Guidance: Using the Nexus Policy Assessment Tool – NEPAT – for teaching

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1. Background

Applying knowledge in realistic or semi-realistic contexts is essential for developing complex skills, but **real-world practice in higher education** is often limited, difficult to access, or ethically challenging for novice learners. To overcome these barriers, simplified practice—such as simulations—can offer structured, manageable experiences that replicate key aspects of professional tasks. **Simulations allow learners to engage with authentic problems** in a controlled environment, supporting skill development while minimizing risks. While full authenticity isn't always ideal for learning, adjusting the level of realism in simulations can optimize educational outcomes, making it important to assess how well simulations mirror real-life demands, contexts, and interactions.[1]

The **NExus Policy Assessment Tool (NEPAT)** is an **interactive simulation tool** designed to help users analyze the **complex interconnections** between **Water, Energy, Food, and Ecosystems (WEFE)** in (transboundary) River Basins (see an overview of the five cases in Figure 1). By simulating different climate and socioeconomic scenarios, NEPAT empowers policymakers, researchers, and stakeholders to assess the potential impacts of policies and make informed decisions for sustainable resource management. **NEPAT has been developed as part of the NEXOGENESIS project to support policy assessment and decision-making across diverse river basins.** To gain a deeper understanding of the broader context and objectives behind NEPAT, you can explore the **Nexogenesis project** at nexogenesis.eu.

[1] More information about how simulations can help students learn can be found in the Annex under Background on the usage of simulation tools for higher education teaching.

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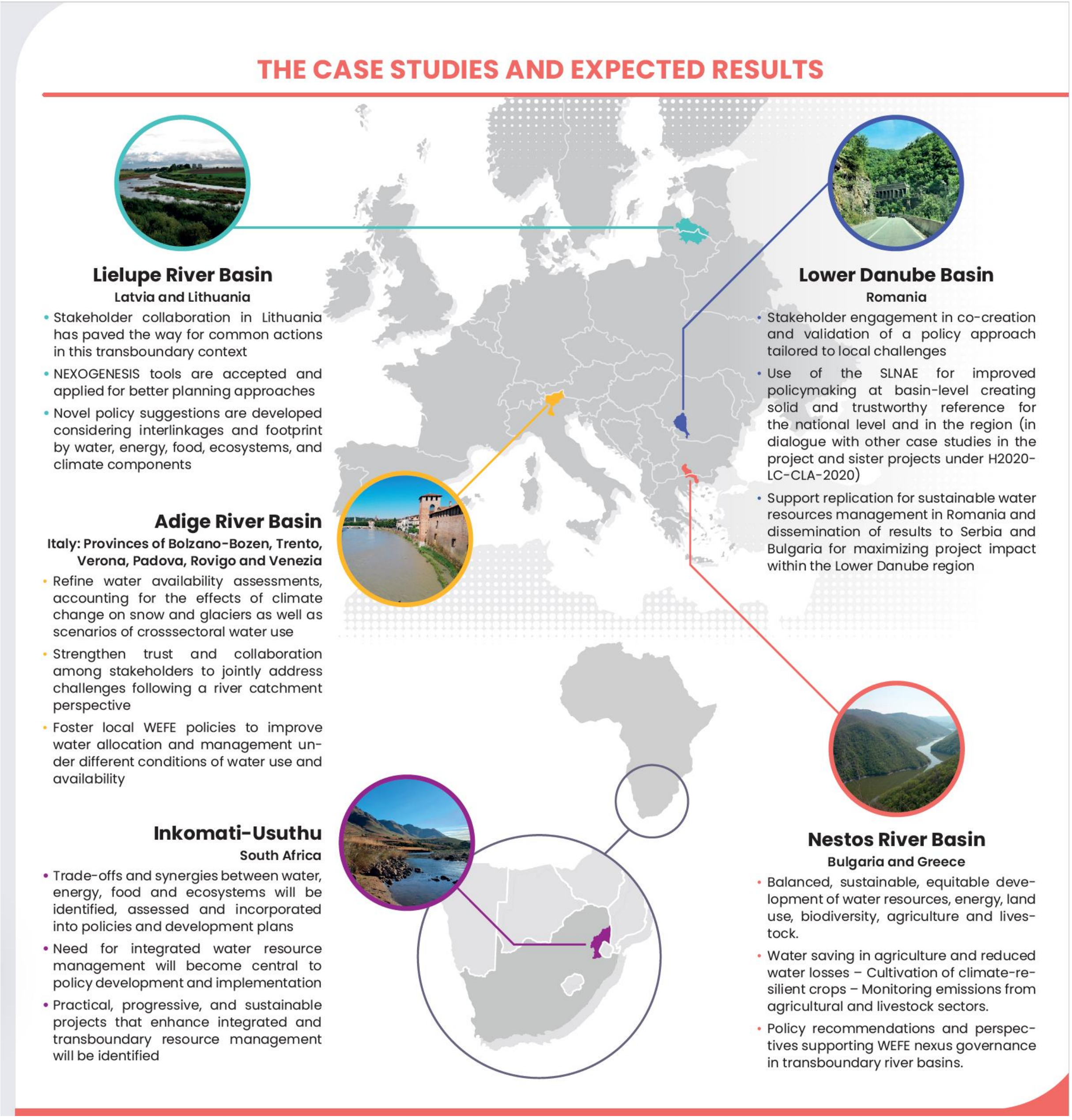

Figure 1 : The five NEXOGENESIS case studies.

The tool is based on **policy goals** and **policy instruments** that were identified and selected by the respective case study stakeholders and were subsequently also implementable in the modelling context (see the full co-creation approach applied in NXG in Figure 2). This means that they were measurable enough and that sufficient data and research was available to be able to describe the effects of the policy instrument application in the underlying System Dynamics Model. To learn more about the modelling please refer to [Deliverable D3.2](#) and [D3.4](#), and Wang et al. (2023).

In addition to displaying the effects of policy instruments on policy goals, NEPAT also displays these effects on the **WEFE Nexus Footprint**. This footprint is an index that is based on a set of sector specific indicators describing the degree to which the policy instruments affect these indicators in a positive or negative manner. More information on the WEFE Nexus Footprint can be found in [Deliverable D3.7](#).

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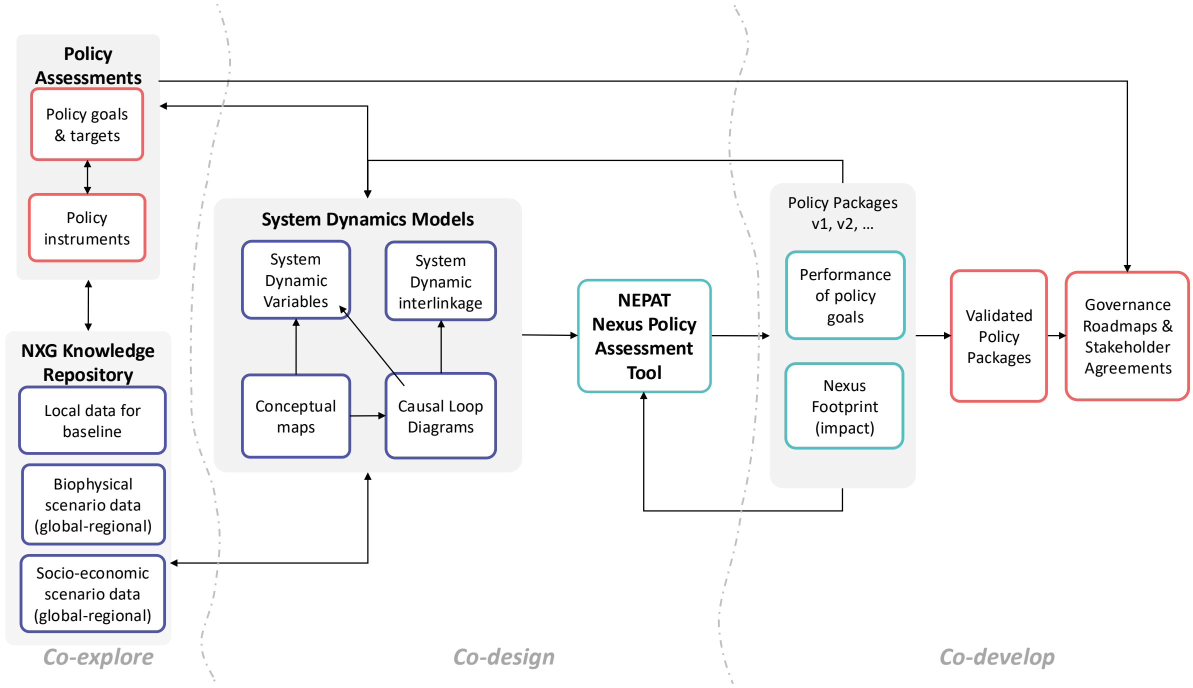

Figure 2 :Overview of the NXG Approach and the phases of implementation.

One of NEPAT's most powerful features is its ability to suggest effective policies using artificial intelligence. The tool can analyze a vast range of scenarios and **provide customized recommendations to help achieve specific goals within the WEFE nexus**. This feature is particularly useful for identifying the most impactful policy measures, optimizing resource management, and adapting policies to different future conditions.

NEPAT is designed not only as a technical tool but as a **collaborative platform** that facilitates discussions between policymakers, researchers, and stakeholders. By providing clear data visualizations and interactive tools, NEPAT supports:

- **Informed policy dialogue:** Users can explore different policy options and their potential consequences.
- **Cooperative decision-making:** Users can work together to develop strategies that benefit multiple sectors.

2. Using NEPAT for teaching

NEPAT is designed to serve a diverse range of users involved in policy assessment, decision-making, and research within the Water, Energy, Food, and Ecosystems (WEFE) nexus. For students **and educational institutions NEPAT can help enhance learning about policy analysis, sustainability, and resource management** by providing an interactive tool for exploring real-world scenarios. An overview of the **NEXOGENESIS case studies** can be found in Appendix 5.1.

In NEPAT, the main hub for exploring and analyzing results is in the **Simulation View** (Figure 3) which includes the following features:

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- Global View – See an overview of your case study
- Policy Instruments – Add and fine-tune your policies
- Policy Goals – Check how well your policies are meeting objectives
- Nexus Footprint **–** See how policies impact different sectors
- Detailed View – Dive deep into simulation variables
- Decision Support System – Get AI-powered policy recommendations

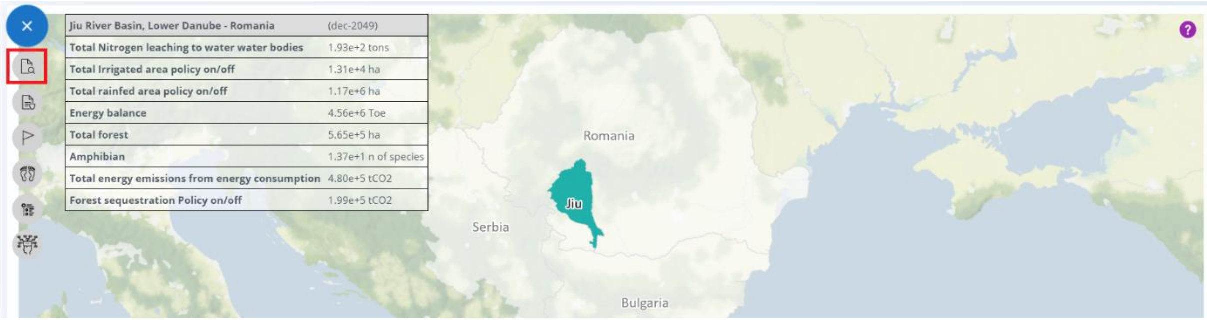

Figure 3: The Global view of each of the case studies is the entry point to the simulation experience

The **main aim of using NEPAT is to better understand the trade-offs and synergies** that result from multi-sectoral interlinkages and how to design and implement policies in a manner that they minimize trade-offs and maximize synergies. While the tool offers sophisticated modelling and decision-support, the NXG project has shown that the challenges come with what the tool shows, namely, which sector to prioritize and why and how to adapt policies (also in their implementation) to reduce inter- and intra-sectoral conflicts. In the NXG project the tool was used as an entry point for discussions with stakeholders, often technical staff of ministries, river basin authorities and researcher entities.

For example, in one university course focused on environmental policies students used NEPAT to explore competing water and energy strategies in the Jiu River Basin in Romania. By simulating two different climate scenarios and applying a mix of agricultural and hydropower policies, students were able to analyze trade-offs and present recommendations during a mock stakeholder debate, deepening their understanding of cross-sectoral tensions and policy impacts (find the respective example exercise for the Jiu River Basin in Annex 5.5).

Scaffolding – adjusting the learning context by increments - is crucial for helping novice learners tackle ill-structured problems by reducing cognitive load and guiding problem-solving through task adjustments, hints, and structured support. It can take many forms—such as worked examples, prompts, checklists, role assignments, and reflection phases—ranging from high instructional guidance to high self-regulation. The effectiveness of scaffolding depends on learners' prior knowledge: novices benefit from more structured support, while advanced learners gain more from self-directed strategies. In virtual or game-based learning, instructors play a key role in aligning activities with curricula, acting as facilitators, and incorporating collaborative elements. Involving students in game design can also improve engagement and learning outcomes by ensuring relevance and innovation.

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Based on these insights from research on how to make best use of simulation tools in higher education teaching, we offer below some ideas of scaffolding that allow for **different degrees of complexity to address the WEFE Nexus**, namely:

1) Using NEPAT to maximize for sectoral policies either for one or more than one sector. This can be done in free exploration as well as by using the embedded decision-support system.
2) Using the NEPAT results for a role-playing activity. Here students can choose a sectoral stance and discuss the results with their peers, paying attention to maximizing synergies across the sectors and minimizing trade-offs.
3) Using the NEPAT results to look at a particular policy (and their respective governance roadmaps) and to prioritize their implementation based on a set of criteria, including economic constraints.

The sub-sections below describe the suggested flows and working modalities for these three exercises. The needed information or resources to carry out the modalities are highlighted and linked to in the respective parts. Some of it can be found online on the NEXOGENESIS website, and other elements are found in the appendix to this document.

2.1 Exercise 1: Optimizing policy selection for nexus outcomes

NEPAT is built as a highly sophisticated and complex modelling and AI tool. The baseline for any educational activity is thus to familiarize students with NEPAT and its functionalities[2]. A potential flow/agenda for a **2-to-2.5-hour session** is shown in Table 1.

Preconditions for this modality are:

- students need to have access to an electronic device, ideally a laptop or desktop computer (the tool is visually complex and using smaller hand-held devices will not allow for a full user experiences)
- good and stable internet connection
- Group sizes should probably be limited to no more than 3-4 people to allow for exploration

[2] The way this is set up students will get to explore the main use of the NEPAT which is to look at how policy instruments influence policy goals and the WEFE Nexus footprint. For classes with students where there is a higher interest in more detailed knowledge about the modelling or the way certain indicators or data points change over time, a different, more detailed approach may be needed.

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Table 1 : Flow of the modality of exploring NEPAT

Duration	Activity	Aim/Additional information
15 min	Introduce the aim of the activity (to better understand trade-offs and synergies between policies in WEFE Nexus settings) and the flow of the activity (introduction to the tool to be used, questions to be answered, debrief)	Set the scene
5 min	Introduction to NEXOGENESIS and the aim of the project, e.g. through this video NEXOGENESIS – Project presentation	Provide background and context
10 min	Introduction to the NEPAT by watching this video The NEXOGENESIS tool by Lluis Echeverria Rovira, EURECAT and this The WEFE Nexus Footprint by Gareth Simpson, JAWS and this Nexus system thinking and integration in NEXOGENESIS by Prof. Chrysi Laspidou, UTH	Provide understanding about the tool, the underlying modelling and the outcomes. Further information on the WEFE footprint can be found in 5.2 The WEFE Footprint.
5 min	Pause for questions	Allow students to reflect on the context.
5 min	Introduce the activity: - Students will work individually (instructors can choose to also set up small groups of 2-3 students per groups) - The activity consists of 3+ questions that students need to answer.	
15 min	Watch the NEPAT step-by-step guide video NEXOGENESIS – The NEPAT Tool or introduce it yourself.	Get students to understand the functionalities of the tool. The full user manual can be found HERE, a short summary is found below in How to use NEPAT.
5 min	Enter NEPAT using the guest account	Instructors can choose to have students enter NEPAT using a registered account if they wish to break the activity into multiple lectures and want students to return to where they left off
	Decide if students get to choose the case study on their own or if a specific (set of) case stud(ies) will be explored	Case studies 2, 3 and 5 have policy instruments across all WEFE sectors, whereas case studies 1 and 4 are more limited in scope and water centric. Case studies 1 and 2 are transboundary whereas the other ones are bound nationally. Case studies are described in 5.1 Overview of NEXOGENESIS case studies. The respective policy goals and policy instruments can be found in a listing in List of policy

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		goals for each of the case studies and List of policy instruments for each of the case studies. Depending on the size of the group it can be interesting to limit the exploration to only one case or to divide the group into sub-groups to explore multiple cases (i.e. Group 1 explores case study 1, Group 2 explores case study 2, etc.). Find **a specific example in** Example of a Policy Selection Optimization exercise (on GHG emissions for the Jiu River Basin) for direct use or as inspiration.
15 min	Allow for free exploration	Students get to familiarize themselves with the tool.
15 min	**Question 1:** Choose a set of policies (policy package) based on your knowledge that you think will maximize all WEFE sectors. Check in the goals and footprint views of how well your policy package did? Which trade-offs can you find across the WEFE Nexus sectors?	Students need to use their knowledge to decide on the 'right' policy package and assess the consequences. Students may want to take screenshots of their results or open NEPAT in multiple browser windows.
15 min	**Question 2:** Add a second policy package and choose policies that you think will maximize only ONE WEFE Nexus sector. Compare with the results of the first policy package from Q1. What changed in the goals, the footprint and the trade-offs? Think about why the results changed or not.	Determine here if you want to be prescriptive and choose the WEFE sector to be maximized beforehand (e.g. only water) or not. This exercise allows students to look at the differences in sectoral policy making versus integrated policy making across the WEFE Nexus sectors.
15 min	**Question 3:** Now turn to the DSS and re-explore question 1. Does the DSS come up with the same suggestion you made? Look at the ranking of the policy packages. Are there any policy packages that you think would be more reasonable than others (e.g. economic or social costs, more or less trade-offs)? Why? (Question 4: The same as in question 3 but with using the DSS to re-explore question 2)	The DSS provides the optimal solutions, but it does not account for economic or social costs. Some policies may be harder to implement than others. The more policies need to be implemented, usually, the more costly and challenging it will be to actually do. This question allows students to reflect further about the impacts of the policies.
30 min	**Debrief: (suggested questions)** Introduction to debrief:	There are numerous techniques for debriefing that predominantly exist in the medical field. For a nice review have a look at: *(PDF) Debriefing Methods in Simulation-Based Education*.

