H2020 Project COASTAL - Deliverable D6-revised v7 - Model and Data Inventory

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COASTAL
Collaborative Land-Sea Integration Platform

Model and Data Inventory

Deliverable D6 -REVISED
Version 7
WP2 Knowledge Transition T2.1 - Data and Model Base
Lead beneficiary: HCMR and SU

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DEM	Demonstrator, pilot, prototype	
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Executive Summary

The quantification of the physical, socio-economic and environmental coastal-rural interactions in the six representative case studies, (project objective 2), which is needed for the system dynamics modelling (WP4) is the main scope of WP2. This work package is a bridge between the qualitative and quantitative operations of COASTAL, transforming the mental maps created through local and scientific knowledge into quantitative data. This transformation is achieved through the use of existing databases and models developed by 3rd parties, and where necessary on newly collected data. The aim is to build the scientific model constructs that are needed for the synergistic analysis of the rural - coastal interactions, and for the performing the strategic business and policy analysis that is done by WP3. The first task of WP2 is to identify the data needs, and collect the data and models to support the quantitative analysis. This quantification includes the formulation of equations to describe the interactions between system state variables, thresholds and time delays, initial conditions, and model parameter settings. This deliverable is an inventory of the necessary data and models that are needed to transform concepts into model parameters for the system dynamic models. The structure of the deliverable reflects the two periods during the project when each MAL identified and recorded the data and models needed for their quantitative Stock-Flow modelling analysis. Data and models included in the first submission of the deliverable (January 2019) are included in APPENDIX A of this report and are based on each MAL's expected needs after the completion of the sectoral workshops for each case study.

Document Updates (May-September 2020):

Since the submission of the initial inventory there has been more interaction with the stakeholders (reported in D04, Tiller *et al,* 2020) and the MALs have identified a problem scope (reported in D12, DeKok *et al,* 2019) and have defined their basic model structure (reported in D13 Viaene *et al*, 2020). Thus, each MAL has had the opportunity to re-evaluate data and models needs and focus their respective inventories which are now presented in APPENDIX B (Tables B-1 to B-6). The interactions with the stakeholders were used to clearly identify each case areas problem that could be translated into system dynamic land sea interaction models by the use of quantifiable variables. This report contains a descriptive analysis of how each MAL made these connections and selected their set of data and models needed for this quantification and a table of problems identified for each MAL.

Updating the inventory at this stage can include links of the Stock-Flow variables in the structured models directly to the data and models that will be used to quantify the initial or normal values, delays, system limits, current trends and historic time series. The next WP2 deliverable D07, will outline quantitative information including available data and models that are/will be used to support/validate equations and parameter settings in the SD models that are (being) developed in the MALs. This deliverable will also summarize envisioned scenario analysis procedure and some reflections on relevant policies at international, regional and national levels according to the SD modelling and its anticipated outcomes. The

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update inventory of COASTAL Stock-Flow models Inventory of Data and Third Party Models are included as Tables in Appendix B.

The data inventory is useful in examining the availability of existing knowledge (in data and models) that are needed to quantify the main dynamic cause-effect synergies and define the baseline values of SD model variables for each case study. Adding to this the inventory is necessary for integrating and harmonizing the data and models from the different sources and for the different case studies, and involves analysis and evaluation of the availability, quality and usefulness of the data and models, as well as the spatial-temporal scales and periodicities of data and model results/outputs. Using a combination of data and background models can improve the accuracy and details of the SD modelling, while, a comprehensive metadata inventory will be useful in future studies contributing to the knowledge-exchange objective of COASTAL and increasing the potential of reusing data as well as validating the results.

