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Climate action, environment, resource
Efficiency and raw materials

D4.1: LEARNING GOALS DEFINITION

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1	TV	30/11/2016	INTERNALLY REVIEWED VERSION FOR DELIVERY
2	TV	16/06/2017	THE ORIGINAL VERSION OF THIS DELIVERABLE WAS PARTIALLY BASED ON THE STATE OF THE CASE STUDIES IN PROJECT MONTH 6. A REVISED VERSION, RELECTING EVOLVED INSIGHTS FROM THE CASE STUDIES IN CHAPTER 4 AND SECTION 5.3 HAS BEEN ADDED AS ANNEX 1. FURTHER PROGRESS OF THE CASE STUDIES MAY BE REASON TO FUTURE REVISIONS.

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Executive summary

Task 4.1 has defined a first version of the SIM4NEXUS Serious Game tool learning goals considering: i) the scope of the game, ii) the contents to be included, iii) the knowledge to be imparted, and iv) the assessment items needed to test the learning. The learning goals are oriented by two main purposes: i) to allow users to learn about concrete facts, terminology, acronyms, concepts, rules, procedures and soft skills related to the Nexus management domain; and ii) to gain insight into the decisions and behaviours of the players.

The first version of the learning goals provided in this report has been defined considering every particularity of each case study at this stage of the project. A methodology to define the learning goals has been developed. This approach has been used to support this report, and will also be used in future iterations as the project gains insights on each case study. Thanks to this methodology, which results in a set of guided steps for information collection and learning goals definition, a more comprehensive and precise analysis has been able to be done. More concretely, this has helped: (i) case study leaders and other involved actors to better explain their needs and objectives, (ii) requirements collection in a common framework, (iii) collaborative discussion and evolution of requirements, decisions, and objectives, and finally, (iv) learning goals definition.

This report introduces the general principles of the serious game, so as to build a first common understanding of potential roles of the game in training and policy processes, making case study leaders and other relevant involved actors understand which the capabilities of a serious game tool are, and leading to a better definition of the learning goals.

A framework to fit the different terms in a common manner has been defined, linked to the methodology. The common framework includes the case studies definitions, together with their indicators, interlinkages, time and spatial scales, objectives, and also relates this entities with their respective missions, roles and learning goals in the Serious Game. In addition to the learning goals, the common framework represents a first inventory of potential assessment items to test the learning for each case study.

In conclusion, great efforts have been devoted at this early stage of the project to fulfil the task objectives (Task 4.1), not just for the report per se, but because of the high complexity of the task, i.e., understanding all the case studies, entities, relations and restrictions. The methodology used has covered successfully the necessities for this tasks, and therefore, it will continue being the basis for any future iterations of this report. Next steps will rely on more results coming from other Work Packages, interviews, and other sources, which are expected to bring more precise information. Accordingly, more concrete learning goals will be able to be defined, tailored to each case study, and maximising impact.

Changes with respect to the DoA

In the original plan for task T4.1, work package WP2 (Policy analysis and the nexus) was described as a major source of information for defining the learning goals. However, since deliverables from WP2 describing the international and national/regional policies are planned for project months M12 and M14 respectively, and the present deliverable is due in M6, we collected data directly from the case studies in order to define a first version of the learning goals. As a consequence, the present report must be considered a living document, in which definitions of the learning goals may be adapted to insights gained in the course of the project.

Dissemination and uptake

This report is public, so it is accessible for everyone. However, the specific targeted audience of this report are the beneficiaries of the project, in particular the case study leaders and the beneficiaries participating in the development of the serious game and the complexity science models. The purpose of this report is to provide grounding for a common understanding of the principles of the serious game and the leaning goals to be achieved for stakeholders in the case studies. Additionally the methodology presented here can be useful in similar approaches for future/other projects.

Short Summary of results

Data have been collected about the case studies, specifying the policy objectives, the relevant interlinkages between NEXUS components, the indicators to measure policy efficacy, and relevant types of stakeholders for each case study. Based on this information, learning goals for each case study, general learning goals, and a common framework comparing the case studies and realizing instantiations of the game for each case study have been defined.

Evidence of accomplishment

Data collected from the case studies are available in the WP4 documents section of the SIM4NEXUS Projectplace directory. The resulting definitions of learning goals and comparison of case studies with respect to interlinkages, policy goals, indicators, and involved types of stakeholders are included in the present deliverable.

Glossary / Acronyms

TERM	EXPLANATION / MEANING
DE-CZ-SK	EAST GERMANY-CZECH REPUBLIC-SLOVAKIA TRANSBOUNDARY CASE STUDY
FR-DE	FRENCH-GERMAN TRANSBOUNDARY CASE STUDY
KEE	KNOWLEDGE ELICITATION ENGINE
P&R	PENALTIES AND REWARD
SW UK	SOUTH WEST OF THE UNITED KINGDOM (REGIONAL CASE STUDY)
WP	WORK PACKAGE

1 Introduction

This introduction presents the structure of the present report and a description of SIM4NEXUS Task 4.1, of which this report is the related deliverable.

1.1 Structure of the document

This report is structured in 7 Chapters and 1 Appendix as follows:

Chapter 1 is the introduction.

Chapter 2 explains the principles of the serious game, in order to build a first common understanding of potential roles of the game in training and policy processes.

Chapter **Error! Reference source not found.** elaborates on the approach taken to collect data about the ase studies and to define the learning goals and the common framework.

Chapter 4 contains a short description of the case studies in which the serious game is to be applied. The 12 case studies have different regional, national, international and global scales and cover different aspects of the nexus, such as low carbon economy, water quality management, biodiversity, and sustainable food production. The chapter concludes with a presentation of the learning goals, as they have resulted from a first draft by the Task 4.1 team and discussion with the case study leaders.

Chapter 5 compares attributes of the case studies, such as relevant nexus component interlinkages, policy objectives, indicators, and stakeholder types. These attributes are the basis for the development of case study specific instances of the game in a common framework.

Chapter 6 concludes the report with recommendations for further development and maintenance of the learning goals definitions and the common framework.

The format used to describe the case studies is included in Annex A.

The remaining part of the present chapter provides background information on the goals and status in the project of Task 4.1.

1.2 SIM4NEXUS Task 4.1 goals and background

Task 4.1 is part of work package WP4. According to the Grant Agreement, "*WP4 focuses on defining, implementing, testing and validating the Serious Game. The Serious Game will assist policy makers and stakeholders to better understanding and visualizing policies at various geographical and temporal resolutions, leading towards a better scientific understanding of the Nexus via unique immersive experience. WP4's objectives are:*

- *WP4-O1: Define and implement the game strategy, users, roles and storylines, taking into account temporal (short, medium and large) and geographical scales (regional, national, European and global) and promoting 'learning by doing' where the users will learn from wins and losses.*
- *WP4-O2: Determine gaming objectives that permit to understand how complex social-technological water-energy-food systems work under climate change and how to manage the water resources.*
- *WP4-O3: Define and collect the information requirements among all platform components and flow.*

- *WP4-O4: Define and implement the mechanisms to accumulate learning from users, incorporating the learnt knowledge into subsequent rounds, and to learn from Nexus knowledge and integration methodology.*
- *WP4-O5: Define and implement a GUI in order to permit the users to play and re-play scenarios, modifying real-life variables to test changes in components and outcomes.*
- *WP4-O6: Validate the solution in a development environment."*

In particular WP4-O1 and WP4-O2 are relevant for Task 4.1. The task description according to the grant agreement is "*T4.1 will define the SIM4NEXUS Serious Game tool learning goals considering: i) the scope of the game, ii) the content to be included, iii) the knowledge to be imparted, and iv) the assessment items needed to test the learning. The scope of the learning goals is the holistic management of the Nexus, where decisions taken in one part trigger effects on the other. To represent that scope, content to be included encompasses representation of attributes and statuses of all related and relevant actors, entities and infrastructures in the Nexus depending in the concrete scale of analysis. Learning goals will consider different time and geographic scales, making learning process include knowledge at short, medium and large temporal scale, related to regional, national, European and global understanding of the complex interactions in the Nexus. Learning goals will be oriented by two main purposes: i) to allow users to learn about concrete facts, terminology, acronyms, concepts, rules, procedures and soft skills related to the Nexus management domain; and ii) to gain insight into the decisions and behaviours of the players. It will build on the results of WP1 to identify the main issues and interactions involved with the learning goals, and on the results of WP2 to identify the types of policies and decision makers that must be supported by the Serious Game. The learning goals will be formulated based on questionnaires with the partners involved in WP1 and WP2 and verified in a (web-based) workshop with them. T4.1 is closely related to the accomplishment of WP4-O1 and WP4-O2.*"

Figure 1 displays links between WP4 and other work packages. Since data from WP2 describing the international and national/regional policies are not available yet (planned for project months M12 and M14 respectively), we collected data about policy objectives directly from the case studies in order to define a first version of the learning goals. Except from this single exception, we completed the task as required by the Grant Agreement. The next chapters of the present deliverable report the results.

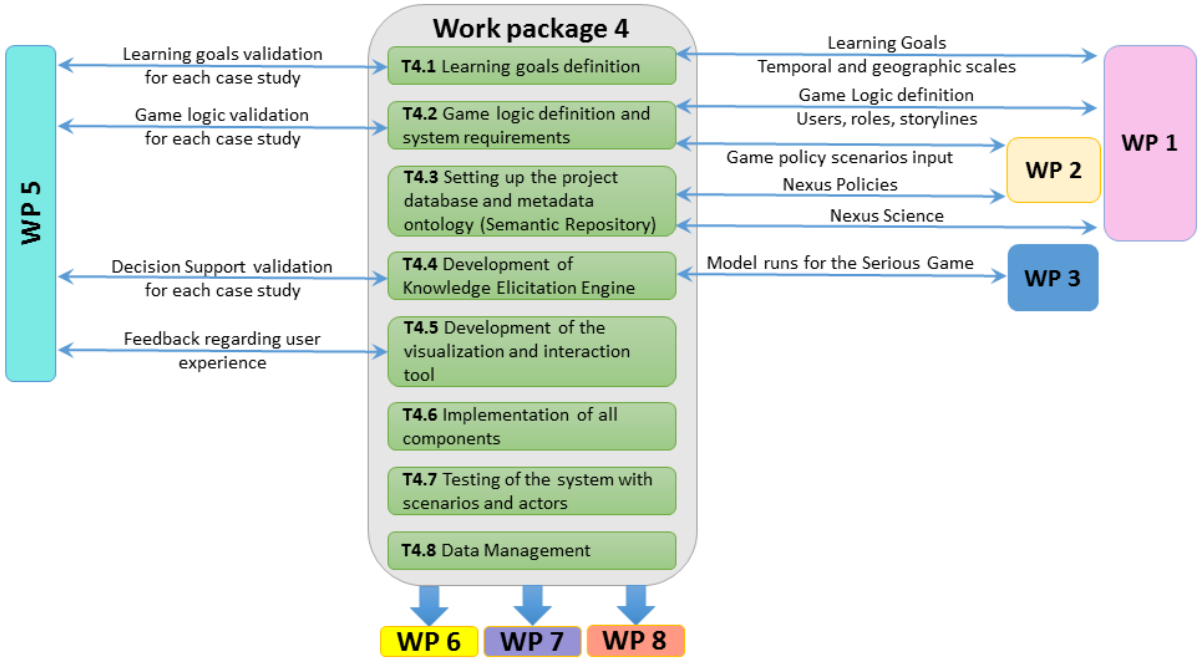

Figure 1. Task-by-Task interactions of Work Package 4 with other Work Packages

2 SIM4NEXUS Serious Game principles

The purpose of this chapter is to present the reader with a brief explanation of the SIM4NEXUS Serious Game principles, as a background for understanding the learning goals. The chapter first presents the goal and the approach, then the process of the game play, and finally the Penalties and Reward (P&R) System.

The goal of the game is to learn about different policies on the nexus and how these policies impact a particular case study through a "learning by playing" approach. This approach is depicted in Figure 2.

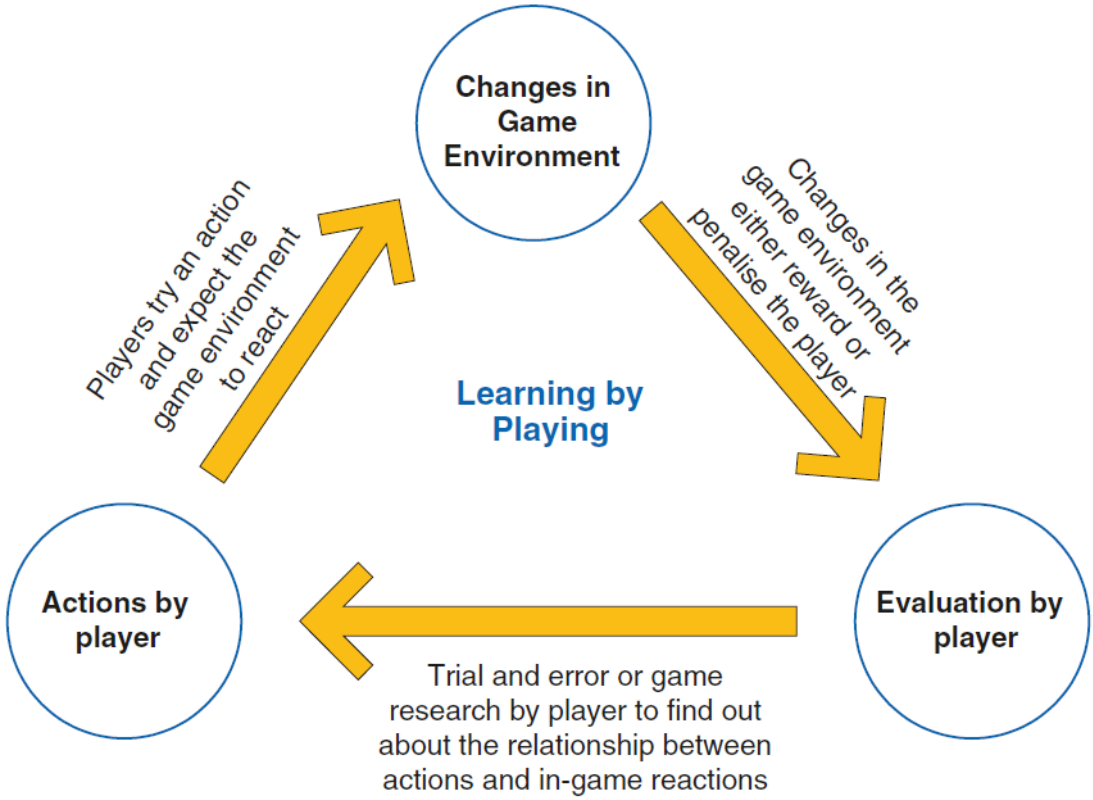

Figure 2. Approach "learning by playing"

Based on this concept the game play for the game is as follows:

As a player, you represent policy makers in the various sectors in a particular area – food, energy, water, climate and/or land use. Your aim is to fulfil the targets (objectives) set out by the national or international bodies by changing or adapting new policies in your area. To succeed in the game, you must learn to fulfil these targets by mixing and matching various cross sector policies without compromising the existing status quo of the other sectors.

Core Experience – What is the player experiencing as they play the game?

The core experience in the game is to play the role of policy makers in food, energy, water, climate, land use. In the game, the player will typically start off with separate "silo-thinking" approaches towards decision making and policy implementation. Over the course of playing the game, they will be

encouraged to change towards a more integrated NEXUS-compliant policy implementation approach and decision making.

Base Mechanics – What does the player actually do?

The player will have a target at the start of each turn of the game and he/she will have to implement policies to try to achieve the target. The turn ends when the player has decided on the policies which are to be implemented to achieve the targets and clicks on "next turn" button. The game will compute the policies made and an analysis of the decisions will be displayed in the following turn, with a new target to achieve for the turn.

The list of targets for each of the case study will be primarily determined during the case study interactions with the stakeholders, however there will also be targets from the European and Global case studies. The list of targets will also be categorised into the case studies, an example of the classification is presented in Table 1:

Table 1. List of targets classification example

Target case study	Target text	NEXUS Component	Target indicator	Target achievement value
Global, European	Improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and increasing recycling and safe reuse globally	Water	Percentage of water bodies with good water quality	70
Sardinia	Increase renewable energy production	Energy	Percentage of renewable energy production	5
…				

The targets are envisioned to be displayed in a step-by-step manner to the player. This will help guide the player on what to do during the game play.

Penalties and Reward (P&R) System – What behaviour within the game is encouraged or discouraged?

Silo-thinking in decision making and policy implementation within the game is discouraged, whereas integrated NEXUS-compliant decision making is encouraged. For every target in each turn, the player is encouraged to look at policies in all sectors and consider them to achieve a target.

The P&R system will be in 3 parts:

1. **Key indicators across all NEXUS components**. These key indicators are yet to be defined and will require inputs from WP2, WP3, and WP5. It is noted that while it is not possible to have all key indicators showing positive values all the time, the player will be rewarded when there are more indicators showing positive results than vice versa. At this moment of writing, there is also no consideration to weigh the indicators yet and the assumption is that all indicators will have the same weight. This may change as the project processes.