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	We want everyone to stay in contact in a respectful and professional manner. Please be reminded that we do not desire offensive or incriminating comments, insults, or negative reviews. There will be three or four different stages in this process. The process will take no more than approximately 30 minutes. Reaction: How was the exercise? Describe your feelings and thoughts about the exercise. Analysis: What was the exercise about? In which question did you (and your team) succeed and feel challenged? I noticed some of you mention…; let's explore this further. Can you think of strategies of how to tackle some of the issues in the future? What would need to happen to induce transformative change? Summary: What can we learn from this exercise? What would you do differently if you had to do it again? If you had to make these kinds of decision in real life, which point would you particularly consider? What did you learn today? Conclusion: Do you have any further questions or comments? Thank you again for participating in the exercise today.	Available from: https://www.researchgate.net/publication/352528333_Debriefing_Methods_in_Simulation-Based_Education [accessed Mar 17 2025]. The questions to the right are adopted from Table 3 of the above-mentioned publication.

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2.2 Exercise 2: Role-playing sectoral discussions

The NEPAT does not give hard recommendations on which policies to choose, implement or adapt. It is rather a tool to foster discussions amongst stakeholders, experts and policymakers. It intends to highlight the complexities of policies and their side effects on other sectors that are, at first glance, outside of the realm of the policy. In NEXOGENESIS, the NEPAT was used to have these conversations across stakeholders. In this activity, we suggest mimicking these conversations through role-playing. A suggested flow of this 2-2.5-hour activity is presented in Table 2.

Preconditions for this modality are:

- Depending on the number of participants it may be good to be able to put the respective case study groups into separate rooms; conversations may become heated, and it would be good to be able to talk freely.
- Group sizes would ideally be between 4 (to represent at least all WEFE Nexus sectors) to a maximum of 10 participants to allow for meaningful conversations.
- Participants would be assigned to one of the five case studies.

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Table 2: Flow of the role-playing modality

Duration	Activity	Aim/Additional information
15 min	Introduce the aim of the activity (to better understand the complexities of decision-making when taking into account collateral effects that surpass one's sectoral realm) and the flow of the activity (introduction to roleplay, questions to be answered, debrief)	Set the scene
Do the following steps only if you haven't done them before already.		
5 min	Introduction to Nexogenesis and the aim of the project, e.g. through this video NEXOGENESIS – Project presentation	Provide background and context
10 min	Introduction to the NEPAT by watching this video The NEXOGENESIS tool by Lluis Echeverria Rovira, EURECAT and this The WEFE Nexus Footprint by Gareth Simpson, JAWS and this Nexus system thinking and integration in NEXOGENESIS by Prof. Chrysi Laspidou, UTH	Provide understanding about the tool, the underlying modelling and the outcomes
5 min	Pause for questions	Allow students to reflect on the context.
15 min	Introduce the activity: - Briefly introduce how role-playing works - Presentation of the stakeholder landscape of the chosen case study - Students will choose to represent one stakeholder each - Students will be presented with the results of the NEPAT for each of the case studies - The aim of the role-play is for students to discuss the results of the NEPAT from their point of view.	
5 min	Introduction to role-play: Role-play is an experiential learning method where individuals act out roles in particular situations. These scenarios can range from business negotiations and medical consultations to historical reenactments and customer service interactions. The primary goal of role-play is to provide a safe, controlled environment for participants to experiment with different behaviors, practice problem-solving, and develop a deeper understanding of the subject matter. Key Elements of Role-Play:	Check out some of the following sites to find out more: https://www.teachfloor.com/elearning-glossary/role-play or https://www.niu.edu/citl/resources/guides/instructional-guide/role-playing.shtml

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	• Scenarios: Specific, realistic situations designed to meet learning objectives. • Roles: Defined characters or personas participants adopt during the exercise. • Guidance: Instructions or frameworks provided to participants to navigate the role-play. • Feedback: Constructive critiques and discussions following the role-play to reinforce learning.	
15 min	Presentation of the stakeholder landscape of the chosen case study and selection of personas by students	The instructor should decide if the group gets divided into one or more case studies depending on the number of students. For one case study the group would consist ideally of at least 4 (one persona for each sector) to about 10 people (personas representing research, stakeholders from different levels of policymaking, the private sector, the media, etc.). In NEXOGENESIS a large emphasis was set on stakeholder engagement. In 5.1 Overview of NEXOGENESIS case studies you can find a brief overview of the main stakeholder (groups) and their 'personas' for each case study. These are representations of actual stakeholders we identified and, in part, encountered (not always did all relevant stakeholders engage).
60 min	Each case study group will receive an overview sheet of the main results of the NEPAT. Two versions of the role-play could be played: - **Version 1:** The aim of the participants is to seek the optimal choice of policy instruments to provide equality across all WEFE Nexus sectors. - **Version 2:** The aim is to maximize outputs for one's chosen sector. More 'neutral' participants (such as researchers or media representatives) can act towards highlighting the challenges and opportunities from the sectoral versus a more nexus-oriented approach.	The instructor will hand the respective case study overview to the group. In addition, the instructor could login to NEPAT and use the tool to answer questions that participants might have based on the discussion. The two versions of the role-play can either be played one after the other or the instructor can choose to play just one OR the other. This can also be preceded by a voting or ranking exercise of the respective policy goals. The exercise could then consist in trying to optimize policy instrument selection for those chosen policy goals (e.g. the way South Africa did this).

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30 min	**Debrief: (suggested questions)** Introduction to debrief: We want everyone to stay in contact in a respectful and professional manner. Please be reminded that we do not desire offensive or incriminating comments, insults, or negative reviews. There will be three or four different stages in this process. The process will take no more than approximately 30 minutes. Reaction: How was the exercise? Describe your feelings and thoughts about the exercise. Analysis: What was the exercise about? In which question did you (and your team) succeed and feel challenged? I noticed some of you mention…; let's explore this further. Can you think of strategies of how to tackle some of the issues in the future? What would need to happen to induce transformative change? Summary: What can we learn from this exercise? What would you do differently if you had to do it again? If you had to make these kinds of decision in real life, which point would you particularly consider? What did you learn today? Conclusion: Do you have any further questions or comments? Thank you again for participating in the exercise today.	There are numerous techniques for debriefing that predominantly exist in the medical field. For a nice review have a look at: *(PDF) Debriefing Methods in Simulation-Based Education*. Available from: https://www.researchgate.net/publication/352528333_Debriefing_Methods_in_Simulation-Based_Education [accessed Mar 17 2025]. The questions to the right are adopted from Table 3 of the above-mentioned publication.

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2.3 Exercise 3: Discussing implementation challenges

One of the learnings from the NEXOGENESIS workshops, and generally from resource management research, is that the implementation and enforcement of policy instruments is prone to failure. As one stakeholder put it bluntly: "*We have fantastic policies, now we just need to get it done!"* Therefore, this next activity intends to help students learn about some of the implementation challenges of integrated Nexus policy implementation. This activity will be based on activities that have been identified in NEXOGENESIS from the Governance Assessments and the Roadmapping actions in each of the case studies[3]. Students will be asked to prioritize activities within the roadmaps based on **feasibility** and **need**. This can be combined with roleplaying but can also be done without. Depending on the number of versions that are being applied here, this exercise can last from 1 to 2.5 hours.

Preconditions for this modality are:

- Depending on the number of participants it may be good to be able to put the respective case study groups into separate rooms; conversations may become heated and it would be good to be able to talk freely.
- Participants would be assigned to one of the five case studies.
- Sticky notes, markers, large (at least A2) sized blank papers (4, one for each quadrant).

[3] The NEXOGENESIS governance assessment (NXGAT), policy coherence assessment and roadmapping can be found in Deliverables D1.2, D1.3 and D1.4.

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Table 3 : Flow of the prioritization exercise

Duration	Activity	Aim/Additional information
15 min	Introduce the aim of the activity (to better understand the complexities of decision-making when taking into account collateral effects that surpass one's sectoral realm) and the flow of the activity (introduction to road-mapping, prioritization, debrief)	Set the scene
Do the following step only if you haven't done them before already.		
5 min	Introduction to Nexogenesis and the aim of the project, e.g. through this video NEXOGENESIS – Project presentation	Provide background and context
5 min	Pause for questions	Allow students to reflect on the context.
15 min	Introduce the activity: - Briefly introduce the governance assessment and road mapping that was done in NEXOGENESIS. - The aim of the prioritization exercise is to get a feeling for the challenges in implementation and limitations in budgets and/or human resource capacities.	
Do the following step only if you haven't done them before already AND if you chose the roleplay version of the exercise.		
15 min	Presentation of the stakeholder landscape of the chosen case study and selection of personas by students	The instructor should decide if the group gets divided into one or more case studies depending on the number of students. For one case study the group would consist ideally of at least 4 (one persona for each sector) to about 10 people (personas representing research, stakeholders from different levels of policymaking, the private sector, the media, etc.). In NEXOGENESIS a large emphasis was set on stakeholder engagement. In 5.1 Overview of NEXOGENESIS case studies you can find a brief overview of the main stakeholder (groups) and their 'personas' for each case study. These are representations of actual stakeholders we identified and, in part, encountered (not always did all relevant stakeholders engage).

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20 - 60 min	Each case study group will receive the respective governance roadmaps of their case studies (see an example of CS5 in Example of a governance roadmap). The steps of the activity are as follows: 1. **Transfer the activities** of the governance roadmaps to sticky notes **2. Create a grid** – Set up a grid with four quadrants and assign one broad criteria to each axis. Create arrows on the axes to indicate 'high' or 'low,' as shown below. 3. **Label quadrants** – Based on the axes, label each quadrant as either 'High Need/High Feasibility,' 'High Need/Low Impact,' 'Low Need/High Feasibility,' 'Low Need/Low Feasibility.' 4. **Categorize & Prioritize -** Place competing activities, projects, or programs in the appropriate quadrant based on the quadrant labels. The example below depicts 'Need' and 'Feasibility' as the criteria and items have been prioritized as follows: ➢ *High Need/High Feasibility* – With high demand and high return on investment, these are the highest priority items and should be given sufficient resources to maintain and continuously improve. ➢ *Low Need/High Feasibility* – Often politically important and difficult to eliminate, these items may need to be re-designed to reduce investment while maintaining impact. ➢ *High Need/Low Feasibility* – These are long term projects which have a great deal of potential but will require significant investment. Focusing on too many of these items can overwhelm an agency. ➢ *Low Need/Low Feasibility* – With minimal return on investment, these are the lowest priority items and should be phased out allowing for resources to be reallocated to higher priority items. **This can be played in multiple versions/rounds.** **Version 1:** Students place the sticky notes in the quadrants based on their professional knowledge. **Version 2:** Students take up a role (either the one that they had in the role-playing session or a generic one) and prioritize the activities based	The instructor will hand the respective case study roadmaps to the group. The versions of the activity can either be played one after the other or the instructor can choose to play just one.

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	on the interests of their persona. (When playing both versions it would be could to discuss the results in between). **Version 3**: Assign perceived costs to the activities (values from 1 to 10). Now limit the total value that can be implemented in the high need/high feasibility quadrant to a set maximum amount (e.g. 100). Assess which activities need to be/can be removed from the quadrant and discuss the consequences that this may have on overall outcomes. This can be played in role-play or not.	
10-30 min	**Debrief: (suggested questions)** Introduction to debrief: We want everyone to stay in contact in a respectful and professional manner. Please be reminded that we do not desire offensive or incriminating comments, insults, or negative reviews. There will be three or four different stages in this process. The process will take no more than approximately 30 minutes. Reaction: How was the exercise? Describe your feelings and thoughts about the exercise. Analysis: What was the exercise about? In which question did you (and your team) succeed and feel challenged? I noticed some of you mention…; let's explore this further. Can you think of strategies of how to tackle some of the issues in the future? What would need to happen to induce transformative change? Summary: What can we learn from this exercise? What would you do differently if you had to do it again?	There are numerous techniques for debriefing that predominantly exist in the medical field. For a nice review have a look at: *(PDF) Debriefing Methods in Simulation-Based Education*. Available from: https://www.researchgate.net/publication/352528333_Debriefing_Methods_in_Simulation-Based_Education [accessed Mar 17 2025]. The questions to the right are adopted from Table 3 of the above-mentioned publication.

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	If you had to make these kinds of decision in real life, which point would you particularly consider? What did you learn today? Conclusion: Do you have any further questions or comments? Thank you again for participating in the exercise today.	

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2.4 Exit survey

As an additional feature, instructors could choose to use an exit survey to monitor or check on the learning of the students. In NEXOGENESIS, a survey based on the principles of knowledge generation was used to determine the levels of knowledge generation in system, target and transformational knowledge. The survey is copied below for further use.

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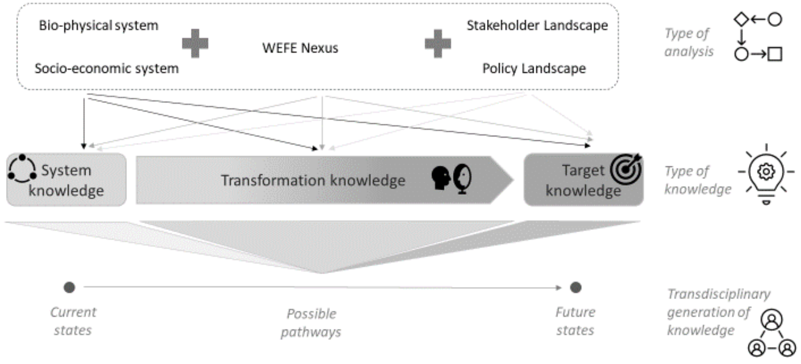
Level of knowledge acquired through the <u>workshop.</u>

In this part, we want to find out how the **current** workshop may have helped you **gain certain knowledge**. In NXG, we undertake different kinds of research through various types of analyses. Each of these types of analyses can lead to co-created knowledge of any or all of these three types of knowledge:

- <u>System knowledge</u>: **knowledge about the current state** of the real-world situation and its context;
- <u>Target knowledge</u>: **knowledge about the desired future state**;
- <u>Transformation knowledge</u>: **knowledge about the pathways** from the current to the future state.



Below we want to find out in how far **this workshop** has helped to create the above-mentioned types of knowledge as per the respective types of analysis. Please tick the number reflecting your perception (*1=not helpful at all; 7=very helpful; N/A=don't know; no answer*).

<table>
<tr><td colspan="8">Biophysical System
(Biological and physiochemical components like the effect of precipitation on water flows)</td><td colspan="8">Socio-Economic System
(Social and economic components like the effect of employment rates on GDP)</td><td colspan="8">WEFE-Nexus
(Interlinkages across Nexus aspects and the overall footprint)</td><td colspan="8">Stakeholder Landscape
(The classification of stakeholders, their relationship towards each other and for the problem & solution)</td><td colspan="8">Policy Landscape
(The classification of policies, their relation to the WEFE Nexus aspects and their role in solving Nexus problems)</td></tr>
<tr><td colspan="40"><u>System Knowledge</u>: To what degree did the workshop help you understand the current state of the …?</td></tr>
<tr><td colspan="8">Biophysical System</td><td colspan="8">Socio-Economic System</td><td colspan="8">WEFE-Nexus</td><td colspan="8">Stakeholder Landscape</td><td colspan="8">Policy Landscape</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>N/A</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>N/A</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>N/A</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>N/A</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>N/A</td></tr>
<tr><td colspan="40"><u>Target Knowledge:</u> To what degree did the workshop help you understand the desired state of the …?</td></tr>
<tr><td colspan="8">Biophysical System</td><td colspan="8">Socio-Economic System</td><td colspan="8">WEFE-Nexus</td><td colspan="8">Stakeholder Landscape</td><td colspan="8">Policy Landscape</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>N/A</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>N/A</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>N/A</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>N/A</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>N/A</td></tr>
<tr><td colspan="40"><u>Transformation Knowledge:</u> To what degree did the workshop help you understand how to influence the …?</td></tr>
<tr><td colspan="8">Biophysical System</td><td colspan="8">Socio-Economic System</td><td colspan="8">WEFE-Nexus</td><td colspan="8">Stakeholder Landscape</td><td colspan="8">Policy Landscape</td></tr>
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</table>

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3. Conclusions

In conclusion, the integration of simulation-based learning, particularly through tools like NEPAT, provides a valuable approach for developing expertise in complex problem-solving within higher education. By offering structured approximations of real-world practice, NEPAT enables learners to engage with authentic challenges in the Water, Energy, Food, and Ecosystems (WEFE) nexus without the ethical and logistical constraints of direct real-world exposure.

The application of scaffolding techniques ensures that learners at different levels of expertise can navigate these simulations effectively. High instructional guidance benefits those with limited prior knowledge, while more advanced learners gain from opportunities to regulate their own learning through reflection and self-directed exploration. The inclusion of role-playing activities, decision-support systems, and policy analysis exercises further enhances engagement and deepens understanding by encouraging collaborative and critical thinking skills.

Moreover, NEPAT's ability to simulate policy impacts and optimize decision-making within the WEFE nexus makes it a powerful tool not only for students but also for policymakers and researchers. The structured learning experiences it facilitates allow students to develop competencies in evaluating trade-offs, maximizing synergies, and formulating strategic policy recommendations.