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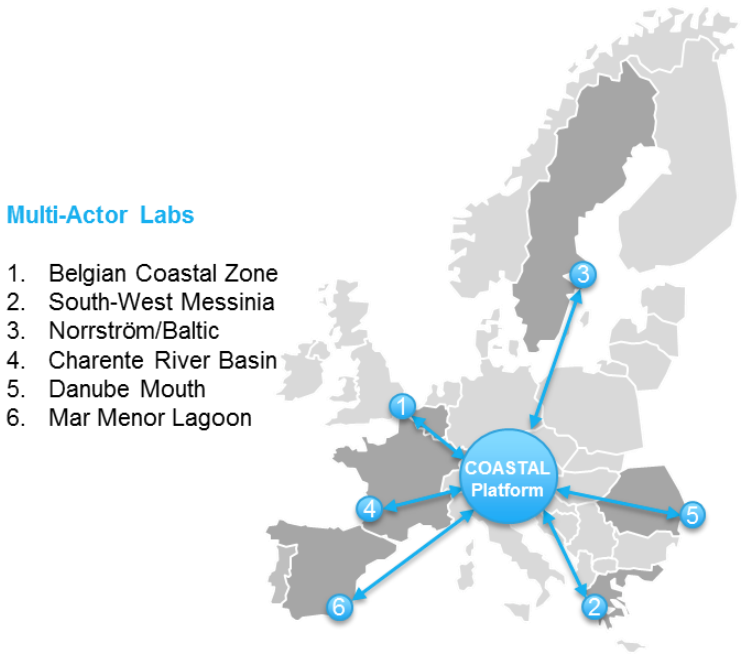
1 Introduction

COASTAL represents a unique collaboration of coastal and rural business entrepreneurs, administrations, stakeholders, and natural and social science experts. Local and scientific knowledge is combined to identify problems and develop practical and robust business road maps and strategic policy guidelines, aimed at improving land-sea synergy. In the core of the program lays the adoption of an interactive Systems Dynamics (SD) approach for supporting business decisions where local stakeholders are directly and indirectly involved in the formulation, testing and application of models to their own problem context.



i. Figure 1-1 Multi - Actor Labs (MALs) on the COASTAL Platform

The project is organised around interacting Multi-Actor Labs (MALs), combining tools and expertise for six case studies representing the major coastal regions in the EU territory (Figure 1-1). A series of workshops for stakeholders have been held for each MAL case study with focus on main problems and opportunities of each area. From these mental models or 'mind maps' have been produced clarifying the problem at hand and the way these are connected to specific policy or management indicators and potential solutions.

These mental maps (qualitative activities) are being used to identify the problems recognised by the stakeholders that will guide each case study leader to structure the Stock-Flow models (Deliverable D13 Viaene *et al*, 2020) of the key land-sea interactions for MAL area (quantitative activities). The development of the quantitative data and the scientific model constructs (project objective 2) is the focus and aim of WP2 with tasks defined based on the conceptual analysis of WP1, to bridge between the qualitative and the quantitative actions of COASTAL (Figure 1-2). This report answers to the first WP2 task, to identify the relevant data, models and their sources, which are needed and can be used to achieve the WP2 aim. As the project progresses all the MALs have the ability to identify and concentrate on problems and actions with the higher impact potential both for the stakeholders and the project partners. This process drives also a re-evaluation of the data and models needed to better describe these problems and opportunities as dynamic systems. As a result the inventory is treated as a live document where both anticipated and actual data needs are being recorded. The initial inventories of anticipated data and model needs for each MAL case study are listed in the Appendix A: COASTAL Stock-Flow models Inventory of Data and Third Party Models. (Tables A-1 to A-6). The updated data and model inventories which are directly connected to particular models and variables are listed in APPENDIX B (Tables B-1 to B6).

