the LENSES project

LEarning and action alliances for NexuS EnvironmentS in an uncertain future

LENSES

WP7

D7.5 Nexus-SDG toolkit as a serious game (v0.1)

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Project coordinator

Project partners

Project Website

www.lenses-prima.eu

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Executive summary

The water and food sectors are inextricably linked so that actions in one policy area commonly have impacts on the other, as well as on the ecosystems that natural resources and human activities ultimately depend upon**.** All three elements – water, food, ecosystems – are crucial for human well-being, poverty reduction, and sustainable socio-economic development. The general objective of the LENSES project is to contribute to improved water allocation and enhanced food security while preserving ecosystems and aiding climate change adaptation, by supporting the operationalization of the Nexus paradigm (from Nexus Thinking to Nexus Doing) through a collective learning process. This approach integrates the concepts of sustainable Nexus management with a resilience-oriented approach, leading decision-makers in accepting uncertainty as an integral part of management and decision-making.

The current document is entitled “Nexus-SDG toolkit as a serious game” and is produced as Deliverable 7.5 under Task 7.5 “Linking Nexus management to SDG delivery” of WP7 “Nexus operationalization for SDG delivery” of the LENSES project. This task, led by DRAXIS, aims to develop a Nexus-SDG toolkit as a serious game that will provide a digital environment where the possible future scenarios regarding the Water-Ecosystems-Food (WEF) NEXUS systems will be explored by stakeholders and possible policy scenarios in the form of Nature-Based Solutions (NBS) will be linked with the Sustainable Development Goals (SDGs) delivery and the ecosystem services that they support. The serious game has been designed to have a participatory approach where a group of participants collectively explore a complex reality and complex challenges regarding the seven pilot areas of the project. Overall, this deliverable provides a comprehensive description of the serious game components, design and system architecture as well as step by step instructions of the gameplay. The Nexus-SDG toolkit as a serious game is publicly available at this link.

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Abbreviations

Abbreviation	Definition
CLD	Causal Loops Diagrams
FAO	Food and Agriculture Organization of the United Nations
GAEZ	Global Agro-Ecological Zones
IIASA	International Institute for Applied Systems Analysis
LUS	Land Use Suitability
NBS	Nature Based Solution
SD	System Dynamics
SDG	Sustainable Development Goals
WEF	Water-Ecosystems-Food

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1 Introduction

The general objective of the LENSES project is to contribute to improved water allocation and enhanced food security while preserving ecosystems and aiding climate change adaptation, by supporting the operationalization of the Nexus paradigm (from Nexus Thinking to Nexus Doing) through a collective learning process. This approach integrates the concepts of sustainable Nexus management with a resilience-oriented approach, leading decision-makers in accepting uncertainty as an integral part of management and decision-making. The project is implemented at seven demonstration pilot sites across the Mediterranean basin, which cover a wide range of environmental, socio-economic and socio-technical conditions. All pilots represent typical Mediterranean conditions, in terms of climate conditions, potentially conflicting uses of the resources, relevance of agricultural activities, types of crops, social context and stakeholders. The seven pilot cases are: the Middle Jordan Valley (Jordan); the Hula Valley, Galilee (Israel); the Doñana national park area, Guadalquivir basin (Spain); the Tarquinia plain (Italy); the Gediz basin & delta (Turkey) and finally, the Koiliaris Critical Zone Observatory (Greece) and the Pinios River Basin Hydrologic Observatory (Greece).

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Serious games are interactive digital experiences with a primary purpose beyond mere entertainment. Their main purpose is to educate, inform, or train users on specific subjects, skills, or concepts while engaging them in an enjoyable and immersive gameplay experience. The objectives of serious games vary widely depending on their intended application, but they often include educating users, changing behaviors, fostering critical thinking, or conducting research. Socio-ecological simulations, or serious games, are a participatory process where a group of participants collectively explore a complex reality and complex challenges. They have been shown to be very effective learning tools that can serve as participatory tools, and support understanding of essential governance issues, including sustainable development, climate change mitigation and disaster risk reduction (Solinksa-Nowak et al., 2018).

The Nexus-SDG toolkit as a serious game aims to deliver a digital environment, that will provide the stakeholders with a game experience to foster sustainability, informed decision-making, and the alignment of NBS with SDGs. The objective is to inspires participants to engage with the pilot’s sustainability challenges, explore future climate change scenarios, make strategic NBS choices, and virtually build a sustainable and resilient future for the pilots of the LENSES project. Additionally, it is developed in order to provide guidance, data-driven insights, and a user-friendly interface to support an informed decision-making digital experience. Finally, the game is designed to offer a visually engaging, participatory experience that empowers participants to contribute actively, fostering critical thinking and meaningful actions within the Nexus-SDG Toolkit. The Nexus-SDG toolkit as a serious game is publicly available at this link.

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1.1 Structure of the document

In the Section that follows Section 2 “General game overview”, a description of the story and concept, game objectives and benefits, gameplay, participants & roles as well as the main pages of the serious game is provided. In Section 3 “Gameplay presentation” an analytical step by step gameplay presentation is provided. In Section 4 “System architecture and technical development”, a technical description of the software used on the implementation and the system architecture is presented. In Section 5 “Useful info”, a description of other tasks’ results that have been incorporated in the serious game, is provided.

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2 General game overview

In this section, a description of the story and concept of the Serious Game is provided as well as the possible users and user stories description that have been take into account in the design of the Serious Game. Finally the main features of the core system is presented as well as an analytical gameplay presentation.

2.1 Story and concept of the game

The Nexus-SDG Serious Game is designed to encourage active and well-informed decision-making on the management of Water-Ecosystems-Food (WEF) Nexus, in pursuit of achieving Sustainable Development Goals (SDG).

Various stakeholder groups connected to the LENSES case study areas engage in assessing the risks associated with their specific challenges, establishing connections between these challenges and the corresponding ecosystem services, and subsequently collaborate to identify the most suitable Nature-Based Solutions (NBS) to advance their progress towards SDGs attainment.

The Nexus-SDG Serious Game is an online, role-playing simulation game that focuses on the challenges related to WEF NEXUS management and the implementation of Nature-Based Solutions. Different solutions to reduce risk are presented to the players, who evaluate the options while taking into consideration a variety of nature-based solutions. The game is designed to educate players about the potential co-benefits and trade-offs associated with NBS through participatory decision-making. For example, a NBS selected by a stakeholder group for addressing one specific challenge, may offer co-benefits for another challenge identified by another stakeholder group for the same area.

The players will have the opportunity to collectively explore WEF related indicators for a selected area, identify challenges, and select nature-based solutions, based on the benefits and synergies created, with an ultimate aim to maximize contribution to the SDGs.

Collaborating in teams, players will make key strategic decisions responding to a series of different Nexus challenges. Finally the game report allows to learn from the collaborative decision-making process.

2.2 Game objectives and benefits

Following the objectives and the benefits of the serious game are presented.

Game objectives

- Address WEF NEXUS challenges in the selected pilot areas in the most effective way.
- Select those set of NBS that maximize contribution to SDGs, supplied ecosystem services, co-benefits and trade-offs among the WEF systems.
- Make salient decisions in collaboration with other stakeholders while exploiting valuable information on the WEF Nexus challenges.

Benefits

REAL WORLD TESTING:

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The Game simulates the governance setting in which NBS solutions are discussed and negotiated amongst stakeholders who have varying interests and views.
Role playing enables players to experience a situation where often opposing views and goals are represented.

PARTICIPATORY:
Participatory process where a group of participants collectively explore a complex reality and complex challenges.

CHALLENGING AND THOUGHT PROVOKING:
This unique process enables individuals within teams to make decisions for NEXUS management. This challenges status quo thinking and demands collaboration, teamwork and engagement.

2.3 Gameplay

Following the main game instructions and the gameplay rules are presented.

1. Participants select the area for which they want to play the game.
2. In the next step, participants are divided into teams of stakeholder groups, depending on their role.
3. The game has 5 stages. In every stage, all players/stakeholder groups play in their turn, before proceeding to the next stage.
4. Players in teams discuss the topics and make critical decisions to deal with the challenges they face and the opportunities offered.
5. At the end of the whole game participants can observe the results of their decisions in the Game Report and prioritize them, based on the synergies and co-benefits achieved.

Gameplay Rules:

- Each group may select at least one Challenge in Stage Challenge selection.
- Each group may select at least one System in Stage System selection.
- Each group may select at least one NBS in Stage NBS selection.
- In every game set, a maximum of 15 NBS may be selected.

2.4 Participants & roles

Following the participants and roles of the users of the Nexus-SDG serious game are presented.

Farmers

Description: Participants representing individual farmers, farmers cooperatives, and related stakeholders engaged in agricultural production and the agriculture sector.

Agricultural Policy Makers

Description: Participants representing national and regional government officials responsible for agricultural and food sector policies and regulations.

Water resource managers

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Description: Participants representing national and regional government officials responsible for water management policies and regulations.

Water Resource Users

Description: Participants representing stakeholders engaged in water use management, such as water supply organizations and irrigation consortia.

Environmental Policy Experts

Description: Participants representing national and regional government officials dealing with ecosystems, climate change, and environmental policies.

Land Use Planners

Description: Participants representing national and regional government officials from the infrastructure and land use planning sector, responsible for shaping land use policies.

Municipal Leaders

Description: Participants representing local government bodies, i.e., municipalities, responsible for local governance and decision-making.

Environmental Advocates (NGOs)

Description: Participants representing Non-Governmental Organizations focused on environmental conservation and sustainable practices, such as environmental associations.

Others

Description: Participants representing a wide range of individuals, organizations, or entities with varied interests and contributions supporting sustainable initiatives and policies.

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3 The Nexus-SDG Serious game online

In this section, each page of the Nexus-SDG Serious game is described in detail accompanied by an image of the respective page of the tool.

3.1 Home page

As shown in Figure 1, the intro page contains a menu to allow the users to select between several informative pages or to start the game. The buttons are the following:

- Play Game
- Objectives
- Instructions
- About
- Credits

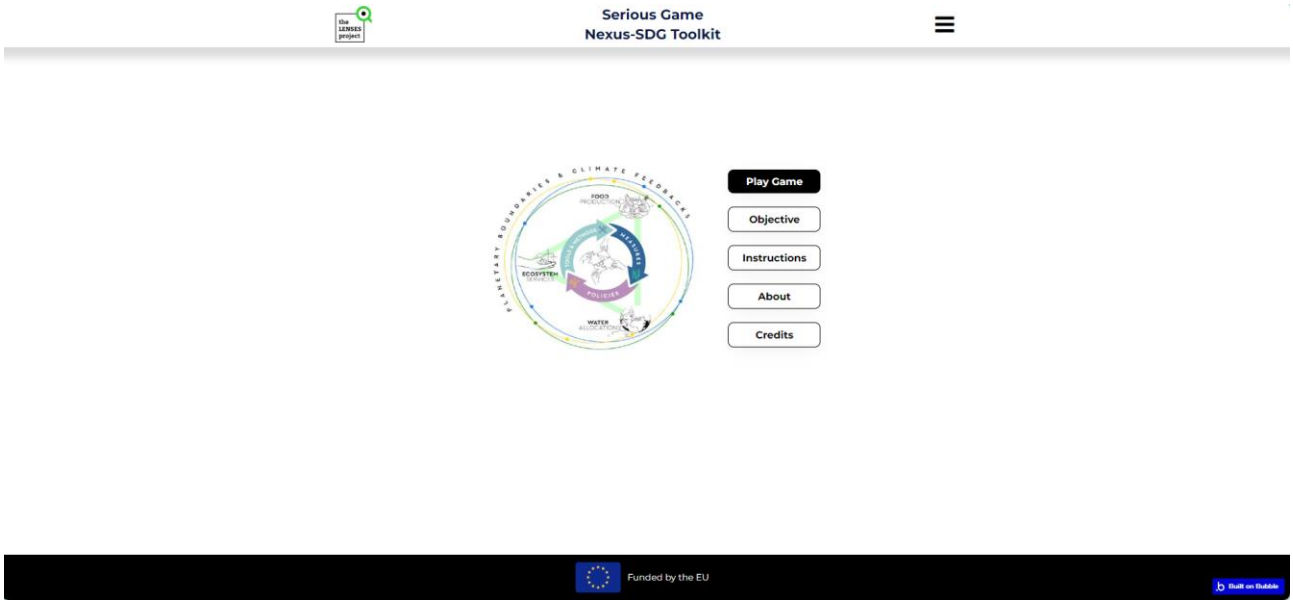

Figure 1. Home Page

3.1.1 Objectives

The Objectives page section provides information on the general objectives and benefits of the serious game (Figure 2).