Ultimately, the successful use of NEPAT in educational settings depends on careful instructional design, ensuring alignment with curricular objectives and providing appropriate scaffolding. By leveraging this tool within a blended learning framework, educators can create dynamic and immersive learning experiences that prepare students for the complexities of real-world policy analysis and resource management. Through continued research and refinement, simulation-based learning will remain an essential strategy for fostering expertise in complex, interdisciplinary domains.

We hope this guide will support higher education lecturers in making use of NEPAT in teaching about complex resource management problems.

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4. References

Wang X., Dong Z., Sušnik J. 2023. System dynamics modelling to simulate regional water-energy-food nexus combined with the society-economy-environment system in Hunan Province, China. *Science of the Total Environment.* 863: 160993. DOI: https://doi.org/10.1016/j.scitotenv.2022.160993 .

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5. Appendix

5.1 Overview of NEXOGENESIS case studies

In NEXOGENESIS five case study areas were used and can be explored in the NEPAT. Full description can be found in the following factsheets. A short description is found below.

CS#1 : https://nexogenesis.eu/wp-content/uploads/2025/07/Factsheet-Case-study-1.pdf
CS#2 : https://nexogenesis.eu/wp-content/uploads/2025/07/Factsheet-Case-study-2.pdf
CS#3 : https://nexogenesis.eu/wp-content/uploads/2025/07/Factsheet-Case-study-3.pdf
CS#5 : https://nexogenesis.eu/wp-content/uploads/2025/07/Factsheet-Case-study-5.pdf

🌍 Case Study 1: Nestos River Basin (Greece & Bulgaria)

📍 **Area:** 5,479 km² | **Length:** 243 km | **Location:** Spans the Bulgaria-Greece border in Southeastern Europe

The **Nestos/Mesta CS** comprises the Nestos/Mesta river basin shared between Greece and Bulgaria. The Nestos/Mesta river springs from the Rila Mountains (BG) and discharges in the Thracian Sea (GR). Its basin area is approximately equal to 5,479 km^2 and its length is about 243 km. The river forms a significant ecosystem throughout its course and its delta is a unique ecosystem protected by the Ramsar Convention and considered as a first priority site under EU Natura 2000. Two dams operate in the Greek part of the basin (downstream) which are mainly used for electricity production purposes, covering also irrigation needs. The main activities supporting local income are agriculture and livestock.

🔗 **More Info:** Nestos River Basin Case Study

🌍 Case Study 2: Lielupe River Basin (Latvia & Lithuania)

📍 **Area:** 17,788 km² | **Location:** Shared between **Latvia & Lithuania** in **Northeastern Europe**

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The **Lielupe CS** is in North-Eastern Europe and includes the 17,788 km² Lielupe river basin shared between Latvia and Lithuania and is situated in the lowland part of the countries. Around 12% of Latvian population and around 11% of Lithuanian population live in this territory (altogether around 800 000 inhabitants). The basin is predominantly used for agriculture (ca. 60%) but also includes large areas of forests (ca. 30%) and some urban areas, as well as wetlands and floodplain meadows including nature protected areas and nature parks. The relief, climate and high soil fertility make suitable conditions for agricultural activities significantly contributing to the economy of the region. Other economic activities in Lielupe CS relate to trade and transport services, as well as the processing industry and public services. Agriculture has intensified over the past decades at the cost of natural grassland habitats. During the last decade the area of croplands has increased while meadows and pastures have been reduced. The development prognosis indicate that these trends will be maintained and coupled with increased volumes of fertilisers utilised in line with intensification of agriculture.

🔗 **More Info:** Lielupe River Basin Case Study

🌍 Case Study 3: Jiu River Basin, Lower Danube (Romania)

📍 **Area:** 16,759 km² | **Location:** Romania | **Part of the Danube River Basin**

The **Lower Danube CS** is focused on the 16,759 km² Jiu River Basin in Romania, a sub-basin of the Danube river, aiming to explore interconnection and replicability crossborder in Serbia and Bulgaria. The Jiu river flows from the Romanian Carpathian Mountains southwards through several counties before it discharges into the Danube at Zaval, the Romanian-Bulgarian border near the Bulgarian city of Oryahovo. The basin is mainly characterised by arable land (48%), forest (30%) and pastures (9%). Population in the upstream mountain areas of the basin rely on the coal mining industry with lignite-based electricity and heat generation, while the downstream areas are characterized by agricultural activities that depend on water supplies for irrigation and hydropower production. The Lower Danube wetland ecosystem, which includes several EU Natura 2000 sites, is highly sensitive and has already lost nearly 80% of its surface area in the last century due to river dredging, land reclamation and flood control measures. Anthropogenic interventions (e.g. dams) along the Danube stimulated erosion and negatively affected the riverbed, while floods and drought events continue to impact the region.

🔗 **More Info:** Jiu River Basin Case Study

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🌍 Case Study 4: Adige River Basin (Italy)

📍 **Area:** 12,100 km² | **Length:** 409 km | **Italy's Second-Longest River**

The **Adige CS** spans over Italy's second-longest river: the 409 km long Adige river that comprises a river basin area of 12,100 km^2. It flows from its source in the Italian Alps through six provinces in northern Italy before it reaches the Venetian Lagoon and flows into the Adriatic Sea. Within the Adige river basin, economic sectors historically developed on abundant water resources: e.g., 61 hydropower stations in the upper part of the basin produce energy exceeding the provincial energy demands, while the valleys in the upstream mountain provinces are characterised by the intensive apple orchards, which represent more than 15% of European apple production. In addition, winter and summer tourism play an important role in the mountain economy, with an annual population increase of 5-6 times the number of permanent residents. The lowlands, downstream of the province of Verona, are characterised by intensive cultivation, mainly including vineyards and cereals irrigated through water withdrawals. The regional park and its wetland ecosystems sustain fisheries, aquaculture and provide essential protection against saline intrusion and coastal erosion. Moreover, the delta has a high recreation value, being an important touristic destination.

🔗 **More Info:** Adige River Basin Case Study

🌍 Case Study 5: Inkomati-Usuthu River Basin (South Africa & Eswatini)

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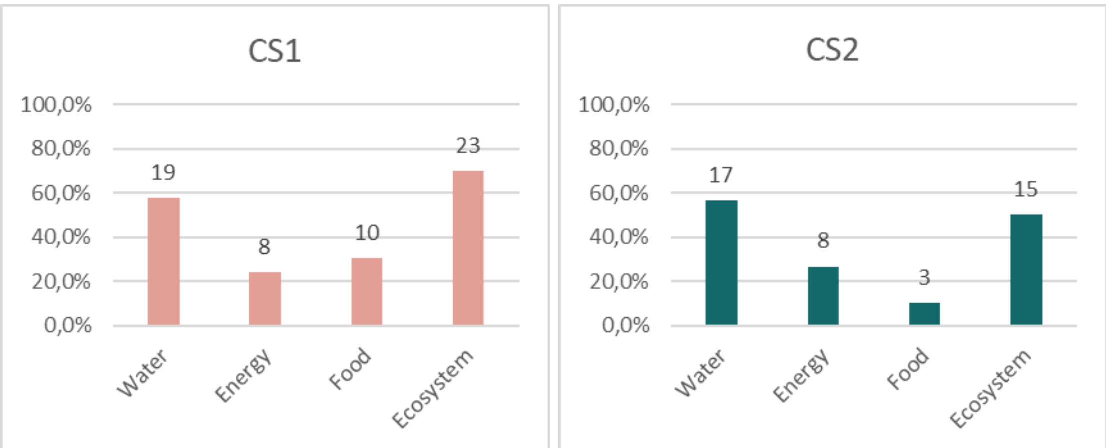
Transboundary Basin | South Africa & Eswatini | Part of the Inkomati-Usuthu Water Management Area

The **Inkomati-Usuthu CS** comprises the Inkomati-Usuthu Water Management Area, which in turn includes several parallel river catchments in South Africa and Swaziland (now known as Eswatini), which later converge to form the Inkomati river at the border with (or within) Mozambique and later flow into the Indian Ocean. The river basin is located downstream of mining activities and contains high potential agricultural land as well as conservation areas, including the southern portion of the Kruger National Park. Thus, the basin is vital to South Africa's development, in particular relating to energy security (coal-fired power stations), food security (almost half of the country's high potential agricultural land) and water security (numerous competing water users).

More Info: Inkomati-Usuthu Case Study

In terms of stakeholders, the following distribution of WEFE sectors (Figure 4) and stakeholder categories (Table 4) was observed across the five case studies. Table 4 also provides a description of the stakeholder categories which can help the instructors in describing the stakeholder personas.



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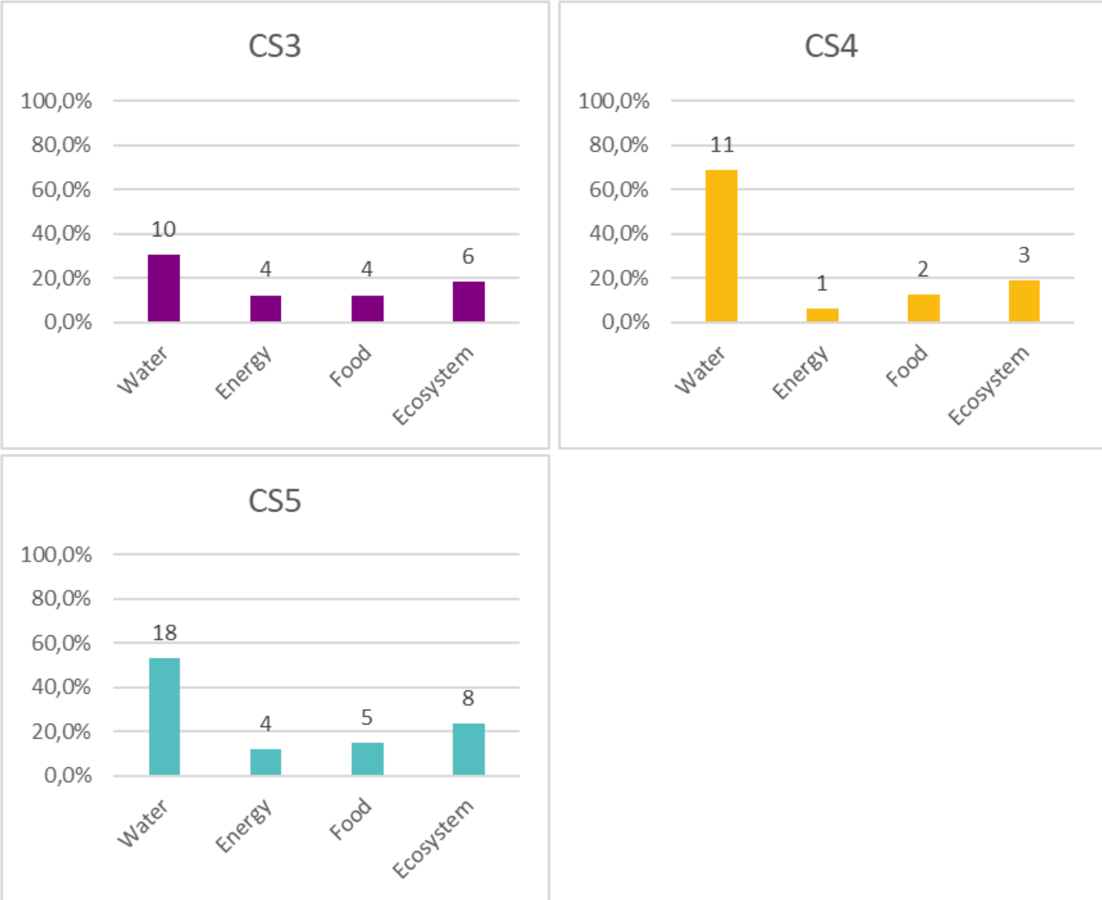

Figure 4 : Overview of the sectoral distribution of stakeholders in each case study

Table 4 : Listing of stakeholders per stakeholder category in each case study and the description of these categories (for the description of personas).

	CS1	CS2	CS3	CS4	CS5	TOTAL
1. Civil society	1	0	4	4	1	10
2. Public initiatives	0	0	0	0	0	0
3. Policy makers at local level/municipalities	11	0	2	0	4	17
4. Policy makers at national level	0	0	6	0	10	16
5. Agricultural authorities and representatives	1	0	3	0	1	5
6. Energy authorities and representatives	0	0	4	0	0	4
7. Water management authorities and represe	4	0	0	5	3	12
8. River basin authorities and representatives	0	0	6	0	6	12
9. Environmental protection authorities and re	4	0	4	3	1	12
10. Business/private or public enterprises	6	0	0	2	5	13
11. Media/science communicators	0	0	3	0	2	5
12. Research and academia	6	0	0	1	1	8
13. Other	0	0	1	1	0	2
TOTAL	33	0	32	15	34	114

#	Category*	Definition	Examples
1	Civil society	Individuals or organised groups (representing a specific community with a collective interest or activity), that are actively engaged (as e.g., users, protectors) to any of the NEXOGENESIS resources and services of interest (water, energy, food, ecosystems - WEFE).	Women's groups, local minorities, CSOs (civil society organisations, including NGOs).
2	Public initiatives	Leader or representative of existing local procedures, arrangements or organised activities carried out by the civil society (see above) that specifically address the interconnection between two or more of the WEFE nexus.	Already existing initiatives where the project can connect to focussing on e.g., Water-Energy, Water-Agriculture.

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#	Category*	Definition	Examples
3	Policy makers at local level/municipalities	Individuals or organisations with an active participation and decision-making power regarding the local management of one or more WEFE-nexus-related resources and services (e.g., water, land, energy, agriculture, biodiversity).	-The ones that work on water issues (local/regional councillors) -Civil servants/policy makers in municipalities, regional admins, governments that work/design/ participate in discussions on water, energy-water, agriculture-water, environment-water issues. -Strategic managers Politicians/ people who can take the decisions (e.g., mayor of the municipality)
4	Policy makers at national level	Individuals or organisations with an active participation and decision-making power regarding the management of one or more WEFE-nexus-related resources and services (e.g., water, land, energy, agriculture) at a national level.	-policy makers in municipalities, regional admins, governments that work/design/ participate in discussions on water, energy-water, agriculture-water, environment-water issues. Strategic managers
5	Agricultural authorities and representatives	Organisations that represent the interests of the farmers or farm managers (see above) in the case study location(s). These organisations address from laws and policies to consultation and capacity development activities towards ensuring a good quality of agricultural activities.	- Agricultural chambers - Strategic managers that work/design/participate in discussions on agriculture, agriculture-water, agriculture-energy, agriculture-environment issues
6	Energy authorities and representatives	Organisations in charge of shaping energy policies, overseeing the enforcement/implementation of laws, including inspection activities (controlling and monitoring).	- Strategic managers that work/design/participate in discussions on energy, energy-water, energy-agriculture, energy-environment issues
7	Water management authorities and representatives	Organisations in charge of shaping water policies, overseeing the enforcement/implementation of laws, including inspection activities (controlling and monitoring).	- Strategic managers that work/design/participate in discussions on water, energy-water, agriculture-water, environment-water issues
8	River basin authorities and representatives	Organisations in charge of developing and implementing water management strategies at a river basin scale. Can include existing transboundary cooperation entities.	- Strategic managers that work/design/participate in discussions on water, energy-water, agriculture-water, environment-water issues at a river basin scale
9	Environmental protection authorities and representatives	Organisations in charge of shaping environmental policies (including ecosystem and biodiversity protection), overseeing the enforcement/implementation of laws, including inspection activities (controlling and monitoring).	- Strategic managers that work/design/participate in discussions on environmental protection (of ecosystem and biodiversity), environment-water issues
10	**Business/private or public enterprises**	Organisations providing goods and services that are actively engaged (as e.g., users, protectors) to any of the NEXOGENESIS resources and services of interest (water, energy, food, ecosystems - WEFE).	- Energy and water supply companies - Mining company
11	Media/science communicators	Individuals or organisations communicating engaged on but not limited to news transmissions, environmental topics for a general audience, or science communication.	- Newspaper - Organisations publishing informative bulletins (e.g., of water resources status)
12	Other consortium members	Individuals or organisations within the NEXOGENESIS project – 'Internal stakeholders' – that can have an interest on the specific case study.	

