers and identifies which specific complementary measures (e.g. regulatory measures, subsidies, knowledge transfer, strengthening collaboration, etc.) could help to overcome these barriers to the implementation of the intervention in the focal area.

The following guiding questions can be used for the discussion:

- What types of financial instruments or mechanisms could be used to support the implementation of WEF nexus solutions (e.g., grants, loans, crowdfunding, public-private partnership, etc.)? How can these financial instruments and subsidies be designed?
- What regulatory measures could be put in place to support the implementation of the intervention (e.g., tax incentives, streamlined permitting processes)?
- What types of knowledge transfer and capacity building programs could be developed to support the implementation of the intervention?
- How can collaboration among government agencies, private sector companies, and civil society organizations be strengthened to support the implementation of interventions?

Part 2: In the second part of the exercise, actors that are key to the implementation of the **intervention** and to the **complementary measures** will be identified through an interest/influence matrix (see Figure 61)

Participants should individually identify the key actors for implementing the intervention and the complementary measures and write them on a post-it. The following guiding questions can be used to define the relevant stakeholders:

- Which groups or individuals will feel the direct effects of the intervention, either positively or negatively?
- Which people or entities have the authority to make key decisions or alter the course of the intervention, and the complementary measures?
- Which stakeholders have the necessary resources (financial, human, technological) to implement the intervention and the complementary measures?
- Are there any stakeholders who may oppose the intervention or create obstacles during the process?

- Who could create resistance or conflicts that might hinder the success of the intervention?
- Which organizations, groups, or individuals can contribute expertise, networks, or strategic support?
- Which stakeholders should be included in assessing the impact and results once the intervention is implemented?

After the identification of the key-stakeholders, the group should discuss and organize the stakeholders in an "Interest-Influence matrix" which helps visualize which actors are involved, their level of interest in the project, and their influence on its success or failure. The matrix is divided into four quadrants based on two main criteria:

- Interest: What is the level of interest of stakeholders regarding the success or impact of the intervention?
- Influence: To what degree can the stakeholder affect the intervention or related decisions?

Based on these two criteria, stakeholders can be positioned into:

High Influence and High Interest

- Who are the stakeholders that have the most power to impact the project or intervention?
- Which stakeholders are directly affected by the intervention outcomes and have strong interest in its success?
- Who are the key decision-makers or influential figures whose support is crucial for the success of the intervention?

High Influence and Low Interest

- Who are the stakeholders that have the power to influence the intervention but show little interest in its implementation?
- Who has the ability to impact major decisions or outcomes but might not be directly concerned with the intervention's details?

Low Influence and High Interest

- Who are the stakeholders that are very interested in the intervention's outcomes but have little power to directly influence decisions?
- Which groups or individuals care about the intervention's success but have limited capacity to affect its progress or outcome?

Low Influence and Low Interest

- Who are the stakeholders who have little power to influence the intervention and are not particularly concerned about its success?
- Which stakeholders are unlikely to be significantly impacted by the project and do not show strong interest in its developments?

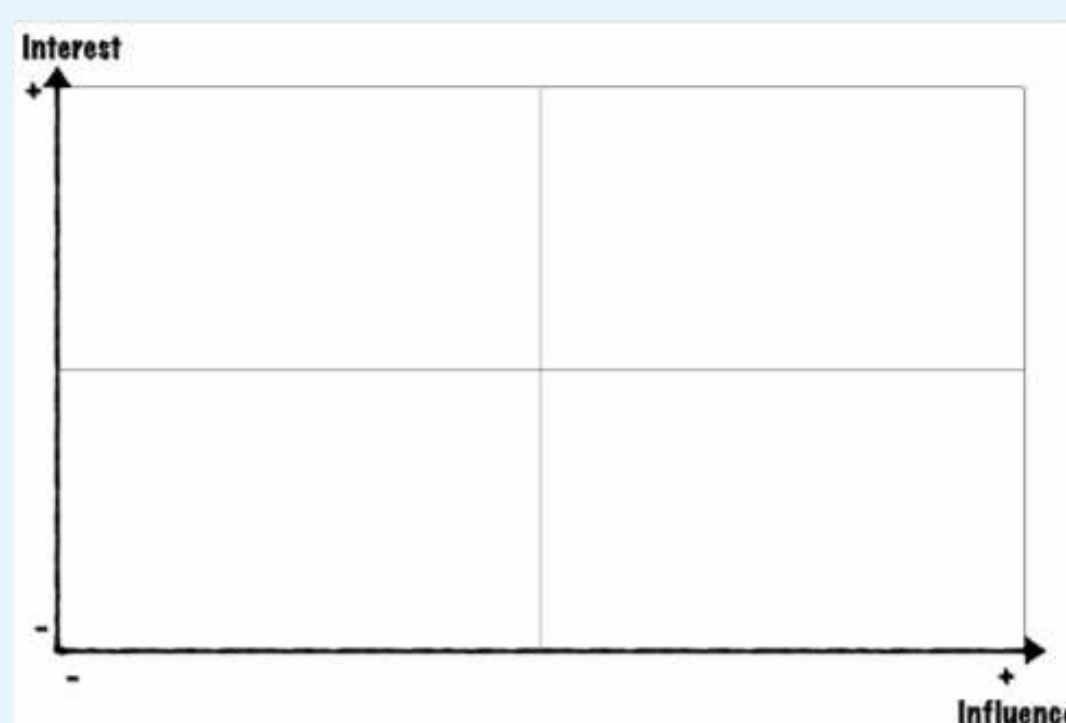


Figure 61: Interest-influence matrix

After the group exercises described above, the “World café” method should be used, with a change of tables, i.e., the participant who has been appointed as group representative stays at the table, while the rest of the group changes tables in a clockwise or counter-clockwise direction. The representative explains the discussion from the sub-group to the new participants. The new participants at the table discuss the results and add new ideas.