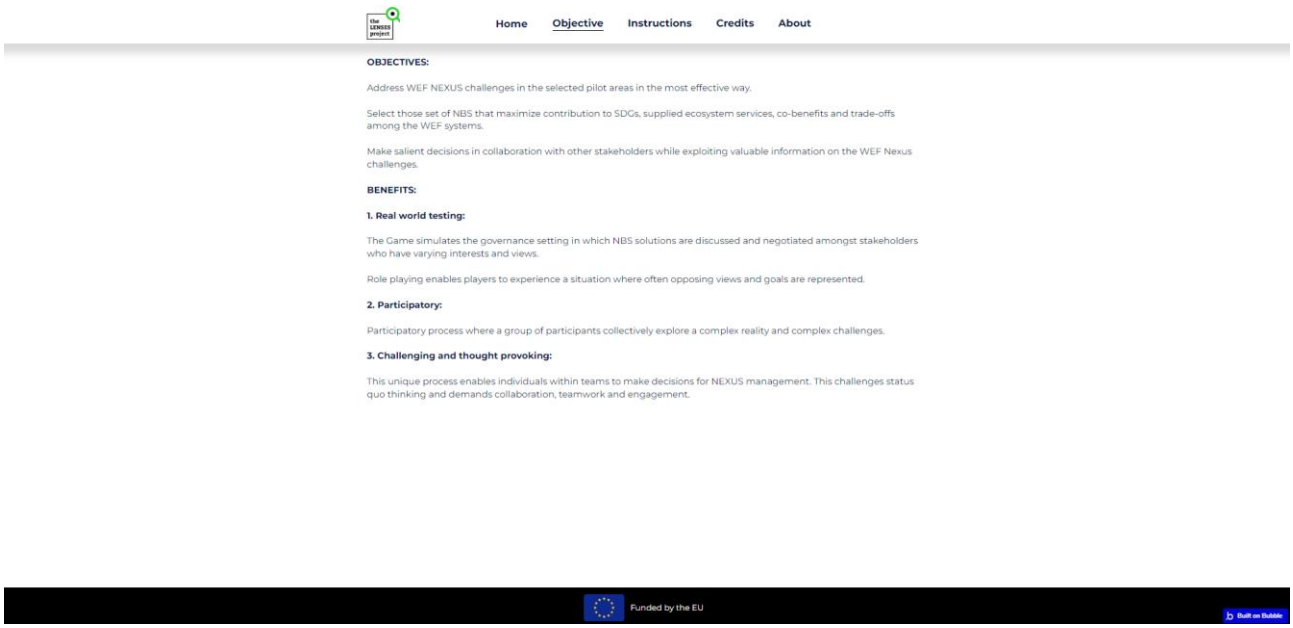

Figure 2. Game Objectives Page

3.1.2 Instructions

The Instructions page provides users with the guidance and rules of the game (Figure 3).

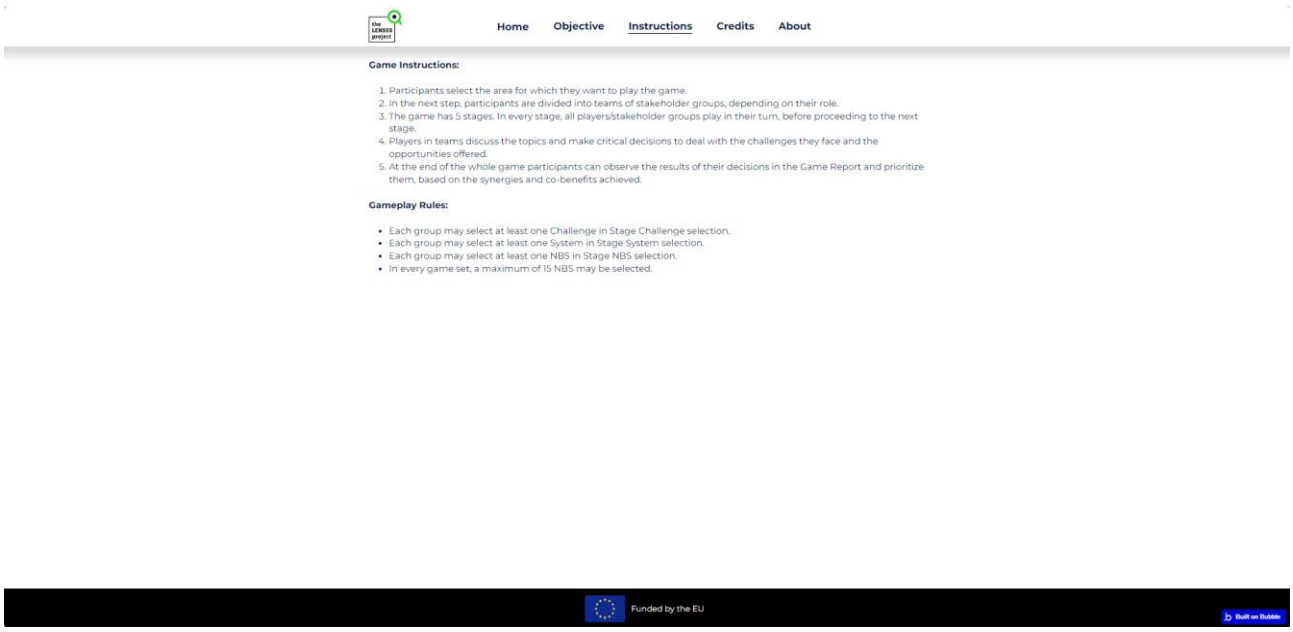

Figure 3. Instructions page

3.1.3 About

The About page provides users with essential background information about the serious game (Figure 4).

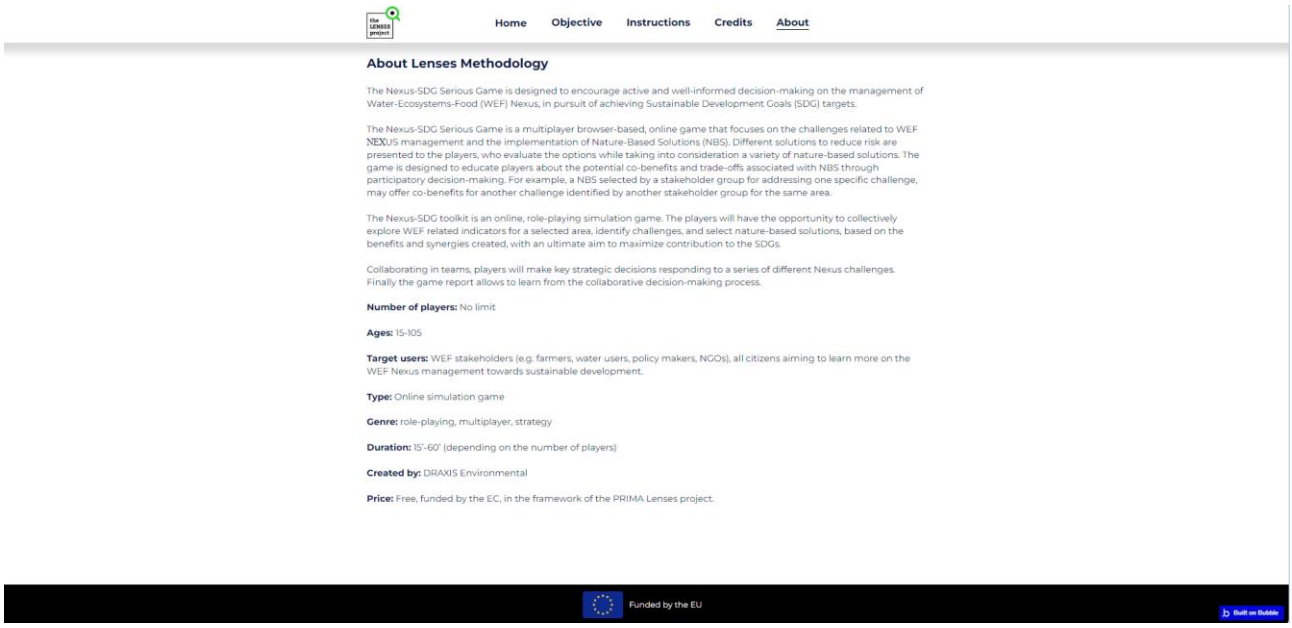

Figure 4. About Page

3.1.4 Credits

The Credits page provides users with the names and info to the LENSES project partners (Figure 5).

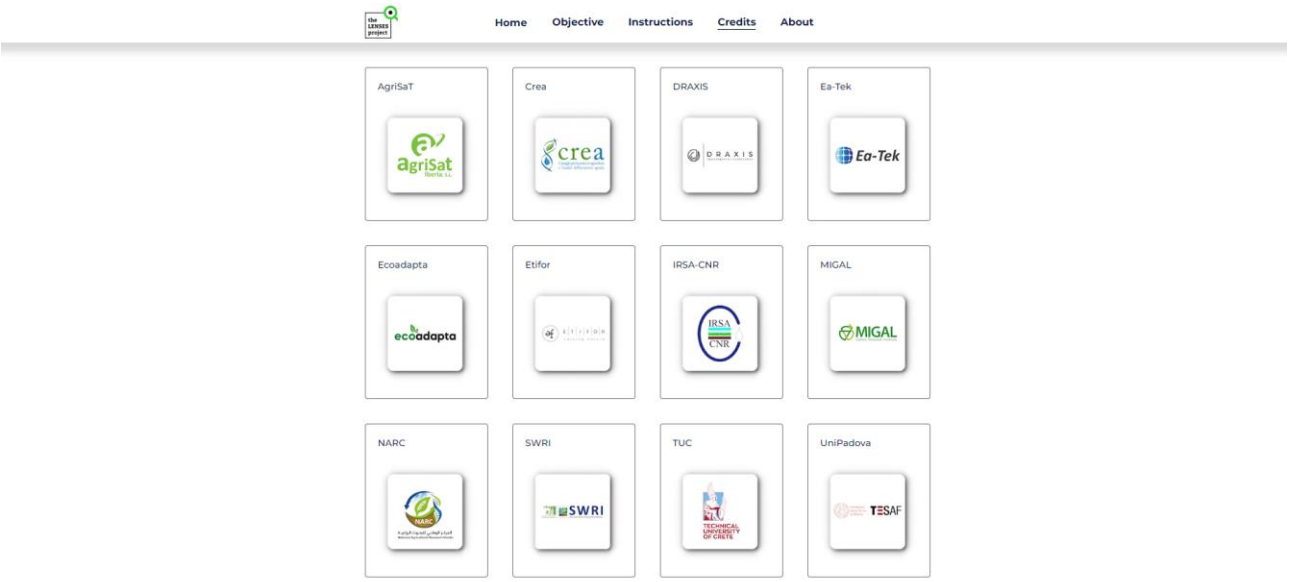

Figure 5. Credits Page

3.2 Gameplay presentation

This section provides a detailed presentation of the Nexus-SDG toolkit as a serious game accompanied by an image of the respective page of the tool. It also serves as a step-by-step guidance to the serious game and to the gameplay experience.

3.2.1 Pilot Selection

The "Pilot Selection" presents the LENSES pilots, each focusing on a variety of sustainability challenges, systems, and scenarios. Participants are tasked with choosing a pilot and procced to the stakeholders selection page.

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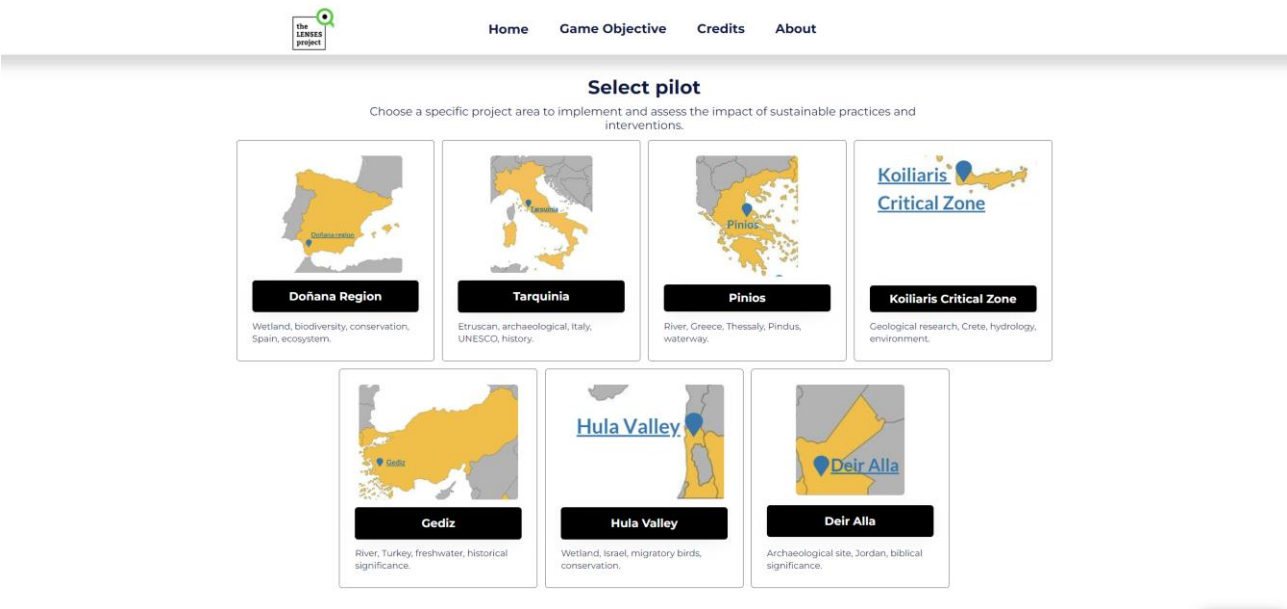

Figure 6. Pilot Selection Page

3.2.2 Role Selection

In this page the list of roles is presented and the participants are tasked with choosing one of them. The roles correspond to the different stakeholder groups associated to the WEF Nexus management (Farmers, Water Management, Authorities, NGOs and Others) that will participate in the main game. More than one players may play as a team representing one stakeholder group/role.