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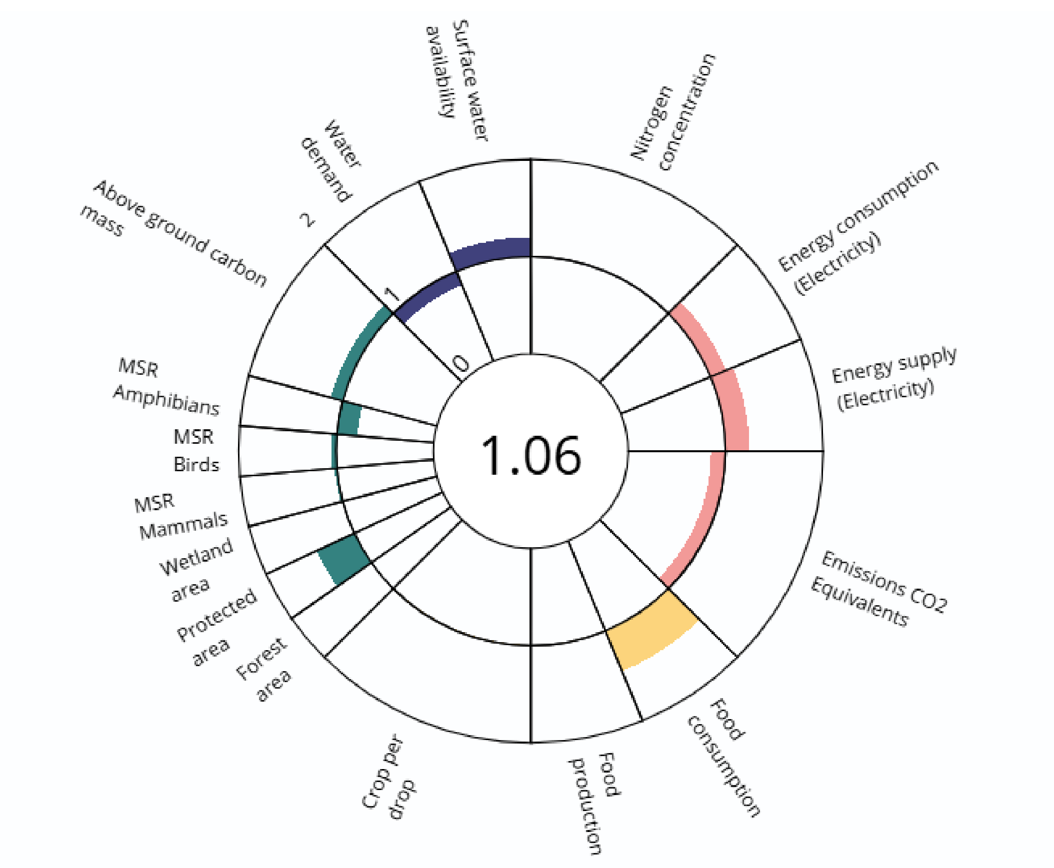
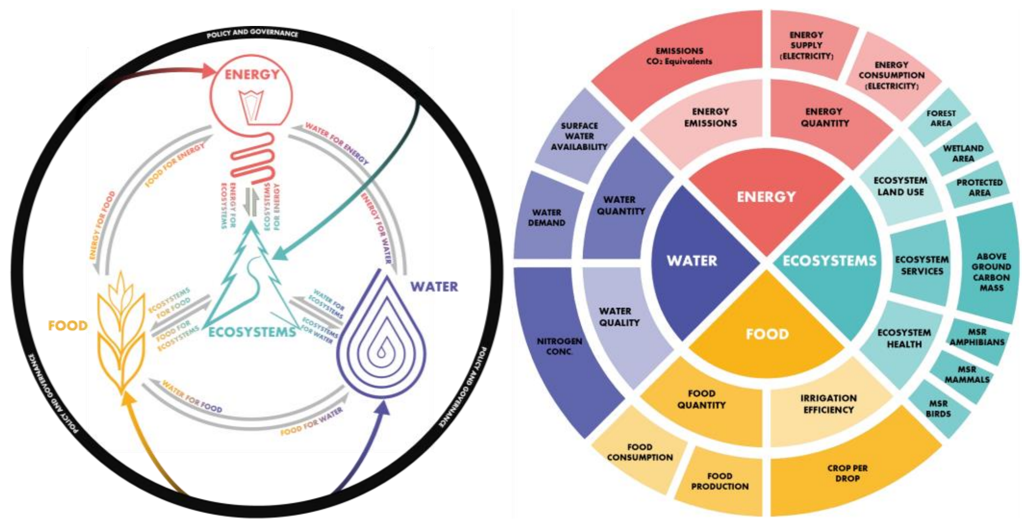
5.2 The WEFE Footprint

The WEFE Footprint provides a visualisation of the WEFE system's status at a particular point in time for a specific river basin (Case Study [CS]) for a particular modelling scenario. It uses the outputs from the NEPAT, informed by the SDMs, to visualise the nexus for the Reference and Policy Future scenarios.



WEFE Footprint Framework

In the conceptualisation of the NXG project, due to the importance of ecosystems and their interlinkages with the three pillars of the WEF Nexus, it was decided that ecosystems would be considered a fourth pillar within the novel water, energy, food, and ecosystems (WEFE) nexus.



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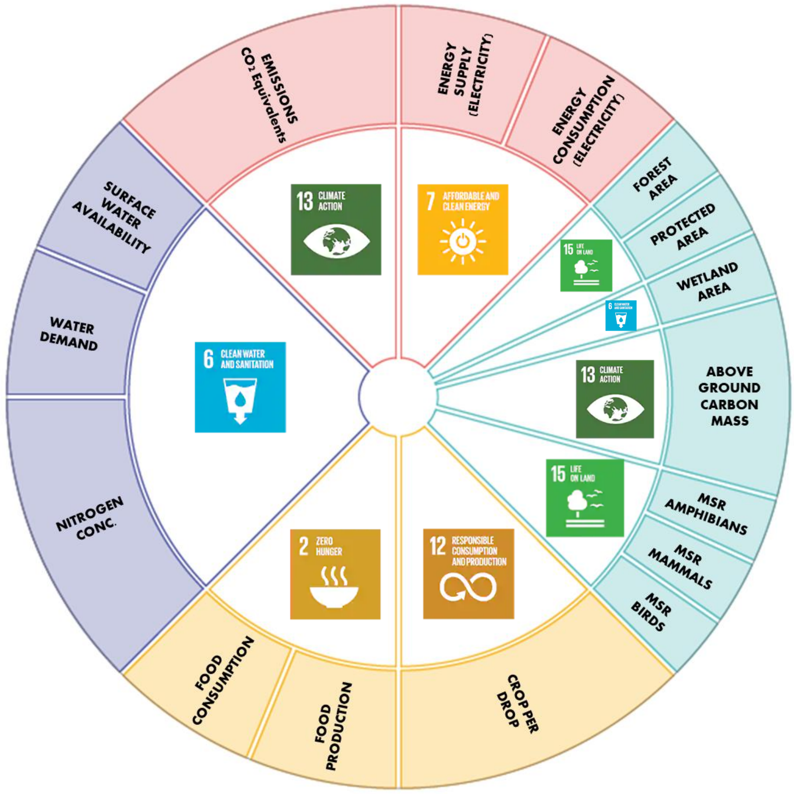
WEFE Footprint and Sustainable Development Goals

The selected indicators can be linked to various Sustainable Development Goals (SDGs) as per the image below. The multi-disciplinary nature of Nexogenesis, the cross-sectoral stakeholder partnerships being formed, and the technologies being applied within the NXG project align well with "SDG 17: Partnerships for the goals". The primary SDG associated with each indicator include SDGs 2, 6, 7, 12, 13 and 15. With secondary links to SDGs 1, 3, 4, 8, 9, 10, 11, and 14.



Data Treatment, Normalisation, Weighting, Direction, and Aggregation

The WEFE Footprint was developed using JRC-COIN's ten-step methodology, 2019, as a basis. The data was treated for outliers and normalised. The normalisation of each indicator was based on the distance from the Initial value of the indicator:

$$\tilde{x}_{I,n} = \frac{x_{I,n} - x_{I,0}}{\max(x_I) - \min(x_I)} * 100 \qquad where:$$

$\tilde{x}_{I,n}$: *Normalised value of indicator I in year n*

$x_{I,0}$: *Value of indicator I in year 0*

$x_{I,n}$: *Value of indicator I in year n*

$\min(x_I)$: *Minimum value of indicator I for all reference and policy future scenarios*

$\max(x_I)$: *Maximum value of indicator I for all reference and policy future scenarios*

The weightings of each indicator are represented by the portion of the circle allocated to each indicator. Equal weighting was given to:

- each indicator within a sub-pillar,
- each sub-pillar within a pillar, and
- each pillar within the WEFE Index.

The indicators that were allocated a negative direction are indicated as red text in the image above. An arithmetic mean was used to aggregate the indicators. The resulting Index has a value between -100 and 100.

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5.3 List of policy goals for each of the case studies

🌍 Case Study 1: Nestos River Basin (Greece & Bulgaria)

- Goal 1: Decrease of Water Demand in Greek Sub Basins by 2050
- Goal 2: Decrease of Water Demand in Bulgarian Sub Basins by 2050
- Goal 3: Decrease of Emissions originating from Energy production in Greek Sub Basins by 2050
- Goal 4: Decrease of Emissions originating from Energy production in Bulgarian Sub Basins by 2050
- Goal 5: Decrease of Emissions originating from all sectors in Greek Sub Basins by 2050
- Goal 6: Decrease of Emissions originating from all sectors in Bulgarian Sub Basins by 2050
- Goal 7: Decrease of Nestos Nitrogen concentration by 2050
- Goal 8: Decrease of Mesta Nitrogen concentration by 2050
- Goal 9: Crop per Drop increase in Greek Sub Basins by 2050
- Goal 10: Crop per Drop increase in Bulgarian Sub Basins by 2050

🌍 Case Study 2: Lielupe River Basin (Latvia & Lithuania)

- Goal 1: Reduce the nitrogen concentration in Lithuania by 8% in 2027
- Goal 2: Reduce the nitrogen concentration in Lithuania by 15% in 2050
- Goal 3: Reduce the nitrogen concentration in Latvia by 10% in 2027
- Goal 4: Reduce the nitrogen concentration in Latvia by 20% in 2050
- Goal 5: Equitable contribution from Lithuania to control transboundary nutrient pollution
- Goal 6: Equitable contribution from Latvia to control transboundary nutrient pollution
- Goal 7: Increase the renewable energy generation (Wind and Solar) in the Lielupe River Basin to reach a potential of 700 GW/h by 2050
- Goal 8: Compensation of arable land GHG emissions by installing renewable energies
- Goal 9: Increase bird biodiversity by 20% in 2027.
- Goal 10: Promote organic farming in Lithuania
- Goal 11: Promote organic farming in Latvia

🌍 Case Study 3: Jiu River Basin, Lower Danube (Romania)

- Goal 1: 90% of the population connected to the water supply network by 2030.
- Goal 2: 87% GHG emission reduction by 2030.
- Goal 3: 97% GHG emission reduction by 2050.
- Goal 4: 56,700 ha in 2026 (at the national level) of new afforested or reforested areas. The percentage of forest increase at the basin level is 5% (2,835 ha) of the national expected afforestation.
- Goal 5: 30% increase in irrigated area for maize.
- Goal 6: 30% increase in irrigated area for rapeseed.
- Goal 7: 30% increase in irrigated area for sunflower.

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- Goal 8: 17% increase in GHG removals by 2030.
- Goal 9: 31% increase in GHG removals by 2050.
- Goal 10: Wetland area increased by 10% by the end of 2027 compared to 2023.
- Goal 11: Allocate 15% of surface water for hydropower production to increase renewable energy in the energy mix.

🌍 Case Study 4: Adige River Basin (Italy)

- To save 25% of water used (average annual usage compared to the baseline) for agricultural purposes by 2040
- Reduce population water consumption of 15% by 2050
- Reduce population energy consumption of 20% by 2050

🌍 Case Study 5: Inkomati-Usuthu River Basin (South Africa & Eswatini)

- Goal 1: Meet the renewable energy goals set in the 2023 Draft Integrated Resource Plan for national electricity supply.
- Goal 2: Reduce emissions to meet the lower limit of the 2030 Nationally Determined Contributions (350 Mt CO2-eq).
- Goal 3: Reduce emissions to meet the upper limit of the 2030 Nationally Determined Contributions (420 Mt CO2-eq).
- Goal 4: Reduce urban water demand by 15% by 2030 as per the National Development Plan.
- Goal 5: Reduce industrial water demand by 10% by 2026 as per the National Water & Sanitation Masterplan.
- Goal 6: Reduce agricultural water demand for crops by 10% per unit of production by 2030.
- Goal 7: Reduce agricultural water demand for livestock by 10% per unit of production by 2030.
- Goal 8: Maintain minimum maintenance flows and basic human needs of 24.5% of total surface water runoff.
- Goal 9: Meet transboundary requirements set by the Progressive Realization of the IncoMaputo Agreement with Mozambique, South Africa, and Swaziland.
- Goal 10: Keep nitrogen concentrations below 2.5 mg/L as per South African Water Quality Guidelines.
- Goal 11: Increase protected areas to meet the 28% growth target set in the 2018 National Protected Area Expansion Strategy.
- Goal 12: Ensure amphibians status doesn't decline as per NBSAP.
- Goal 13: Ensure birds status doesn't decline as per NBSAP.
- Goal 14: Ensure mammals status doesn't decline as per NBSAP.
- Goal 15: Achieve the 2023 targets for subsistence farming as per the National Food and Nutrition Security Plan.
- Goal 16: Ensure local food production grows faster than the expected population growth within the catchment.

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5.4 List of policy instruments for each of the case studies

Case Study 1: Nestos River Basin (Greece & Bulgaria)

- P1: Change of irrigation systems in Bulgarian sub-basins
- P2: Change of irrigation systems in Greek sub-basins
- P3: Replacement of open irrigation canals that transfer water from the river to the crops by closed pipelines
- P4: Reducing the quantity of nitrogen discharged in Bulgarian sub-basins
- P5: Reducing the quantity of nitrogen discharged in Greek sub-basins
- P6: Cultivation of less water demanding crops in Greek sub-basins
- P7: Cultivation of less water demanding crops in Bulgarian sub-basins
- P8: Extensive use of water saving infrastructures by the sector of livestock
- P9: Reforestation activities
- P10: Cultivation of dynamic crops (edible pulse, olives, vegetables) instead of cereals, cotton and sugarbeets
- P11: Decrease of electricity generated by conventional energy sources and increase of electricity produced from RES in the Greek part
- P12: Decrease of electricity generated by conventional energy sources and increase of electricity produced from RES in the Bulgarian part

Case Study 2: Lielupe River Basin (Latvia & Lithuania)

- P1: Extension of use of riparian buffers as a nutrient treatment alternative in Latvia.
- P2: Extension of use of riparian buffers as a nutrient treatment alternative in Lithuania.
- P3: Extension of use of bioreactor and wetland systems as a nutrient treatment alternative in Latvia.
- P4: Extension of use of bioreactor and wetland systems as a nutrient treatment alternative in Lithuania.
- P5: Extension of use of biological farming as a nutrient treatment alternative in Latvia.
- P6: Extension of use of biological farming as a nutrient treatment alternative in Lithuania.
- P7: Long-term policy to determine the fraction of arable land with nutrient treatment in Latvia.
- P8: Long-term policy to determine the fraction of arable land with nutrient treatment in Lithuania.
- P9: Long-term policy to determine the fraction of grasslands used to install renewable energy.
- P10: On/Off policy to allow conversion of 10% of arable land to grasslands in Latvia during the first 12 years of the simulation.
- P11: On/Off policy to allow conversion of 10% of arable land to grasslands in Lithuania during the first 12 years of the simulation.

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Case Study 3: Jiu River Basin, Lower Danube (Romania)

- P1: Sustainable management of the water resources (quantity). Increase connectivity of the population to public networks.
- P2: Decarbonization and promoting renewable energy.
- P3: Protection of biodiversity. National campaign for afforestation and reforestation, including urban forests.
- P4: Extension of irrigated area for maize crops by 30%. The policy allows for shifting currently rainfed land to irrigated land.
- P5: Extension of irrigated area for maize crops by 40%. The policy allows for shifting currently rainfed land to irrigated land.
- P6: Extension of irrigated area for maize crops by 50%. The policy allows for shifting currently rainfed land to irrigated land.
- P7: Extension of irrigated area for maize crops by 100%. The policy allows for shifting currently rainfed land to irrigated land.
- P8: Extension of irrigated area for rapeseed crops by 30%. The policy allows for shifting currently rainfed land to irrigated land.
- P9: Extension of irrigated area for rapeseed crops by 40%. The policy allows for shifting currently rainfed land to irrigated land.
- P10: Extension of irrigated area for rapeseed crops by 50%. The policy allows for shifting currently rainfed land to irrigated land.
- P11: Extension of irrigated area for rapeseed crops by 100%. The policy allows for shifting currently rainfed land to irrigated land.
- P12: Extension of irrigated area for sunflower crops by 30%. The policy allows for shifting currently rainfed land to irrigated land.
- P13: Extension of irrigated area for sunflower crops by 40%. The policy allows for shifting currently rainfed land to irrigated land.
- P14: Extension of irrigated area for sunflower crops by 50%. The policy allows for shifting currently rainfed land to irrigated land.
- P15: Extension of irrigated area for sunflower crops by 100%. The policy allows for shifting currently rainfed land to irrigated land.
- P16: GHG emission reduction from LULUCF mainly through appropriate forest fire management
- P17: Protected habitats. Polder rehabilitation and construction, removing obstacles in watercourses, and restoration of riparian habitats.
- P18: Increase RES% in gross final energy production (PNIESC). Construction of new small hydropower plants, taking into account environmental and social impacts (65 MW, AHE Bumbesti Livezeni) starting from 01.01.2024.

Case Study 4: Adige River Basin (Italy)

- P1: Increase from 79% to 90% and 100% of orchards to drip irrigation by 2030
- P2: Increase from 64% to 90% and 100% of vineyards to drip irrigation by 2030
- P3: Increase from 59% of irrigated area of maize to 70% by 2030
- P4: Increase from 55% to 70% of the irrigated area of vineyards over the total area of vineyards by 2030
- P5: Increase from 89% of irrigated area of orchards to 100% by 2030

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- P6: Decrease of orchards area from 9% to 4,5% converting to vineyards (which will change from 8% to 15%) by 2030
- P7: Decrease of arable land (seminativi) area from 19% to 10% to vineyards (which will change from 8% to 17%) by 2030
- P8: Reduce domestic water use leakage severity from 40% to 30% by 2040
- P9: Reduce domestic water consumption of residents from 7,5m3/capita month to 4,5m3/capita month by 2040
- P10: Reduce water consumption of tourists from 22,5m3/capita month to 13,5m3/capita month by 2040
- P11: Setting a limit to number of tourists stays to 4,1 million of stays per year
- P12: Reduce domestic energy consumption of residents from 125kwh/capita month to 100kwh/capita and of tourists from 300 kwh/capita month to 250kwh/capita month by 2040.

🌍 Case Study 5: Inkomati-Usuthu River Basin (South Africa & Eswatini)

- P1: Set up of local food chains
- P2: Expand protected areas
- P3: Investment in biodiversity management and conservation agriculture
- P4: Protect biodiversity priority areas
- P5: Reparation of water distribution and treatment systems
- P6: Improve water use efficiency
- P7: Stricter carbon emissions targets and taxes
- P8: Enhance food productivity
- P9: Adoption of efficient irrigation techniques
- P10: Development of renewable energy sector

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5.5 How to use NEPAT

To accommodate the needs of both decision-makers and technical experts, NEPAT provides two distinct user experiences. The **Technical Experience** is intended for users who need a more in-depth analysis of policy impacts, allowing them to work with detailed simulations, customizable settings, and advanced modelling techniques. Details on these functionalities can be found in the Advanced functionalities section of the NEPAT User Guide under https://nexogenesis.eu/wp-content/uploads/2025/04/NEPAT-User-Guide.pdf.