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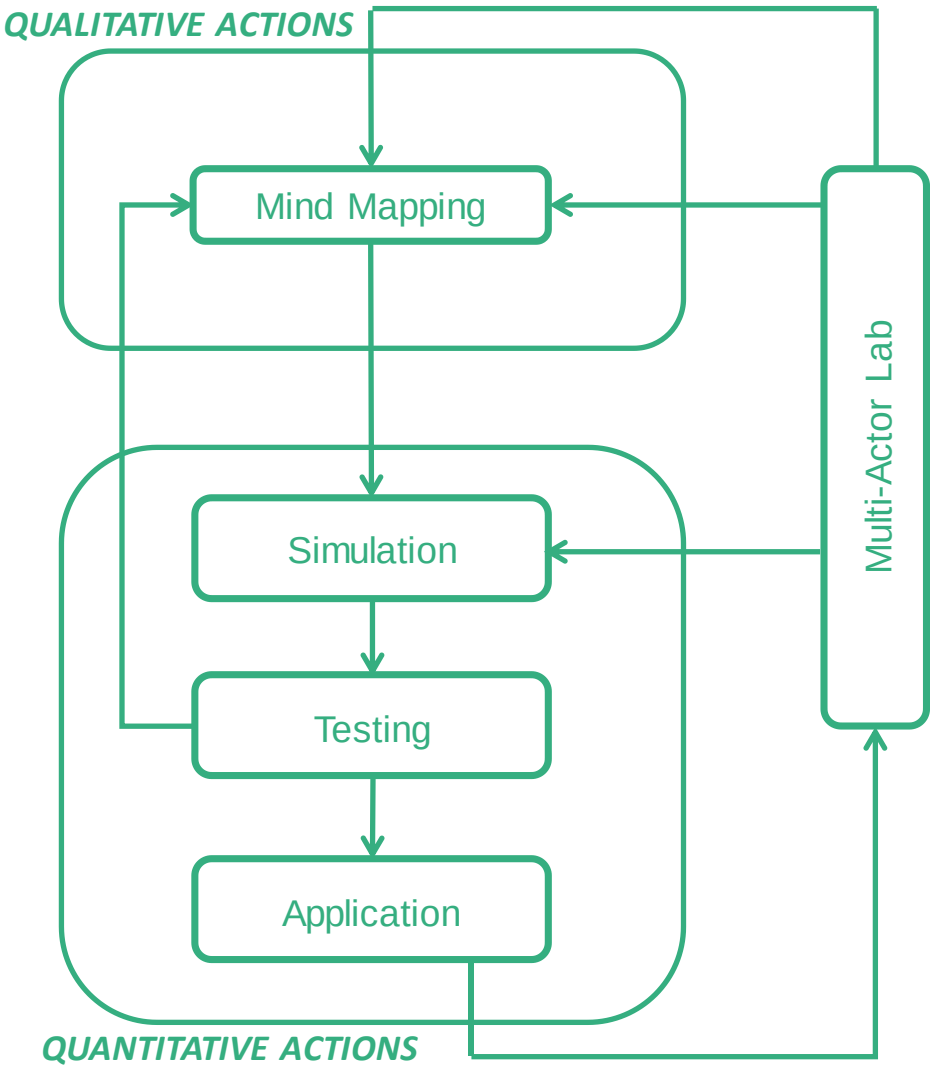

Figure 1-2 Workflow in COASTAL for designing, testing and applying SD-based tools together with the Multi-Actor Labs.

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2 Role of Deliverable

The objective of WP2 is to develop the quantitative data and scientific model constructs needed for synergistic analysis of the rural-coastal interactions identified in WP1. These need to be translated to the level of detail needed for strategic business and policy analysis (Figure 2-1). The tasks of WP2 are based on the outcomes of the conceptual analysis of the coastal-rural feedback dynamics analysed by coastal and rural stakeholders, actors, and researchers in the Multi-Actor Labs. This analysis has led to the identification of specific area problems recognised by the stakeholders which have guided the MAL leaders into defining the problem scope of each case study (DeKok, *et* al, 2019). To the extent possible, the focus of WP2 is on the translation and use of existing data and models developed by 3rd parties for the quantification of the social-economic, physical, and environmental interactions in a System Dynamics (SD) models by WP4 (System Modelling). This quantification includes the formulation of equations to describe the interactions between system state variables, thresholds and time delays, initial conditions, and model parameter settings (D7, due in December 2020).