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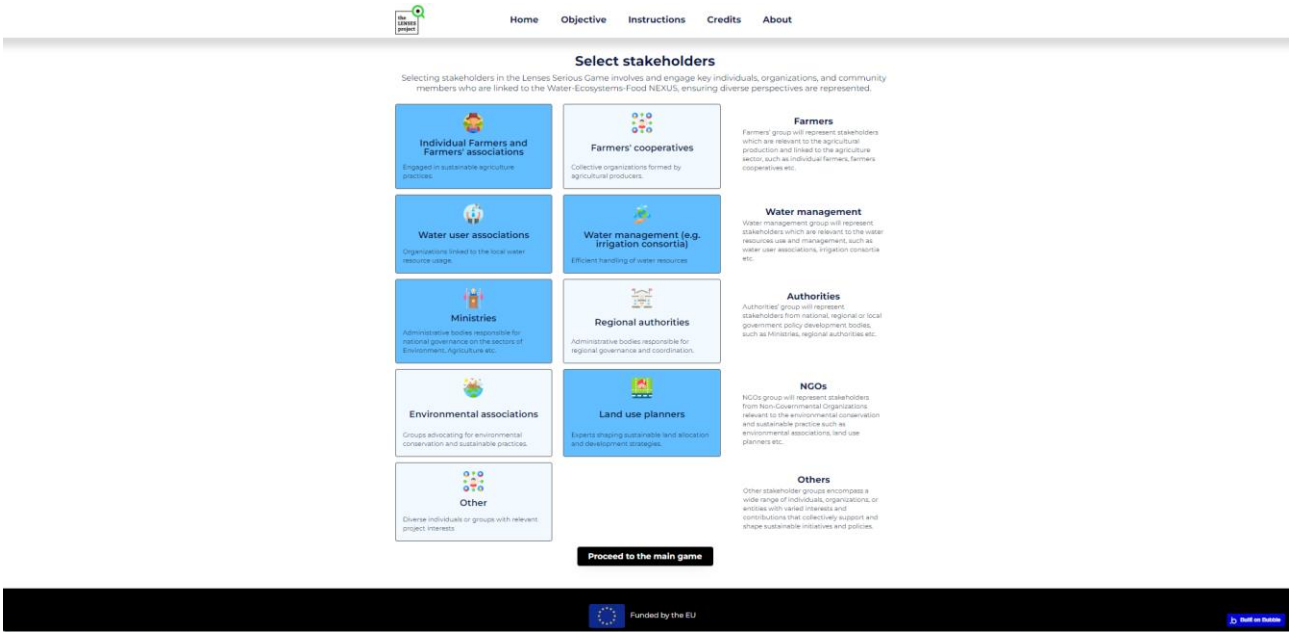

Figure 7. Stakeholder Selection Page

3.2.3 Main Game

The “Main Game" page is the centre of the serious game, where each stakeholder group, will involve into a five-step journey on the game (Figure 8). The game interface is divided into two parts.

The left part showcases interactive maps of climate-related variables and indicators, land use suitability on several crops and water availability information also related to climate change scenarios. Additionally, the pilot system elements are presented here through interactive Causal Loops Diagrams (CLD). This part visualizes in the form of maps and graphs the respective outcomes of several tasks of the LENSES project related to the WEF Nexus systems and their interconnections. Additionally serves as a “window” to available information that participants can be informed about and make data-driven decisions in the serious game. Above this “window” the players of the serious game are being presented (Figure 8), those are the stakeholder groups that participate and have been selected in the previous page process.

The right part showcases the five steps that participants will follow to play the game. In every step, the relevant game information is being presented along with the instructions of each step, so that the participants follow the process of the game (Figure 8). The button “next player” continues the game and procced to the next group (Figure 8). When each group has finished playing all steps, the game is ended and a final report with the results of the game is being produced.

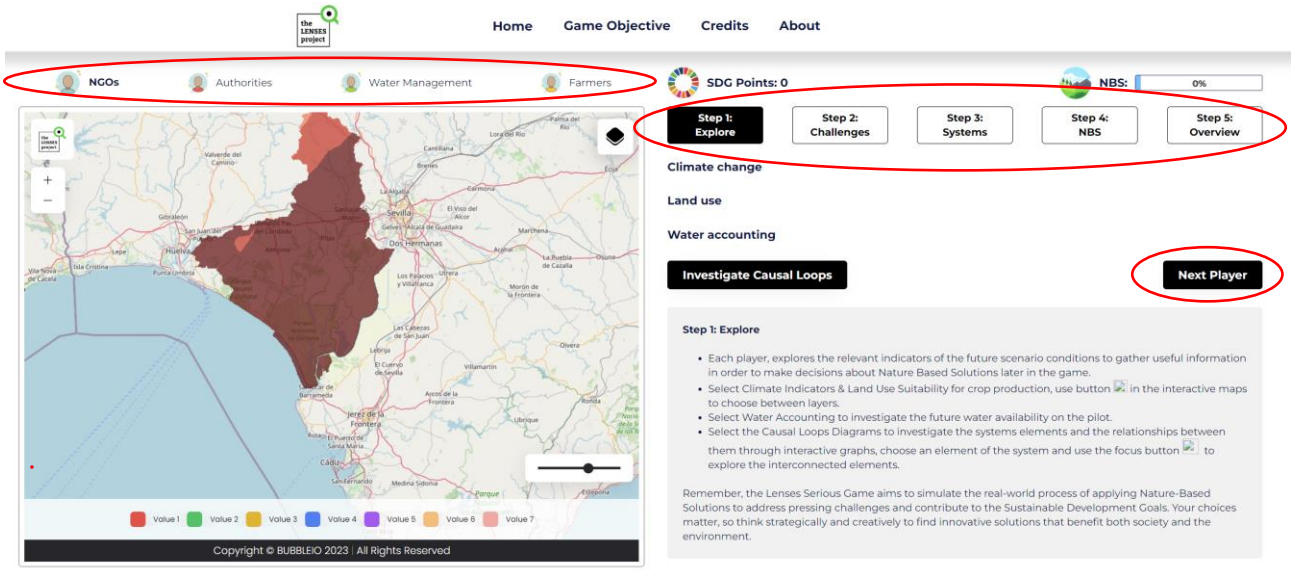

Figure 8. Game Page

3.2.3.1 Step 1: Explore

The step 1: Explore is depicted in Figure 9. In this step the participants are asked to explore through maps and figures the relevant information to the WEF Nexus systems and specifically the information related to climate change hazards, land use suitability and water accounting as well as the Causal Loop Diagrams (CLD) depicting the interconnection of the pilot systems' main Nexus elements.

The participants by choosing the sector they are interested to explore (Figure 9), the relevant information is presented at the window on the left side. By selecting the Layers button on the top-right part of the interactive maps (Figure 9), the players can go through the available indicators and explore the future impact scenarios expected for the pilot. To explore the pilot's system elements through the interactive CLDs, the participants can choose any element of the system and select the focus button (Figure 10) in order to investigate the relationships with other elements of the system. The button 'Next Player" (Figure 9) proceed to the next player group.

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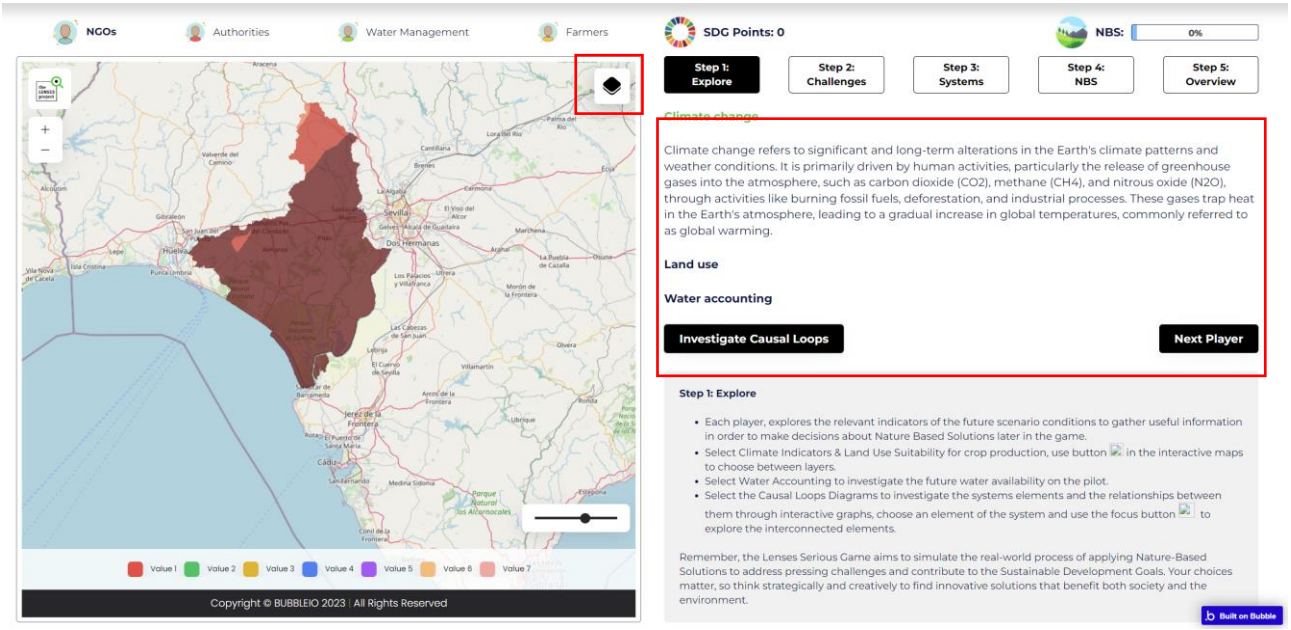

Figure 9. Step 1 Explore

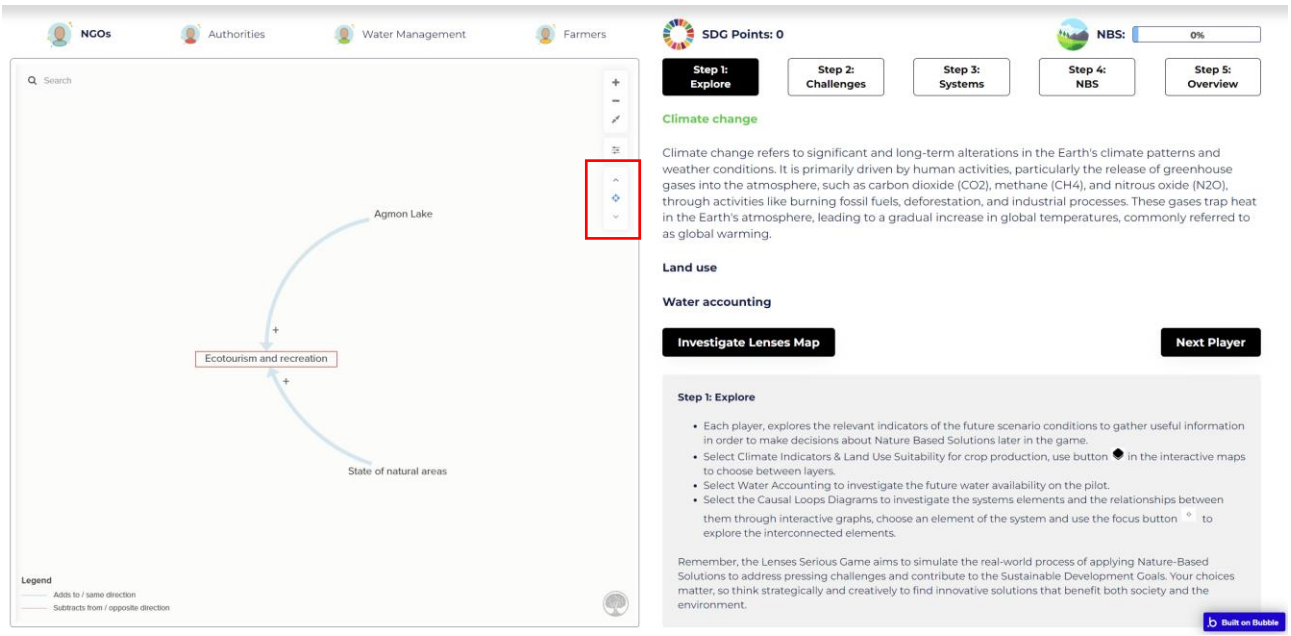

Figure 10. Investigate Causal Loops Diagrams

3.2.3.2 Step 2: Pick a Challenge

The step 2: pick a challenge is depicted in Figure 11. In this step, each stakeholder group is asked to select the challenges that they identify on the pilot relevant to their field of expertise/interest. When each

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stakeholder group/player finalize their selection, the game proceeds to the next group through the button "Next Player". To proceed to the next player, at least one selection must be made.