The **Strategic Experience**, which is the default mode in NEPAT, is tailored for users who require easily interpretable information to support high-level decision-making. It presents simplified yet insightful visualizations of policy impacts without requiring in-depth technical expertise.

- **Simplified Information:** Clear, synthesized data presented using colorful graphics and diagrams for quick comprehension.
- **Visualized Outcomes:** Easily understandable comparisons of policy effects across different scenarios.
- **Summarized Simulation Results:** Indicator evaluations and high-level analysis to facilitate decision-making.

The remainder of this document is based on the basic functionalities and provides an overview of the basic features needed to use NEPAT in higher education teaching settings.

As a first entry point please access the **online video tutorial** available via the NEPAT Video.

1 Accessing NEPAT

To get started with NEPAT, visit NEPAT Login Page or https://nepat-dev.nexogenesis.eu/#/login. The platform offers a simple and flexible login system with three ways to access (see Figure 5):

- **Guest Access** – Explore NEPAT without creating an account.
- **Sign Up & Log In** – Create an account to save your work.
- **Google Login** – Use your Google account for quick and easy access.

Before logging in, you can select your preferred language from the menu at the top of the page. By logging in, you agree to NEPAT's **Privacy Policy** and **Terms of Service**. A link to the full terms is available on the login page if you want to review them before continuing.

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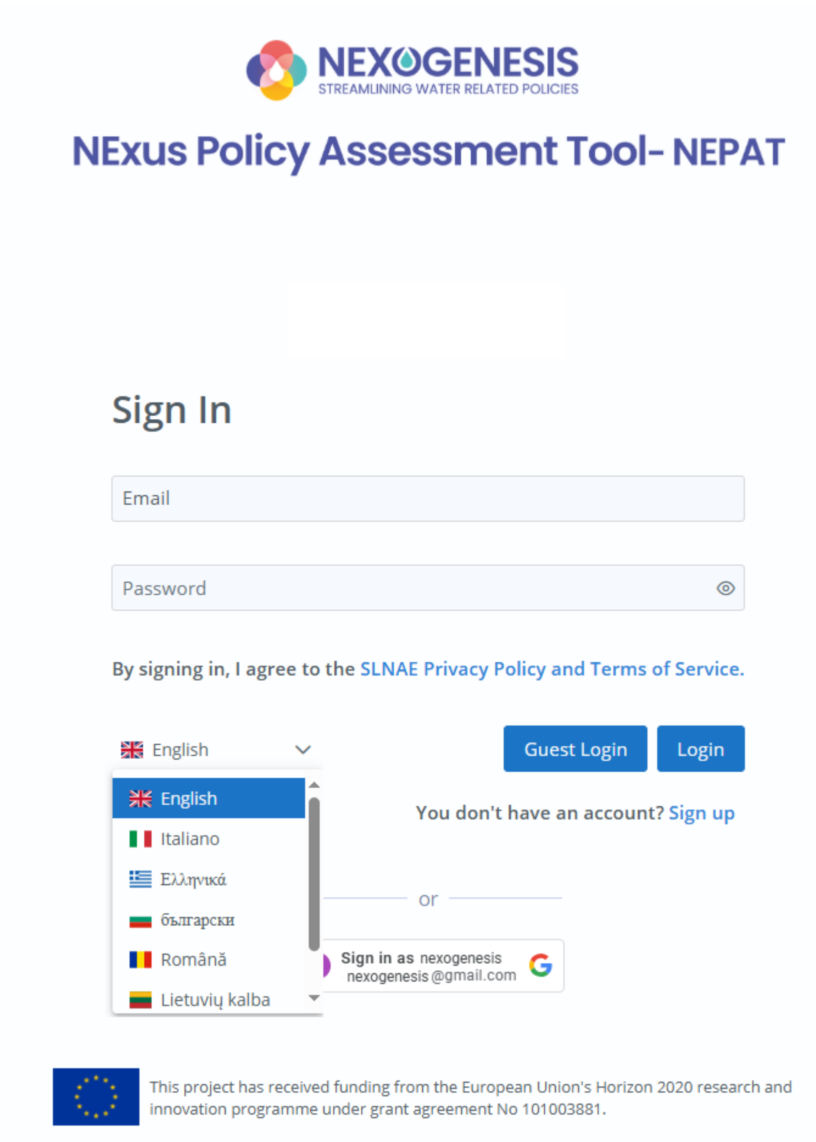

Figure 5. NEPAT login page

Choosing Your Login Option

✅ Guest Login

Want to explore without signing up? Choose the **Guest** option to access all features. You can even save simulations during your session! However, keep in mind that your data will be lost when you log out—so remember to export your work if needed.

✅ Sign Up & Log In

For users who want to save their progress, the **Sign Up** option allows you to create an account. This is ideal for ongoing projects, as it lets you store and manage your simulations. If you already have an account, simply enter your email and password to log in.

✅ Login with Google

Skip manual registration by choosing **Login with Google**. This option provides a fast, secure way to access NEPAT using your Google credentials.

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2 Configuring a Simulation in NEPAT

To begin creating a new simulation, click ***New*** to open the **simulation wizard.** The setup process consists of three simple steps:

Select the Case Study

Begin by choosing a **Case Study** from the available options (Figure 6). To learn more about a specific case study, click the *info* button next to its name (Figure 7).

📝 *Tip:* The *info* button provides details about the case study's geographical location, key features, and relevant context.

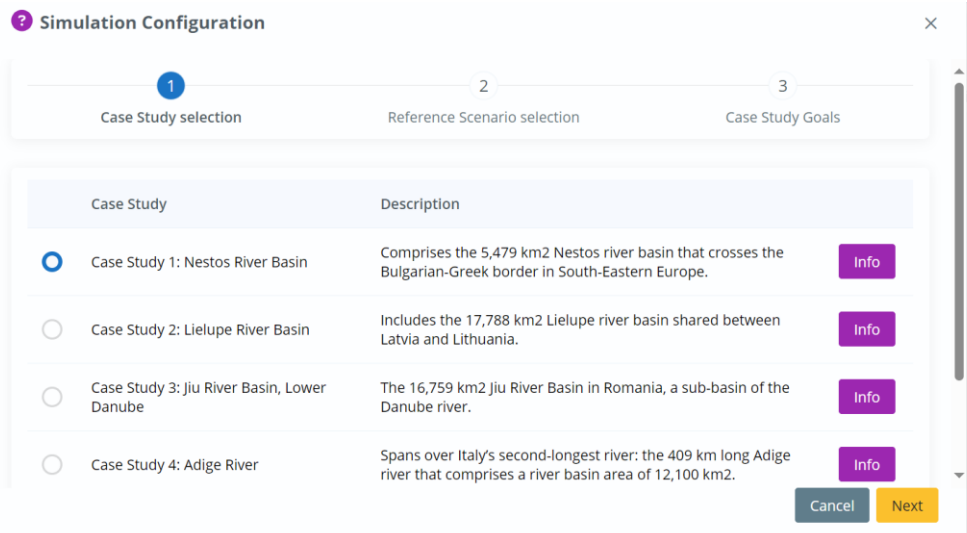

Figure 6. Configuring a simulation in NEPAT: Case Study selection

Figure 7. Configuring a simulation in NEPAT: Case Study details

Select the Reference Scenario

Next, choose a **Reference Scenario** by selecting from a range of **RCPs** (climate projections) and **SSPs** (socioeconomic projections) (Figure 8).

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- Climate projections (RCPs – Representative Concentration Pathways): Describe different levels of greenhouse gas emissions and their potential impact on global temperatures.
- Societal projections (SSPs – Shared Socioeconomic Pathways): Outline different possible future global developments, such as population growth, economic changes, and energy use.

📝 *Tip:* Each combination represents a unique scenario for climate change and socio-economic conditions. Click the *info* button for more details on each scenario.

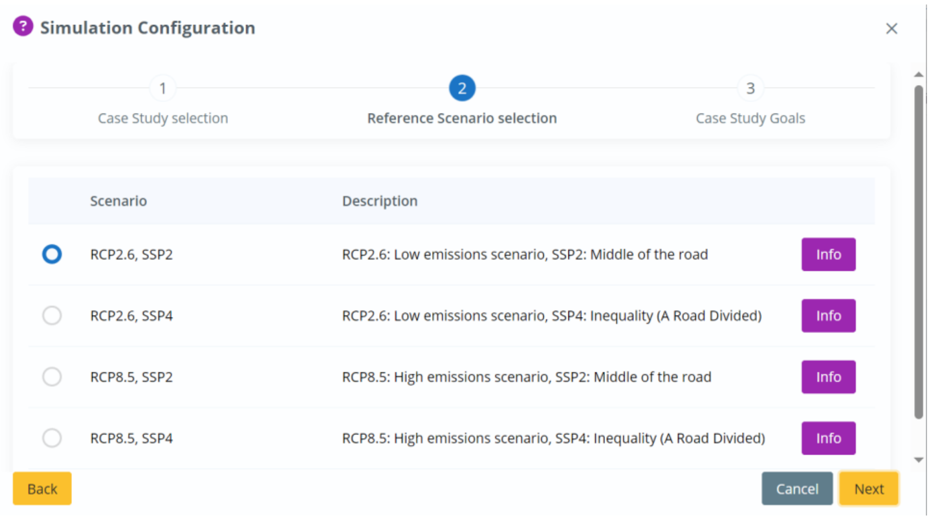

Figure 8. Configuring a simulation in NEPAT: Reference Scenario selection

Set Policy Goals

In this step, review the **default policy goals** for your selected case study, which are derived from relevant directives and legislation (Figure 9). Each goal represents the need to reach a specific target for an indicator by a particular year and sustain this achievement until the end of the simulation. Each goal includes:

- **Description** – A brief overview of the policy goal.
- **Indicator** – The specific variable being measured to track progress (e.g., water availability, energy consumption, or agricultural yield).
- **Target Value** – The desired level the indicator must reach.
- **Target Year** – The deadline by which the target must be achieved.
- **Sustainability Requirement** – The obligation to maintain the target value from the target year until the end of the simulation.

In the **Nestos/Mesta CS**, you can customize the target year for policy goals by selecting the ***Select Year*** button, as shown in Figure 10. The chosen target year will apply to all default policy goals.

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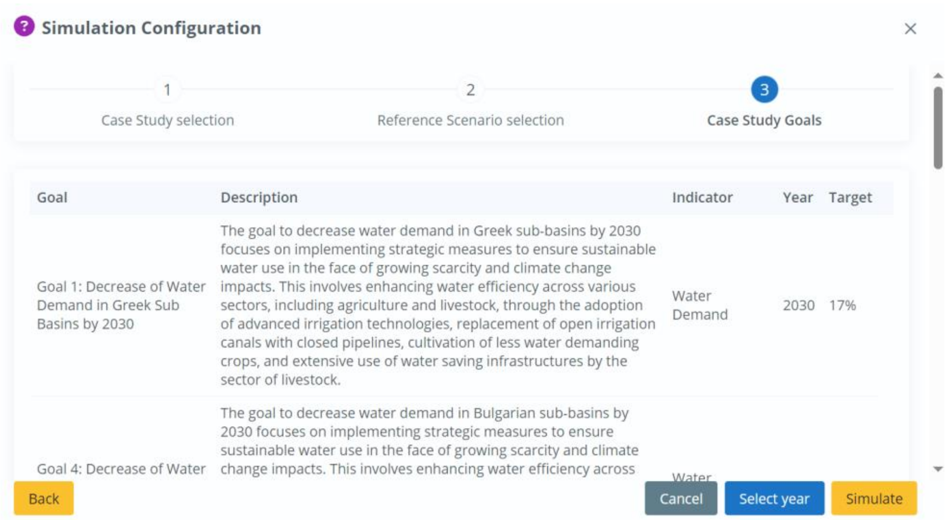

Figure 9. Configuring a simulation in NEPAT: predefined policy goals

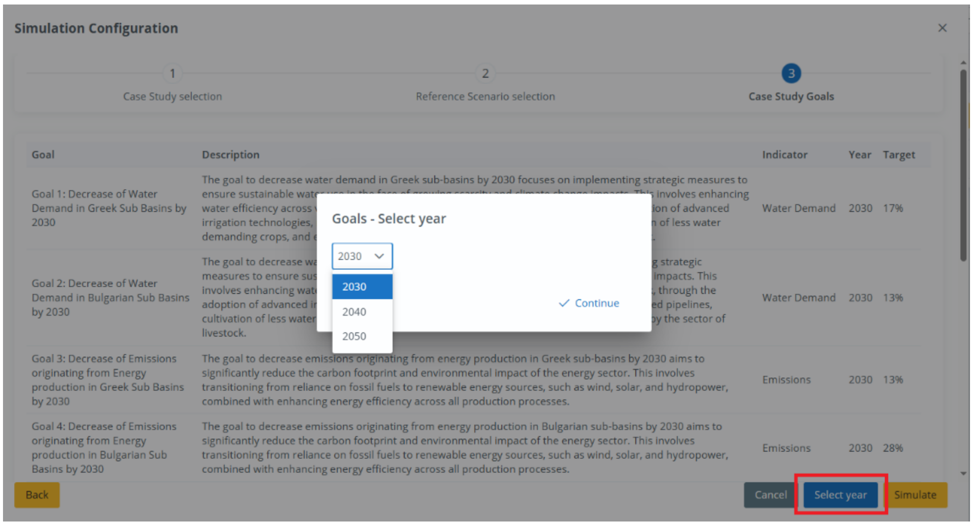

Figure 10. Configuring a simulation in NEPAT: customize the target year in Nestos/Mesta CS

Once everything is set up, click **Simulate** to proceed to the Simulation View, where you can run your simulation and explore the results.

3 Using the NEPAT for policy exploration

Once you finish setting up your simulation, you want to start exploring (a) the policy instruments and their effects on the goals and the WEFE Footprint; and (b) the decision-support system to help you decide on your favourite policy package to achieve your goals.

Policy Goals

Each case study has a set of Policy Goals that were defined in a co-creation process with the respective stakeholders of each case. These policy goals are derived from existing national and/or regional (EU) regulations. They were chosen to be partially SMART, namely, to be ***S****pecific,* ***M****easurable* ***and T****ime-bound.* Section 5.3 of the Appendix contains a list of the goals for each case study.

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The **Policy Goals View** is the **third section** of the dropdown menu (Figure 11). This section helps you track progress toward achieving the objectives set for your case study.

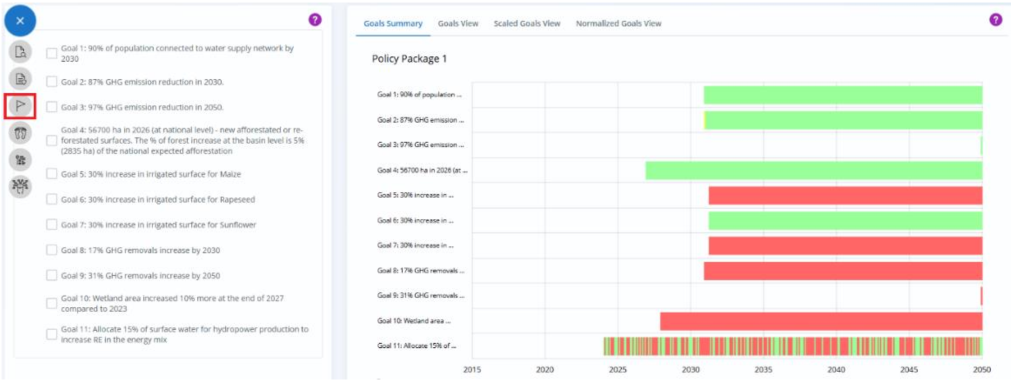

Figure 11. Policy Goals in the Simulation View

The **Goals Summary** gives a quick overview of how well your selected **policy package** is performing (Figure 12). Progress is measured against the **reference scenario** and shown using a **color-coded system** for easy interpretation:

- **Green** – Goal achieved.
- **Yellow** – Progress is **closer to the goal** than to the reference scenario.
- **Red** – Progress is **closer to the reference scenario** than to the goal.
- **Black** – Progress is moving **further away** from the goal.

Figure 12. Policy Goals: Goals Summary

You can find more details about each goal by selecting it. When you select a goal, its description, associated indicator, target value, and target year will be displayed below the goals section (Figure 13).

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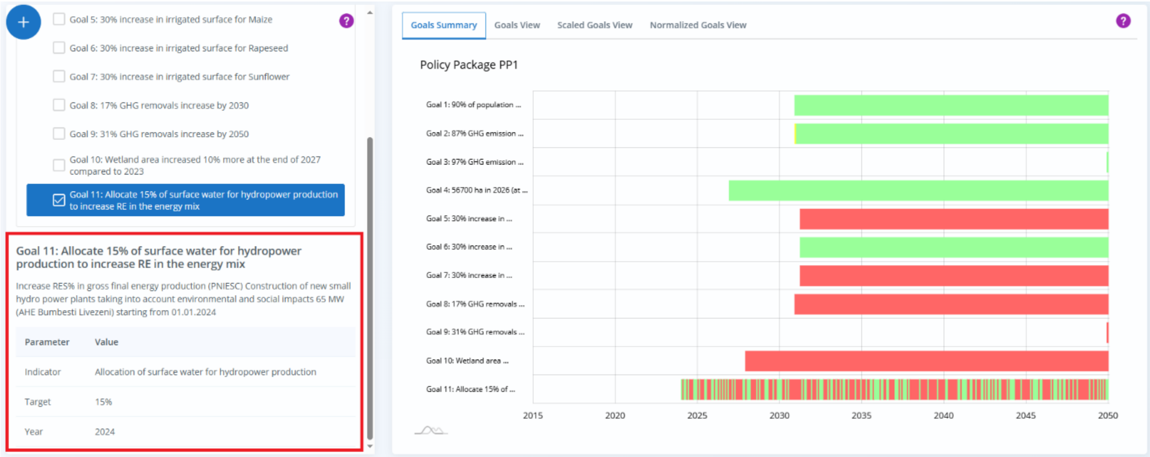

Figure 13. Policy Goals: Goals selection

NEPAT also provides **color-coded flags** in the **Policy Package Summary** to give you a quick visual assessment of overall performance (Figure 14).