2. Events within the game. Events are news happening “on the ground” which add a societal and cultural aspect to the game. These events will be triggered based on the decisions the players made in the game and will be narrated in the same tone as they are encouraged to change towards a more integrated NEXUS-compliant policy implementation approach and decision making. There will also be uncertainties in event triggers to add more realism in the game, e.g., the occurrence of extreme events such as economic crisis or disaster events. There will be three categories of events: informational events which are neutral, negative events which will penalise the player by deducting points, and positive events which will reward the player with bonus points.

3. Score. There will be a score for the player. This score will indicate how successful the player is applying NEXUS-compliant decision making in achieving the targets in the game. Every progression in the time step of the game will add to the score to encourage the player to continue, every policy implemented will add to this score and the events will add to the score.

3 Approach to define learning goals

According to work plan including in the grant agreement, Task 4.1 had to result in the definition of learning goals for players of the Serious Game, and criteria to assess the extent to which players have achieved these learning goals. Since the game is to be applied in the case studies and the case studies have different policy objectives, **the learning goals are different for each case study**. This is an important point that determined the whole approach and added to the complexity of the task. Therefore an approach was developed to define specific learning goals and assessment criteria for each case study. In addition, a **common framework** had to be defined to describe and compare the functionalities, actor roles, policy goals, and assessment criteria (indicators) of the games for the case studies. The present chapter describes the approach taken to collect data about the case studies and define the learning goals based on these data.

The first step in the approach was to collect data about the case studies. A format has been developed and tested to structure the data for the Sardinia case study. Based on this experience, the format was adjusted. After a pilot for the Greek case study, data were collected for all case studies (see the format in Appendix A). The case study leads were requested to complete the format. Not all case study leads had the opportunity to fully complete the format by M6, because not all the stakeholders have been raised and contacted yet. Consequently they will be updated/reviewed as needed in the future (hence the definition of this deliverable as a "living document"). In these cases the Task 4.1 team completed the format as far as possible based on the information in the case study descriptions on www.sim4nexus.eu, and the notes of interviews with the case study leads, held in WP5.

After data collection, learning goals for each case study have been drafted by the task 4.1 team. The draft learning goals have been presented and comments have been solicited in the case studies workshop in Barcelona on 17 November 2016.Finally the learning goals for the case studies were defined and, based on these, the general learning goals could be defined. Figure 3 summarizes the approach. The results are presented in Chapter 4. For future players, the learning goals are preceded by short case study descriptions, based on information from www.sim4nexus.eu and notes of the interviews with the case study leads in WP5.

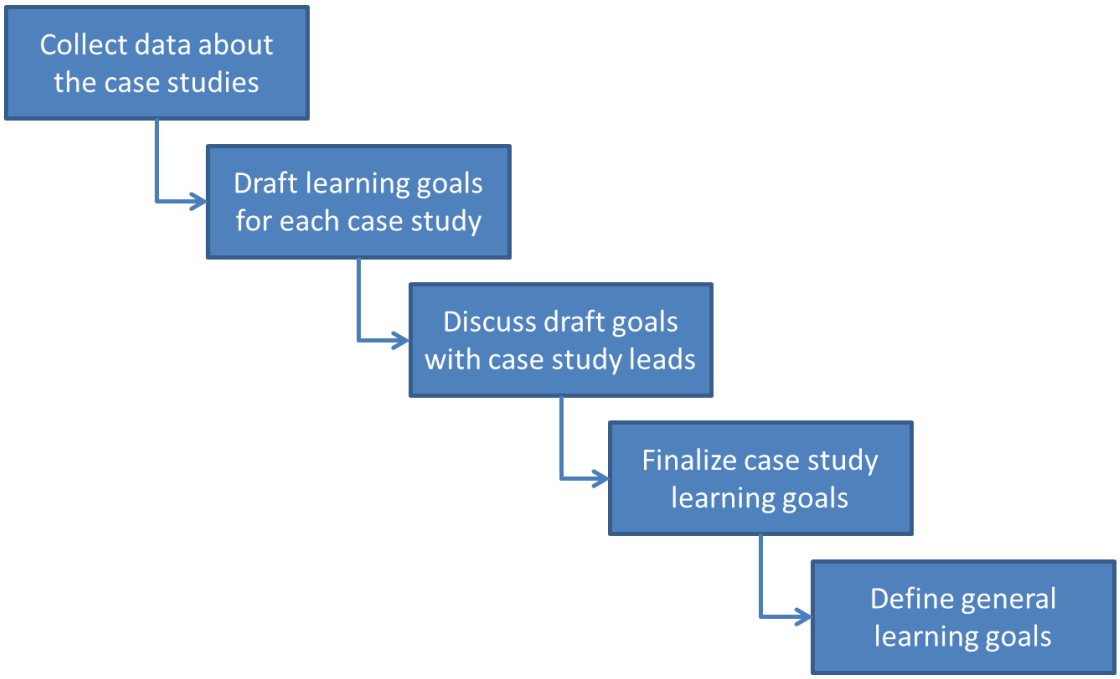

Figure 3. Approach to define the learning goals

4 Learning goals

This chapter introduces the learning goals definition for each case study in SIM4NEXUS at this stage of the project. As stated in the executive summary, D4.1 was planned for M6, while relevant sources for learning goals definition were planned later in the project. Example of relevant sources are the deliverables describing the policies in WP2, which are due in M12 and M14 respectively. For this reason, we have collected data directly from the case studies in order to define a first version of the learning goals, making the present report a **living document**, in which definitions of the learning goals may be adapted to insights gained in the course of the project.

Current general learning goals are the result of the data collection performed along all case studies, specifying the policy objectives, the relevant interlinkages between NEXUS components, the spatial and temporal scales, the indicators to measure policy efficacy, and relevant types of stakeholders for each case study. Specific discussion with case study leads and other involved actors was done during the WP5 Workshop meeting from 16th to 17th November 2016 in Barcelona, which was preceded by several Skype meetings and information exchange by email. The team had a total of seven Skype meetings of 1 – 1½ hour in the period July – November 2016.

Taking all these inputs as source, a first draft by the Task 4.1, can be checked in the following tables[1]. However, a first general learning goal has been defined, which is *to get policy makers and stakeholders to learn about impacts of one policy in the Food-Energy-Water Nexus. In addition, they can identify potential risks and conflicts of interest, trade-offs, and synergies, and learn how to coordinate policies in different domains in order to simultaneously attain multiple goals across the domains*.

Table 2. Region of Andalusia case study

Case study name	Region of Andalusia (Spain)
Case study type	Regional
Case study summary	The Andalusian case study will address how agricultural and environmental policies can be integrated to boost economic activity while reducing resource use and promoting sustainable water management, climate change mitigation and renewable energy. The main driver of the study is the water shortage problem, which has been aggravated by climate change. Tourism, as an important sector in the region has also increased the scarcity of water. The demand for water reaches its peak in summer due to tourism and agriculture. The goal is to raise awareness on the interdependence of water, energy and agriculture. A second goal is to advise local authorities. The main research question is: how can the policies become more integrated or coordinated to promote the sustainable use of water under changing climatic conditions.
Case study learning goals	You will learn how policies in the domains of agriculture, sustainable water management, and renewable energy can affect each other under climate change conditions, in a region where high agricultural production and tourism are competing for water.

[1] Due to formal complications (i.e. change of partner responsible for this Case Study in the Grant Agreement), no specific learning goals could be drafted for the Azerbaijan case study by M6.

Table 3. Island of Sardinia case study

Case study name	Island of Sardinia (Italy)
Case study type	Regional
Case study summary	The focus of the Sardinian case study is on agriculture, hydropower, tourism, energy, and food security. Sardinia's main sectors are tourism and agriculture. The case study will address how policy, incentives (e.g. agricultural and tourism policy), and eventual new infrastructure can be integrated to support sustainable food production, quality of water for urban use, and a sustainable tourist sector. These policies and incentives have to take into account climate change, internal population migration to the coasts and main cities, and the need for increased reliance on renewable energy sources and reduced greenhouse gas emissions. The main goal is to raise awareness about the interlinkage between water, energy and tourism. Another goal is to influence policy decisions on water management, energy development and tourism. Water is a priority, as it is essential to the biodiversity of the wetlands.
Case study learning goals	You will learn how regional policies, in the domains of water management, agriculture, tourism development, hydropower and alternative energy sources, can affect sustainable food/energy development goals severely competing for water resources under climate change.

Table 4. Southwest of the UK case study

Case study name	Southwest of the United Kingdom
Case study type	Regional
Case study summary	The case study will address how legislation, policy and its interpretation, with incentives for agricultural policy can be integrated to support both sustainable food production, and provision of water and wastewater services in a region with a significant tourism industry, in the face of climate change, population growth and the need for reduced greenhouse gas emissions. The main focus of the study is to influence land use management policies (where extreme weather causes flooding and washes away soil from intensively-farmed land) constrained by the (economic) importance of agriculture for the region (with three quarters of its land area devoted to it). There is also a significant draw to the region of tourists, which adds an additional pressure on land use and water resources. A second goal of the case study is to understand the way in which governance has the ability to constrain and restrict the move towards a more sustainable, smart, and flexible energy system. Another important issue is water quality which needs to be preserved especially along coastal zones.
Case study learning goals	You will learn how regional policies of land use for agriculture, renewable energy (wind and solar farms), and water management affect each other in a region with high risk of heavy rainfall and flooding.

Table 5. The Netherlands case study

Case study name	The Netherlands
Case study type	National
Case study summary	The goal of the Dutch case study is to identify low-carbon and resource-efficient pathways for the Nexus under the condition of climate change. It will focus on climate mitigation (and adaption) strategies that make use of bio-energy. All Nexus elements will be taken into account. For example, the shift towards a low-carbon economy will influence land-use and the nutrient cycle, but also has consequences for the water demand. Water issues are high on the Dutch agenda. In the future, it is expected droughts and floods will be more severe. There are also salinity issues due to sea level rise amongst others. The case study will assess the socioeconomic and technological consequences of the road to a low-carbon economy using water, land and carbon footprints of Dutch production and consumption. The road(s) to a low-carbon economy should be identified in close cooperation with stakeholders such as private sector, research organisations. The expectation is to be able to work on long-term trends and policy options, a perspective which is commonly not a major concern of policy-makers. The research results will be used to raise awareness among the policy-makers and other stakeholders.
Case study learning goals	The Netherlands: You will learn how policies aiming for a low-carbon economy with reduced energy demand per capita and reduced greenhouse gas emissions, can affect land and water use including land, carbon and water footprints, agricultural production, and risks of flooding and droughts under different climate change scenarios.

Table 6. Sweden case study

Case study name	Sweden
Case study type	National
Case study summary	The Swedish case study focuses on the Nexus of water-climate-forest. It tries to establish the optimal use of Swedish resources for the purposes of climate change mitigation and adaptation. Rising temperatures, increasing annual rainfall and the longer growing season are gradually making Sweden a more attractive place to grow forest biomass and agricultural products. The research concentrates on the alternative uses of the additional biomass potential (carbon sequestration in standing forests versus increased bioenergy or agricultural production) and the consequences for the available water supply and quality, and potential impact on other water goods and services. The goals of the case study are to increase the understanding of forest-water interlinkages in the context of climate change, as well as to bring research and stakeholders together and communicate the results.
Case study learning goals	You will learn how increasing afforestation for biomass and energy production interferes with water management policies aiming to reduce risks of flooding, droughts, water shortages for hydropower, and water quality, related to climate change.

Table 7. Greece case study

Case study name	Greece
Case study type	National
Case study summary	The Greek case study is on a national scale with an emphasis on energy needs and water scarcity issues. Tourism causes a high demand for water, energy and food resources in the summer. Energy, both in the form of fossil fuels and renewables, is therefore a focus. Agriculture, which is also a major sector in Greece, will soon potentially be encumbered with a fee for water. A main drive for this case study is to apply water saving practices in agriculture. One goal for the implementation of the case study is to provide advice to policy makers about the interdependence of energy, water and food. Another goal is to provide knowledge to adapt agricultural practices. Water and energy are the main concerns with a focus on tourism and agriculture as key sectors of the economy.
Case study learning goals	You will learn how national policies in the domains of water management, renewable power production, and land use affect each other and result in changes in food production, tourism, greenhouse gas emissions, and quality and quantity of water resources.

Table 8. Latvia case study

Case study name	Latvia
Case study type	National
Case study summary	The Latvian case study will quantify the potential of biomass for energy production, and consider interlinkages with the other Nexus components water, food and climate in the context of climate change. Latvia has a high potential for renewable energy, but remains largely dependent on imported fossil fuels and electricity. Small hydropower plants do not deliver high energy values, but are rather harmful for nature. There is a threat of increasing use of fertilizers, herbicides and pesticides due to the increased planting of fast growing energy plants and crops; eutrophication and water pollution from phosphorous and nitrogen are main concerns. The study will evaluate abatement costs of different energy policies, and their impacts on water, air, biodiversity, land use and future climate change. Policy priorities relate to low-carbon development and climate change mitigation. The case study will address trade-offs between biomass and energy security, aiming for the sustainable production of energy.
Case study learning goals	You will learn how national and local policies aiming for a low carbon economy and energy autarky interact and affect policies in the domains of land use for forestry and biomass production, biological food production, ecosystem services, and water quality management.

Table 9. France-Germany case study

Case study name	France-Germany
Case study type	Transboundary
Case study summary	The case study focuses on the factors enabling or constraining transboundary governance on climate adaptation in the Rhine river basin. The main question is how to identify and decide upon pathways to achieve the below 2°C target in a balanced way. The energy transition in the Rhine region is an example at the heart of the EU new Climate Agenda (post COP21). A second research question relates to specific issues regarding the use of fibres and biomass for energy production and chemical industry, as it reduces the use of fossil fuels but potentially increases competition with land use for agricultural production and biodiversity of water species. Additional research topics concern synergies and trade-offs in policies regarding flood protection, water retention and design of natural habitats, reserves, and wetlands.
Case study learning goals	France-Germany: You will learn about the synergies and trade-offs in policies regarding flood protection, water retention and design of natural habitats, and wetlands on the one hand, and renewable energy policies regarding hydropower and biomass on the other hand, in the densely-populated, industrial area of the Upper Rhine.

Table 10. Eastern Germany, Czech Republic and Slovakia case study

Case study name	Eastern Germany, Czech Republic and Slovakia
Case study type	Transboundary
Case study summary	The transboundary Germany- Czech Republic-Slovakian case study focuses on the effects of land use management and water retention policies on two water related indicators under stress - water quantity and quality. Agro-urban zones (intensive agriculture and non-permeable urban surface) are areas with higher temperatures (heat islands). The heat is a contributor to unstable air that concentrates as clouds over areas with lower temperatures. As a result, there is less rain over the agro-urban zones, and too much rain over the mountain zones. Retention in ecosystems will lead to decrease of run-off, production of sensible heat through evaporation and instead of vertical clouds horizontal clouds with rainfall across wider landscape area can be formed which do not lead to torrential rains causing local and downstream floods. The transboundary project includes three countries: Slovakia, Czech Republic and Germany. The Czech Republic transfers water to Germany through Elbe/Labe river. Slovakia is not physically connected but faces similar issues. The greater fluctuation of water supply in downstream Germany leads to seasonal flooding, as well as a shortage of water for agriculture during dry periods, lower water quality, and sedimentation in the Elbe estuary.
Case study learning goals	You will learn about the interrelations between effects of upstream land use and water retention policies and downstream stability of flow that may prevent floods and sedimentation, and water availability for irrigation in the Elbe/Labe basin. You will learn about land use policies that increase retention of rainwater in forested, agricultural, and urban landscapes; retention in ecosystems will lead to decrease of run-off, and reduce vertical cloud formation that leads to heavy local rainfall and flooding in other areas.

Table 11. Continental case study

Case study name	Continental (Europe)
Case study type	Continental
Case study summary	The European case study includes all five aspects of the Nexus in examining the transition to a low carbon economy. The goal is not to give details on the energy transition itself, but on the interactions with other elements of the Nexus. The case study will investigate how the transition will affect each sectoral policy's objectives. It will explore both the economic policy incentives to facilitate - as well as the wider economic impacts of making - the transition. The relationships between the various elements of the Nexus will be approached via both technical demands and economic linkages. Examples of technical demands are water demand for food, energy crops and hydropower, and the climate impacts on agricultural yields. Examples of economic linkages via prices for goods and resources; are the impact of climate and energy policy on land prices and how these in turn affect food prices and food accessibility.
Case study learning goals	You will learn how policies targeting indicators for one of the sustainable development goals impact those for other goals, in particular with respect to indicators for renewable energy, water, food security related goals as well as planetary boundaries, in a European context.