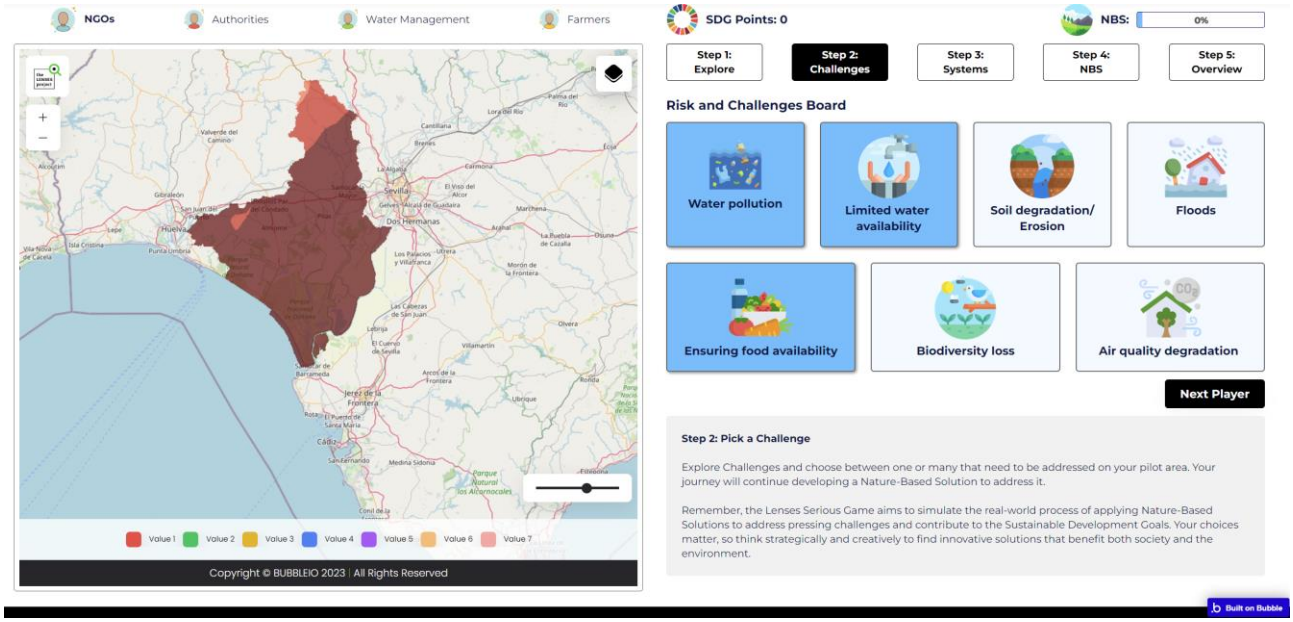

Figure 11. Pick a Challenge

3.2.3.3 Step 3: Pick a System

The step 3: pick a system is depicted in Figure 12. In this step, each group is asked to select the systems to which they want to apply NBS. When each stakeholder group/player finalize their selection, the game proceeds to the next group through the button "Next Player". To proceed to the next group at least one selection must be made.

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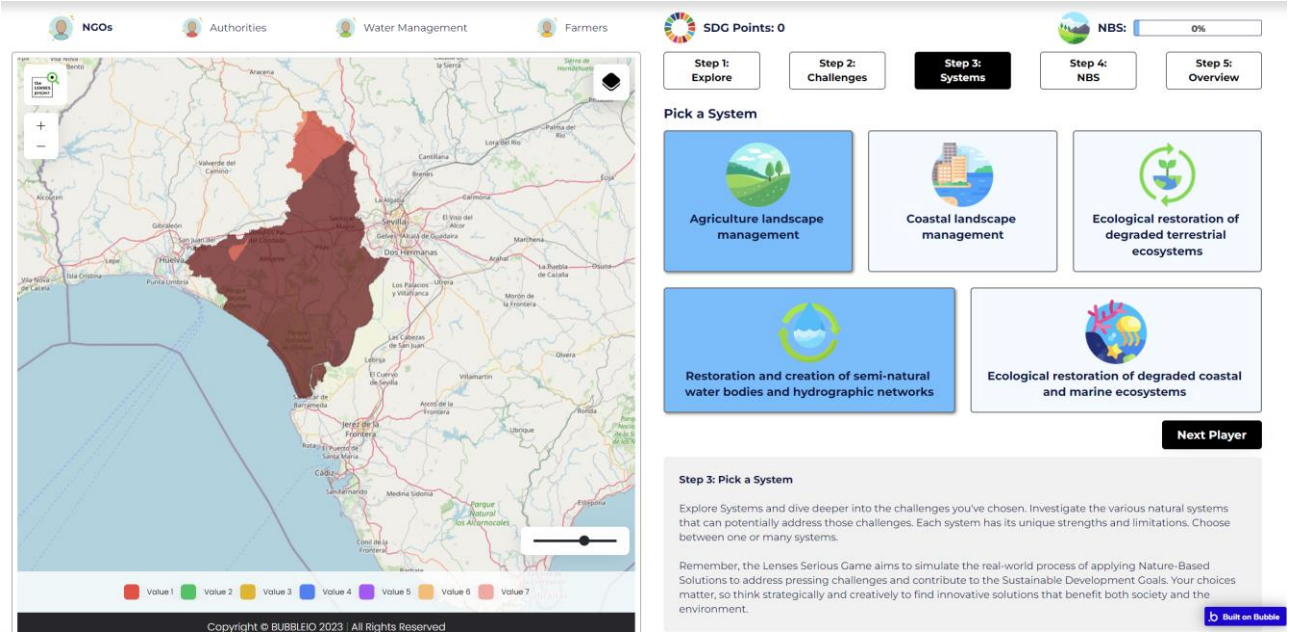

Figure 12. Pick a System

3.2.3.4 Step 4: Pick a NBS

The step 4: pick a NBS is depicted in Figure 13. In this step, each stakeholder group is asked to select one or more NBS that they identify as most appropriate to address the challenges that they have identified. The NBS which are linked to the challenges selected by each group are presented in a drop-down menu (Figure 13). When a specific NBS is selected from the list, then the relevant description is presented (Figure 13) and the respected SDG points collected are presented in the SDG counter (Figure 13). Additionally, each time a NBS is selected, the progress bar of NBS is filled accordingly with the percentage achieved.

When each stakeholder group/player finalizes its selection, the game proceeds to the next stakeholder group through the button “Next Player”. To proceed to the next group at least one NBS selection must be made.

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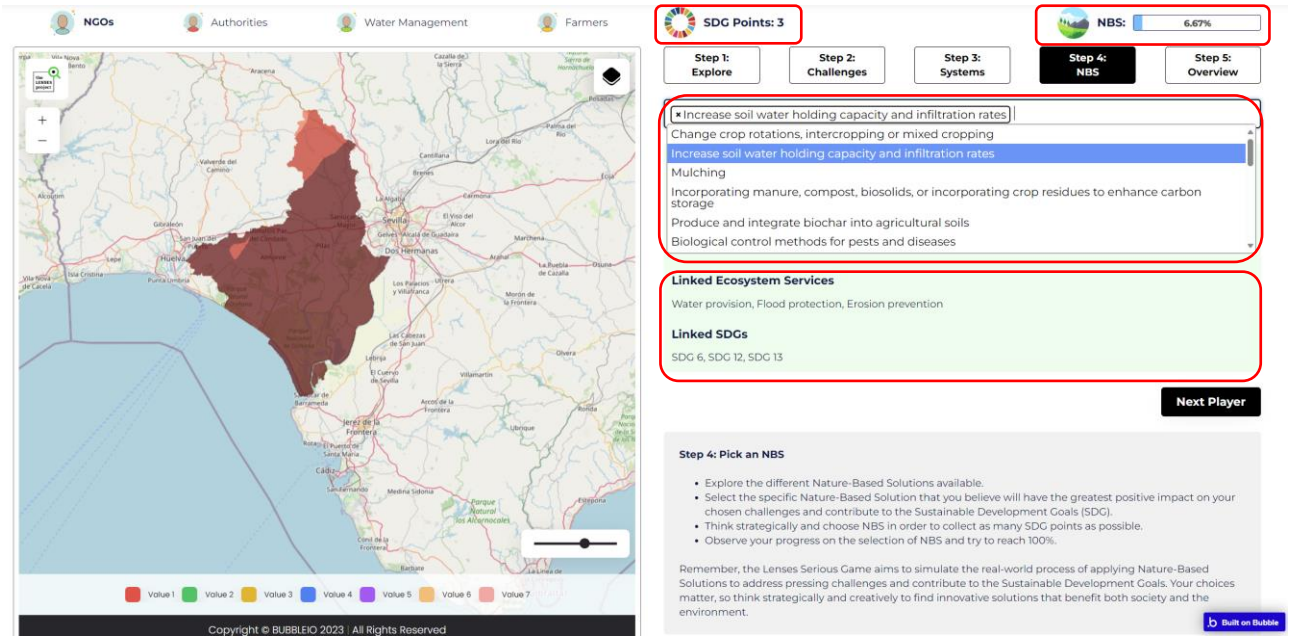

Figure 13. Pick an NBS

3.2.3.5 Step 5: Overview

The step 5: overview is depicted in Figure 14. In this step, the overview of the selection process has been presented based on the selection of the NBS from all groups in the previous steps. The SDG points collected are presented for each SDG in order to assess the results. Additionally the number of NBS and challenges that have been selected is also presented. The game continues through the button “Show Report”.