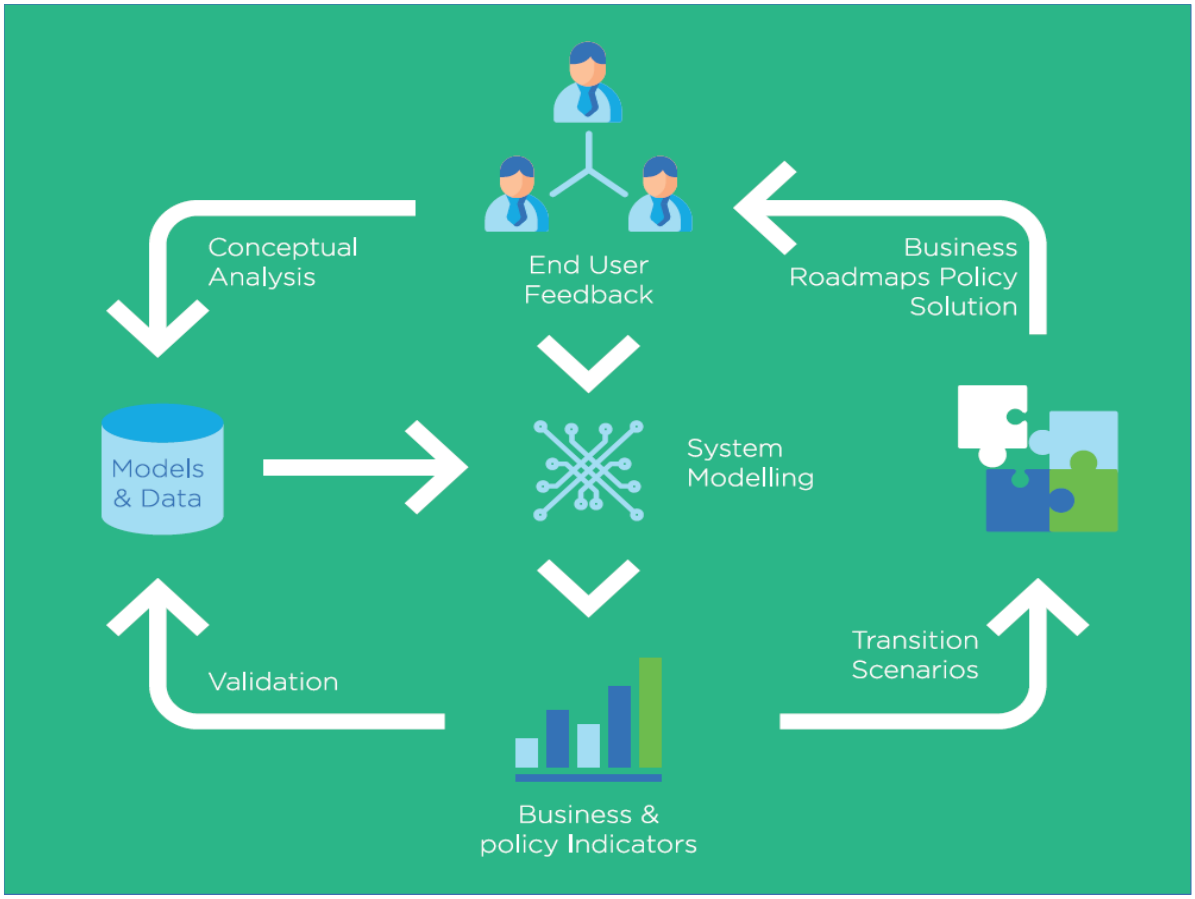

Figure 2-1 General workflow in the COASTAL project (https://h2020-coastal.eu).