Table 12. Global case study

Case study name	Global
Case study type	Global
Case study summary	The global case study will focus on global challenges (e.g. increasing food demand) and international trade features, with policy priorities on food security, resource efficiency, low-carbon energy and climate change mitigation, water availability and vulnerability to water stress and floods, water quality, biodiversity and ecosystem services. Given the high level of integration and the low level of detail, the case study will mostly be used to identify the prevailing Nexus policy challenges, and to find broad-scale synergies and trade-offs between options in achieving various Sustainable Development Goals, and to inform about divergence, robustness and flexibility of global development pathways. The global case study is useful to provide the global context to the smaller scale case studies, and to highlight synergies and trade-off at the global scale, which are informative to the regional case studies. The main focus will be on the impact of water constraints on food security and human development as well as the impact of climate change on aggravating or relieving water problems.
Case study learning goals	You will learn how policies targeting indicators for one of the sustainable development goals impact those for other goals, in particular with respect to indicators for renewable energy, water, food security related goals as well as planetary boundaries, in a Global context.

5 Common Framework

The previous section has introduced the case studies and the learning goals. For the SIM4NEXUS serious game we envision a generic game shell in which specific games for each case study can be loaded. This chapter presents the common framework, comprising the generic shell and table formats to specify the unique characteristics of the game loads for the cases studies. The first section (5.1) describes the idea of a generic shell with case specific loads. The second section (5.2) describes how the case specific loads can be characterised. Using these concepts, the third section provides a first characterization of the case studies in terms of involved actors, policy objectives and indicators.

5.1 Generic game structure

The serious games for the cases studies will be implemented in a generic shell, equipped with general facilities for user interfacing, data presentation, data base access, knowledge elicitation, and artificial agents advising the player about possible actions or playing the role of other actors in the system. As depicted in Figure 4, the generic shell can be loaded with specific cases. A case is specified by one or more missions, expressed in policy options and target values of indicators, such as greenhouse gas emissions, employment, GDP, water quality indicators, biodiversity indicators, etc.

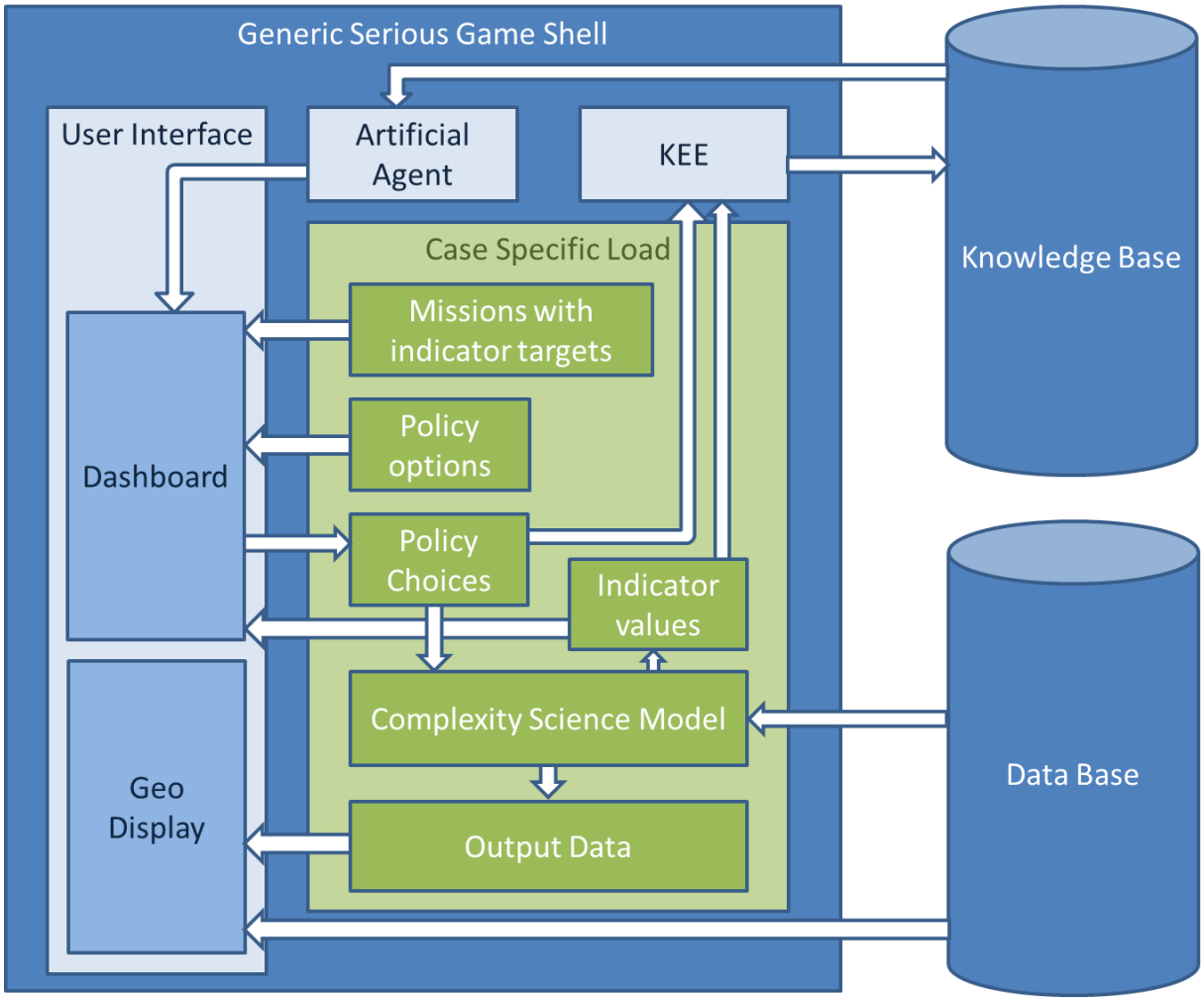

Figure 4. Relations between components of the generic game shell and specific case study load

When the generic shell is loaded with a specific case, the player is presented with a mission in terms of indicator targets, and a set of policy options, as describe in Chapter 2. The player's policy choices are input to the complexity science models (developed in WP3), which simulate the behaviour of the nexus for one period. After the indicator values and the geographic data display have been updated, the player can adjust the policy choices, and so on. In the end the players' performance in the game is assessed by comparing actual indicator values with the missions' target values.

A player can be advised by an artificial agent, using the SIM4NEXUS knowledge base. In addition to nexus knowledge from a diversity of sources, the knowledge base contains information about previous choices made by the current and other players, and the resulting evolution of the indicator values. The Knowledge Elicitation Engine (KEE) continuously records data about policy choices and resulting indicator values, and uses those observations to build an extending body of knowledge about the behaviours of players and the consequences of their actions.

5.2 Concepts to characterize specific games

As described in the previous section, the generic shell can be loaded with specifications of games for different cases. The core of a specific load is a complexity science model, developed for a particular case. The complexity science model simulates the behaviour of the nexus, based on the players' policy choices. As a result, the indicators of the system's status are updated and reported to the players. Important concepts to characterise the case specific load are the interlinkages between nexus components covered by the complexity science model, the policy options available to the players, and the indictors to assess performance. Figure 5 depicts these and other concepts which are required to specify the case specific load.

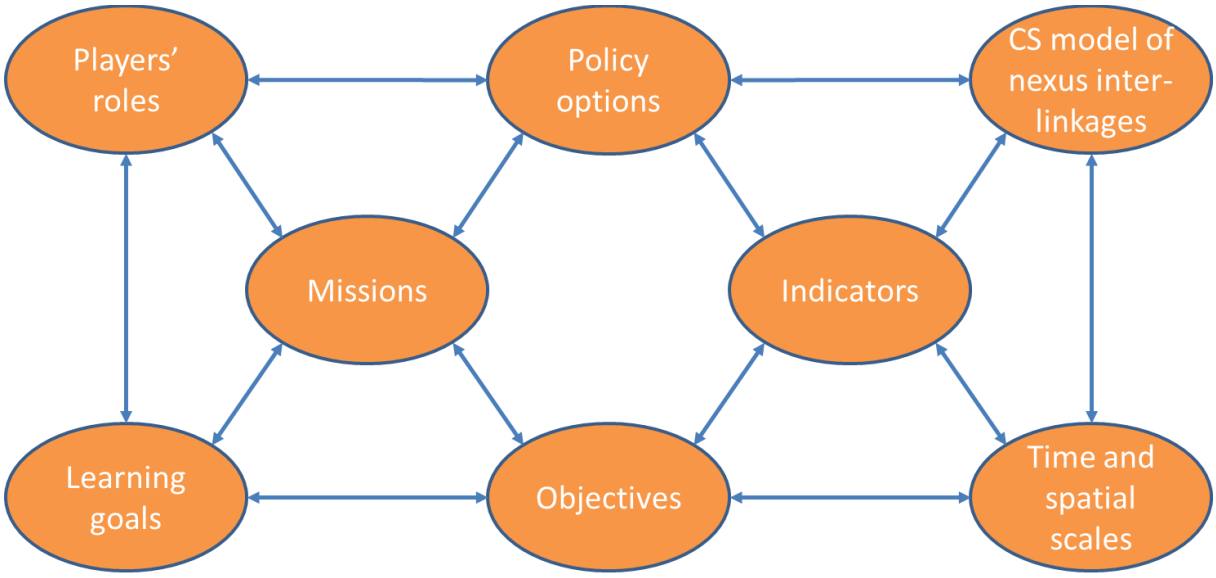

Figure 5. Concepts that specify case studies for the Serious Game

In addition to the interlinkages, policy options, and indicators, the load of a case is characterised by spatial and time scales, the players' roles, and the missions with policy objectives in terms of targeted indicator values that implement the learning goals. These aspects must be precisely specified in order to develop a game load for a case study.

5.3 First characterization of the case study loads

This section presents a fist characterization of the case studies. The goal of this exercise is to identify the potential players of the game, to provide background for concretizing the learning goals into missions, and to identify indicators that can serve as assessment criteria. We will first compare the case studies with respect to coverage of the interlinkages, and then compare the case studies with respect to actors, policy goals, and indicators, respectively. The section is concluded by a discussion of the results.

5.3.1 Coverage of the interlinkages by the case studies

Based on the case study descriptions and the learning goals described in Chapter 4, and the data collected with the formats as included in Appendix A, we can compare the case studies with respect to the relevance of interlinkages between nexus components. Table 13 compares the regional and trans-border case studies with respect to the salient interlinkages. As it appears from Table 13, water management and its interlinkages with policies on the other nexus components are the main policy issue in most regional and trans-border case studies.

Table 13. Salient interlinkages for the regional and trans-border case studies

changing component / affected component	climate	water	food	land use	Energy
climate		R:Andalusia R:Sardinia T:FR-DE T:DE-CZ-SK	R:Andalusia R:SW UK	 T:DE-CZ-SK	
water			R:Andalusia R:Sardinia R:SW UK T:DE-CZ-SK	 R:SW UK T:FR-DE T:DE-CZ-SK	R:Andalusia R:Sardinia T:FR-DE
food	R:Andalusia	R:Andalusia R:Sardinia R:SW UK T:DE-CZ-SK		 R:SW UK	
land use	 T:DE-CZ-SK	R:Andalusia R:Sardinia R:SW UK T:FR-DE T:DE-CZ-SK	 T:DE-CZ-SK		 R:SW UK
energy	R:Andalusia R:Sardinia R:SW UK T:FR-DE	R:Andalusia R:SW UK T:FR-DE	R:Andalusia T:FR-DE	 T:FR-DE	

Legend for spatial scale: R: regional; N: national, T: trans-border; C: continental; G: Global

Table 14 compares the national, continental, and global case studies. In these case studies, the interlinkages concerning energy policy are important issues in addition to water management. For the design of the game, we may conclude that water management is the central topic for the regional and transboundary case studies, while for national, continental, and global cases the low-carbon economy will be the central topic setting preconditions for policy decisions in other nexus domains.

Table 14. Salient interlinkages for the national case studies

changing component	affected component climate	water	food	land use	energy
climate		N:Latvia N:Sweden N:Netherlands C:European G:Global	N:Greece C:European	N:Greece N:Latvia N:Sweden	N:Greece N:Sweden
water			N:Greece C:European	N:Greece N:Sweden N:Netherlands	N:Greece N:Latvia N:Sweden C:European
food		N:Greece N:Latvia N:Netherlands C:European G:Global		N:Greece N:Latvia C:European	
land use		N:Greece N:Latvia N:Sweden N:Netherlands C:European	N:Latvia N:Netherlands		N:Greece N:Sweden C:European
energy	N:Greece N:Latvia N:Netherlands C:European G:Global	 N:Sweden N:Netherlands C:European G:Global	N:Latvia N:Netherlands G:Global	N:Greece N:Latvia N:Sweden N:Netherlands C:European G:Global	

Legend for spatial scale: R: regional; N: national, T: trans-border; C: continental; G: Global

5.3.2 Case studies compared with respect to involved actors

The decision making actor types in the case studies have been identified using the information in the case study posters on www.sim4nexus.eu and the data collected with the format described in Appendix A. The actor types are compared across the case studies in Table 15.

Table 15. Types of actors mentioned as decision makers by the case study studies

Decision making actor type	Andalusia	Sardinia	SW UK	DE-CZ-SK	FR-DE	Greece	Latvia	Sweden	Netherlands	EU	Global
International organisations (EC, UN, OECD, etc.)										X	X
International river basin committee				X	X						
National ministry of environment				X		X	X		X		
National ministry of agriculture/food				X		X	X	X	X		
National ministry of planning/development				X		X	X				
National ministry of economy/tourism/infrastruct.						X	X		X		
National water management authority				X		X					
National energy agency								X			
National forestry agency								X			
Regional ministry/agency of environment	X	X			X						
Regional ministry/council of agriculture	X				X						
Regional ministry of tourism		X									
Regional water and environment agency	X		X								
Regional energy agency	X		X				X				
Regional water management authority		X	X	X	X	X			X		
Regional forestry agency								X			
Local port authority				X	X						
Counties / municipalities			X	X	X	X	X	X			
Drinking water/sewerage companies		X	X	X		X	X				
Power companies		X	X		X	X	X		X		
Farmers union			X	X		X	X		X	X	
Forest owners/organizations								X			
NGOs			X	X	X		X				
Private sector									X		

5.3.3 Case studies compared with respect to policy objectives

Policy goals are important attributes of the case studies. In the game design they will be used to concretize the learning goals into missions that can be evaluated with respect the player's understanding and ability to influence the Nexus, while taking different interlinked aspects (climate change, water, food, land use, and energy) into account. Table 16 presents the policy goals that have been identified using the information in the case study posters on www.sim4nexus.eu and the data collected with the format described in Appendix A.

Table 16. Policy goals mentioned by the case study studies

Policy goal	Andalusia	Sardinia	SW UK	DE-CZ-SK	FR-DE	Greece	Latvia	Sweden	Netherlands	EU	Global
Sustainable development goals										X	
Food security										X	X
Resource efficiency											X
Low carbon economy		X	X			X	X		X	X	X
Energy self-supply							X				
Management of conventional energy			X			X					
Diversification of energy sources		X				X	X				
Renewable energy	X		X		X			X			
Bio-economy				X	X		X				
Reduce climate impacts	X		X	X		X		X			
Flood/drought risk management		X	X	X	X	X		X	X		X
Reduce local heavy storms				X							
Reduce river flow fluctuations				X							
Surface and ground water quality	X	X	X			X		X			
Sustainable water withdrawals	X									X	
Biodiversity		X		X			X				X
Protected nature areas				X	X					X	
Green areas (urban and forest)				X		X					
Economically healthy agricultural sector										X	
Sustainable forests								X			
Land use management						X					
Involve economic sectors in policy									X		
Economic development							X				
Employment		X		X		X					
Improve tourist product/services		X		X		X					
Sustainable/biological food production		X					X				
Food/nutritional quality						X					

5.3.4 First inventory of potential indicators

Indicators measure the status of the nexus. When policy changes have been made by players, the indicator changes measure the success of their actions. In training programs the indicator values can be used as criteria to assess a player's learning.

In the case study formats according to Appendix A and in the learning goals reported in Chapter 4, many indicators are proposed (see Table 17). For the learning purposes of the game, the number of indicators must be limited. In the design of the games, a selection of indicators must probably be made, or some indicators may be combined using weight factors. For now, we have this long list, indicating potential assessment criteria that can be used in the games for the respective case studies.