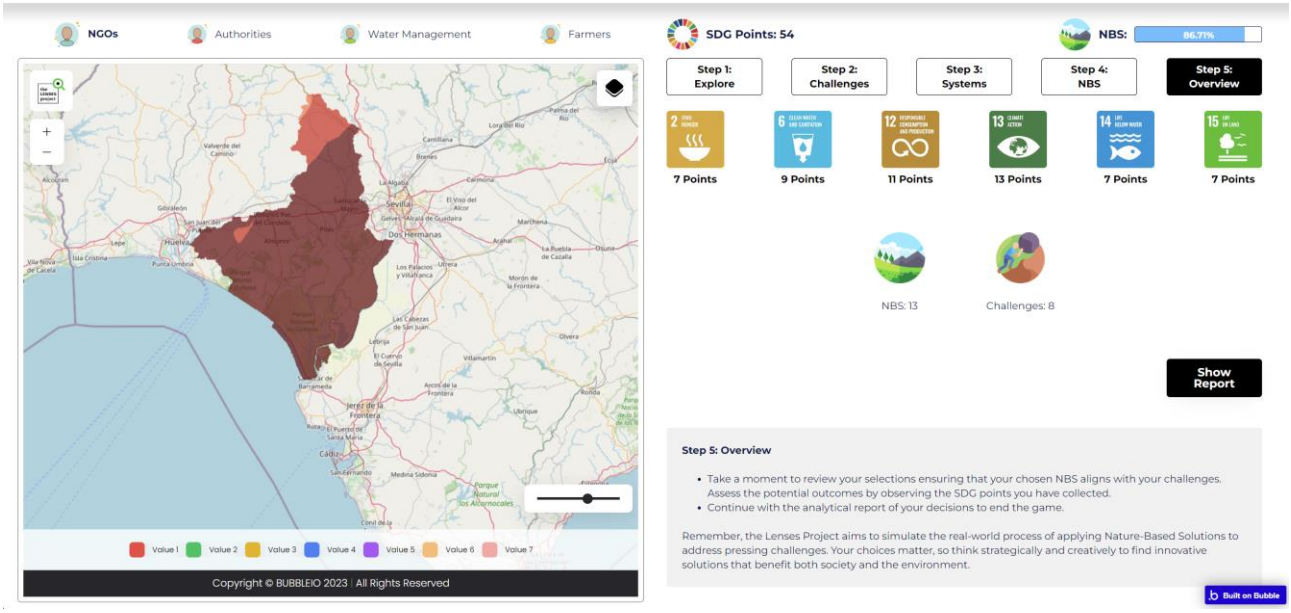

Figure 14. Overview

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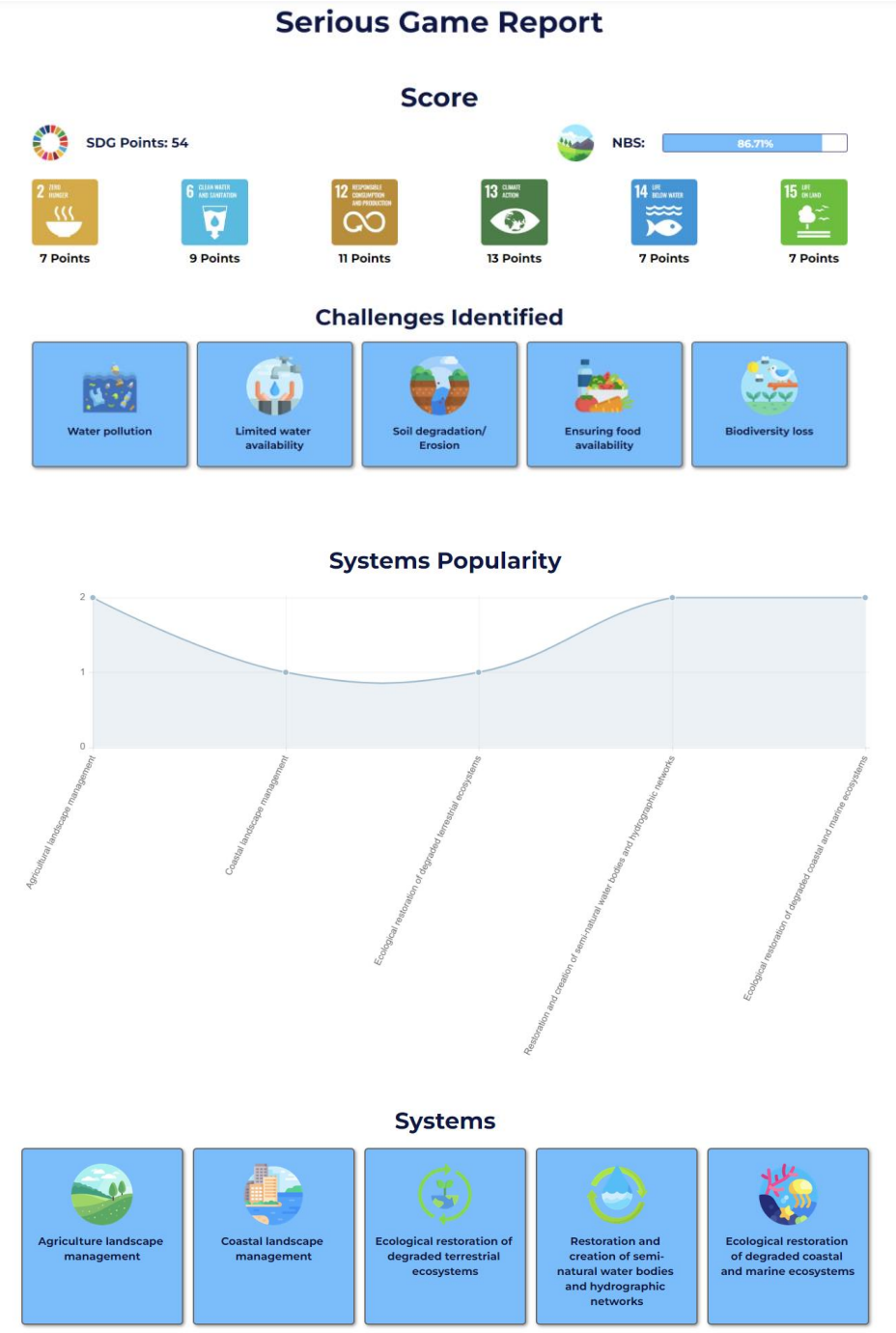
3.2.3.6 Report

The report page is depicted in Figure 15. This is the final page of the game where an informative report presents the game results, based on the NBS selection. The SDG point collected, challenges identified, NBS popularity chart, the ecosystem services used by the NBS and the description of all the NBS which are selected, is presented in this report.



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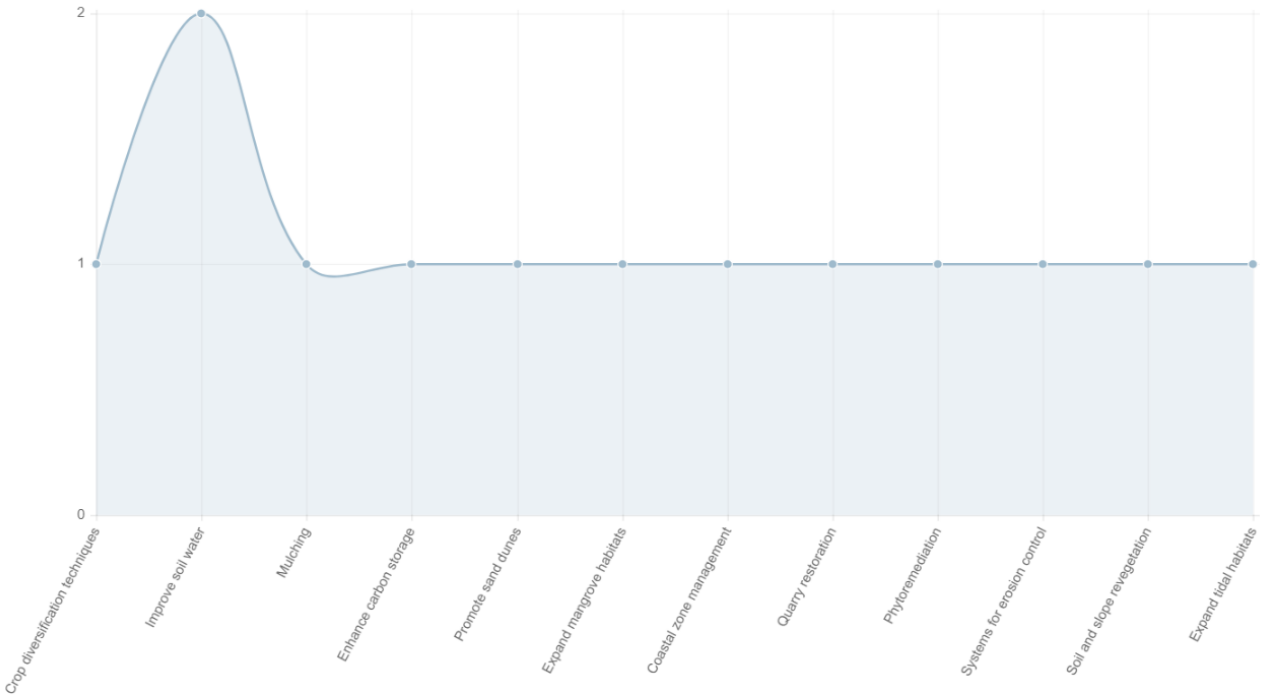
NBS Popularity



NBS Selected

Title

Change crop rotations, intercropping or mixed cropping

Description

Crop rotation is the practice of planting different crops sequentially on the same plot of land to improve soil health, optimize nutrients in the soil, and combat pest and weed pressure

Linked Ecosystem Services

Food provision, Erosion prevention, Seed dispersal, Soil formation & composition, Crop pollination

Linked SDGs

SDG 2, SDG 12, SDG 13

Title

Increase soil water holding capacity and infiltration rates

Description

The improvement of water holding capacity, infiltration rate and aggregate stability are main factors to prevent water and soil loses

Linked Ecosystem Services

Water provision, Flood protection, Erosion prevention

Linked SDGs

SDG 6, SDG 12, SDG 13

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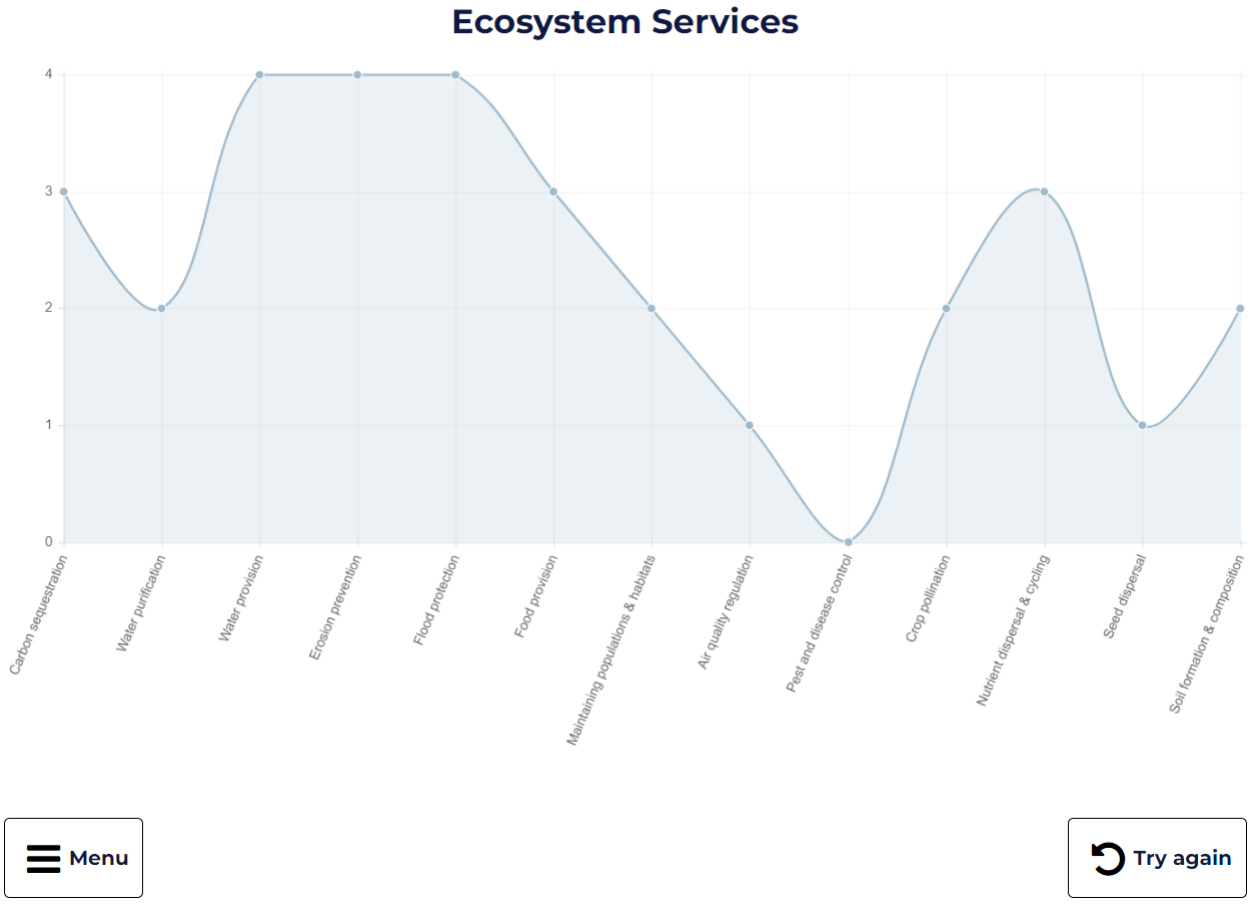

Figure 15. Report Page

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4 System architecture and technical features

In this section the software and applications used to design and develop the Nexus-SDG Toolkit as a serious game is presented with detailed descriptions.

4.1 Bubble

Bubble is the main platform used to develop the serious game and incorporate the interactive web maps build with Leaflet and interactive diagrams build with Kumu application.

4.1.1 Front-End (User Interface):

The front-end of the Nexus-SDG Toolkit is the user interface that participants interact with. Bubble.io is the platform which have been used to develop the system and that allows for the creation of dynamic web applications, so that the front-end of this Toolkit to be primarily web-based. Bubble.io, often referred Bubble is a visual web development platform that allows individuals and businesses to create web applications without the need for traditional coding or programming skills. It's a low-code or no-code platform, which means it provides a user-friendly interface for designing and building web applications through visual elements and workflows. Key features of Bubble.io include **visual development** so that developers can design the user interface of their web application by dragging and dropping elements onto the canvas. This visual approach makes it accessible to a wide range of users. Bubble.io includes a **built-in database** where developers can store and manage data for their applications. It supports complex data structures and relationships. Developers can define **workflows and logic** using a visual editor. This allows for the creation of interactive and dynamic web applications. Applications built on Bubble.io are designed to be responsive, adapting to different screen sizes and devices. Bubble.io offers a powerful set of tools for creating web-based solutions without the need for extensive coding expertise.

The user interface (UI) design for the Nexus-SDG Toolkit as a serious game is characterized by a clean and minimalistic aesthetic, ensuring a user-friendly and focused experience. It prominently features four main options:

1. **Play Game:** The "Play Game" option serves as the central element of the UI, inviting users to engage with the serious game. It is highlighted with a distinct color button to draw attention.
2. **Game Objective:** The "Game Objective" option provides users with a clear understanding of the game's purpose and goals. It is easily accessible, placed under the “Play game” as a button.
3. **About:** The "About" option offers users additional context about the Lenses EU project. It includes information about the project's background, objectives, and key stakeholders. This option is designed to be informative and insightful.
4. **Credits:** The "Credits" option acknowledges the contributions of the organizations involved in the project's development. This option is accessible for users to recognize and appreciate the project's collaborators.