WP2 will develop system behavioural tests and collect the supporting data and model components available for the calibration of the SD model (WP4) and the validation of the dynamic patterns for business

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and policy indicators for WP3 (Business and Policy Analysis). Generic modelling principles and algorithms will be developed to facilitate the exchange of knowledge between the case studies and reuse of model constructs, making the task of system modellers easier.
WP2 connects with WP1 and WP4 to delineate the problem context, potential causes, and spatial-temporal boundaries and resolution for the modelling based on the outcomes of the sectoral workshops with local actors and stakeholders. This information will be used to identify the data and associated models required for analysing the coastal and rural processes for each case study. In principle, field work and laboratory testing is avoided. It will be limited to fulfil the data needs for calibrating non-linear functions required to quantify the system feedback structures. The work of WP2 can be broken down into three subtasks:

- **Data and Model Base**: identifying the data needs, and collecting the data and models to support the quantitative analysis of the physical, socio-economic and environmental processes affecting land-sea feedback dynamics;
- **Knowledge Transition**: translating models and data into equations and parameters settings, allowing the quantification;
- **Confidence Building**: formulating tests and collecting data to assist WP4 with the scientific validation of the SD models

2.1 Data and Model Inventory

Deliverable D6 is a Data and Model Inventory – consisting of a comprehensive inventory of data and models for each case study, including problems and model boundaries, spatial-temporal scales, processes, variables and parameters that are needed for Task 2.2. (Knowledge Transition). The deliverable is structured in the form of presenting descriptive information, both on the models and the data to be used that are necessary to support the SD modelling activities of COASTAL (WP4). These system modelling activities are based on a problem-driven stock-flow modelling, referred to as SD modelling (De Kok et al., 2018). The general principle is to explain the dynamic transition behaviour of the land-sea system from the internal feedback structure of the system. The interaction of positive (reinforcing) and negative (balancing) feedback loops in the system affect the short-, mid- and long-term impacts of business and public policy decisions, which can sometimes be counterintuitive (Sterman, 2000). The ultimate goal of the SD modelling is policy analysis – analysing simulated policy impacts to support the formulation of business road maps and policy guidelines (WP3). An example of a stock-flow model is shown in Figure 4. The SD model describes the negative side-effects of continuing tourism expansion, which can push the pressure on resources (here the available space) until the maximum capacity is reached. This model uses two ‘stock’ variables: the total number of tourists and coastal attractiveness, and two ‘flow’ variables determining the change of the stocks (coastal and attractiveness *change*).

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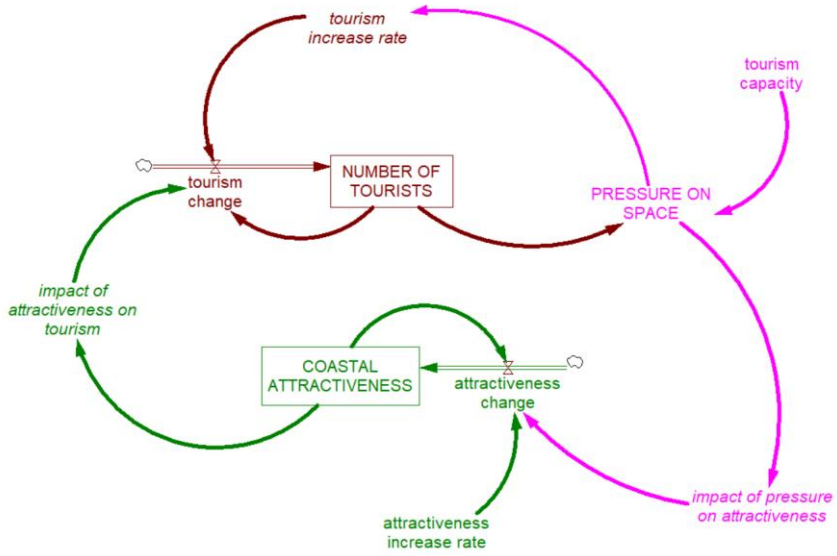

Figure 2-2 Example of a stock-flow model for coastal tourism, used to clarify the principles of SD modelling during the kickoff meeting (De Kok et al., 2018).