The summary flag color in the Policy Package Summary is based on the worst performance found in the Goals Summary View:

🟢 **Green Flag** – The goal remains green from the year of achievement until the end of the simulation.

🟡 **Yellow Flag** – The goal turns yellow at any point, even if it is mostly green, but never red or black.

🔴 **Red Flag** – The goal turns red at any point, even if it is mostly yellow or green, but never black.

⚫ **Black Flag** – The goal turns black at any point, even if it is mostly red, yellow, or green.

📌 **Note:** Some goals have a target year set to the same year, meaning they appear in the visualization without a color-coded flag. To see details, hover over the flag to display a breakdown of goals for that year, along with their individual flag colors (Figure 14).

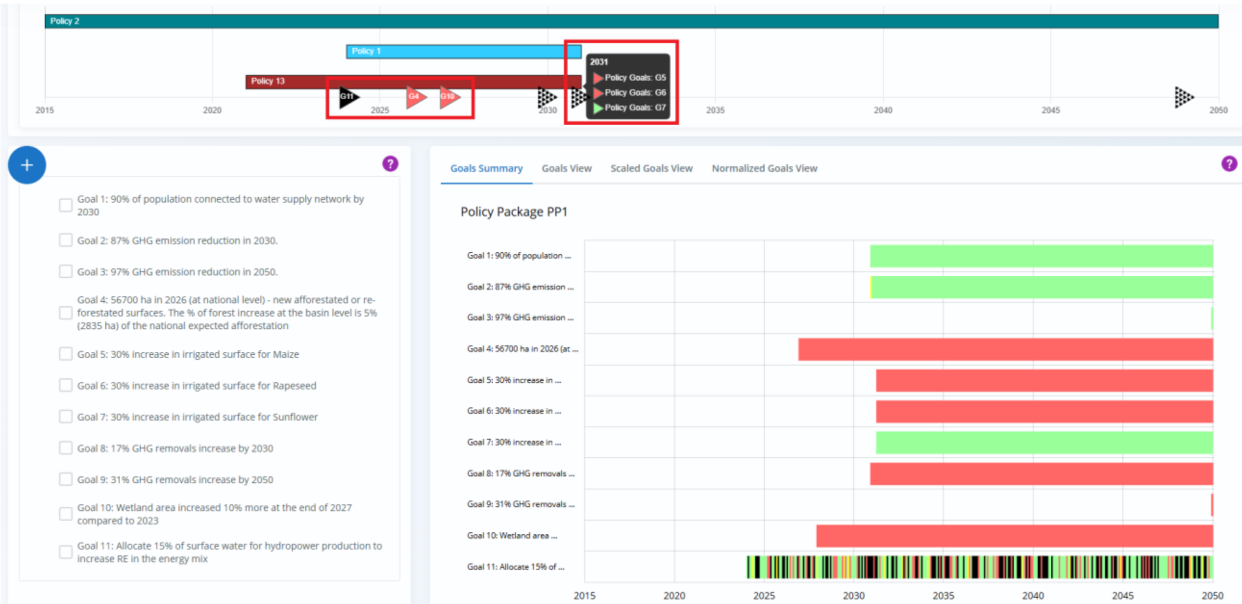

Figure 14. Policy Goals: Goals Summary and Policy Package Summary

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For a more in-depth analysis, you can select a goal and explore it using three interactive views, each offering a unique way to assess progress toward policy targets (Figure 15).

1. Goals View (default view)

- Shows how selected indicators evolve over time from 2015 to 2050, using a monthly timestep.
- Displays values as they are, without any scaling or normalization.
- Enables comparisons between the reference scenario, policy scenario, and target values, helping users assess the impact of policy measures.

2. Scaled Goals View (for easier comparisons)

- Uses min-max scaling to normalize values within a range of -1 to 1.
- Makes it easier to compare indicators with different units or magnitudes.
    - Helps when comparing variables with very different value ranges.
    - Ensures all indicators fit on the same scale for better visual analysis.

3. Normalized Goals View (for relative comparisons)

- Adjusts values relative to the reference scenario, which is fixed at 1.
- Highlights whether the policy scenario aligns with or deviates from the reference scenario, providing insights into policy effectiveness.
    - Clearly shows whether policies are improving or worsening key indicators.
    - Helps identify policy trade-offs, where improving one variable might negatively affect another.

All charts in these views are interactive, allowing users to toggle variables on or off using the legend for a customized analysis. Each view tracks indicator changes from 2015 to 2050, displaying their evolution and enabling easy comparisons across different scenarios.

Figure 15. Policy Goals: Goals Detailed Views

Policy Instruments

Each case study has a set of Policy Instruments that were defined in a co-creation process with the respective stakeholders of each case. Similar to the policy goals, the instruments are also derived from existing national and/or regional (EU) regulations. They were chosen to be applicable in the modelling context, meaning that they needed to have measurable or

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describable effects (i.e. through justifiable and solid assumptions) on the stocks and flows of the System Dynamics Model of each of the cases.

The **Policy Instruments View** is the **second section** of the dropdown menu. In this section, you can explore and configure policy instruments for your case study. These instruments affect different sectors and are integrated into simulation models, allowing you to analyze their impact on the Water-Energy-Food-Ecosystems (WEFE) nexus.
Policy instruments are grouped by sector, with distinct colors and icons for easy identification. You can study their individual effects or combine multiple instruments into a policy package to assess their impact on the entire system.

Selecting policies for policy packages

A **policy package** is a set of policy instruments configured to simulate their **collective** impacts on the WEFE nexus in the selected reference scenario (from 2015 to 2050).

Follow these steps to set up and apply a policy package:

✅ **Step 1: Selecting a Policy Instrument**

- Browse through the available policy instruments, organized by sector.
- Click on a policy to view its definition and key parameters in the center of the screen.

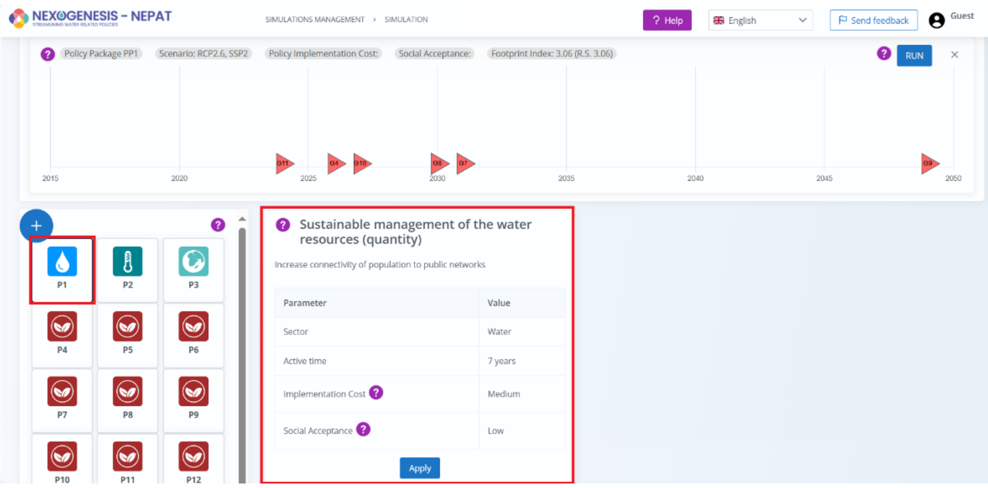

Figure 16. Configuring a Policy Package: Step 1

✅ **Step 2: Applying a Policy Instrument**

- Once you've selected a policy, click the **Apply** button to include it in your policy package.
- The selected policy will now appear in the Policy Package Summary at the top of the page.
- Repeat Step 1 to apply multiple policy instruments as needed.

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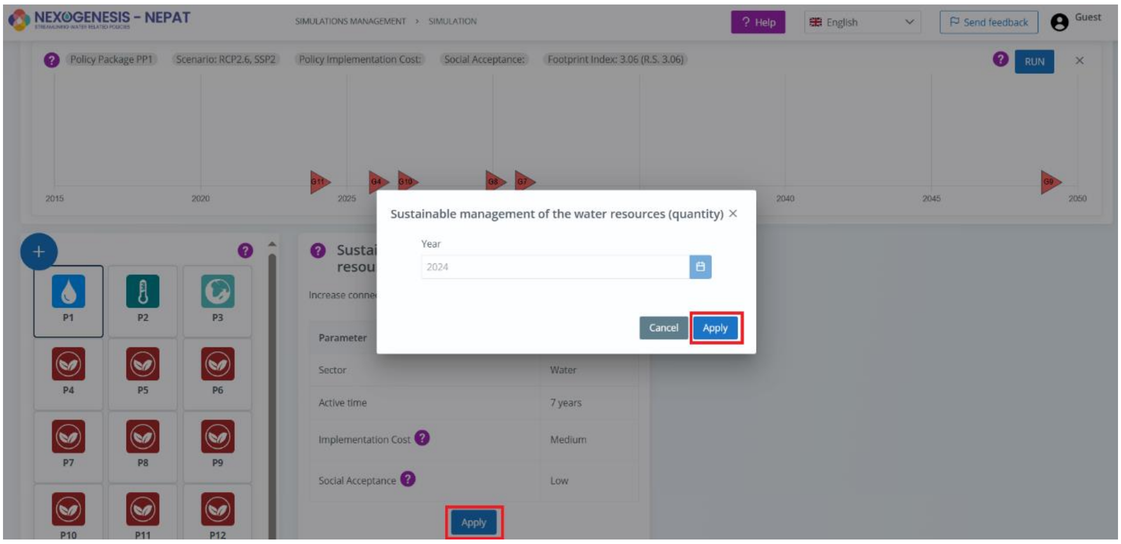

Figure 17. Configuring a Policy Package: Step 2

✅ Step 3: Running the Simulation

- After adding all desired policies, click the ***RUN*** button to simulate the scenario for the 2015–2050 period.
- The system will process the data and generate results across the WEFE nexus.
- All views will update automatically, reflecting the impact of the selected policies.

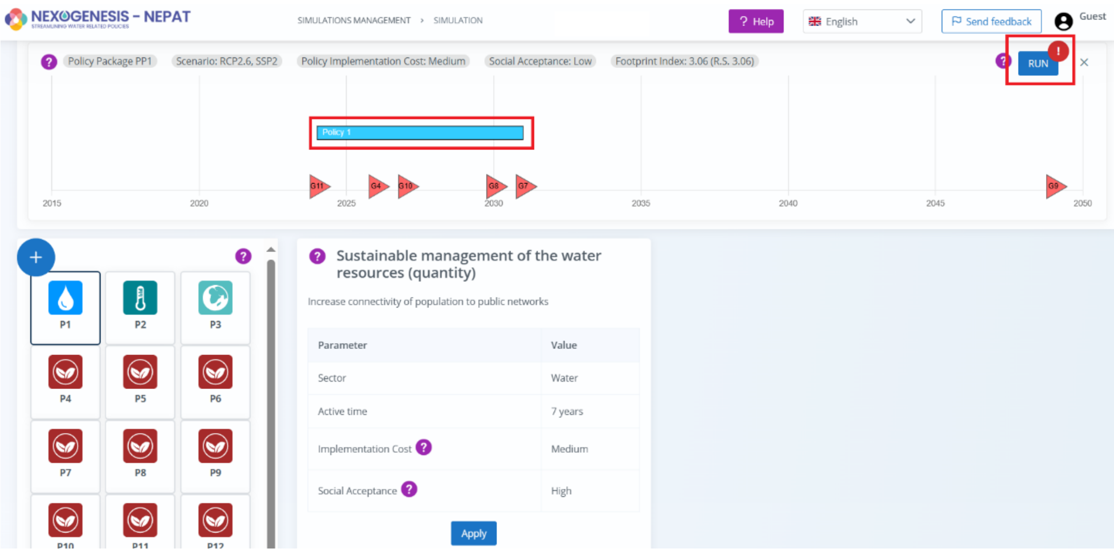

Figure 18. Configuring a Policy Package: Step 3

✅ Step 4: Exploring Your Results

- Once the simulation is complete, use the main menu ⊕ to analyze how the policy instruments affect the system across different views.

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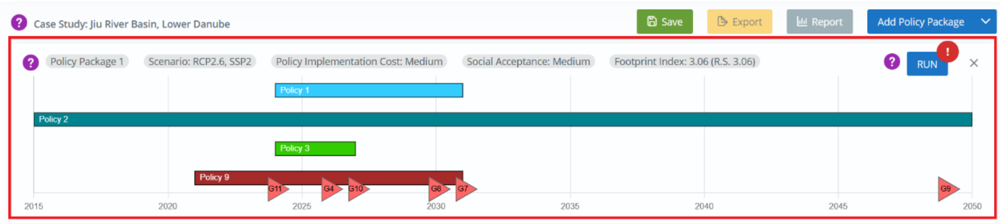

Figure 19. Policy Package Summary: Policy instruments, indicators, and run button

Once you have included the desired ***Policy Instruments***, click the ***RUN*** button to simulate the policy impacts across the WEFE nexus. This will process your selected policies and generate results based on your settings.

📌 **Note:** If you modify your policy package—by adding or deleting policies—the ***RUN*** button will display an **exclamation mark (!)**. This serves as a reminder that you must rerun the simulation to ensure all results reflect the latest changes.

After running the simulation, you can explore the outcomes using the different analysis tools available in the main menu. You can run more than one policy package simulation which allows you to compare different combinations of policies and their effects on the set goals.

Comparing multiple policy packages

NEPAT allows you to compare different policy scenarios within the same case study. You can create and analyze multiple policy packages to assess how different policy combinations perform and identify the most effective approach.

✅ <u>Step 1: Add Policy Packages</u>

To explore different policy options, you need to create multiple policy packages (Figure 20).

- Click the ***Add Policy Package*** button.
- Select the ***Reference Scenario*** for the new policy package.
- Repeat this process to ***add more policy packages*** for comparison.

Figure 20. Comparing policy packages in the NEPAT

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✅ Step 2: Assign Policy Instruments to Each Policy Package

When working with multiple policy packages, you need to specify which **policy instruments** should be included in each one (Figure 21).

- Select a ***policy instrument*** from the available options.
- Choose which ***policy package*** should include this instrument.
- Repeat for all desired policy instruments.

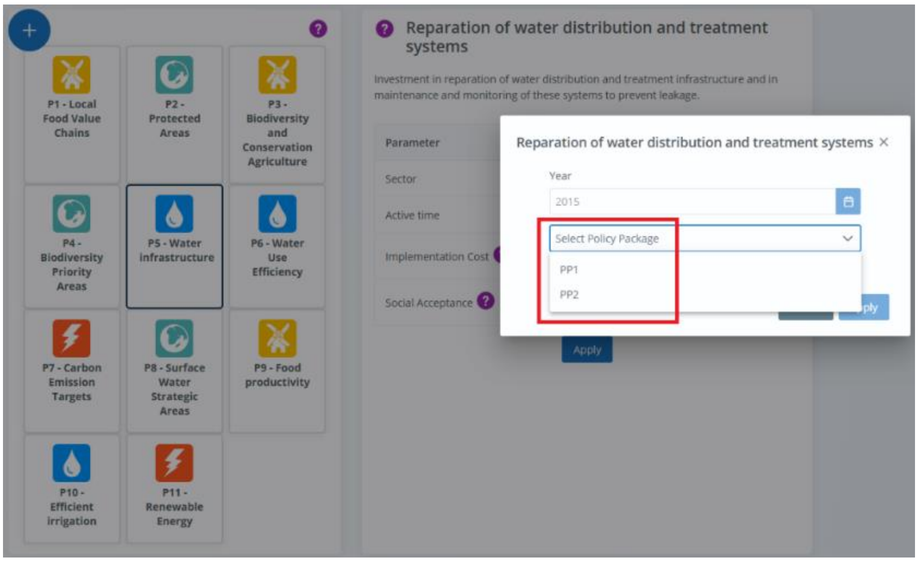

Figure 21. Selection of policy instruments for multiple policy packages

✅ Step 3: Run Simulations for Each Policy Package

Each policy package must be run separately to generate results.

- Click the ***Run*** button next to each policy package.
- Wait for the system to process the simulation.
- If needed, remove a policy package by clicking the ***cross icon*** next to the ***Run*** button (Figure 20).

✅ Step 4: Compare Results in Different Views

Once the simulations are complete for all policy packages, you can analyze and compare results across different **interactive views**. Results are presented for all configured policy packages.

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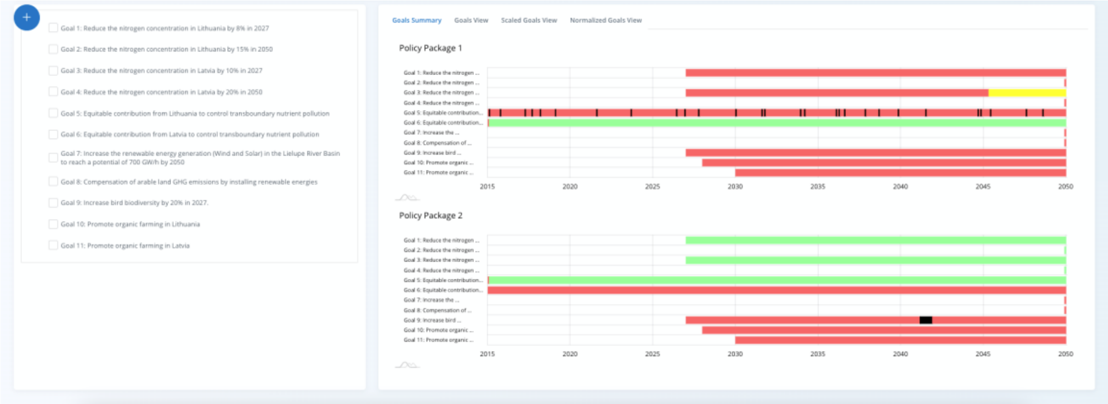

Figure 22. Policy goals view for two separate policy packages

Analyze trade-offs and select the best policy package

- Review the results across the different views.
- Identify trade-offs, where one policy package may improve certain goals but negatively affect others.
- Choose the policy package that best aligns with your objectives.