Key Design Principles:

- **Minimalism:** The UI employs a minimalist approach with clean lines, ample white space, and a limited color palette to reduce visual clutter and maintain focus on the essential options.
- **Clarity:** Text and icons are used to clearly label each option, ensuring users understand their purpose at a glance.
- **Consistency:** The design maintains a consistent visual style and layout throughout the UI, enhancing usability and user recognition.
- **Accessibility:** Consideration is given to accessibility features, such as text legibility, button size, and color contrast, to ensure inclusivity.
- **Responsive Design:** The UI is responsive, adapting seamlessly to various screen sizes and devices for a consistent experience.
- **Visual Hierarchy:** "Play Game" is visually emphasized as the primary action, with "Game Objective," "About," and "Credits" presented in a logical order that guides users through the project's information.
- **User-Friendly Navigation:** Navigation elements, such as buttons or a menu, make it intuitive for users to access different sections of the game and project information.

Overall, the UI design aims to create a harmonious balance between minimalism, functionality, and user engagement. It ensures that users can easily access the game and relevant project information while experiencing a visually pleasing and user-centric interface.

Game Flow Analysis

1. **Page Selection**
    - After clicking "Play Game," users are directed to the “Pilot Selection” page.
    - Here, users can choose from a list of 7 available pilot projects areas for implementation.
    - Each pilot represents a specific area where sustainable practices and interventions will be applied.
2. **Stakeholder Selection**
    - Once a pilot is chosen, users proceed to the “Stakeholders Selection” page.
    - In this step, users are prompted to identify and select key stakeholders who will be involved in the pilot project.
    - Stakeholders may include individual farmers, water user associations, regional authorities, environmental associations, and more. With 5 general groups consisting of Farmers, Water Management, Authorities, NGOs and Others
    - Users can explore descriptions of each stakeholder group and make selections that best suit their agenda.
3. **Main Game:**
    - After selecting stakeholders and pressing the “Proceed to main game” button, users land in the main game interface, where they will actively engage in sustainability decision-making.
4. **Exploring (Studying and Investigating)**
    - Users start by exploring the chosen pilot region, on the left-hand side of the page. They can use the Leaflet frame to navigate through the area.

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- They can study about various aspects, including Climate change, Land use and Water accounting. There also a button allowing them to investigate causal loops, by replacing the left-hand frame to a Kumo map, that shows how the environment can be affected.
- After every player has finished his exploration the bottom-right button will change to “Next Step” instead of "Next Player”.

It is important to note at this point, that the users will not be able to navigate through the different steps in any other way nor will they be able to return to a preview player or step.

5. **Challenges**
   - Next, users are presented with a list of 7 sustainability challenges that are applicable to the chosen pilot.
   - Challenges include Water pollution, Limited water availability, Soil degradation/erosion, Floods, Ensuring food availability, Biodiversity loss, and Air quality degradation.
   - Users select any number of challenges that they aim to address during the pilot project.
6. **System**
   - Next, users are presented with a list of 6 Type of systems that can be applied to the pilot.
   - Systems include Agriculture landscape management, Coastal landscape management, Ecological restoration of degraded terrestrial ecosystems, Restoration and creation of semi-natural water bodies and hydrographic networks and lastly Ecological restoration of degraded coastal and marine ecosystems.
   - Users select any number of Systems that they want to apply the pilot project.
7. **Nature-Based Solution (NBS)**
   - Users move on to selecting a NBS for implementing sustainability measures.
   - NBS’s may include Mulching, Integrated coastal management, Quarry restoration, Re-vegetation of riverbanks, Dune replenishment etc. corresponding to the Systems chosen in the previous step by the player.
   - Depending on the number of players the will be a different number of maximum NBS that can be selected. No. 1 = 15 NBS, No. 2 = 8 NBS, No. 3 = 5, No. 4 = 4 NBS, No. 5 = 3
8. **Overview**
   - After finalizing the NBS selection, users are presented with an overview of all their previous choices, including the points per SDG, the number of selected NBS and the number of selected Challenges.
   - The players can the press the “Show Report” button redirecting them to the final page of the Game.
9. **Report**
   - The Serious Game report displays the Score (SDG points and NBS Percentage), Challenges Identified, Systems Popularity Chart, Selected Systems, NBS Popularity Chart, a list of every single NBS selected along with all the corresponding information (Title, Description, Linked Ecosystem Services, Linked SDGs) and finally an Ecosystem Services Chart.

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4.1.2 Back-End (Server Side):

Bubble.io handles the server-side logic and database management. It provides a visual interface for defining data structures and workflows.

- **Database:** Use Bubble.io's built-in database to store Game, NBS, Partners, Stakeholders.
  - **Game** datatype has the following fields: Challenges, Ecosystem Services, NBS, Stakeholder Groups and System.
  - **NBS** datatype has the following fields: Category, Description, Ecosystem Services, SDG, Short, Title, Type of system.
  - **Partners** datatype has the following fields: Image, Name
  - **Stakeholders** datatype has the following fields: Name
- **Workflows:** Creating workflows to handle the logic of NBS selection, SDG alignment, scoring calculations, and progress tracking.

3. External Integrations:

Bubble provides a various external services or APIs to enhance the toolkit's functionality, but the Toolkit only used the embedded links from Leaflet and Kumo using html (iframe).

4. Hosting and Deployment:

Bubble.io offers hosting services, allowing the Serious Game to be easily and quickly deployed on their infrastructure and also set up our custom domain.

6. Data Security and Privacy:

Data security and privacy compliance is ensured using Bubble.io's built-in security features, including encryption and role-based access controls.

7. Testing and Debugging:

Bubble.io has many built-in testing tools to identify and resolve issues during development. Constantly checking in the background and informing for any errors and providing the debug mode on the preview screen is also very useful.

8. Scaling and Performance:

Monitor application performance and scale resources as need in terms of how complicated (calculations) the Toolkit demands. Bubble.io also provides scalability options.

9. Support and Maintenance:

Bubble.io ensures ongoing support and maintenance, including bug fixes, updates, and feature enhancements.

4.2 Leaflet

Leaflet has been used to develop the interactive maps of climate-related Indicators and crops land use suitability.

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Leaflet is an open-source JavaScript library for creating interactive maps on websites. It is a lightweight and versatile mapping library that provides developers with the tools to integrate maps into web applications easily. Leaflet is known for its simplicity, flexibility, and extensive plugin ecosystem, making it a popular choice for web developers who want to add mapping functionality to their projects.

Key features and characteristics of Leaflet include:

1. **Lightweight:** Leaflet is designed to be lightweight and fast-loading, making it suitable for a wide range of web applications.
2. **Customizable:** The appearance and behavior of maps using CSS and JavaScript can be customized, allowing for a high degree of flexibility and personalization, for our case to depict the layers needed.
3. **Interactivity:** Leaflet supports a variety of interactive features such as markers, popups, tooltips, and zooming, enabling users to interact with maps seamlessly.
4. **Tile Layers:** Users can overlay different types of map data, including custom tilesets, raster maps, and vector maps from various sources like OpenStreetMap, Mapbox, and more.
5. **Geolocation:** Leaflet includes geolocation support, allowing users to find their location on the map and access nearby points of interest.
6. **Plugin System:** The library has a rich ecosystem of plugins that extend its functionality. These plugins cover a wide range of use cases, from heatmaps to route planning.
7. **Cross-Browser Compatibility:** Leaflet is compatible with major web browsers, ensuring consistent performance and functionality across platforms, including Bubble.io.
8. **Community and Documentation:** Leaflet has an active community of users and developers, along with comprehensive documentation and tutorials to help newcomers get started.
9. **Open Source:** Leaflet is open-source software released under the BSD-2-Clause license, making it freely available for anyone to use and modify.

Leaflet is commonly used for a variety of web mapping applications, including interactive maps on websites, location-based services, geospatial data visualization, and more. It's a versatile tool and it is being used in the left-hand side of the Serious Game in order for the players to easily explore the pilot area they selected and be informed on the climate-related variables so that they can make the best decision.

4.3 Figma

Figma has been used on the design process of the serious game.

Figma is a web-based design and prototyping tool used for creating user interfaces (UI) and user experiences (UX) for web and mobile applications. It is particularly popular among designers, developers, and product teams for its collaborative and cloud-based approach to design. Figma offers a range of features that facilitate the design, collaboration, and prototyping processes.

Key features and characteristics of Figma include:

1. **Cloud-Based:** Figma operates entirely in the cloud, which means that users can access their design projects from any device with an internet connection. This cloud-based approach enables real-time collaboration and eliminates the need for version control.
2. **Collaboration:** Figma is designed for collaborative work. Multiple users can simultaneously edit and comment on a design project, making it ideal for teams spread across different locations.
3. **Real-Time Editing:** Users can see live updates as collaborators make changes to a design file. This real-time editing feature streamlines the design process and encourages teamwork.
4. **Prototyping:** Figma includes a built-in prototyping tool that allows creating interactive prototypes of the designs created. This is useful for user testing and demonstrating how an application will function.
5. **Components and Libraries:** Figma allows designers to create and use design components, libraries and reusable elements, making it easy to maintain design consistency across multiple screens and projects.
6. **Vector Editing:** The tool offers powerful vector editing capabilities, allowing designers to create and manipulate shapes, icons, and graphics with precision.
7. **Version History:** Figma keeps a history of changes made to a design project, making it possible to revert to previous versions if needed.
8. **Plugins:** Figma has a growing ecosystem of plugins that extend its functionality. These plugins can automate tasks, add new design capabilities, and integrate with other design tools.
9. **Cross-Platform:** Figma is compatible with various operating systems, including Windows, macOS, and Linux, through its web-based interface.
10. **Asset Export:** Design assets can be easily exported for development, ensuring that developers have access to the necessary design files and assets for implementing the UI/UX.

Figma has gained popularity due to its ability to streamline the design and collaboration process, making it a valuable tool for teams working on digital products and applications.

In the following figures, some of the prototypes of the Serious Game Toolkit are presented.

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Figure 15. Prototype of Home Screen

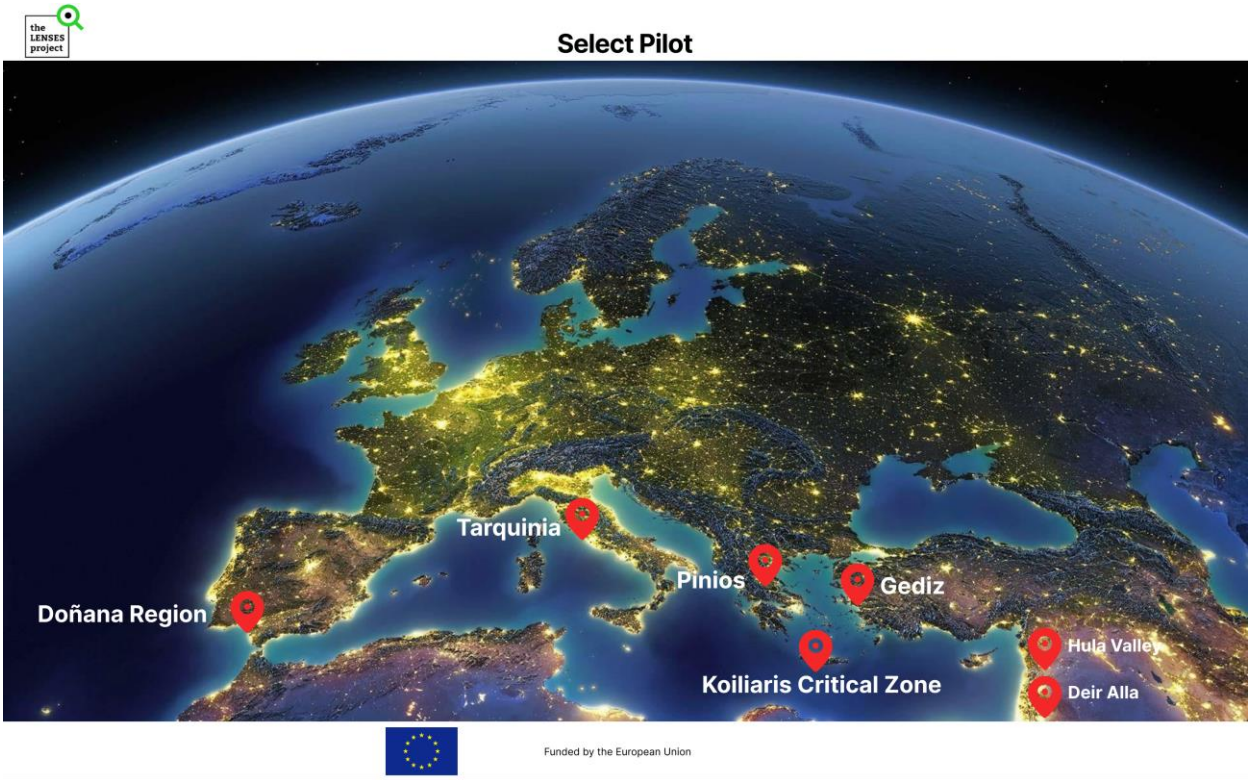

Figure 16. Prototype of Selection of Pilot (1/2)