Table 17. Indicators mentioned by the case study studies and in the learning goals

Indicator	Andalusia	Sardinia	SW UK	DE-CZ-SK	FR-DE	Greece	Latvia	Sweden	Netherlands	EU	Global
Population						X					
GDP (per sector)							X		X		X
Employment (per sector, esp. agri and tourism)		X		X		X					
Tourist arrivals		X		X		X					
Resource efficiency (GDP/resource usage)	X										X
Energy consumption			X				X		X		
Fossil fuel consumption						X					
Imported/total energy consumption							X				
Renewable/total energy consumption	X	X	X		X	X		X	X	X	X
Ren./total en. consumption in transport								X			
Bioenergy production				X	X		X		X		
Hydropower energy production		X			X		X				
Wind/solar energy production		X	X		X		X				
Nuclear energy production					X		X				
Energy production/consumption in agriculture											
power supply emissions			X								
GHG emissions	X	X				X	X	X	X	X	
Use and capacity of CCS storage									X		
Length of growing season								X			
Water demand		X								X	
River discharge				X							
water temperature						X					
Nutrient concentrations	X	X									
Nutrient loads											X
Regulation of rivers					X			X			
flood risk & droughts			X	X	X	X			X		X
Heavy storm frequency				X							
Water retention/flooding area				X	X			X			
Evaporation from diverse land types				X							
Erosion / land degradation				X							
Surface and ground water quality						X		X			
Sulphur deposition								X			
Nutrient retention								X			
Agricultural water consumption		X		X		X					
Irrigation area				X							
Water balance	X										

(Table continues on next page)

Indicators mentioned by the case study studies and in the learning goals (continued)

Indicator	Andalusia	Sardinia	SW UK	DE-CZ-SK	FR-DE	Greece	Latvia	Sweden	Netherlands	EU	Global
Cropland area				X		X					X
Pasture area				X		X					
Forest area				X		X	X				
Area set aside for nature				X						X	
Urban area				X		X					
Green urban area				X		X					
Area for biomass production							X				
Biomass production (photosynthesis)				X							
Ecosystem services		X	X			X	X				
Biodiversity intactness/aquatic vegetation				X		X				X	X
fish species and algal blooms				X		X					
demand agri products (food, feed, biofuel)						X				X	
Crop production									X	X	X
Livestock production									X	X	X
Farm Income (revenue, cost)										X	
N,P,K balances			X								
Trade flows										X	
Food/crop prices - quantities										X	
New land										X	
Water and land requirements for energy			X								
Environmental indicators for forestry								X			
Sustainability assessment			X				X				
% sustainable/biological food production		X					X				
Food quality and nutritional value						X					

5.3.5 Discussion of the results

In the work presented in this chapter we have identified commonalities and difference across the case studies. This information is useful for the design of the generic game shell and the specific game loads for the case studies. Table 17 identifies potential assessment criteria. Actual indicators and assessment criteria to be used, must be specified in the next steps of the game design.

Tables to compare policy options and time scales and time/spatial resolution across the use cases must still be composed. At the current stage of definition of the case studies in the project, this information is not yet available.

Furthermore, the information presented in this chapter represents a snapshot of the current state of case study design. The data may require updating in the course of the project, which makes this report a “living document”.

6 Conclusions and recommendations

A first version of the learning goals has been provided in this report in Chapter 3, considering every particular and specific characteristics of each case study at this stage of the project. As mentioned in previous sections, this report has to be considered as a living document which will evolve along project execution, iterating learning goals definition, to better fit case studies' necessities while maximising project results and impact.

However, this report goes far beyond this specific objective. In Chapter 2, the general principles of the serious game have been introduced to build a first common understanding of potential roles of the game in training and policy processes, making case study leaders and other relevant involved actors understand which the capabilities of a serious game tool are, and leading to a better definition of the learning goals.

In addition, in Chapter 3, a methodology to define the learning goals has been defined. This approach has been used to support this report, and will also be used in future iterations as the project gains insights on each case study. Thanks to this methodology, which results in a set of guided steps for information collection and learning goals definition, a more comprehensive and precise analysis has been carried out. More concretely, this has helped: (i) the case study leaders and other involved actors to better explain their needs and objectives, (ii) the collection of requirements in a common framework, (iii) a collaborative discussion and evolution of requirements, decisions, and objectives, and finally, (iv) the definition of the learning goals.

A framework to fit the different terms in a common manner has been defined in Chapter 5, which is linked to the methodology. The common framework includes the case studies definitions, together with their indicators, interlinkages, time and spatial scales, objectives, and also relates this entities with their respective missions, roles and learning goals in the Serious Game.

In conclusion, great efforts have been devoted at this early stage of the project to fulfil the task objectives (Task 4.1), not just for the report per se, but because of the high complexity of the task, i.e., understanding all the case studies, entities, relations and restrictions. The methodology used has covered successfully the necessities for this tasks, and therefore, it will continue being the basis for any future iterations of this report. Next steps will rely on more results coming from other Work Packages, interviews, and other sources, which are expected to bring more precise information. Accordingly, more concrete learning goals will be able to be defined, tailored to each case study, and maximising impact.

Appendix A: Format used to structure data about the cases studies

The following pages contain the format used to collect and structure data about the case studies. The case study leads were requested to complete the form by e-mail:

"Dear case study leader,

In Task 4.1 we are currently working on definition of the learning goals for the serious game. We plan to have instantiations of the game for each case study, based on the policy goals and the "complexity science models" to be developed for the case studies. The games can be used in the case studies to interact with stakeholders. In addition, they can be applied in more general contexts like training programmes and courses.

We foresee two learning loops in the game. Firstly, users can try and experience the effects of policy interventions on the complex of NEXUS components, through the interlinkages. The game will be based on missions to be accomplished by players. Missions will have multiple objectives, for instance: increase employment in the tourist industry on Sardinia with ...%, while reducing greenhouse gas emissions with ...%, increasing sustainable local food supply with ...%, and increasing ecosystem services with ...%.

In a second, wider, loop, the system can learn from the players' actions. The purpose of this wider loop learning, is to gather data on stakeholders' decisions and to offer insight into the consequences of the decisions for the NEXUS. The second loop will be supported by artificial intelligence (the "Knowledge Elicitation Engine"). We hope that, in the future, artificial agents based on the collected data can be implemented in the game, which can take the roles of particular stakeholders. Thus, we aim to enable simulations of interactions between policy processes on different NEXUS components and different levels of aggregation, in addition to the biophysical processes.

Now, first we must collect information on the case studies. The information to be collected includes the relevant interlinkages, the policy objectives, the stakeholders involved, and the indicators and input data to be used. We intend to describe each case study using a format like attached to this e-mail. We hope that you will help us by completing and returning the attached format by 1 November. Our planning is to present and discuss a draft version of the deliverable D4.1, with proposed leaning goals for each case study, in the case study workshop in Barcelona, 16 November.

With kind regards,
…"

SIM4NEXUS: Case study information needs for the serious game
(Task 4.1: define learning goals of SG)

The purpose of this format is to collect information on which **a first version of the learning goals of the serious game can be drafted for each of the case studies**, and on the basis of which the learning goals can be compared with respect to coverage of interlinkages between the NEXUS components, policy objectives, indicators used, data sources and models, involved actors and expected contributions to the case study outcomes.

We are aware that the level of detail requested in this format may not be completely available in the present phase of the project. We just request you to fill out the format as far as possible on the basis of the information you now have about the case study. As a next step we plan to propose learning goals for the case study and discuss these with the case study leads.

An example of the format filled out for the Sardinia case study, as far as information is now available, is included as an annex.

Case study: ...

- Object system's characteristics
  - Spatial scale: (regional/national/continental/global)
  - Spatial resolution: (grid size or regional/national/continental/global)
  - Time scale: (1 year / several years / >10 years)
  - Time resolution: …
  - Interlinkages between NEXUS components relevant for the case study (please specify some narratives to explain the nature of each the relevant interlinkages at your CS (why? how?)

Relevant interlinkages for case study: ...					
Changing component	**Affected component**				
	climate	**water**	**food**	**land use**	**energy**
climate					
water					
food					
land use					
energy					

- Policy objectives and indicators for each case study: Can you please specify (preliminary ideas about) the development policy objectives to be set and attained in the case study and the indictors to be used to formulate the objectives?

Policy objectives and indicators for case study: ...				
Policy objective	**Indicator**	**Spatial resolution**	**Time resolution**	**Comment**

- Data sources and variables to be used in each case study (shape files, thematic data, statistics), as far as now known.

Data sources to be used in case study: ...				
Data source	**Variable**	**Spatial resolution**	**Time resolution**	**Comment**

- Models and inputs to be used in the case study: What are the current ideas about the use of thematic models (which models, based on which inputs to be used)

	MODEL		
INPUT	…	…	…
Climate change model			
Crop growth model			
climate change scenario			
development scenario			
reference year			
which input is used in which particular model			

- Actor roles (policy makers, businesses, education, research, NGO's, general public) which are expected to be relevant in the case study, and names or number of the actors

Actors involved in the policy process in case study: **…**				
Actor role	**Name or number of actors**	**Responsibilities of the actor with respect to the NEXUS**	**Which are the actors' options to affect the NEXUS**	**How is actor affected by the NEXUS**

- Which contributions to knowledge or decision making of the actors in the case study do you expect from the serious game.

Expected contributions from the serious game for case study: **…**				
Actor role	**Name or number of actors**	**Potential contributions to knowledge level of stakeholders**	**Potential contributions to decision making, facilitating the policy process**	**Potential insights on actors' behaviours to be gained by researchers**

Additional questions:

1. Is effective decision making with respect to the NEXUS and efficient resource utilization currently hindered by gaps in knowledge, awareness, decision making processes or skills? If so, which gaps exist in the case at hand?

…

2. Are any NEXUS interlinkages (partially) ignored in current decision making in the Case Study? If so, which interlinkages are ignored? (please indicate a priority order)

…

3. Could a serious game contribute to improve decision making with respect to currently ignored interlinkages? Consider opportunities like (not exhaustive):
    a. Educate current decision makers to be aware of interlinkages and consequences of climate change
    b. Find solutions by individually simulating the effect of interventions
    c. Experience how interventions by others can affect NEXUS components for which a decision maker is responsible
    d. Support collective decision making in joint gaming sessions involving different stakeholders

…

4. If relevant, what could policy makers (involved in the case study) learn from a serious game, at a general level (insight into the importance of interlinkages) and in particular decision processes (simulating effects of alternative interventions and of interventions by made others).

…

5. What could other policy makers (not involved in the case study) and students learn from a serious game simulating the present case study?

…

6. Would such a serious game be interesting for the general public and, if so, what could the general public learn from it?

…

ANNEX: example of filled-out format

Case study: Sardinia

- Object system's characteristics
  - Spatial scale: regional: 1 region NUTS2
  - Spatial resolution: entire region
  - Time scale: long term (>10 years)
  - Time resolution: An internal time step for parts of the model (hydrology/water balance) which will be monthly; An overall time step for the complexity science model, which will be 10 years.
  - Interlinkages between NEXUS components relevant for the case study (please specify some narratives to explain the nature of each the relevant interlinkages)

Relevant interlinkages for case study: **Sardinia**					
Changing component	**Affected component**				
	climate	**water**	**food**	**land use**	**energy**
climate		Reduce hydrological risks			
water			Crop production		Hydropower production
food		Irrigation requirements			
land use		Eutrophication of reservoirs and pressure on the water storage capacity			
energy	Distribution networks for electricity and conflicts with energy providers limit the potential development of a low carbon economy				

- Policy objectives and indicators for the case study: Can you please specify (preliminary ideas about) the policy objectives to be attained in the case study and the indictors to be used to formulate the objectives?

Policy objectives and indicators for case study: **Sardinia**				
Policy objective	**Indicator**	**Spatial resolution**	**Time resolution**	**Comment**
A low carbon society	Greenhouse gas emissions.	The region		
Reduce hydrological risks				
halt the loss of biodiversity	Ecosystem services			
Increase employment	employment			
obtain a sustainable tourism sector	Number of visitors in shoulder months over total			

sustainable (local) food production	% of products produced in the region			
increase alternative power production	Alternative power production/total			

- Data sources and variables to be used in the case study (shape files, thematic data, statistics), as far as now known

Data sources to be used in case study: **Sardinia**				
Data source	**Variable**	**Spatial resolution**	**Time resolution**	**Comment**
Satellite image of the island				Likely not needed. If used, then from MODIS
Map: Position of the region in Europe		marker		
Map: Position of reservoirs with volumes above 1M m3	position			
Thematic map: Eutrophication of water bodies				
???	energy consumption	Aggregate for entire region (NUTS2)	Annual	12000 GW/h per year. Hydralulic 240GW/h ; Eolic 1600 GW/h; Solar 653 GW/h.
Demographics	population	Island level	annual	
Economics			Annual	15M tourists

- Models and inputs to be used in the case study: What are the current ideas about the use of thematic models (which models, based on which inputs to be used)

	MODEL		
INPUT	CAPRI	E3ME	GTAP
Climate change model - global circulation model??	not directly in CAPRI but through results from crop growth models	not applicable	not present
Crop growth model	LPjML, WOFOST		
climate change scenario	RCP 4.5 and 8.5	Depends on what policy you want implemented. Carbon tax to achieve a certain emission reduction?	the RCP linked to the selected SSP
development scenario	SSPs projection of GDP and Population growth (we can choose among the 5 SSPs)	See comment above.	SSPs projection of GDP and Population growth (we can easily choose among the 5 SSPs according to Floor's indication)
baseline year	2008 (2007-2009), ex-post data until 2011	2005	2011

input use	Model baseline: agricultural market projections from the AGLINK-COSIMO model; bioenergy from PRIMES.		

- Actor roles (policy makers, businesses, education, research, NGO's, general public) which are expected to be relevant in the case study, and names or number of the actors

Actors involved in the policy process in case study: **Sardinia**				
Actor role	**Name or number of actors**	**Responsibilities**	**Which are the actors' options to affect the NEXUS**	**How is actor affected by the NEXUS**
government	The regional ministry of the Environment	Formulate policy goals		
Regional Water Authority	ENAS	provision of water for irrigation and of quality water for urban use		
Drinking water provider	ABBANOA	quality water for urban use		
Electric companies	number?	Power supply		
Irrigation consortia	number?			
association of farmers				
association of tourist facilities				

- Which contributions to knowledge or decision making of the actors in the case study do you expect from the serious game and which insights in actors' behaviours do you expect to gain

Expected contributions from the serious game for case study: **Sardinia**				
Actor role	**Name or number of actors**	**Potential contributions to knowledge level of stakeholders**	**Potential contributions to decision making, facilitating the policy process**	**Potential insights on actors' behaviours to be gained by researchers**
government	The regional ministry of the Environment. The water authority Ministry of industry and energy		which policies to implement to reduce hydrological risks, halt the loss of biodiversity, to obtain a sustainable tourism and support the agricultural sector while accounting for the water criticalities	

Additional questions:

7. Is effective decision making with respect to the NEXUS and efficient resource utilization currently hindered by gaps in knowledge, awareness, decision making processes or skills? If so, which gaps exist in the case at hand?

…

8. Are any NEXUS interlinkages (partially) ignored in current decision making in the case at hand? If so, which interlinkages are ignored? (please indicate a priority order)

…

9. Could a serious game contribute to improve decision making with respect to currently ignored interlinkages? Consider opportunities like (not exhaustive):
    a. Educate current decision makers to be aware of interlinkages and consequences of climate change
    b. Find solutions by individually simulating the effect of interventions
    c. Experience how interventions by others can affect NEXUS components for which a decision maker is responsible
    d. Support collective decision making in joint gaming sessions involving different stakeholders

…

10. If relevant, what could policy makers (involved in the case study) learn from a serious game, at a general level (insight into the importance of interlinkages) and in particular decision processes (simulating effects of alternative interventions and of interventions by made others).

…

11. What could other policy makers (not involved in the case study) and students learn from a serious game simulating the present case study?

…

12. Would such a serious game be interesting for the general public and, if so, what could the general public learn from it?

…

Horizon 2020 Societal challenge 5
Climate action, environment, resource
Efficiency and raw materials

D4.1: LEARNING GOALS DEFINITION, REVISION 1

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Executive summary

Task 4.1 has defined a first version of the SIM4NEXUS Serious Game tool learning goals considering: i) the scope of the game, ii) the contents to be included, iii) the knowledge to be imparted, and iv) the assessment items needed to test the learning. The learning goals are oriented by two main purposes: i) to allow users to learn about concrete facts, terminology, acronyms, concepts, rules, procedures and soft skills related to the Nexus management domain; and ii) to gain insight into the decisions and behaviours of the players.

The first version of the learning goals provided in this report has been defined considering every particularity of each case study at this stage of the project. A methodology to define the learning goals has been developed. This approach has been used to support this report, and will also be used in future iterations as the project gains insights on each case study. Thanks to this methodology, which results in a set of guided steps for information collection and learning goals definition, a more comprehensive and precise analysis has been able to be done. More concretely, this has helped: (i) case study leaders and other involved actors to better explain their needs and objectives, (ii) requirements collection in a common framework, (iii) collaborative discussion and evolution of requirements, decisions, and objectives, and finally, (iv) learning goals definition.

This report introduces the general principles of the serious game, so as to build a first common understanding of potential roles of the game in training and policy processes, making case study leaders and other relevant involved actors understand which the capabilities of a serious game tool are, and leading to a better definition of the learning goals.

A framework to fit the different terms in a common manner has been defined, linked to the methodology. The common framework includes the case studies definitions, together with their indicators, interlinkages, time and spatial scales, objectives, and also relates this entities with their respective missions, roles and learning goals in the Serious Game. In addition to the learning goals, the common framework represents a first inventory of potential assessment items to test the learning for each case study.