The variable 'Pressure on Space' is an 'auxiliary' variable (Sterman, 2000). This variable is a function of the stock variable 'number of tourists' and a model parameter 'tourism capacity', which is a constant in the model. Finally, we notice some variables are denoted as '*impact on… '*. These refer to non-linear dependencies between variables. For these COASTAL adopts and approach based on graphical 'table functions' (Sterman, 2000) which are easier to interpret than mathematical equations and can be designed interactively if necessary. An example of a non-linear table function for the impact of coastal attractiveness (a dimensionless variable with range 0-100) on tourism change is shown in Figure 2-3. The rate at which the attractiveness for tourism affects the tourism change will rapidly increase and slow down again when the maximum attractiveness is approached.

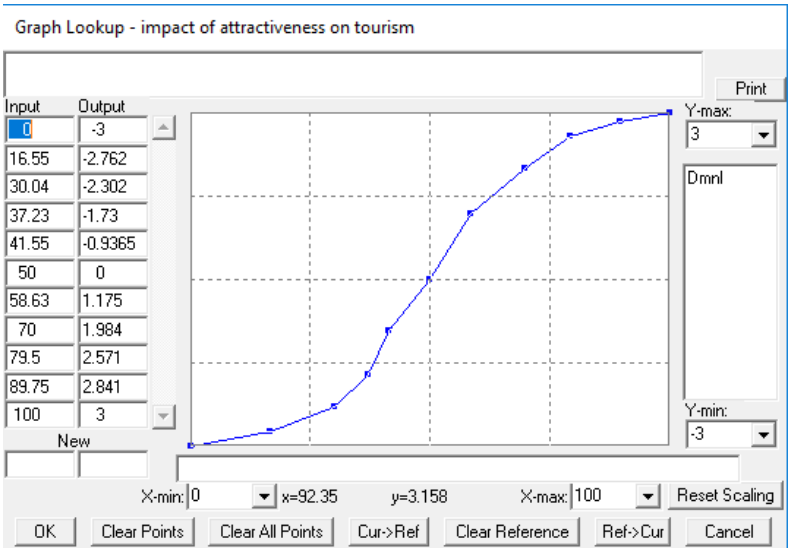

Figure 2-3 Example of a non-linear table function for the impact of coastal attractiveness on tourism change.

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In principle we distinguish three supportive functions for data and models: problem analysis, model design, and model validation. The example for tourism illustrates how data can be used in multiple ways:

- to analyse historic time series of data and graphs describing the problem, so-called 'reference modes' (Sterman, 2000)
- to set the initial values of the key system variables ('stocks')
- to determine the standard (normal) values of the rate of change of variables
- to fix constants used in the model (parameters)
- to define the shape non-linear functions, complementing human judgement
- for validation of business and policy simulations (using independent data)

This inventory contains descriptive information on the availability of data and models needed to transform the causal loops determined during the sectoral workshops and mind mapping activities of WP1 into stock-flow diagrams that will be needed to create the system dynamic models for WP4. The update of the deliverable was prepared after the finalisation of the structure of the models for each case study (Viaene *et al,* 2020), with the intent of connecting the models directly to the inventory

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3 Background

This deliverable is the basis for the creation of the system dynamic models as it includes an inventory of the necessary data and models that will be needed to transform concepts into model parameters. Such an inventory is necessary in order to identify, screen and collect the data and models needed for each case study (WP2 – obj1) and to formulate a model work plan for addressing the SD modelling of interactions (WP2 – obj2). However, parallel sector workshops and detailed analysis of the mind – maps will better define the demands on model and data based on detailed formulations of each case specific problem.