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Figure 17. Prototype of Selection of Pilot (2/2)

Figure 18. Prototype of Selection of Stakeholder

Figure 20. Prototype of Selection of Risks and Challenges

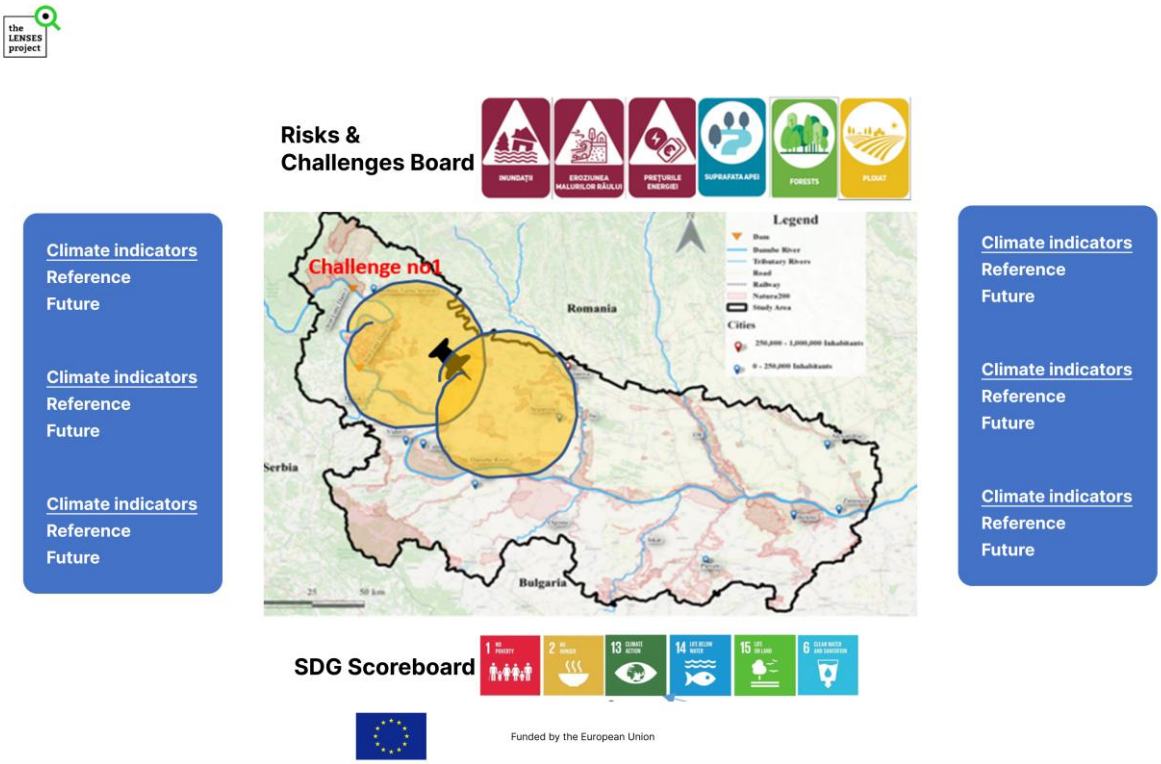

Figure 21. Prototype of Selection of Game Page (1/3)

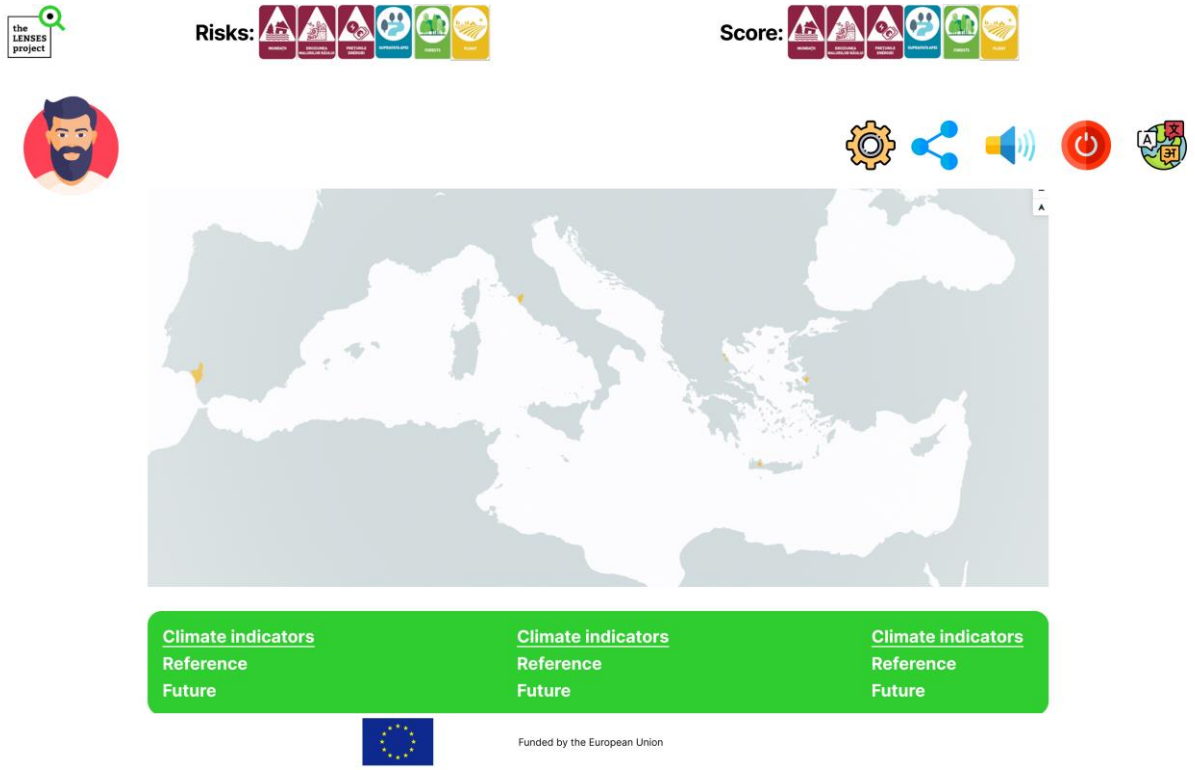

Figure 22. Prototype of Selection of Game Page (2/3)

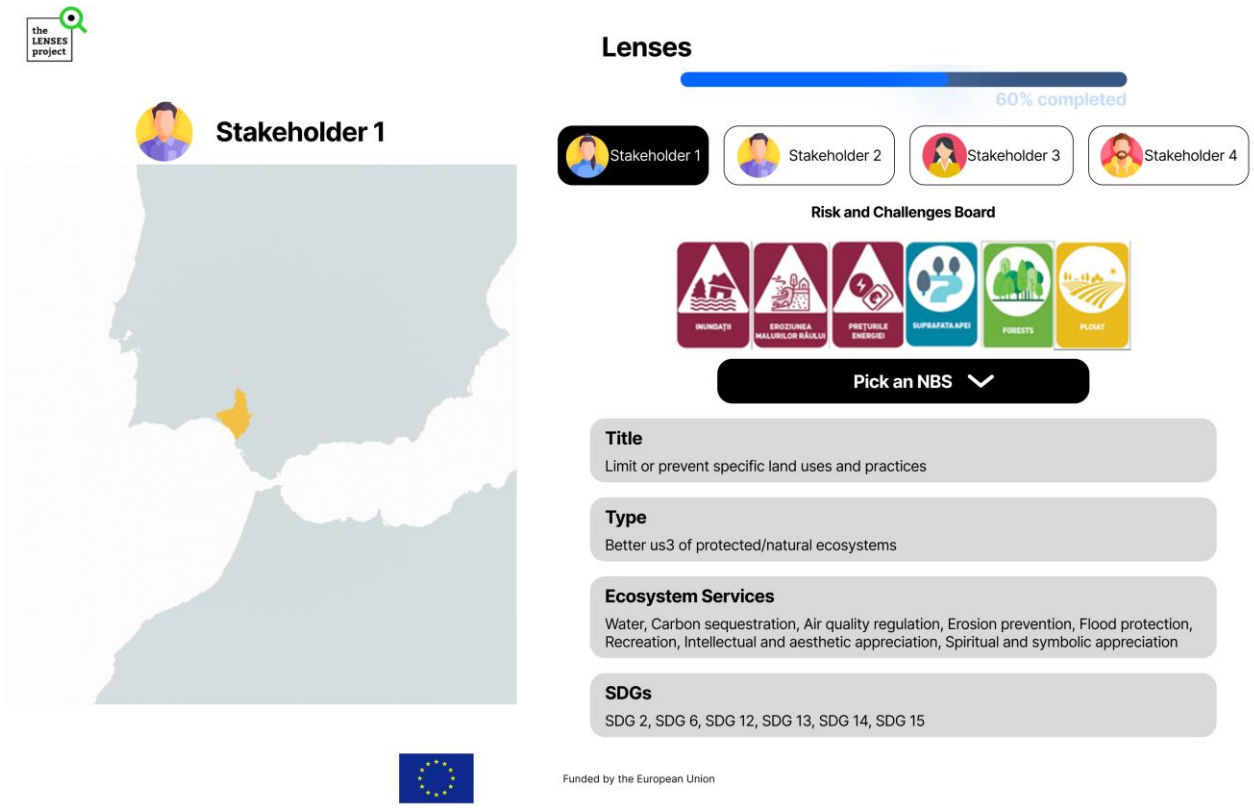

Figure 23. Prototype of Selection of Game Page (3/3)

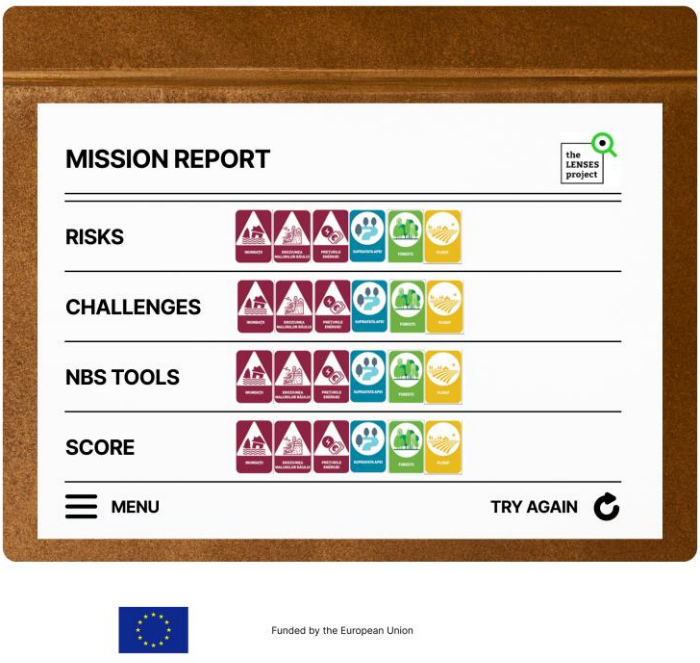

Figure 24. Prototype Serious Game Report

4.4 Kumu

Kumu has been used for the development of the interactive casual loops diagrams of the pilots areas from the partner IRSA, which is responsible for the task 4.2 “Participatory System Dynamics Modelling” in the LENSES project.

Key features and characteristics of Kumu include:

1. **Network Mapping:** Kumu specializes in creating network maps, which are visual representations of interconnected nodes (entities) and edges (relationships) that help users understand and analyze complex systems and connections.
2. **Interactive Visualization:** Kumu's visualizations are highly interactive, allowing users to explore and manipulate the network graph. You can click on nodes, zoom in and out, and filter information to gain insights.
3. **Data Import:** Users can import data from various sources, including spreadsheets and databases, to create network maps. Kumu supports data in formats like CSV and Excel.
4. **Customizable Elements:** Kumu provides extensive customization options for nodes, edges, and the overall layout of the network. Users can define colors, shapes, labels, and other attributes to represent their data effectively.
5. **Collaborative Environment:** Kumu is built for collaboration. Multiple users can work on the same project simultaneously, making it a valuable tool for teams analyzing complex systems or conducting research.
6. **Analytics and Metrics:** Kumu offers analytical tools to measure network properties, centrality, and other metrics to gain insights into the relationships within the network.
7. **Storytelling:** Users can create narratives or stories within Kumu to guide viewers through their visualizations, explaining the significance of various nodes and edges.
8. **Privacy and Sharing:** Kumu allows users to control the privacy settings of their projects, making them public or private. You can also share projects with collaborators or embed them in websites.
9. **Integration:** Kumu provides integrations with popular data sources and tools like Google Sheets and Google Drive, making it easier to connect and visualize data.
10. **Templates and Examples:** Users can start with pre-designed templates or explore a gallery of example projects to get inspiration and guidance for their own network maps.

Kumu is used in various domains, including social sciences, organizational management, data analysis, and more, to visualize and make sense of complex relationships and systems. It's a powerful tool for understanding connections, patterns, and insights that might be hidden in large and intricate datasets. In our case we are using it so that the users have a better understanding of the information provided by the Leaflet.