In conclusion, great efforts have been devoted at this early stage of the project to fulfil the task objectives (Task 4.1), not just for the report per se, but because of the high complexity of the task, i.e., understanding all the case studies, entities, relations and restrictions. The methodology used has covered successfully the necessities for this tasks, and therefore, it will continue being the basis for any future iterations of this report. Next steps will rely on more results coming from other Work Packages, interviews, and other sources, which are expected to bring more precise information. Accordingly, more concrete learning goals will be able to be defined, tailored to each case study, and maximising impact.

Since the present report is used as a living document in the project, the first version (Month 6 of the project) has been updated according to evolved insights from the case studies in Month 12. When the case studies proceed, further updates may follow.

Changes with respect to the DoA

In the original plan for task T4.1, work package WP2 (Policy analysis and the nexus) was described as a major source of information for defining the learning goals. However, since deliverables from WP2 describing the international and national/regional policies are planned for project months M12 and M14 respectively, and the present deliverable is due in M6, we collected data directly from the case studies in order to define a first version of the learning goals. As a consequence, the present report

must be considered a living document, in which definitions of the learning goals may be adapted to insights gained in the course of the project.

Dissemination and uptake

This report is public, so it is accessible for everyone. However, the specific targeted audience of this report are the beneficiaries of the project, in particular the case study leaders and the beneficiaries participating in the development of the serious game and the complexity science models. The purpose of this report is to provide grounding for a common understanding of the principles of the serious game and the leaning goals to be achieved for stakeholders in the case studies. Additionally the methodology presented here can be useful in similar approaches for future/other projects.

Short Summary of results

Data have been collected about the case studies, specifying the policy objectives, the relevant interlinkages between NEXUS components, the indicators to measure policy efficacy, and relevant types of stakeholders for each case study. Based on this information, learning goals for each case study, general learning goals, and a common framework comparing the case studies and realizing instantiations of the game for each case study have been defined.

Evidence of accomplishment

Data collected from the case studies are available in the WP4 documents section of the SIM4NEXUS Projectplace directory. The resulting definitions of learning goals and comparison of case studies with respect to interlinkages, policy goals, indicators, and involved types of stakeholders are included in the present deliverable.

Glossary / Acronyms

TERM	EXPLANATION / MEANING
DE-CZ-SK	EAST GERMANY-CZECH REPUBLIC-SLOVAKIA TRANSBOUNDARY CASE STUDY
FR-DE	FRENCH-GERMAN TRANSBOUNDARY CASE STUDY
KEE	KNOWLEDGE ELICITATION ENGINE
P&R	PENALTIES AND REWARD
SW UK	SOUTH WEST OF THE UNITED KINGDOM (REGIONAL CASE STUDY)
WP	WORK PACKAGE

1 Introduction

This introduction presents the structure of the present report and a description of SIM4NEXUS Task 4.1, of which this report is the related deliverable. The first edition of this report was delivered in November 2016. The present version has been revised based on evolved insights from the case studies. In Chapter 4 the characterizations and learning goals of the case studies have been revised. The tables in Section 5.3 have been updated. Two new subsections have been added to Section 5.3, describing some preliminary ideas on policy options to be offered to players and learning from their actions.

1.1 Structure of the document

This report is structured in 6 Chapters and 1 Appendix as follows:

Chapter 1 is the introduction.

Chapter 2 explains the principles of the serious game, in order to build a first common understanding of potential roles of the game in training and policy processes.

Chapter 3 elaborates on the approach taken to collect data about the case studies and to define the learning goals and the common framework.

Chapter 4 contains a short description of the case studies in which the serious game is to be applied. The 12 case studies have different regional, national, international and global scales and cover different aspects of the nexus, such as low carbon economy, water quality management, biodiversity, and sustainable food production. The chapter concludes with a presentation of the learning goals, as they have resulted from a first draft by the Task 4.1 team and discussion with the case study leaders.

Chapter 5 compares attributes of the case studies, such as relevant nexus component interlinkages, policy objectives, indicators, and stakeholder types. These attributes are the basis for the development of case study specific instances of the game in a common framework.

Chapter 6 concludes the report with recommendations for further development and maintenance of the learning goals definitions and the common framework.

The format used to describe the case studies is included in Annex A.

The remaining part of the present chapter provides background information on the goals and status in the project of Task 4.1.

1.2 SIM4NEXUS Task 4.1 goals and background

Task 4.1 is part of work package WP4. According to the Grant Agreement, "*WP4 focuses on defining, implementing, testing and validating the Serious Game. The Serious Game will assist policy makers and stakeholders to better understanding and visualizing policies at various geographical and temporal resolutions, leading towards a better scientific understanding of the Nexus via unique immersive experience. WP4's objectives are:*

- *WP4-O1: Define and implement the game strategy, users, roles and storylines, taking into account temporal (short, medium and large) and geographical scales (regional, national, European and global) and promoting 'learning by doing' where the users will learn from wins and losses.*
- *WP4-O2: Determine gaming objectives that permit to understand how complex social-technological water-energy-food systems work under climate change and how to manage the water resources.*
- *WP4-O3: Define and collect the information requirements among all platform components and flow.*
- *WP4-O4: Define and implement the mechanisms to accumulate learning from users, incorporating the learnt knowledge into subsequent rounds, and to learn from Nexus knowledge and integration methodology.*
- *WP4-O5: Define and implement a GUI in order to permit the users to play and re-play scenarios, modifying real-life variables to test changes in components and outcomes.*
- *WP4-O6: Validate the solution in a development environment.*"

In particular WP4-O1 and WP4-O2 are relevant for Task 4.1. The task description according to the grant agreement is "*T4.1 will define the SIM4NEXUS Serious Game tool learning goals considering: i) the scope of the game, ii) the content to be included, iii) the knowledge to be imparted, and iv) the assessment items needed to test the learning. The scope of the learning goals is the holistic management of the Nexus, where decisions taken in one part trigger effects on the other. To represent that scope, content to be included encompasses representation of attributes and statuses of all related and relevant actors, entities and infrastructures in the Nexus depending in the concrete scale of analysis. Learning goals will consider different time and geographic scales, making learning process include knowledge at short, medium and large temporal scale, related to regional, national, European and global understanding of the complex interactions in the Nexus. Learning goals will be oriented by two main purposes: i) to allow users to learn about concrete facts, terminology, acronyms, concepts, rules, procedures and soft skills related to the Nexus management domain; and ii) to gain insight into the decisions and behaviours of the players. It will build on the results of WP1 to identify the main issues and interactions involved with the learning goals, and on the results of WP2 to identify the types of policies and decision makers that must be supported by the Serious Game. The learning goals will be formulated based on questionnaires with the partners involved in WP1 and WP2 and verified in a (web-based) workshop with them. T4.1 is closely related to the accomplishment of WP4-O1 and WP4-O2.*"

Figure 1 displays links between WP4 and other work packages. Since data from WP2 describing the international and national/regional policies are not available yet (planned for project months M12 and M14 respectively), we collected data about policy objectives directly from the case studies in order to define a first version of the learning goals. Except from this single exception, we completed the task as required by the Grant Agreement. The next chapters of the present deliverable report the results.

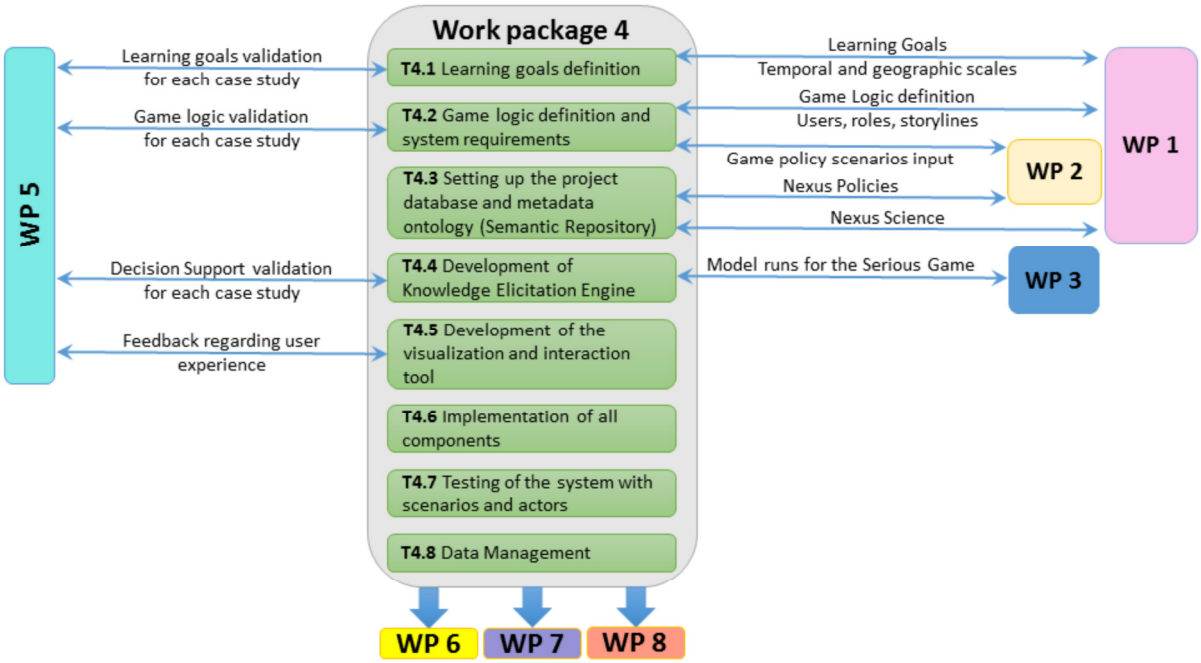

Figure 1. Task-by-Task interactions of Work Package 4 with other Work Packages

2 SIM4NEXUS Serious Game principles

The purpose of this chapter is to present the reader with a brief explanation of the SIM4NEXUS Serious Game principles, as a background for understanding the learning goals. The chapter first presents the goal and the approach, then the process of the game play, and finally the Penalties and Reward (P&R) System.

The goal of the game is to learn about different policies on the nexus and how these policies impact a particular case study through a "learning by playing" approach. This approach is depicted in Figure 2.

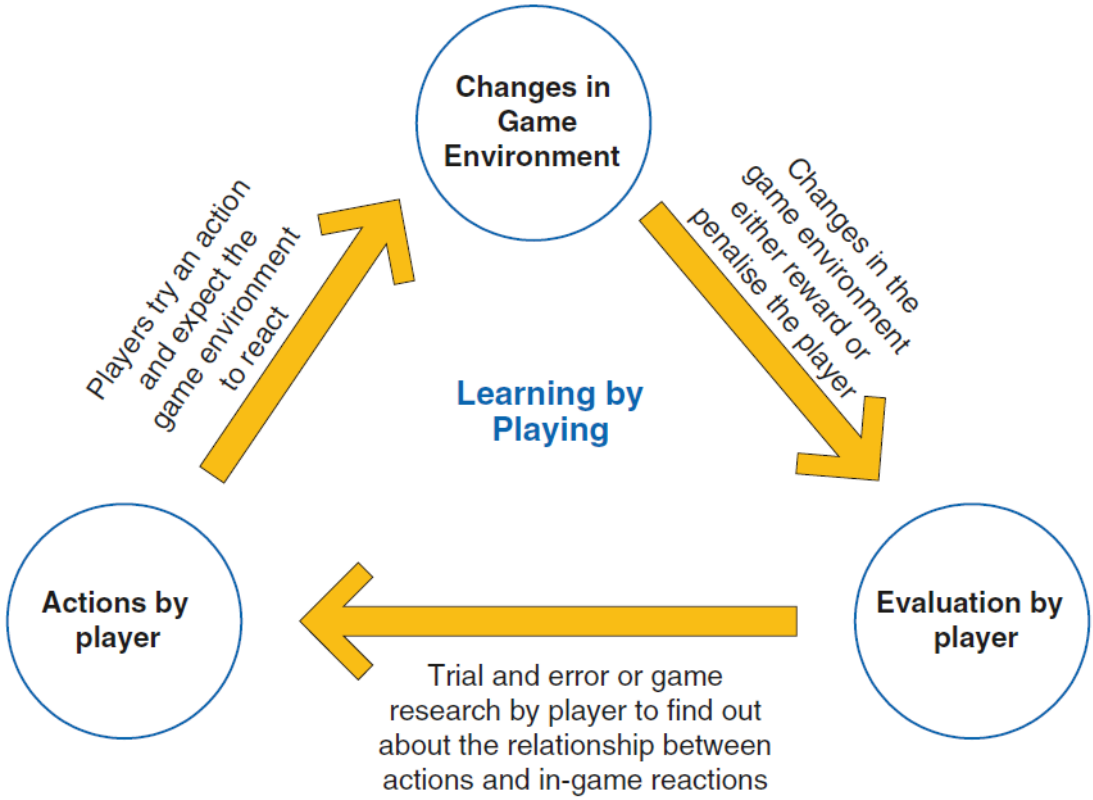

Figure 2. Approach "learning by playing"

Based on this concept the game play for the game is as follows:

As a player, you represent policy makers in the various sectors in a particular area – food, energy, water, climate and/or land use. Your aim is to fulfil the targets (objectives) set out by the national or international bodies by changing or adapting new policies in your area. To succeed in the game, you must learn to fulfil these targets by mixing and matching various cross sector policies without compromising the existing status quo of the other sectors.

Core Experience – What is the player experiencing as they play the game?

The core experience in the game is to play the role of policy makers in food, energy, water, climate, land use. In the game, the player will typically start off with separate "silo-thinking" approaches towards decision making and policy implementation. Over the course of playing the game, they will be

encouraged to change towards a more integrated NEXUS-compliant policy implementation approach and decision making.

Base Mechanics – What does the player actually do?

The player will have a target at the start of each turn of the game and he/she will have to implement policies to try to achieve the target. The turn ends when the player has decided on the policies which are to be implemented to achieve the targets and clicks on "next turn" button. The game will compute the policies made and an analysis of the decisions will be displayed in the following turn, with a new target to achieve for the turn.

The list of targets for each of the case study will be primarily determined during the case study interactions with the stakeholders, however there will also be targets from the European and Global case studies. The list of targets will also be categorised into the case studies, an example of the classification is presented in Table 1:

Table 1. List of targets classification example

Target case study	Target text	NEXUS Component	Target indicator	Target achievement value
Global, European	Improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and increasing recycling and safe reuse globally	Water	Percentage of water bodies with good water quality	70
Sardinia	Increase renewable energy production	Energy	Percentage of renewable energy production	5
…				

The targets are envisioned to be displayed in a step-by-step manner to the player. This will help guide the player on what to do during the game play.

Penalties and Reward (P&R) System – What behaviour within the game is encouraged or discouraged?

Silo-thinking in decision making and policy implementation within the game is discouraged, whereas integrated NEXUS-compliant decision making is encouraged. For every target in each turn, the player is encouraged to look at policies in all sectors and consider them to achieve a target.

The P&R system will be in 3 parts:

1. **Key indicators across all NEXUS components**. These key indicators are yet to be defined and will require inputs from WP2, WP3, and WP5. It is noted that while it is not possible to have all key indicators showing positive values all the time, the player will be rewarded when there are more indicators showing positive results than vice versa. At this moment of writing, there is also no consideration to weigh the indicators yet and the assumption is that all indicators will have the same weight. This may change as the project processes.

2. **Events within the game**. Events are news happening "on the ground" which add a societal and cultural aspect to the game. These events will be triggered based on the decisions the players made in the game and will be narrated in the same tone as they are encouraged to change towards a more integrated NEXUS-compliant policy implementation approach and decision making. There will also be uncertainties in event triggers to add more realism in the game, e.g., the occurrence of extreme events such as economic crisis or disaster events. There will be three categories of events: informational events which are neutral, negative events which will penalise the player by deducting points, and positive events which will reward the player with bonus points.

3. **Score.** There will be a score for the player. This score will indicate how successful the player is applying NEXUS-compliant decision making in achieving the targets in the game. Every progression in the time step of the game will add to the score to encourage the player to continue, every policy implemented will add to this score and the events will add to the score.

3 Approach to define learning goals

According to work plan including in the grant agreement, Task 4.1 had to result in the definition of learning goals for players of the Serious Game, and criteria to assess the extent to which players have achieved these learning goals. Since the game is to be applied in the case studies and the case studies have different policy objectives, **the learning goals are different for each case study**. This is an important point that determined the whole approach and added to the complexity of the task. Therefore an approach was developed to define specific learning goals and assessment criteria for each case study. In addition, a **common framework** had to be defined to describe and compare the functionalities, actor roles, policy goals, and assessment criteria (indicators) of the games for the case studies. The present chapter describes the approach taken to collect data about the case studies and define the learning goals based on these data.

The first step in the approach was to collect data about the case studies. A format has been developed and tested to structure the data for the Sardinia case study. Based on this experience, the format was adjusted. After a pilot for the Greek case study, data were collected for all case studies (see the format in Appendix A). The case study leads were requested to complete the format. Not all case study leads had the opportunity to fully complete the format by Month 6 of the project, because not all the stakeholders have been raised and contacted yet. Consequently they will be updated/reviewed as needed in the future (hence the definition of this deliverable as a "living document"). In these cases the Task 4.1 team completed the format as far as possible based on the information in the case study descriptions on www.sim4nexus.eu, and the notes of interviews with the case study leads, held in WP5.