Nexus Footprint

The **Nexus Footprint View** is the **fourth section** of the dropdown menu (Figure 23). This section provides a comprehensive annual assessment of the WEFE Nexus, measuring performance and interactions across its four key pillars: Water, Energy, Food, and Ecosystems. The index uses a scale from -100 to 100 to show whether an area is improving, stable, or declining over time. This clear structure helps users analyze both individual and combined impacts across the Nexus.

The WEFE Footprint Index follows a hierarchical structure, consisting of:

- **Four main pillars** – Water, Energy, Food, and Ecosystems.
- **Nine sub-pillars** – Each pillar is further divided into sub-pillars for more detailed analysis.
- **Sixteen indicators** – These measurable variables provide specific insights into Nexus dynamics.

This layered approach enables users to examine trends at different levels, from a high-level overview to detailed insights on individual indicators.

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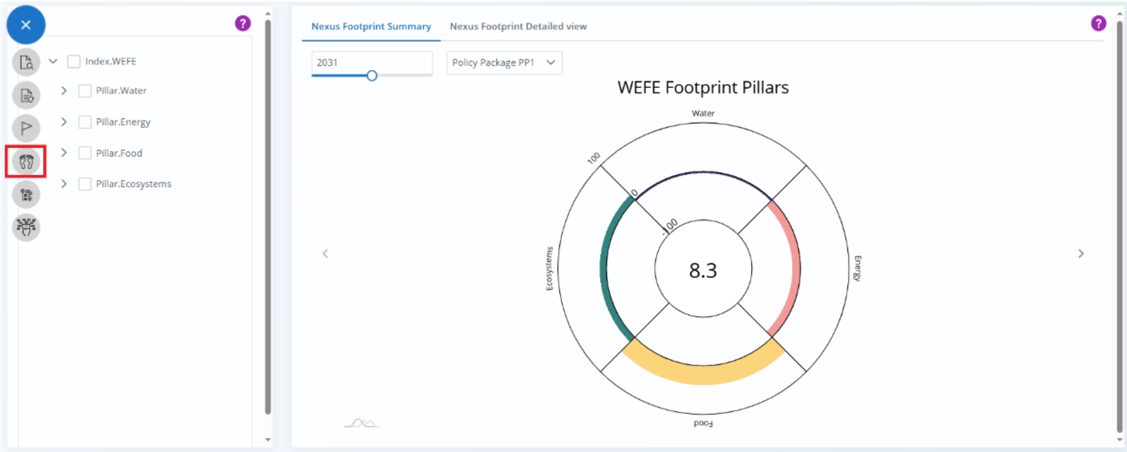

Figure 23. Nexus Footprint in the Simulation View

The **Nexus Footprint Summary,** located on the right, is a dynamic, interactive diagram that lets you explore the WEFE Footprint variables compared to the baseline year of 2015 (Figure 24). This will allow you to assess whether, for example, the water pillar performs significantly better, worse or similarly to the baseline.

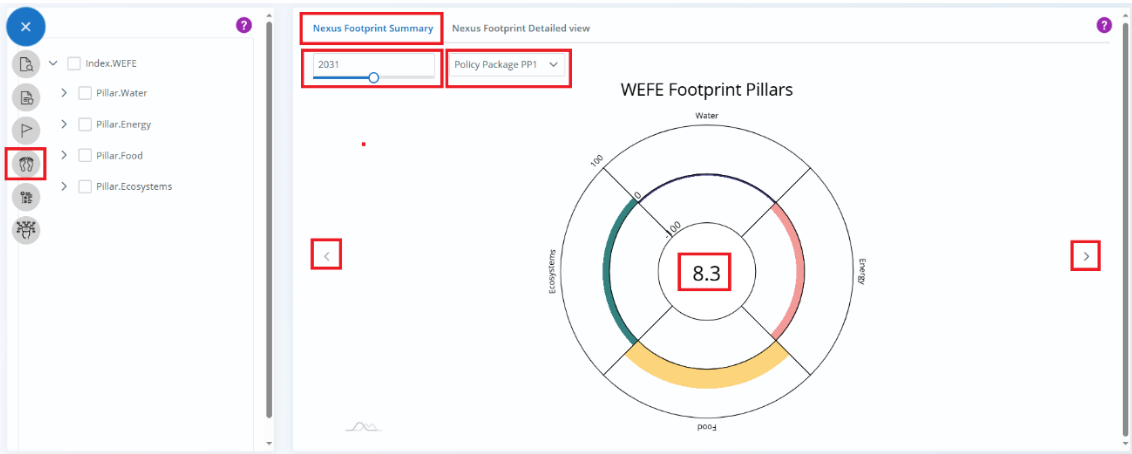

Figure 24. Nexus Footprint: Nexus Footprint Summary

- **Select a Year** – See how the footprint changes over time.
- **Choose a Policy Package** – Compare different policy options.
- **Central Index Score** – Shows the overall WEFE performance.
- **Navigate Between Levels** – Use arrows to explore pillars, sub-pillars, and indicators.
- **Color Coding** – Each pillar has a unique color for easy recognition:
  - *Blue* = Water
  - *Red* = Energy
  - *Yellow* = Food
  - *Green* = Ecosystems
- **Hover for Details** – Move your cursor over any section to see specific values.
- **Understanding the Scores** – Each level—indicators, sub-pillars, and pillars—has a value between -100 and 100:

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✔ *Positive values* = Improvements compared to baseline year 2015.
❌ *Negative values* = Decline compared to baseline year 2015.

The **Nexus Footprint Detailed View** (Figure 25) helps you track how selected indicators evolve from 2015 to 2050, with yearly updates. This allows you to compare two scenarios:

- The **Reference Scenario** (no policies applied)
- The **Policy Future Scenario** (with selected policy instruments)

By comparing these scenarios, you can see how different policies impact key indicators over time.

✅ **Step 1: Select Indicators**

- Choose specific variables from the left list (e.g., Water Demand, as in Figure 25).

✅ **Step 2: View Detailed Analysis**

- Once selected, the graph on the right will show how these values change over time.

✅ **Step 3: Customize Your Chart**

- Use the legend to show or hide specific variables by clicking on them.

In Figure 25, the chart shows **Water Demand** under both the Reference Scenario and a selected Policy Package (PP1).

- **Both scenarios show a negative impact** compared to the 2015 baseline (values are below 0).
- **PP1 worsens the impact**—its values are even lower than the Reference Scenario. This suggests that the policy instruments applied in this scenario negatively affect Water Demand.

Even though Water Demand is negatively affected, the Policy Package Summary shows all green flags (Top Section in the Figure 25)—meaning that the overall policy goals are achieved. The policies are meeting their objectives, but they also create trade-offs—in this case, a negative impact on Water Demand. By exploring these insights, you can make informed decisions and find a balance between policy goals and potential side effects.

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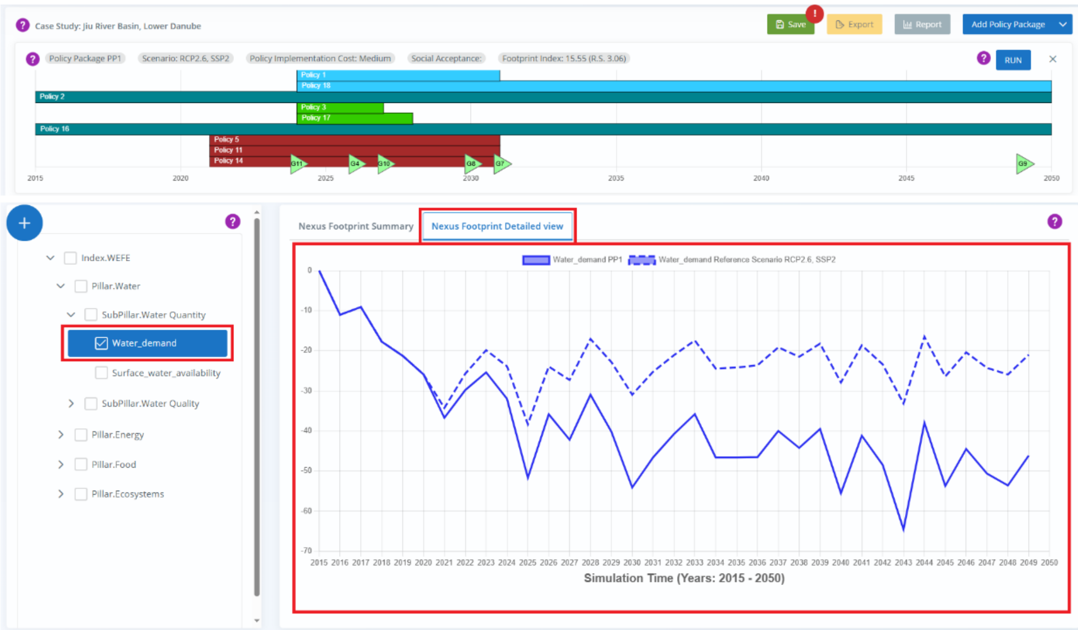

Figure 25. Nexus Footprint: Nexus Footprint Detailed View

In the Footprint Section, it's important to note that not all Case Studies modelled every variable. If a variable (pillar, subpillar, or indicator) is not considered for a given Case Study, it will appear in grey in the footprint graphics (Figure 26). Additionally, these variables will not be visible in the Nexus Footprint Detailed View.

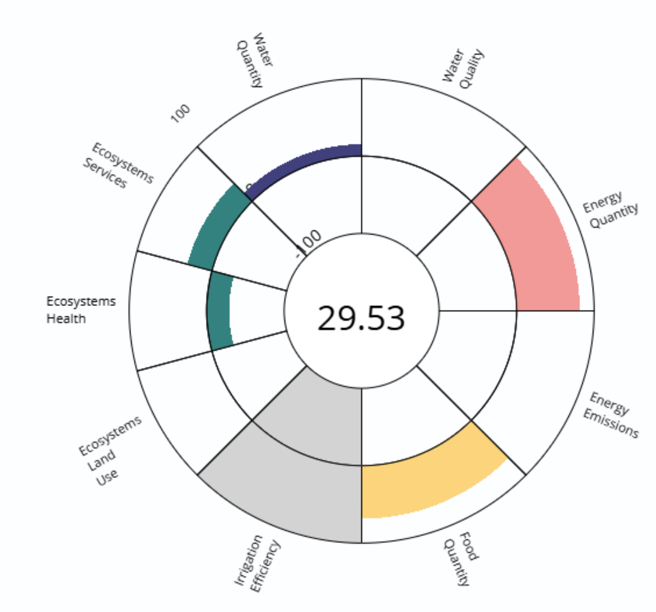

Figure 26. Nexus Footprint: Nexus Footprint Summary with Greyed-Out Indicators

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Decision Support System

The **NEPAT Decision Support System (DSS) View** is the **sixth section** of the dropdown menu (Figure 27). This section is designed to help you identify policy packages that align with your specific goals and priorities. This tool provides flexible and customizable recommendations, allowing you to explore tailored policy solutions and evaluate their potential impacts.

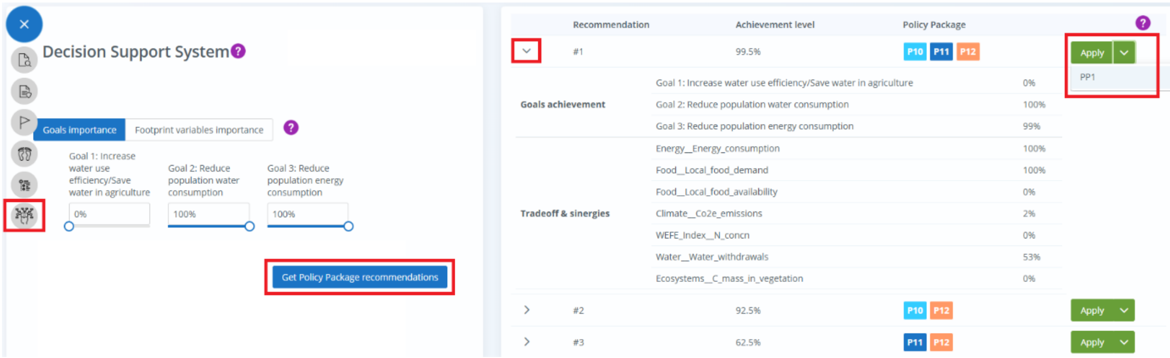

Figure 27. Decision Support System in the Simulation View

To generate policy recommendations, follow these steps:

✅ **<u>Step 1: Define your criteria</u>**

The DSS allows you to focus on either goals or footprint variables, but not both at the same time:

- ***Prioritizing Goals***
  - Click the **Goals Importance** button.
  - Select the goals you want to focus on assigning **weights (percentages)** to in-dicate their importance.
- ***Prioritizing Footprint Variables***
  - Click the **Footprint Variables Importance** button.
  - Select the footprint variables you want to emphasize adjusting their **weights** to influence the recommendations.

By adjusting these weights, you guide the DSS to focus on what matters most to you.

📝 *Tip: You can distribute weights equally or prioritize some goals by assigning them with higher percentages.*

✅ **<u>Step 2: Get Policy Package Recommendations</u>**

Click the Get Policy Package Recommendations button.

✅ **<u>Step 3: Understanding the Recommendations</u>**

Once you define your criteria, the DSS generates up to 10 recommended policy packages, displayed on the right side of the screen. Each recommendation includes:

- **Overall Goal Achievement Score** – The average achievement of selected goals.
- **Detailed Policy List** – The specific policies included in the package.

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- **Expandable Goal Details** – A dropdown menu showing how well each goal is met, helping you assess trade-offs.
- **Apply Button** – Allows you to apply the selected policy package directly to the *Policy Package Summary*.

By exploring the ranked recommendations, you can compare different policy options and select the most effective strategy for your needs.

📌 **Note:** If no recommendations are provided, it means the DSS could not identify a better solution for the given scenario then to do nothing. This may occur when no feasible alternatives meet the defined policy goals or footprint variables (Figure 28).

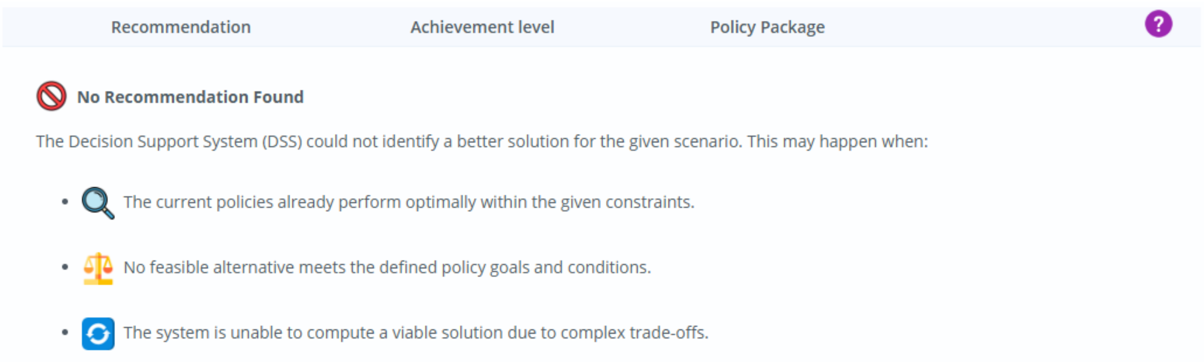

Figure 28. The DSS could not identify a better solution for the given scenario

You can then apply the policy package of your choice by following the instructions in the previous section and explore the goals achievements and footprint variables.

Generating a simulation report

NEPAT also lets you **export results as a PDF report**, making it easy to review and present findings.

- Simulations can only be reported from the 🔍 **Simulation View**
- Click the ***Report*** button.
- The pdf report is directly generated and downloaded to your device.

This feature works for:

- A single policy package analysis.
- A comparison of multiple policy packages.

💡 What's included in the report?

The report provides a structured summary of the simulation, including:

- **Introduction** – A description of the case study and reference scenario.
- **Reference Scenario Description** – The combination of RCP (climate projection) and SSP (socioeconomic projection) used in the simulation.
- **Policy Package Summary** – A breakdown of the policies included in the package.
- **Policy Package Impact** – A Sunburst graph visualizing the effects of the policy package, along with a comparative Sunburst graph against the reference scenario**.**

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- **Goals Achievement** – A summary of the goals considered in the simulation, using the **color-coded chart** to indicate achievement levels:
  - **Green** – Goal achieved.
  - **Yellow** – Progress is **closer to the goal** than to the reference scenario.
  - **Red** – Progress is **closer to the reference scenario** than to the goal.
  - **Black** – Progress is moving **further away** from the goal.
- **WEFE Footprint Index** – An overview of the index, including visual representations of its key pillars, sub-pillars, and indicators.

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5.6 Example of a Policy Selection Optimization exercise

Welcome to the NEPAT hands on demonstration! You are a decision-maker tasked with creating a sustainable future for the **Jiu River Basin**. Recently, we've noticed that the greenhouse gas balance, measured by the variable *Climate.GHG balance (tCO2)*, is too high, indicating that the emissions are greater than the amount of CO_2 removed from the atmosphere.

🌍 **Mission:** Implement policies to decrease the *Climate.GHG balance (tCO2)* in the Jiu River Basin by reducing emissions or enhancing carbon sequestration.

🔔 **Remember:**

- ✅ **Positive** Climate.GHG balance → More emissions than absorption
- ❌ **Negative** Climate.GHG balance → More absorption than emissions
- 🎯 **Goal:** Shift the balance downward! ⬇️

Exercise 1: Develop a strategy

From this set of policies, determine the most effective and practical options for reducing the greenhouse gas balance and write down your chosen policy package.