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5 Useful info

This Section shows the relevant information from other tasks of the LENSES project that have been incorporated into the serious game. The Section is broken down into sub-sections that each represents a group of outputs that is linked to the serious game.

5.1.1 WEF Nexus

The water and food sectors are inextricably linked so that actions in one policy area commonly have impacts on the other, as well as on the ecosystems that natural resources and human activities ultimately depend upon. All three elements – water, food, ecosystems – are crucial for human well-being, poverty reduction, and sustainable socio-economic development.

As a first step, it is crucial to identify the challenges related to the Water-Food-Ecosystems (WEF) Nexus that the area in question is confronting. Understanding these challenges provides a basis for considering Nature-Based Solutions (NBS) that can effectively address them. To streamline the selection of NBS, the WEFE nexus-related challenges are connected to Ecosystem Services (ES) whose provision or enhancement could aid in tackling these challenges.

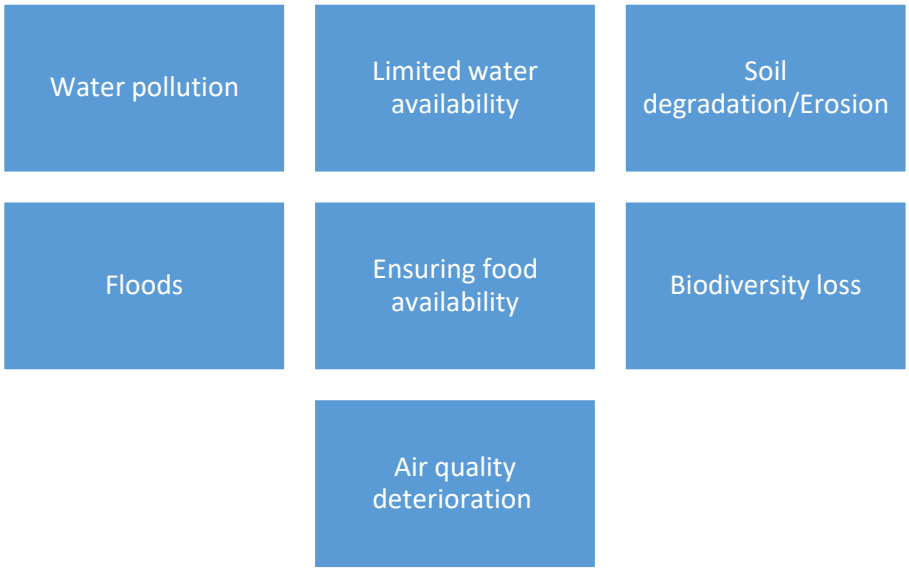

Figure 16. WEF Challenges

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Ecosystem services on the other hand are the benefits that humans derive from ecosystems and are a key element for addressing WEF challenges and achieving Nexus security. Ecosystem services are categorized into four main types:

Provisioning Services: These are the products obtained from ecosystems, including food and water.

Regulating Services: Ecosystems regulate natural processes and conditions, such as climate, water flow, pollination, and disease.

Supporting Services: These services are necessary for the production of all other ecosystem services.

Cultural Services: Ecosystems also provide cultural, aesthetic, and recreational benefits.

Ecosystem services highlight the interconnectedness of nature and human societies. Recognizing the value of these services is crucial for sustainable development and conservation efforts. By understanding the importance of ecosystem services, policymakers, businesses, and communities can make informed decisions that promote both human well-being and environmental conservation. Preserving ecosystems and their services is essential for current and future generations, as these services are fundamental to human survival and prosperity.

The **Ecosystem Services** linked to the NBS are:

- Food provision
- Water provision
- Water purification
- Erosion prevention
- Flood protection
- Carbon sequestration
- Air quality regulation
- Maintaining populations & habitats
- Pest and disease control
- Crop pollination
- Nutrient dispersal & cycling
- Seed dispersal
- Soil formation & composition

5.1.2 Nbs and SDGs

Nature-based solutions are cost-effective measures for climate adaptation, biodiversity and risk mitigation that are inspired by nature and supported by natural processes. They not only reduce risks from extreme weather events, but they have co-benefits that promote sustainable development goals.

Over two-thirds of the countries committed to the Paris Agreement are actively using nature-based solutions (NBS) to tackle climate change and adapt to its challenges. These solutions, inspired and supported by nature, not only save costs but also deliver environmental, social, and economic benefits while enhancing resilience (European Commission 2020). They offer practical answers to a wide range of real-world issues, including reducing natural disasters and creating societies that can withstand climate impacts. To unlock their full

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potential, it's vital to integrate NBS into local, national, and global policies, as well as incorporate them into strategies for managing risks, land use, and spatial planning.

The Sustainable Development Goals (SDGs), also known as the Global Goals, United Nations (2023), were adopted by all United Nations Member States in 2015 as a universal call to action to end poverty, protect the planet, and ensure that all people enjoy peace and prosperity by 2030.

The 17 SDGs are integrated—they recognize that action in one area will affect outcomes in others, and that development must balance social, economic and environmental sustainability.

Nature-based solutions are closely related to the SDGs as they offer innovative and sustainable approaches to address various social, economic, and environmental challenges outlined in the goals. Integrating NbS into policies and initiatives is essential for achieving the SDGs and ensuring a more sustainable future for all.

Specifically, the SDGs related to WEF NEXUS challenges and the respective NBS are shown next.

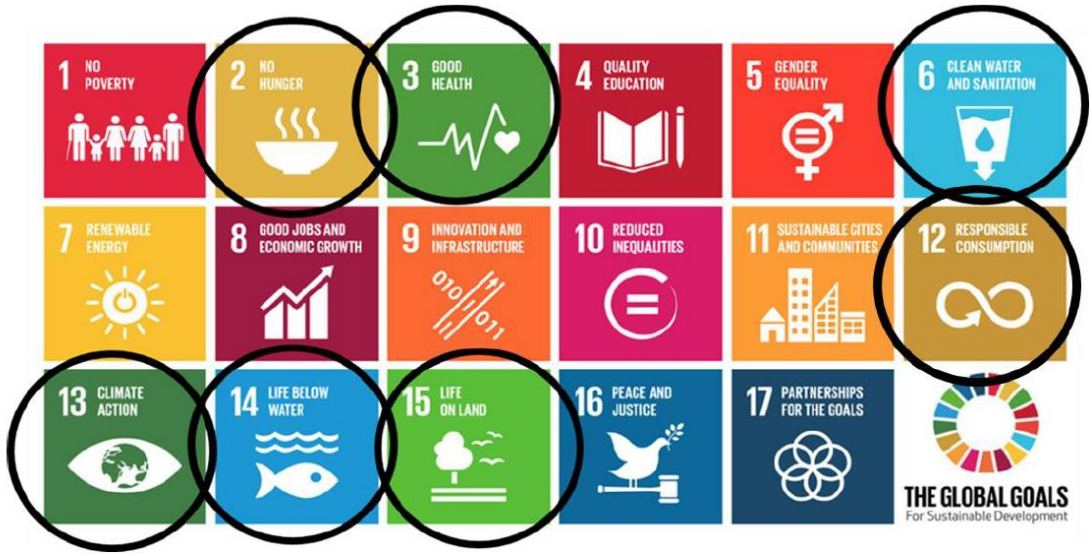

Figure 17. Presentation of SDGs (Black circle depicts those related to NEXUS)

5.1.3 Participatory System Dynamics Modelling – Causal Loops Diagrams

The task 4.2 Participatory System Dynamics Modelling provided with the causal loops diagrams of the pilot areas that have been incorporated in the serious game.

System Dynamics (SD) comprises a series of tools and methods to describe, model, simulate and analyse dynamically complex issues and/or systems taking jointly into account the processes, information, organizational boundaries and strategies. Both qualitative and quantitative approaches exist in SDM, whose

use depends on analysis objectives, employed methodology and addressed audience. Qualitative SDM allows the analysis of the system behaviour with the help of a conceptual (mental) model, often based on Causal Loops Diagrams CLDs which capture how elements in the system are interrelated by depicting cause-and-effect linkages and feedback loops. The need for qualitative forms of model-building is often dictated by the existence of a large number of 'soft' elements in a system and on 'textual' data obtained e.g., from interviews.

The core building blocks of CLDs are variables and the direct causal relationships between them, which can be either positive or negative (an increase in A causes B to rise or vice versa, respectively). One key element of CLDs is related to feedback loops. A feedback loop consists of two or more causal links between elements that are connected in a cyclical form. The behaviour of a variable is therefore (partly) caused by its own past behaviour. There are two different types of feedback loops: positive and negative feedback loops. A positive (or reinforcing) feedback loop - in isolation – is self-enhancing and generate exponentially escalating behaviour which could be (extremely) beneficial or (extremely) detrimental. A negative (or balancing) feedback loop – in isolation - generates balancing or goal-seeking behaviour, being sources of stability as well as resistance to change. Feedback loops hardly ever exist in isolation and are often strongly connected with a variation of the relative strength over time. Complex system behaviours often arise due to such shifts in the relative strengths of feedback loops.

Although CLDs only include qualitative information, their analysis can help deconstructing system interactions and better understand behaviours that might often be unpredictable and counterintuitive. A 'descriptive' and 'structural' analysis of the CLD can be performed and is proposed in LENSES. The former relates to the analysis of the main dynamics that affect the state and potential evolution of relevant variables (mainly based on the identification and description of key feedback loops). The latter is based on the use of graph theory measures: by measuring network structure (e.g., how densely coupled variables are, or how central a node is) important information about the nature of the network as a whole can be inferred.

The combination of the descriptive and structural analysis allows the identification of Nexus challenges (i.e. key intersectoral issues affecting the Nexus sustainability that need to be addressed across sectors in an integrated way), and support the screening of potential leverage points, i.e., points in the system where local intervention could have large impacts at system scale.

As a CLD can be represented as a directed graph of variables and their connections, centrality measures can help quickly and objectively pinpoint important phenomena regardless of the size or complexity of the map.

5.1.4 Climate related indicators, Land Use Suitability, Water Accounting

Task 7.2 on Climate Projections & Climate Risk Assessments aims to provide the LENSES project partners (scientific and pilot teams) as well as the broader project stakeholders with valuable information on the expected changes in the main climate variables as well as on the fit-for-nexus climate risk assessments for the seven project pilot areas. In specific, an ensemble of global and regional climate models is utilized to examine the climate variables of mean temperature, total precipitation, and potential evapotranspiration based on two Representative Concentration Pathways, the RCP4.5 and the RCP8.5. The analysis takes place for the period from 2011 to 2100 where the simulations for future projections are available, while the period

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1971 to 2000 is used as the reference period. This task provides in the serious game the climate projections variables and several climate-related indicators for the future period of 2040-2070 relative to the RCP 8.5 scenario.

Task 7.3 “Land-use suitability mapping tool using EO-based indicators” aims to produce maps of Land Use and future Land Use Suitability (LUS) in the pilot areas. The methodology was based on the Land Suitability Index and an overlay analysis that depends on the soil, water, climate, and crop management. Future LUS has been predicted under different climate change scenarios, which in this case are for the years 2050, 2070 and 2090 in order to validate results with the methodology developed by the Food and Agriculture Organization of the United Nations (FAO) and the International Institute for Applied Systems Analysis (IIASA); the Global Agro-Ecological Zones (GAEZ). This task provides in the serious game the LUS maps for the future period of 2040-2070 relative to the RCP 8.5 scenario.

Task 7.4 “Water accounting, allocation and planning” addresses the fundamental need to understand the functioning of our hydrological systems and how they respond to climate change and anthropogenic impacts, e.g., in the form of land-use changes. This supports a Nexus perspective on integrated water resource management, supported by the following steps: (i) Carry out water accounting at acceptable spatial and temporal resolutions for our WEF Nexus systems. (ii) Establish sectoral water demands for pilot areas as well as evaluate associated priorities. (iii) Perform water balance simulations in order to examine sectoral (irrigation, environmental, energy, urban) water allocation policies/practices as “business as usual” versus “Nexus targeted” approach. This task provides in the serious game the water accounting results for the future period of 2040-2070 relative to the RCP 8.5 scenario.

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References

Bubble. (n.d.). Bubble Academy. https://bubble.io/academy

FigMa: The Collaborative Interface Design Tool. (n.d.). Figma. https://www.figma.com/

Kumu. (n.d.). https://www.kumu.io/

Leaflet — an open-source JavaScript library for interactive maps. (n.d.). https://leafletjs.com/

Solinska-Nowak, A., Magnuszewski, P., Curl, M., French, A., Keating, A., Mochizuki, J., Liu, W., Mechler, R., Kulakowska, M., & Jarzabek, L. (2018). An overview of serious games for disaster risk management – Prospects and limitations for informing actions to arrest increasing risk. International Journal of Disaster Risk Reduction, 31, 1013-1029. https://doi.org/10.1016/j.ijdrr.2018.09.001

United Nations (2023), Department of Economic and Social Affairs, Sustainable Development. https://sustainabledevelopment.un.org/sdgs

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