After data collection, learning goals for each case study have been drafted by the task 4.1 team. The draft learning goals have been presented and comments have been solicited in the case studies workshop in Barcelona on 17 November 2016. Finally the learning goals for the case studies were defined and, based on these, the general learning goals could be defined. Figure 3 summarizes the approach. The results are presented in Chapter 4. For future players, the learning goals are preceded by short case study descriptions, based on information from www.sim4nexus.eu and notes of the interviews with the case study leads in WP5.

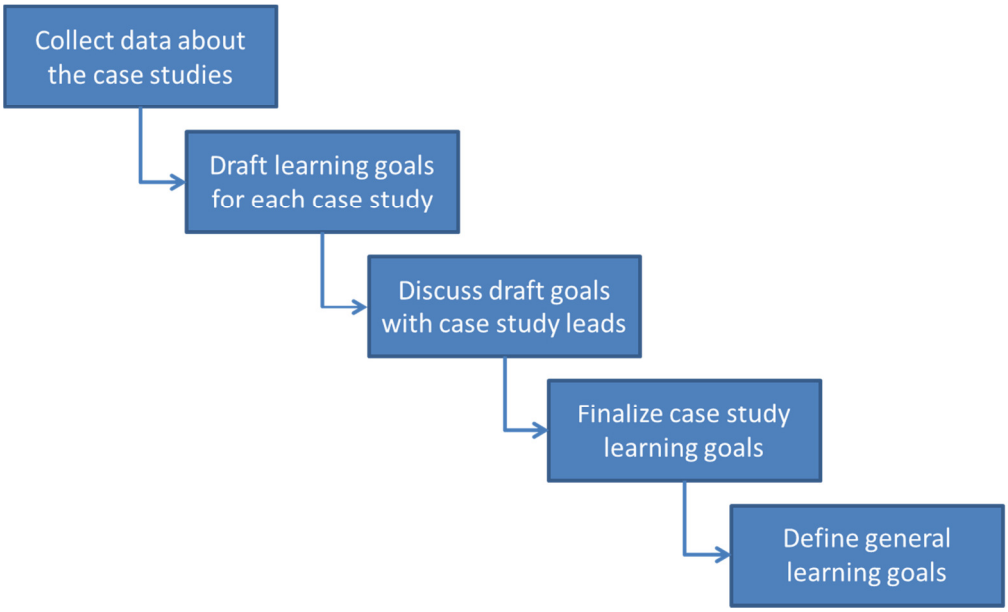

Figure 3. Approach to define the learning goals

In Month 12 of the project, the cases study leads updated the tables in this report, according to the current status of their research, and some case studies could already provide preliminary information on policy choices to be implemented in the game, and data about the players' behaviours to be collected through the Knowledge Elicitation Engine (KEE). Subsections on these topics have been added to Section 5.3.

4 Learning goals

This chapter introduces the learning goals definition for each case study in SIM4NEXUS at this stage of the project. As stated in the executive summary, D4.1 was planned for M6, while relevant sources for learning goals definition were planned later in the project. Example of relevant sources are the deliverables describing the policies in WP2, which are due in M12 and M14 respectively. For this reason, we have collected data directly from the case studies in order to define a first version of the learning goals, making the present report a **living document**, in which definitions of the learning goals may be adapted to insights gained in the course of the project.

Current general learning goals are the result of the data collection performed along all case studies, specifying the policy objectives, the relevant interlinkages between NEXUS components, the spatial and temporal scales, the indicators to measure policy efficacy, and relevant types of stakeholders for each case study. Specific discussion with case study leads and other involved actors was done during the WP5 Workshop meeting from 16th to 17th November 2016 in Barcelona, which was preceded by several Skype meetings and information exchange by email. The team had a total of seven Skype meetings of 1 – 1½ hour in the period July – November 2016.

Taking all these inputs as source, the following tables have been drafted by the Task 4.1 team and offered review by the case study leads[1]. In addition, the general learning goal has been defined, which is *to get policy makers and stakeholders to learn about impacts of one policy in the Food-Energy-Water Nexus. In addition, they can identify potential risks and conflicts of interest, trade-offs, and synergies, and learn how to coordinate policies in different domains in order to simultaneously attain multiple goals across the domains*.

Table 2. Region of Andalusia case study

Case study name	Region of Andalusia (Spain)
Case study type	Regional
Case study summary	The Andalusian case study will address how agricultural and environmental policies can be integrated to boost economic activity while reducing resource use and promoting sustainable water management, climate change mitigation and renewable energy. The main driver of the study is the water shortage problem, which has been aggravated by climate change. Tourism, as an important sector in the region has also increased the scarcity of water. The demand for water reaches its peak in summer due to tourism and agriculture. The goal is to raise awareness on the interdependence of water, energy and agriculture. A second goal is to advise local authorities. The main research question is: how can the policies become more integrated or coordinated to promote the sustainable use of water under changing climatic conditions.
Case study learning goals	You will learn how policies in the domains of agriculture, sustainable water management, and renewable energy can affect each other under climate change conditions, in a region where high agricultural production and tourism are competing for water.

[1] Due to formal complications (i.e. change of partner responsible for this Case Study in the Grant Agreement), no specific learning goals could be drafted for the Azerbaijan case study by M6.

Table 3. Island of Sardinia case study

Case study name	Island of Sardinia (Italy)
Case study type	Regional
Case study summary	The focus of the Sardinian case study is on agriculture, hydropower, tourism, energy, and food security. Sardinia's main sectors are tourism and agriculture. The case study will address how policy, incentives (e.g. agricultural and tourism policy), and eventual new infrastructure can be integrated to support sustainable food production, quality of water for urban use, and a sustainable tourist sector. These policies and incentives have to take into account climate change, internal population migration to the coasts and main cities, and the need for increased reliance on renewable energy sources and reduced greenhouse gas emissions. The main goal is to raise awareness about the interlinkage between water, energy and tourism. Another goal is to influence policy decisions on water management, energy development and tourism. Water is a priority, as it is essential to the biodiversity of the wetlands.
Case study learning goals	You will learn how regional policies, in the domains of water management, agriculture, tourism development, hydropower and alternative energy sources, can affect sustainable food/energy development goals severely competing for water resources under climate change.

Table 4. Southwest of the UK case study

Case study name	Southwest of the United Kingdom
Case study type	Regional
Case study summary	The case study will address how legislation, policy and its interpretation, with incentives for agricultural policy can be integrated to support both sustainable food production, and provision of water and wastewater services in a region with a significant tourism industry, in the face of climate change, population growth and the need for reduced greenhouse gas emissions. The main focus of the study is to influence land use management policies (where extreme weather causes flooding and washes away soil from intensively-farmed land) constrained by the (economic) importance of agriculture for the region (with three quarters of its land area devoted to it). There is also a significant draw to the region of tourists, which adds an additional pressure on land use and water resources. A second goal of the case study is to understand the way in which governance has the ability to constrain and restrict the move towards a more sustainable, smart, and flexible energy system. Another important issue is water quality which needs to be preserved especially along coastal zones.
Case study learning goals	You will learn how regional policies of land use for agriculture, renewable energy (wind and solar farms), and water management affect each other in a region with high risk of heavy rainfall and flooding.

Table 5. The Netherlands case study

Case study name	The Netherlands
Case study type	National
Case study summary	The goal of the Dutch case study is to identify low-carbon and resource-efficient pathways for the Nexus under the condition of climate change. It will focus on climate mitigation (and adaption) strategies that make use of bio-energy. All Nexus elements will be taken into account, although the main focus will be on land use due to the land requirements of bio-energy and competing claims. Land is already a pressing factor in the Netherlands (high prices). Land can be used for carbon uptake (growing) biomass, which can be used to produce bio-energy crops or feed for animals which results in biogas from manure digestion. The case study will assess the socioeconomic and technological consequences of the road to a low-carbon economy and address effects on land and water use in the Netherlands as well as water, land and carbon footprints of Dutch production and consumption related to the use of bio-energy. The road(s) to a low-carbon economy should be identified in close cooperation with stakeholders such as policy makers, private sector, and research organisations. The research results will be used to raise awareness among the policy-makers and other stakeholders.
Case study learning goals	The Netherlands: You will learn how policies aiming at a low-carbon economy with respect to biomass as a major renewable energy resource will affect land and water use, agricultural production, and risks of flooding and droughts under different climate change scenarios in The Netherlands, including land, carbon and water footprints.

Table 6. Sweden case study

Case study name	Sweden
Case study type	National
Case study summary	The Swedish case study focuses on the Nexus of water-climate-forest. It tries to establish the optimal use of Swedish resources for the purposes of climate change mitigation and adaptation. As both water quantity and quality are affected by forests, climate change is expected to alter forest's role in regulating water flows and influencing water availability. Moreover, rising temperatures, increasing annual rainfall and the longer growing season are gradually making Sweden a more attractive place to grow forest biomass. The interactions of forest, water and climate change as an overarching issue promise to be of crucial importance in future years. The research concentrates on the alternative uses of the additional biomass potential (carbon sequestration in standing forests versus increased bioenergy production), additional hydropower potential, and the consequences for the available water supply and quality, and potential impact on other water goods and services. The goals of the case study are to increase the understanding of forest-water interlinkages in the context of climate change, as well as to bring research and stakeholders together and communicate the results.
Case study learning goals	You will learn how increasing afforestation for biomass and energy production interferes with water management policies aiming to reduce risks of flooding, droughts, water shortages for hydropower, and water quality, related to climate change.

Table 7. Greece case study

Case study name	Greece
Case study type	National
Case study summary	The Greek case study is on a national scale with an emphasis on energy needs and water scarcity issues. Tourism causes a high demand for water, energy and food resources in the summer. Energy, both in the form of fossil fuels and renewables, is therefore a focus. Agriculture, which is also a major sector in Greece, will soon potentially be encumbered with a fee for water. A main drive for this case study is to apply water saving practices in agriculture. One goal for the implementation of the case study is to provide advice to policy makers about the interdependence of energy, water and food. Another goal is to provide knowledge to adapt agricultural practices. Water and energy are the main concerns with a focus on tourism and agriculture as key sectors of the economy. Climate change impacts are also taken into account.
Case study learning goals	You will learn how national policies in the domains of water management, energy production, climate, food, land use, agricultural and tourist sector affect each other and result in changes in food production, tourism, greenhouse gas emissions, and quality and quantity of water resources.

Table 8. Latvia case study

Case study name	Latvia
Case study type	National
Case study summary	The Latvian case study will quantify the potential of biomass for energy production, and consider interlinkages with the other Nexus components water, food and climate in the context of climate change. Latvia has a high potential for renewable energy, but remains largely dependent on imported fossil fuels and electricity. Small hydropower plants do not deliver high energy values, but are rather harmful for nature. There is a threat of increasing use of fertilizers, herbicides and pesticides due to the increased planting of fast growing energy plants and crops; eutrophication and water pollution from phosphorous and nitrogen are main concerns. The study will evaluate abatement costs of different energy policies, and their impacts on water, air, biodiversity, land use and future climate change. Policy priorities relate to low-carbon development and climate change mitigation. The case study will address trade-offs between biomass and energy security, aiming for the sustainable production of energy.
Case study learning goals	You will learn how national and local policies aiming for a low carbon economy and energy autarky interact and affect policies in the domains of land use for forestry and biomass production, biological food production, ecosystem services, and water quality management.

Table 9. France-Germany case study

Case study name	France-Germany
Case study type	Transboundary
Case study summary	The case study focuses on the factors enabling or constraining transboundary governance on climate adaptation in the Rhine river basin. The main question is how to identify and decide upon pathways to achieve the below 2°C target in a balanced way. The energy transition in the Rhine region is an example at the heart of the EU new Climate Agenda (post COP21). Additional research topics concern synergies and trade-offs in policies regarding flood protection, water retention and design of natural habitats, reserves, and wetlands.
Case study learning goals	France-Germany: You will learn about the synergies and trade-offs in policies regarding flood protection, water retention and design of natural habitats, and wetlands on the one hand, and climate change adaptation and mitigation pathways, in the densely-populated, industrial area of the Upper Rhine.

Table 10. Eastern Germany, Czech Republic and Slovakia case study

Case study name	Eastern Germany, Czech Republic and Slovakia
Case study type	Transboundary
Case study summary	The transboundary Germany- Czech Republic-Slovakian case study focuses on the effects of land use management and water retention policies on two water related indicators under stress - water quantity and quality. Agro-urban zones (intensive agriculture and non-permeable urban surface) are areas with higher temperatures (heat islands). The heat is a contributor to unstable air that concentrates as clouds over areas with lower temperatures. As a result, there is less rain over the agro-urban zones, and too much rain over the mountain zones. Retention in ecosystems will lead to decrease of run-off, production of sensible heat through evaporation and instead of vertical clouds horizontal clouds with rainfall across wider landscape area can be formed which do not lead to torrential rains causing local and downstream floods. The transboundary project includes three countries: Slovakia, Czech Republic and Germany. The Czech Republic transfers water to Germany through Elbe/Labe river. Slovakia is not physically connected but faces similar issues. The greater fluctuation of water supply in downstream Germany leads to seasonal flooding, as well as a shortage of water for agriculture during dry periods, lower water quality, and sedimentation in the Elbe estuary.
Case study learning goals	You will learn about the interrelations between effects of upstream land use and water retention policies and downstream stability of flow that may prevent floods and sedimentation, and water availability for irrigation in the Elbe/Labe basin. You will learn about land use policies that increase retention of rainwater in forested, agricultural, and urban landscapes; retention in ecosystems will lead to decrease of run-off, and reduce vertical cloud formation that leads to heavy local rainfall and flooding in other areas.

Table 11. Continental case study

Case study name	Continental (Europe)
Case study type	Continental
Case study summary	The European case study includes all five aspects of the Nexus in examining the transition to a low carbon economy. The goal is not to give details on the energy transition itself, but on the interactions with other elements of the Nexus. The case study will investigate how the transition will affect each sectoral policy's objectives. It will explore both the economic policy incentives to facilitate the transition - as well as the wider economic impacts of making it. The relationships between the various elements of the Nexus will be approached via both technical demands and economic linkages. Examples of technical demands are water demand for food, energy crops and hydropower, and the climate impacts on agricultural yields. Examples of economic linkages via prices for goods and resources; are the impact of climate and energy policy on land prices and how these in turn affect food prices and food accessibility.
Case study learning goals	You will learn how policies targeting indicators for one of the sustainable development goals impact those for other goals, in particular with respect to indicators for renewable energy, water, food security related goals as well as planetary boundaries, in a European context.

Table 12. Global case study

Case study name	Global
Case study type	Global
Case study summary	The global case study will focus on global challenges (e.g. increasing food demand) and international trade features, with policy priorities on food security, resource efficiency, low-carbon energy and climate change mitigation, water availability and vulnerability to water stress and floods, water quality, biodiversity and ecosystem services. Given the high level of integration and the low level of detail, the case study will mostly be used to identify the prevailing Nexus policy challenges, and to find broad-scale synergies and trade-offs between options in achieving various Sustainable Development Goals, and to inform about divergence, robustness and flexibility of global development pathways. The global case study is useful to provide the global context to the smaller scale case studies, and to highlight synergies and trade-off at the global scale, which are informative to the regional case studies. The main focus will be on the impact of water constraints on food security and human development as well as the impact of climate change on aggravating or relieving water problems.
Case study learning goals	You will learn how policies targeting indicators for one of the sustainable development goals impact those for other goals, in particular with respect to indicators for renewable energy, water, food security related goals as well as planetary boundaries, in a Global context.

5 Common Framework

The previous section has introduced the case studies and the learning goals. For the SIM4NEXUS serious game we envision a generic game shell in which specific games for each case study can be loaded. This chapter presents the common framework, comprising the generic shell and table formats to specify the unique characteristics of the game loads for the cases studies. The first section (5.1) describes the idea of a generic shell with case specific loads. The second section (5.2) describes how the case specific loads can be characterised. Using these concepts, the third section provides a first characterization of the case studies in terms of involved actors, policy objectives and indicators.

5.1 Generic game structure

The serious games for the cases studies will be implemented in a generic shell, equipped with general facilities for user interfacing, data presentation, data base access, knowledge elicitation, and artificial agents advising the player about possible actions or playing the role of other actors in the system. As depicted in Figure 4, the generic shell can be loaded with specific cases. A case is specified by one or more missions, expressed in policy options and target values of indicators, such as greenhouse gas emissions, employment, GDP, water quality indicators, biodiversity indicators, etc.