Water Policies	Description
P1	Increase population connectivity to public water supply networks.
P18	Build new small hydropower plants to boost renewable energy.
Climate Policies	**Description**
P2	Phase out of all lignite coal and lignite-powered thermal power plants, with an objective for decarbonization and promoting renewable energy.
P16	Reduce GHG emissions through improved land use and forestry.
Ecosystem Policies	**Description**
P3	Implement a national program for afforestation and reforestation, including urban forests.
P17	Rehabilitate polders, clear watercourse obstacles, and restore riparian habitats.

Land Policies	Crop type	Description
P4	Maize	30% shift of cultivation from rainfed to irrigated land.
P5		40% shift of cultivation from rainfed to irrigated land.
P6		50% shift of cultivation from rainfed to irrigated land.
P7		100% shift of cultivation from rainfed to irrigated land.
P8	Rapeseed	30% shift of cultivation from rainfed to irrigated land.
P9		40% shift of cultivation from rainfed to irrigated land.
P10		50% shift of cultivation from rainfed to irrigated land.
P11		100% shift of cultivation from rainfed to irrigated land.
P12	Sunflower	30% shift of cultivation from rainfed to irrigated land.
P13		40% shift of cultivation from rainfed to irrigated land.
P14		50% shift of cultivation from rainfed to irrigated land.

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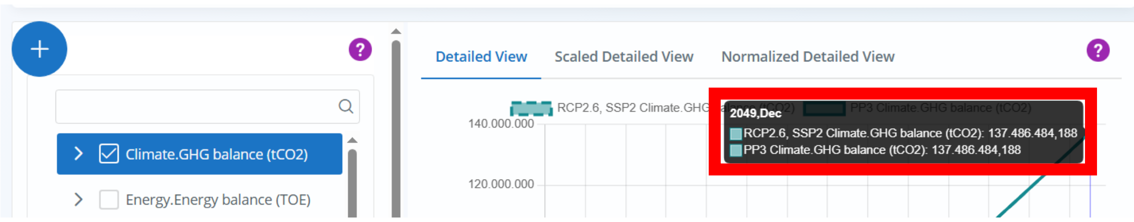
P15		100% shift of cultivation from rainfed to irrigated land.

<u>Exercise 2: Assess the impact of selected policies using NEPAT</u>

Use the NEPAT to evaluate the effects of the policies selected in Exercise 1. Assess whether these policies effectively reduce the greenhouse gas balance in the Jiu River Basin by following these steps:

1. Access NEPAT: https://nepat.nexogenesis.eu/
2. Configure a simulation for the Jiu River Basin case study, using the reference scenario RCP2.6, SSP2.
3. Implement the policies you chose in Exercise 1.
4. Run the simulation.
5. Navigate to the detailed view to find the variable *Climate.GHG balance (tCO2).*



6. Write the final value of *Climate.GHG balance (tCO2)* (2049, Dec) in both the reference scenario and the policy scenario.

Put your answer here

<u>Policies:</u>	**RCP2.6, SSP2**	**PP1**
Climate.GHG balance (tCO2)		

7. Did the chosen policy package achieve a reduction in the *Climate.GHG balance (tCO2)* variable for 2050?
   - Yes
   - No

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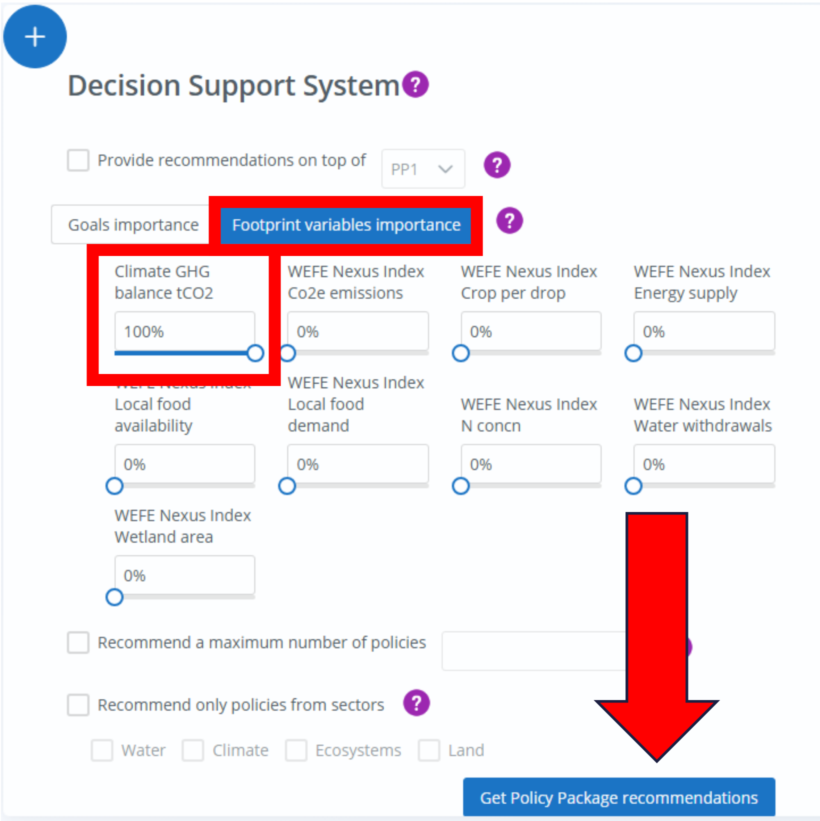
<u>Exercise 3: Ask the recommendation system!</u>

1. Create a new policy package: go to the summary view and click on "Add Policy Package" -> "RCP2.6 SSP2".
2. Use the decision support system to request policy recommendations for improving the greenhouse gas balance in the Jiu River Basin.



3. Take the first policy package suggested by the system and apply it to your simulation.
4. Check the final value of the *Climate.GHG balance (tCO2)* for the year 2050 in both the reference scenario and the policy scenario.

Put your answer here

<u>Policies:</u>	**RCP2.6, SSP2**	**PP2**
Climate.GHG balance (tCO2)		

5. Review the outcomes of this policy package and compare them with the results from your previously selected policies.
   - Did the recommendation system suggest a solution you had not considered?
     - Yes
     - No
   - Is this recommended policy package more effective than the policies you originally selected?
     - Yes
     - No

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5.7 Background on the usage of simulation tools for higher education teaching

Knowledge application in realistic or semi-realistic contexts plays a crucial role in developing complex skills (Chernikova et al., 2020). According to theories of expertise development, learners can attain high levels of expertise in complex problem-solving tasks if they possess adequate prior knowledge and engage in extensive practice. Ideally, such practice should involve authentic problems relevant to a professional domain. However, higher and further education programs often offer limited opportunities for real-life problem-solving. Additionally, engaging in real-world practice without structured guidance can overwhelm students and introduce risks and ethical concerns—such as when working with actual students or patients without proper preparation. Furthermore, real-world settings may not always provide sufficient practice opportunities, as critical situations may occur infrequently or require significant time before their outcomes become evident. These challenges make real-life practice both difficult to access and, at times, suboptimal for novice learners. To address this, simplified versions of practice, in which complexity is reduced (Grossman et al., 2009), can help learners focus on specific professional tasks while minimizing confusion and optimizing learning resources. In higher education, simulations offer a viable way to implement such approximations of practice, enabling students to work with authentic problems in a structured environment that supports the acquisition of complex skills.

Cook et al. (2013) stated that simulation is an "educational tool or device with which the learner physically interacts to mimic real life" and in which they emphasize "the necessity of interacting with authentic objects". Simulation-based learning helps integrate elements of real-world practice into educational settings, making professional contexts more accessible in schools and universities. Through simulations, learners can assume specific roles and actively engage in hands-on (and cognitively engaging) experiences within a controlled professional environment. Research indicates that complete authenticity is not always optimal for learning. Consequently, scholars often highlight the value of adjusting reality within simulated settings to enhance learning outcomes. Therefore, it is crucial to assess how closely a simulation aligns with actual practice, considering factors such as the demands placed on learners, the characteristics of the simulated scenario, and the involvement of the environment and/or participants.

When learners, particularly those in the early stages of expertise development, encounter ill-structured problems, scaffolding is essential to enhance learning and prevent cognitive overload, distraction, or reliance on superficial aspects of a situation (see Hmelo-Silver et al., 2007; Kirschner et al., 2006). Scaffolding supports problem-solving by adjusting tasks, limiting possible solution paths, and providing hints that help learners coordinate problem-solving steps or interactions. Additionally, it can involve taking over certain elements of the learning material to reduce cognitive demands. Meta-analyses indicate that scaffolding has a moderate positive effect on various learning outcomes.

Research findings suggest that university instructors may benefit from taking a more active role in aligning games with the curriculum, ensuring their integration into a blended learning framework that combines face-to-face instruction with online materials (Vlachopoulos and Makri, 2017). Studies also indicate that acting as game masters could be an effective way to

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scaffold virtual experiences and enhance student engagement. Additionally, research highlights the value of designing games with a focus on multiplayer collaboration to improve learning outcomes. Findings further recommend involving students as co-designers, as their input can introduce innovative ideas and unconventional approaches that better align with their learning needs.

Instructional support can be implemented in multiple ways. Learners may receive a theoretical introduction or preliminary information on handling materials (knowledge conveyance) or be scaffolded directly within the learning environment. Support strategies include step-by-step procedural guidance (e.g., worked examples or modeling), observation scripts, checklists, structured rules for addressing a case (e.g., prompts), role assignments with predefined actions or goals, and self-reflective exercises that encourage learners to assess their problem-solving approach, set goals, and monitor progress (e.g., inducing reflection phases).

These scaffolding strategies can be placed along a continuum, ranging from high instructional guidance with minimal self-regulation to high self-regulation with little instructional support (Chernikova et al., 2019). For instance, examples that demonstrate solutions or model target behavior represent high instructional guidance and require less self-regulation. In contrast, reflection phases encourage learners to evaluate their goals, analyze their own performance, and plan future actions but provide minimal guidance during problem-solving. Role assignments prescribe a specific problem-solving approach, whereas prompts offer hints or additional information about task execution, varying in the level of guidance they provide.

Research has shown that these scaffolding techniques effectively support the development of diagnostic competencies (Chernikova et al., 2019). Additionally, findings suggest an interaction between scaffolding type and learners' prior professional knowledge: those with greater prior knowledge benefit more from scaffolding with lower instructional guidance, whereas those with limited prior knowledge perform better when supported by higher instructional guidance.

Further reading and references:

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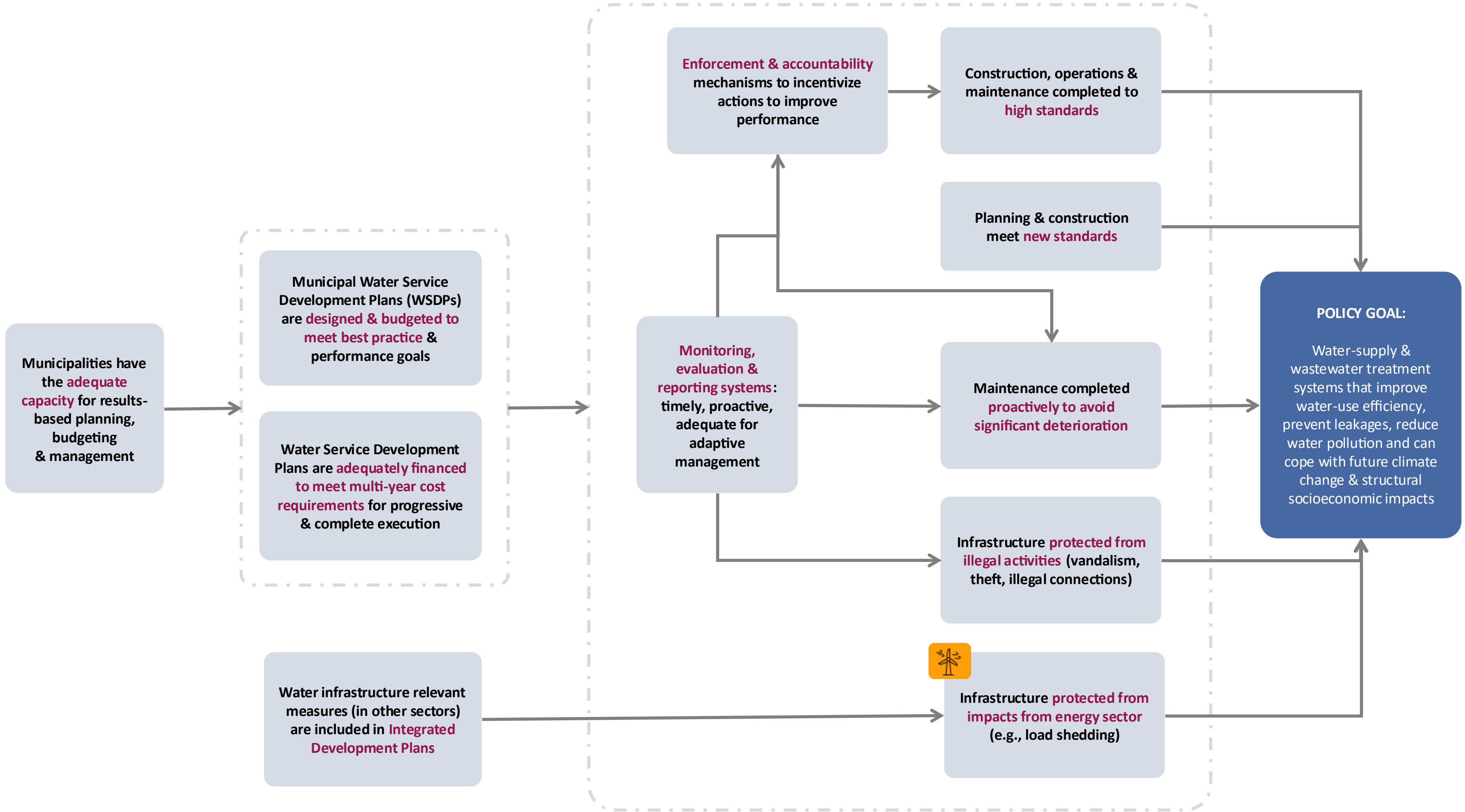
5.8 Example of a governance roadmap



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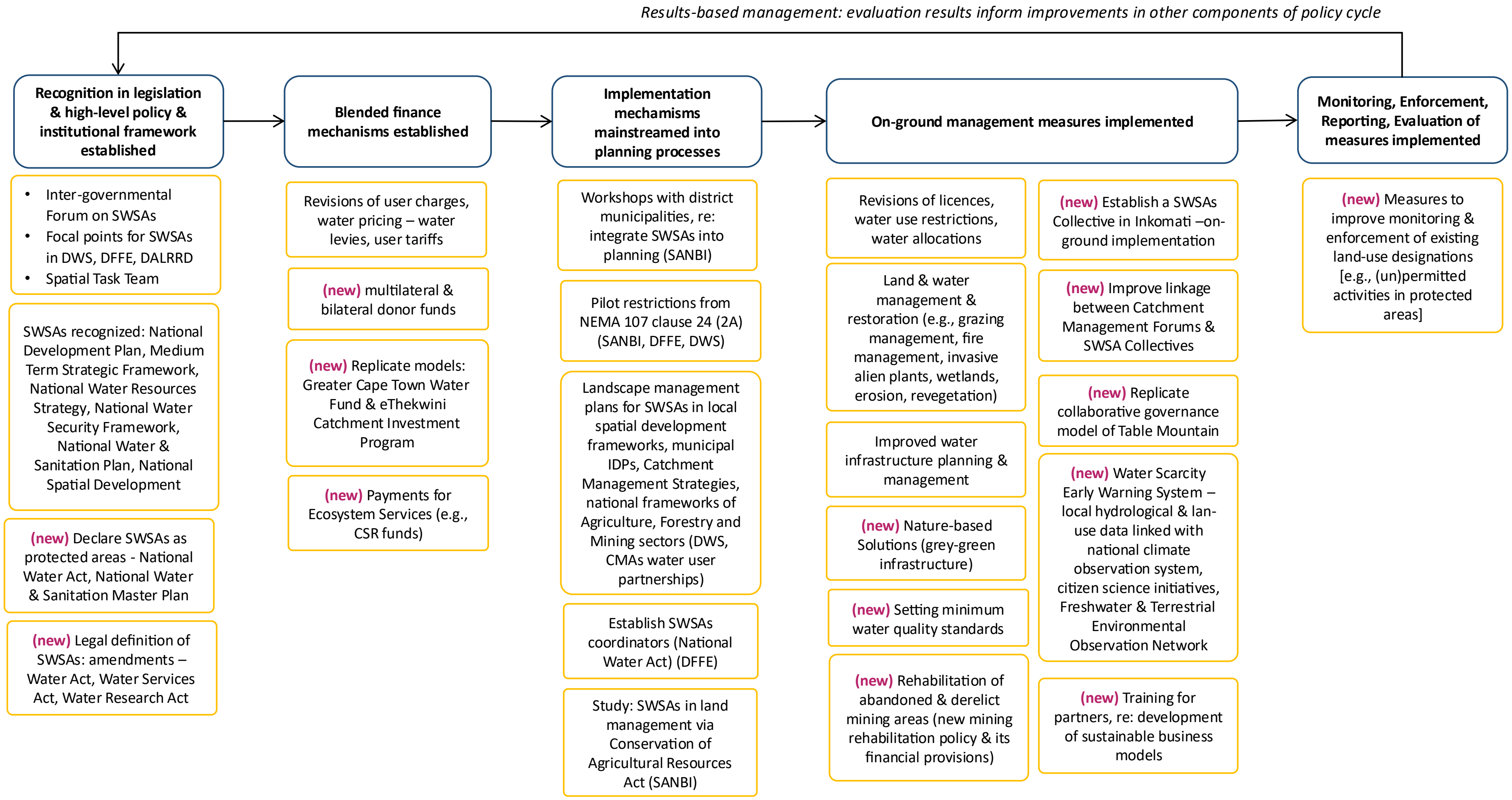
Roadmap: Securing Strategic Water Source Areas



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