Part 3: The group representative presents the results of the sub-groups to the plenary, and there is room for discussion.

3. Closing of the workshop (10 minutes)**Expected output**

A list of specific complementary measures to support the implementation pathways of the intervention, based on the barriers identified in the assessment phase, along with influence–interest stakeholder matrices.

6.1 Nexus Bridging Plans

Nexus Bridging Plans (NBP) are one of the main outputs of the implementation of the WEF Framework 2.0. NBPs summarize main insights obtained from the implementation of the different WEF methods, describe the implementation pathways for the different interventions that have been selected, and outline the additional policy measures that are needed for their implementation, with the overarching aim to improve the WEF nexus.

The NBPs should be accessible to a diverse audience, including stakeholders with different levels of technical expertise, by presenting the content in a structured, concise, and reader-friendly way.

The download below provides an overview of the structure of the Nexus Bridging Plan and its different elements, to serve as a guideline for writing the NBP.

Executive summary of the NBP

- Summarize the main **WEFe nexus problem** in the area, based on the Causal Loop Diagram by the stakeholders. All sectors of the WEF nexus should be included in the problem description. It should be mentioned if certain nexus dimensions are particularly important in the area.
- Briefly describe the **intervention(s)** that has/have been selected for the focal area and how it addresses the main WEF nexus problem. Summarize the measures (financial, political, capacity-building measures, etc.) that are needed to strengthen the acceptance and facilitate the adoption of the intervention.
- Briefly summarize the **transdisciplinary approach** that was implemented in the focal area to select and assess the intervention, including who participated, how the intervention was selected, and whether other interventions were discussed as well.

Methodological approach

Briefly describe how the framework was implemented in the focal area, which stakeholder groups were involved. Mention if there were any problems encountered during the framework implementation that may have influenced the outcomes.

Context description

- Briefly mention the social and/or territorial **boundaries** of the focal area, and how it relates to other administrative and/or biophysical boundaries. Include a map of the country or region (depending on their size).
- Briefly describe the broader **socio-economic and ecological context** and related challenges of the region that influence the WEFe Nexus and the implementation of the intervention in the focal area.
- Briefly describe the **upcoming trends and future projections** for the availability of water, land, energy resources, and the state of ecosystems, as well as for socio-economic challenges such as population growth or increasing rates of urbanization which both may result in growing demands for natural resources for the focal area.

WEFe nexus issue

- Summarize the **WEFe nexus problems** that have been identified in the focal area, including the main drivers and consequences. Present the problem in the form of a coherent narrative, following the storyline developed during the stakeholder workshop, and include the Causal Loop Diagram (CLD) as a visual element.
- Briefly describe the **stakeholders** that are involved in and affected by the main WEFe nexus problem, their main interests, and how they relate to the WEFe nexus problem. Explain how the main WEFe nexus problems are perceived by the stakeholders and whether there are confronting views. Mention which stakeholders participated in the process of selecting and evaluating the intervention.
- Briefly describe the **perception of ecosystem services by stakeholders**, and make visible what people value or not in the natural systems of the area. Describe what kind of ecosystems services (provisioning, regulating or cultural) are valued most, and whether these perceptions change depending on the type of technological intervention applied in the area.

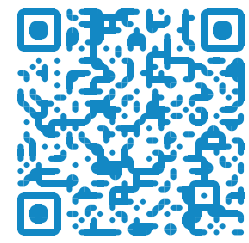
WEFe solution(s): Interventions and complementary measures

- Describe the local **intervention** that has been selected for the focal area, what it mainly is about, and how the intervention aims to solve the WEFe nexus problem in the area.
- Summarize the **barriers and facilitating factors** to the intervention as identified in the stakeholder workshop in terms of financial dimensions, physical implementation, and social, political and administrative aspects.

- Describe the **complementary measures for implementation facilitation** that are needed to overcome the identified barriers, as well as to strengthen the acceptance and adoption of the intervention at the local level in the focal area. These measures can include, for example, economic, political, social, or capacity building measures. It should also be mentioned which actors are in charge of these complementary measures and reflect their potential to implement them.
- Describe the **performance** of the intervention in terms of how it contributes to solving the WEFe nexus problem. This means the extent to which the intervention helps to reduce the use of water, energy or land and protect ecosystems, while ensuring that food production and local livelihoods are maintained or improved. The limitations of the intervention in terms of solving the WEFe nexus problem in the area should also be openly addressed in order to portray a realistic picture.
- If several interventions have been selected or are considered important to solve the WEFe nexus issue in the focal area, they can be described as well according to the above structure. Explain why additional interventions are considered important.

Conclusion

Briefly summarize the potential of the intervention to solve WEFe nexus problems, as well as the complementary measures (economic, political, capacity-building, or social measures) that are needed for a successful implementation of the intervention. Mention official national or regional political objectives/ policies related to the WEFe nexus (e.g. SDGs, food security, etc.) to which the intervention can contribute. Briefly discuss the limitations of the intervention, and the additional interventions that are required to address the WEFe nexus problem of the focal area in a holistic way, considering also future trends and challenges related to the use of water, energy, land, and ecosystems.



Additional documents

Access complementary resources
and technical guidance

7. References and additional documents

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