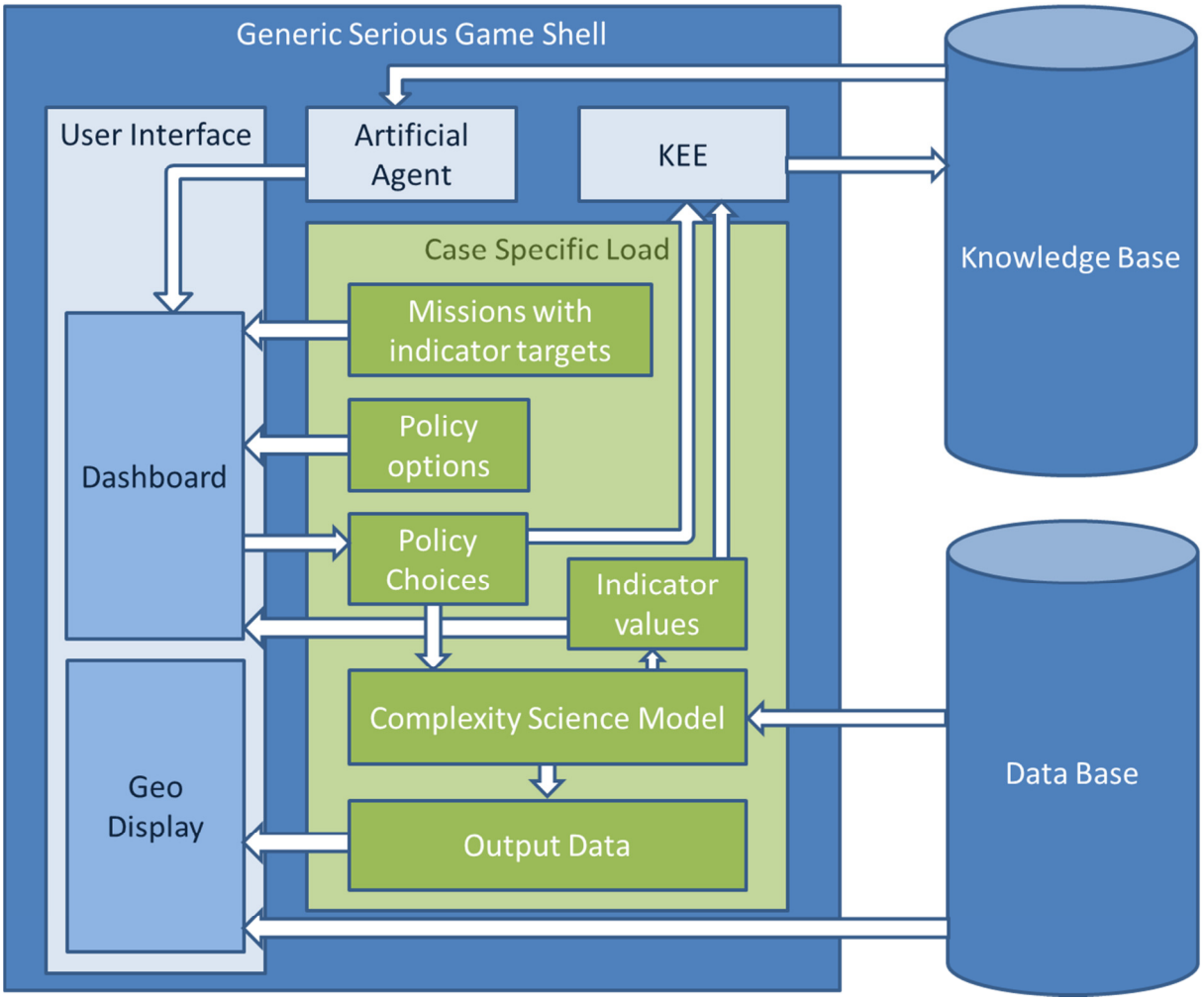

Figure 4. Relations between components of the generic game shell and specific case study load

When the generic shell is loaded with a specific case, the player is presented with a mission in terms of indicator targets, and a set of policy options, as describe in Chapter 2. The player's policy choices are input to the complexity science models (developed in WP3), which simulate the behaviour of the nexus for one period. After the indicator values and the geographic data display have been updated, the player can adjust the policy choices, and so on. In the end the players' performance in the game is assessed by comparing actual indicator values with the missions' target values.

A player can be advised by an artificial agent, using the SIM4NEXUS knowledge base. In addition to nexus knowledge from a diversity of sources, the knowledge base contains information about previous choices made by the current and other players, and the resulting evolution of the indicator values. The Knowledge Elicitation Engine (KEE) continuously records data about policy choices and resulting indicator values, and uses those observations to build an extending body of knowledge about the behaviours of players and the consequences of their actions.

5.2 Concepts to characterize specific games

As described in the previous section, the generic shell can be loaded with specifications of games for different cases. The core of a specific load is a complexity science model, developed for a particular case. The complexity science model simulates the behaviour of the nexus, based on the players' policy choices. As a result, the indicators of the system's status are updated and reported to the players. Important concepts to characterise the case specific load are the interlinkages between nexus components covered by the complexity science model, the policy options available to the players, and the indictors to assess performance. Figure 5 depicts these and other concepts which are required to specify the case specific load.

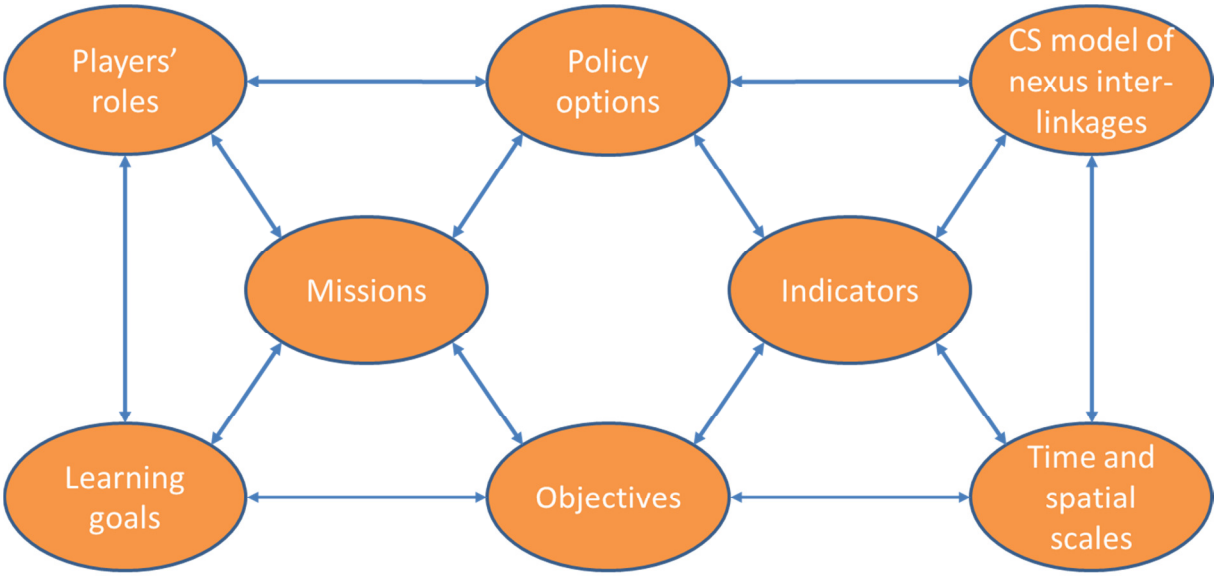

Figure 5. Concepts that specify case studies for the Serious Game

In addition to the interlinkages, policy options, and indicators, the load of a case is characterised by spatial and time scales, the players' roles, and the missions with policy objectives in terms of targeted indicator values that implement the learning goals. These aspects must be precisely specified in order to develop a game load for a case study.

5.3 Characterization of the case study loads

This section presents a fist characterization of the case studies. The goal of this exercise is to identify the potential players of the game, to provide background for concretizing the learning goals into missions, and to identify indicators that can serve as assessment criteria. We will first compare the case studies with respect to coverage of the interlinkages, and then compare the case studies with respect to actors, policy goals, and indicators, respectively. Preliminary ideas from some case studies on policy choices to be offered to players, and the knowledge to be learnt from their decisions, is presented. The section is concluded by a discussion of the results.

5.3.1 Coverage of the interlinkages by the case studies

Based on the case study descriptions and the learning goals described in Chapter 4, and the data collected with the formats as included in Appendix A, we can compare the case studies with respect to the relevance of interlinkages between nexus components. Table 13 compares the regional and trans-border case studies with respect to the salient interlinkages. As it appears from Table 13, water management and its interlinkages with policies on the other nexus components are the main policy issue in most regional and trans-border case studies.

Table 13. Salient interlinkages for the regional and trans-border case studies

changing component / affected component	climate	water	food	land use	Energy
climate		R:Andalusia R:Sardinia T:FR-DE T:DE-CZ-SK	R:Andalusia R:SW UK	R:Andalusia T:DE-CZ-SK	R:Andalusia
water			R:Andalusia R:Sardinia R:SW UK T:DE-CZ-SK	 R:SW UK T:FR-DE T:DE-CZ-SK	R:Andalusia R:Sardinia T:FR-DE
food	R:Andalusia	R:Andalusia R:Sardinia R:SW UK T:DE-CZ-SK		 R:SW UK	
land use	 T:DE-CZ-SK	R:Andalusia R:Sardinia R:SW UK T:FR-DE T:DE-CZ-SK	 T:DE-CZ-SK		 R:SW UK T:FR-DE
energy	R:Andalusia R:Sardinia R:SW UK T:FR-DE	R:Andalusia R:SW UK T:FR-DE	R:Andalusia	 T:FR-DE	

Legend for spatial scale: R: regional; N: national, T: trans-border; C: continental; G: Global

Table 14 compares the national, continental, and global case studies. In these case studies, the interlinkages concerning energy policy are important issues in addition to water management. For the design of the game, we may conclude that water management is the central topic for the regional and transboundary case studies, while for national, continental, and global cases the low-carbon economy will be the central topic setting preconditions for policy decisions in other nexus domains.

Table 14. Salient interlinkages for the national case studies

changing component	affected component climate	water	food	land use	energy
climate		N:Latvia N:Sweden N:Netherlands C:European G:Global	N:Greece C:European	N:Greece N:Latvia N:Sweden	N:Greece N:Sweden
water			N:Greece C:European	N:Greece N:Sweden N:Netherlands	N:Greece N:Latvia N:Sweden C:European
food		N:Greece N:Latvia N:Netherlands C:European G:Global		N:Greece N:Latvia N:Netherlands C:European	N:Latvia
land use		N:Greece N:Latvia N:Sweden N:Netherlands C:European	N:Latvia N:Netherlands C:European		N:Greece N:Latvia N:Sweden C:European
energy	N:Greece N:Latvia N:Netherlands C:European G:Global	N:Sweden N:Netherlands C:European G:Global	N:Latvia N:Netherlands C:European G:Global	N:Greece N:Latvia N:Sweden N:Netherlands C:European G:Global	

Legend for spatial scale: R: regional; N: national, T: trans-border; C: continental; G: Global

5.3.2 Case studies compared with respect to involved actors

The decision making actor types in the case studies have been identified using the information in the case study posters on www.sim4nexus.eu and the data collected with the format described in Appendix A. The actor types are compared across the case studies in Table 15.

Table 15. Types of actors mentioned as decision makers by the case studies

Decision making actor type	Andalusia	Sardinia	SW UK	DE-CZ-SK	FR-DE	Greece	Latvia	Sweden	Netherlands	EU	Global
International organisations (EC, UN, OECD, etc.)										X	X
International river basin committee				X	X						
National ministry of environment				X	X	X	X		X		
National ministry of agriculture/food				X		X	X		X		
National ministry of planning/development				X		X	X				
National ministry of economy/tourism/infrastruct.						X	X		X		
National ministry of foreign affairs						X					
National water management authority				X	X	X		X			
National energy agency						X		X			
National forestry agency								X			
Regional ministry/agency of environment	X	X			X						
Regional ministry/council of agriculture	X				X						
Regional ministry of tourism	X	X									
Regional water and environment agency	X		X		X						
Regional energy agency	X		X		X		X				
Regional water management authority	X	X	X	X	X	X		X	X		
River basin authority	X										
Regional forestry agency											
Local port authority				X	X						
Counties / municipalities			X	X	X	X	X	X			
Drinking water/sewerage companies		X	X	X		X	X	X			
Power companies	X	X	X		X	X	X		X		
Farmers union	X		X	X		X	X		X	X	
Water users associations	X										
Forest owners/organizations								X			
NGOs	X		X	X	X		X	X			
Private sector						X			X		
Labour Unions						X					

5.3.3 Case studies compared with respect to policy objectives

Policy goals are important attributes of the case studies. In the game design they will be used to concretize the learning goals into missions that can be evaluated with respect the player's understanding and ability to influence the Nexus, while taking different interlinked aspects (climate

change, water, food, land use, and energy) into account. Table 16 presents the policy goals that have been identified using the information in the case study posters on www.sim4nexus.eu and the data collected with the format described in Appendix A.

Table 16. Policy goals mentioned by the case studies

Policy goal	Andalusia	Sardinia	SW UK	DE-CZ-SK	FR-DE	Greece	Latvia	Sweden	Netherlands	EU	Global
Sustainable development goals						X		X		X	
Food security						X				X	X
Resource efficiency					X	X		X			X
Low carbon economy		X	X		X	X	X		X	X	X
Energy self-supply							X				
Management of conventional energy			X			X					
Diversification of energy sources		X				X	X				
Renewable energy	X		X		X	X	X	X	X		
Bio-economy				X			X				
Reduce climate impacts	X		X	X	X	X		X			
Flood/drought risk management		X	X	X	X	X		X	X		X
Reduce local heavy storms				X							
Reduce river flow fluctuations				X	X						
Surface and ground water quality	X	X	X			X	X	X			
Sustainable water withdrawals	X							X		X	
Biodiversity		X		X	X	X	X				X
Protected nature areas				X	X	X				X	
Green areas (urban and forest)				X		X					
Economically healthy agricultural sector						X				X	
Sustainable forests								X			
Land use management					X	X			X		
Involve economic sectors in policy									X		
Economic development						X	X			X	
Employment		X		X		X	X				
Improve tourist product/services		X		X		X					
Sustainable/biological food production		X				X	X				
Food/nutritional quality						X					

5.3.4 First inventory of potential indicators

Indicators measure the status of the nexus. When policy changes have been made by players, the indicator changes measure the success of their actions. In training programs the indicator values can be used as criteria to assess a player's learning.

In the case study formats according to Appendix A and in the learning goals reported in Chapter 4, many indicators are proposed (see Table 17). For the learning purposes of the game, the number of indicators must be limited. In the design of the games, a selection of indicators must probably be

made, or some indicators may be combined using weight factors. For now, we have this long list, indicating potential assessment criteria that can be used in the games for the respective case studies.

Table 17. Indicators mentioned by the case studies and in the learning goals

Indicator	Andalusia	Sardinia	SW UK	DE-CZ-SK	FR-DE	Greece	Latvia	Latvia	Sweden	Netherlands	EU	Global
Population						X				X		
GDP (per sector)						X	X	X		X		X
Employment (per sector, esp. agri and tourism)	X	X		X		X	X					
Tourist arrivals	X	X		X		X						
Resource efficiency (GDP/resource usage)	X									X		X
Energy consumption			X			X	X	X		X		
Fossil fuel consumption						X					X	
Imported/total energy consumption							X	X				
Renewable/total energy consumption	X	X	X			X	X		X	X	X	X
Ren./total en. consumption in transport									X			
Bioenergy production				X			X	X		X		
Hydropower energy production		X			X		X	X	X			
Wind/solar energy production	X	X	X				X	X				
Nuclear energy production								X				
Energy production/consumption in agriculture							X					
Power supply emissions			X									
GHG emissions	X	X				X	X	X	X	X	X	
Length of growing season									X			
Water demand		X			X	X					X	
River discharge				X	X				X			
Water temperature					X	X						
Nutrient concentrations		X					X					
Nutrient loads							X					X
Regulation of rivers					X				X			
Flood risk & droughts			X	X	X	X			X	X		X
Heavy storm frequency				X								
Water retention/flooding area				X	X				X			
Evaporation from diverse land types				X								
Erosion / land degradation				X								
Surface and ground water quality						X	X		X			
Sulphur deposition												
Nutrient retention									X			
Agricultural water consumption	X	X		X		X				X		
Irrigation area	X			X								
Water balance	X											

(Table continues on next page)

Indicators mentioned by the case studies and in the learning goals (continued)

Indicator	Andalusia	Sardinia	SW UK	DE-CZ-SK	FR-DE	Greece	Latvia	Sweden	Netherlands	EU	Global
Cropland area	X			X		X			X		X
Pasture area	X			X		X					
Forest area				X		X	X				
Area set aside for nature				X						X	
Urban area				X		X			X		
Green urban area				X		X					
Area for biomass production							X		X		
Biomass production (photosynthesis)				X				X			
Ecosystem services		X	X		X	X	X				
Biodiversity intactness/aquatic vegetation				X	X	X				X	X
Fish species and algal blooms				X	X	X					
Demand agri products (food, feed, biofuel)	X					X			X	X	
Crop production	X								X	X	X
Livestock production	X								X	X	X
Farm Income (revenue, cost)	X									X	
N,P,K balances	X		X								
Trade flows	X									X	
Food/crop prices - quantities	X									X	
New land										X	
Water and land requirements for energy			X		X		X		X		
Environmental indicators for forestry								X			
Sustainability assessment			X				X				
% sustainable/biological food production		X					X				
Food quality and nutritional value						X					
Purchase price of wood							X				
Purchase price of biofuels							X				

5.3.5 Policy options

For the first revision of this deliverable, the case studies were asked for preliminary ideas on policy options to be implemented in the game. Due to the stage of definition and stakeholder interaction, most case studies could not yet provide a good overview at the time of data collection for this report. Some case studies could already present some ideas. Table 18 presents ideas on the type of policy choices to be presented to players.

Table 18. Suggestions for policy choices to be realized in the game, for some case studies

Case study name	Policy choices/interventions available to players
European	The policy choices and interventions will be related to major EU policy initiatives related to the elements of the NEXUS (e.g. water framework directive, Natura 2000, Energy Roadmap etc...). The tools for policy interventions would be in the form of taxes (such as a carbon tax or a tax on meat consumption), subsidies (such as subsidies for renewable energies, organic farming etc...) and regulations (such as restrictions on land, fertilizer and water use).
Sweden	- Subsidies for different types of renewable energy production (biogas, biofuel from forest biomass, hydropower, etc.) - Taxes on different types of energy (e.g. biofuel from biomass) - Regulations regarding groundwater abstraction - Regulations regarding felling rates
Latvia	We would wish to include the existing support mechanisms operated in Latvia: feed-in tariffs for electricity, net-metering, VAT tax allowance on the supply of biomass and biogas, biofuels (info source: www.res-legal.eu/search-by-country/latvia/)
Greece	- Subsidies - Funding opportunities - Taxes - Policy goals - Policy means (to achieve the respective goals) - Business opportunities

5.3.6 Learning from player's decisions

One purpose of the game is to learn from policy choices made by players. The Knowledge Elicitation Engine (KEE) is to facilitate this learning. For the first revision of the present deliverable, the case studies were asked what to learn from players' choices in the game. As for the policy options, most case studies could not yet provide a good overview at the time of data collection for this report. Some case studies could already present some preliminary ideas. Table 19 presents ideas on learning from players' actions.

Table 19. Suggestions for learning from players' actions

Case study name	What to learn about the decisions
European	It is currently envisioned that the players of the game would be staff at NGOs and EU policy departments that would typically be focused solely on their single element of the NEXUS. The hope it that this game would facilitate a common understanding on the importance of coherent EU NEXUS policy. The knowledge we would hope to elicit from them when they play the game would be - How narrow is their current focus? Are they just looking for solutions for their area of the nexus in a zero sum game type of thinking or are they also looking for solutions that involve synergies between nexus areas? Are they aware of the effects of policy in their nexus area would have on other areas in the nexus? - Do their strategies change during game play? How do they respond to threats to their area of the nexus after some experience in the game? Do they actively look for synergistic solutions? Do they understand the importance of the other elements of the nexus? Do they understand the impact of policy in other elements of the nexus on their own nexus element? And the other way around; do they understand the impact of policy in their element of the nexus on the other nexus elements.
Sweden	- Which sector is prioritized by players (e.g. forest versus water)? - To what extent can players be influenced by information about previous choices made by other players?
Latvia	We would like to learn on players choices with regard: - Use of imported fuel/electricity import versus local production from RES e.g., biomass. - Many small energy generation installations versus 1 large scale installation; - Centralised electricity production versus decentralised electricity production in small scale CHP on biomass, biogas or from wind or solar power. - Export of biomass/biofuels versus promotion of local use.
Greece	- Strategic-future plans of players - Preferences of players - Priorities of players - Investment options of players - Issues that the players change after the 'inspection' of the consequences - How they change their future plans with respect to the consequences - Possible alternative future solutions / scenarios of players

5.3.7 Discussion of the results

In the work presented in this chapter we have identified commonalities and difference across the case studies. This information is useful for the design of the generic game shell and the specific game loads for the case studies. Table 17 identifies potential assessment criteria. Actual indicators and assessment criteria to be used, must be specified in the next steps of the game design.

Tables to compare policy options and time scales and time/spatial resolution across the use cases must still be composed. At the current stage of definition of the case studies in the project, this information is not yet available.

Furthermore, the information presented in this chapter represents a snapshot of the current state of case study design. The data may require updating in the course of the project, which makes this report a “living document”.

6 Conclusions and recommendations

A first version of the learning goals has been provided in this report in Chapter 3, considering every particular and specific characteristics of each case study at this stage of the project. As mentioned in previous sections, this report has to be considered as a living document which will evolve along project execution, iterating learning goals definition, to better fit case studies' necessities while maximising project results and impact.

However, this report goes far beyond this specific objective. In Chapter 2, the general principles of the serious game have been introduced to build a first common understanding of potential roles of the game in training and policy processes, making case study leaders and other relevant involved actors understand which the capabilities of a serious game tool are, and leading to a better definition of the learning goals.

In addition, in Chapter 3, a methodology to define the learning goals has been defined. This approach has been used to support this report, and will also be used in future iterations as the project gains insights on each case study. Thanks to this methodology, which results in a set of guided steps for information collection and learning goals definition, a more comprehensive and precise analysis has been carried out. More concretely, this has helped: (i) the case study leaders and other involved actors to better explain their needs and objectives, (ii) the collection of requirements in a common framework, (iii) a collaborative discussion and evolution of requirements, decisions, and objectives, and finally, (iv) the definition of the learning goals.

A framework to fit the different terms in a common manner has been defined in Chapter 5, which is linked to the methodology. The common framework includes the case studies definitions, together with their indicators, interlinkages, time and spatial scales, objectives, and also relates this entities with their respective missions, roles and learning goals in the Serious Game.

In conclusion, great efforts have been devoted at this early stage of the project to fulfil the task objectives (Task 4.1), not just for the report per se, but because of the high complexity of the task, i.e., understanding all the case studies, entities, relations and restrictions. The methodology used has covered successfully the necessities for this tasks, and therefore, it will continue being the basis for any future iterations of this report. Next steps will rely on more results coming from other Work Packages, interviews, and other sources, which are expected to bring more precise information. Accordingly, more concrete learning goals will be able to be defined, tailored to each case study, and maximising impact.

Appendix A: Format used to structure data about the cases studies

The following pages contain the format used to collect and structure data about the case studies. The case study leads were requested to complete the form by e-mail:

"Dear case study leader,

In Task 4.1 we are currently working on definition of the learning goals for the serious game. We plan to have instantiations of the game for each case study, based on the policy goals and the "complexity science models" to be developed for the case studies. The games can be used in the case studies to interact with stakeholders. In addition, they can be applied in more general contexts like training programmes and courses.

We foresee two learning loops in the game. Firstly, users can try and experience the effects of policy interventions on the complex of NEXUS components, through the interlinkages. The game will be based on missions to be accomplished by players. Missions will have multiple objectives, for instance: increase employment in the tourist industry on Sardinia with ...%, while reducing greenhouse gas emissions with ...%, increasing sustainable local food supply with ...%, and increasing ecosystem services with ...%.

In a second, wider, loop, the system can learn from the players' actions. The purpose of this wider loop learning, is to gather data on stakeholders' decisions and to offer insight into the consequences of the decisions for the NEXUS. The second loop will be supported by artificial intelligence (the "Knowledge Elicitation Engine"). We hope that, in the future, artificial agents based on the collected data can be implemented in the game, which can take the roles of particular stakeholders. Thus, we aim to enable simulations of interactions between policy processes on different NEXUS components and different levels of aggregation, in addition to the biophysical processes.

Now, first we must collect information on the case studies. The information to be collected includes the relevant interlinkages, the policy objectives, the stakeholders involved, and the indicators and input data to be used. We intend to describe each case study using a format like attached to this e-mail. We hope that you will help us by completing and returning the attached format by 1 November. Our planning is to present and discuss a draft version of the deliverable D4.1, with proposed leaning goals for each case study, in the case study workshop in Barcelona, 16 November.

With kind regards,
…"

SIM4NEXUS: Case study information needs for the serious game
(Task 4.1: define learning goals of SG)

The purpose of this format is to collect information on which **a first version of the learning goals of the serious game can be drafted for each of the case studies**, and on the basis of which the learning goals can be compared with respect to coverage of interlinkages between the NEXUS components, policy objectives, indicators used, data sources and models, involved actors and expected contributions to the case study outcomes.

We are aware that the level of detail requested in this format may not be completely available in the present phase of the project. We just request you to fill out the format as far as possible on the basis of the information you now have about the case study. As a next step we plan to propose learning goals for the case study and discuss these with the case study leads.

An example of the format filled out for the Sardinia case study, as far as information is now available, is included as an annex.

Case study: ...

- Object system's characteristics
  - Spatial scale: (regional/national/continental/global)
  - Spatial resolution: (grid size or regional/national/continental/global)
  - Time scale: (1 year / several years / >10 years)
  - Time resolution: …
  - Interlinkages between NEXUS components relevant for the case study (please specify some narratives to explain the nature of each the relevant interlinkages at your CS (why? how?)

Relevant interlinkages for case study: ...					
Changing component	**Affected component**				
	climate	**water**	**food**	**land use**	**energy**
climate					
water					
food					
land use					
energy					

- Policy objectives and indicators for each case study: Can you please specify (preliminary ideas about) the development policy objectives to be set and attained in the case study and the indictors to be used to formulate the objectives?

Policy objectives and indicators for case study: ...				
Policy objective	**Indicator**	**Spatial resolution**	**Time resolution**	**Comment**

- Data sources and variables to be used in each case study (shape files, thematic data, statistics), as far as now known.

Data sources to be used in case study: ...				
Data source	**Variable**	**Spatial resolution**	**Time resolution**	**Comment**

- Models and inputs to be used in the case study: What are the current ideas about the use of thematic models (which models, based on which inputs to be used)

	MODEL		
INPUT	…	…	…
Climate change model			
Crop growth model			
climate change scenario			
development scenario			
reference year			
which input is used in which particular model			

- Actor roles (policy makers, businesses, education, research, NGO's, general public) which are expected to be relevant in the case study, and names or number of the actors

Actors involved in the policy process in case study: **…**				
Actor role	**Name or number of actors**	**Responsibilities of the actor with respect to the NEXUS**	**Which are the actors' options to affect the NEXUS**	**How is actor affected by the NEXUS**

- Which contributions to knowledge or decision making of the actors in the case study do you expect from the serious game.

Expected contributions from the serious game for case study: **…**				
Actor role	**Name or number of actors**	**Potential contributions to knowledge level of stakeholders**	**Potential contributions to decision making, facilitating the policy process**	**Potential insights on actors' behaviours to be gained by researchers**

Additional questions:

1. Is effective decision making with respect to the NEXUS and efficient resource utilization currently hindered by gaps in knowledge, awareness, decision making processes or skills? If so, which gaps exist in the case at hand?

…

2. Are any NEXUS interlinkages (partially) ignored in current decision making in the Case Study? If so, which interlinkages are ignored? (please indicate a priority order)

…

3. Could a serious game contribute to improve decision making with respect to currently ignored interlinkages? Consider opportunities like (not exhaustive):
    a. Educate current decision makers to be aware of interlinkages and consequences of climate change
    b. Find solutions by individually simulating the effect of interventions
    c. Experience how interventions by others can affect NEXUS components for which a decision maker is responsible
    d. Support collective decision making in joint gaming sessions involving different stakeholders

…

4. If relevant, what could policy makers (involved in the case study) learn from a serious game, at a general level (insight into the importance of interlinkages) and in particular decision processes (simulating effects of alternative interventions and of interventions by made others).

…

5. What could other policy makers (not involved in the case study) and students learn from a serious game simulating the present case study?

…

6. Would such a serious game be interesting for the general public and, if so, what could the general public learn from it?

…

ANNEX: example of filled-out format

Case study: Sardinia

- Object system's characteristics
  - Spatial scale: regional: 1 region NUTS2
  - Spatial resolution: entire region
  - Time scale: long term (>10 years)
  - Time resolution: An internal time step for parts of the model (hydrology/water balance) which will be monthly; An overall time step for the complexity science model, which will be 10 years.
  - Interlinkages between NEXUS components relevant for the case study (please specify some narratives to explain the nature of each the relevant interlinkages)

Relevant interlinkages for case study: **Sardinia**					
Changing component	**Affected component**				
	climate	**water**	**food**	**land use**	**energy**
climate		Reduce hydrological risks			
water			Crop production		Hydropower production
food		Irrigation requirements			
land use		Eutrophication of reservoirs and pressure on the water storage capacity			
energy	Distribution networks for electricity and conflicts with energy providers limit the potential development of a low carbon economy				

- Policy objectives and indicators for the case study: Can you please specify (preliminary ideas about) the policy objectives to be attained in the case study and the indictors to be used to formulate the objectives?

Policy objectives and indicators for case study: **Sardinia**				
Policy objective	**Indicator**	**Spatial resolution**	**Time resolution**	**Comment**
A low carbon society	Greenhouse gas emissions.	The region		
Reduce hydrological risks				
halt the loss of biodiversity	Ecosystem services			
Increase employment	employment			
obtain a sustainable tourism sector	Number of visitors in shoulder months over total			

sustainable (local) food production	% of products produced in the region			
increase alternative power production	Alternative power production/total			

- Data sources and variables to be used in the case study (shape files, thematic data, statistics), as far as now known

Data sources to be used in case study: **Sardinia**				
Data source	**Variable**	**Spatial resolution**	**Time resolution**	**Comment**
Satellite image of the island				Likely not needed. If used, then from MODIS
Map: Position of the region in Europe		marker		
Map: Position of reservoirs with volumes above 1M m3	position			
Thematic map: Eutrophication of water bodies				
???	energy consumption	Aggregate for entire region (NUTS2)	Annual	12000 GW/h per year. Hydralulic 240GW/h ; Eolic 1600 GW/h; Solar 653 GW/h.
Demographics	population	Island level	annual	
Economics			Annual	15M tourists

- Models and inputs to be used in the case study: What are the current ideas about the use of thematic models (which models, based on which inputs to be used)

	MODEL		
INPUT	CAPRI	E3ME	GTAP
Climate change model - global circulation model??	not directly in CAPRI but through results from crop growth models	not applicable	not present
Crop growth model	LPjML, WOFOST		
climate change scenario	RCP 4.5 and 8.5	Depends on what policy you want implemented. Carbon tax to achieve a certain emission reduction?	the RCP linked to the selected SSP
development scenario	SSPs projection of GDP and Population growth (we can choose among the 5 SSPs)	See comment above.	SSPs projection of GDP and Population growth (we can easily choose among the 5 SSPs according to Floor's indication)
baseline year	2008 (2007-2009), ex-post data until 2011	2005	2011

input use	Model baseline: agricultural market projections from the AGLINK-COSIMO model; bioenergy from PRIMES.		

- Actor roles (policy makers, businesses, education, research, NGO's, general public) which are expected to be relevant in the case study, and names or number of the actors

Actors involved in the policy process in case study: **Sardinia**				
Actor role	**Name or number of actors**	**Responsibilities**	**Which are the actors' options to affect the NEXUS**	**How is actor affected by the NEXUS**
government	The regional ministry of the Environment	Formulate policy goals		
Regional Water Authority	ENAS	provision of water for irrigation and of quality water for urban use		
Drinking water provider	ABBANOA	quality water for urban use		
Electric companies	number?	Power supply		
Irrigation consortia	number?			
association of farmers				
association of tourist facilities				

- Which contributions to knowledge or decision making of the actors in the case study do you expect from the serious game and which insights in actors' behaviours do you expect to gain

Expected contributions from the serious game for case study: **Sardinia**				
Actor role	**Name or number of actors**	**Potential contributions to knowledge level of stakeholders**	**Potential contributions to decision making, facilitating the policy process**	**Potential insights on actors' behaviours to be gained by researchers**
government	The regional ministry of the Environment. The water authority Ministry of industry and energy		which policies to implement to reduce hydrological risks, halt the loss of biodiversity, to obtain a sustainable tourism and support the agricultural sector while accounting for the water criticalities	

Additional questions:

7. Is effective decision making with respect to the NEXUS and efficient resource utilization currently hindered by gaps in knowledge, awareness, decision making processes or skills? If so, which gaps exist in the case at hand?

…

8. Are any NEXUS interlinkages (partially) ignored in current decision making in the case at hand? If so, which interlinkages are ignored? (please indicate a priority order)

…

9. Could a serious game contribute to improve decision making with respect to currently ignored interlinkages? Consider opportunities like (not exhaustive):
    a. Educate current decision makers to be aware of interlinkages and consequences of climate change
    b. Find solutions by individually simulating the effect of interventions
    c. Experience how interventions by others can affect NEXUS components for which a decision maker is responsible
    d. Support collective decision making in joint gaming sessions involving different stakeholders

…

10. If relevant, what could policy makers (involved in the case study) learn from a serious game, at a general level (insight into the importance of interlinkages) and in particular decision processes (simulating effects of alternative interventions and of interventions by made others).

…

11. What could other policy makers (not involved in the case study) and students learn from a serious game simulating the present case study?

…

12. Would such a serious game be interesting for the general public and, if so, what could the general public learn from it?

…