Since the initial inventory was submitted (January 2019), all MALs have made great progress towards the creation of their Dynamic-System models, which has resulted in re-evaluating the data and models needed for quantitatively describing the interactions of the Land-sea systems in the respective case studies

The process has included the identification of the problems acknowledged by the stakeholders, which has led to the establishment of a *Problem Scope* for each MAL (Deliverable D12, DeKok *et al,* 2019), the completion of the first round of MAL workshops and the creation of the Fuzzy Cognitive Maps (Deliverable D04, Tiller *et all,* 2020) and finally the generation of the Pilot Models and Structures for all MALs (D13, Viaene *et al*, 2020)

Updating the inventory at this stage can include links of the Stock-Flow variables in the structured models directly to the data and models that will be used to quantify the initial or normal values, current trends and historic time series. The next WP2 deliverable D07, will outline quantitative information including available data and models that are/will be used to support/validate equations and parameter settings in the SD models that are (being) developed in the MALs. This deliverable will also summarize envisioned scenario analysis procedure and some reflections on relevant policies at international, regional and national levels according to the SD modelling and its anticipated outcomes

3.1 Approach

The data tables included in the first submission of the report (January, 2019) reflected the data and models that were anticipated (and were available) to be used for transforming the characteristics of the land-sea interactions (stemming from the stakeholder descriptions during the sectoral workshops) into quantifiable parameters, variables and their inter-dependencies as necessary for the SD models. The report includes information on possible problems, model boundaries, spatial -temporal scales and processes.

After the finalisation of the structure of the Stock-Flow models for each MAL the data and models needed to quantify the variables and interdependencies were re-assessed with the intent of creating an updated inventory which is directly linked to the quantification needs of the Stock-Flow models.

3.1.1 Transforming Stakeholder Concepts to Models

Participatory, multi-actor approaches are the backbone of COASTAL and activities of the MALs. In these MALs, coastal and rural business entrepreneurs, investors, administrations, economic sectors, and stakeholder networks interact directly with domain experts to co-identify business and policy solutions with

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a maximum potential for societal uptake. COASTAL adopts an iterative and strongly participatory multi-actor approach, combining qualitative group-structuring techniques with quantitative SD modelling. This approach will help to increase the current level of understanding of the environmental, economic, and social processes affecting coastal and rural development. This multi-actor approach supported by participatory modelling techniques is used is to ensure a maximum potential for uptake by the target groups and stakeholder support and exploitation of local knowledge. The case studies for the MALs differ by their problem context, spatial scale, and social-environmental conditions. The organisation of sectoral workshops early in the project aimed at ensuring a full understanding of the local systems and in facilitating an effective information flow towards the development of qualitative and quantitative tools to be used later in the project. The stakeholder workshops produced a series of Mental Maps (6 for each MAL) that give graphical representations of each sectoral group's perceptions of the system in question and the problems and opportunities it presents (WP1 D03). The mental maps are useful in identifying ideas, investigating problems, and providing different perspectives without restrictions (Salerno, 2008). These ideas are linked with lines and arrows, which show and describe how the different concepts are perceived to be related to each other, in terms of propositions about the phenomena based on a representational ontology and epistemology (Scherp, 2013). These mental maps include the local descriptive knowledge and contain information relating to:

- The connections and flows between the different parts of the system in the form of arrows and nodes
- The different conceptual and categorical boundaries that shape the system in the way the different social actors categorise and shape each system
- the impacts and influences between land and sea in the way local actors interact with each other and the system

This descriptive knowledge of the system is being transformed into SD models as part of the tasks of WP4, using existing scientific models and readily available data, collected for each case study in WP2. The integration of stakeholders' perceptions and knowledge into formal knowledge increases a model's perceived utility and consequently the adoption of its results (Gray, *et al*., 2012; Elsawah, *et al.* 2015). Such integration requires the ability to capture the highly qualitative people's ways of thinking and transforming it into quantitative data to be used in decision support tools. The process of transforming the mental maps into Stock-Flow Models is not straightforward as it involves the transformation of qualitative conceptual descriptions into quantitative variables and equations and there are gaps in the process (Kok, 2009) resulting in several assumptions and simplifications. Nonetheless, including these qualitative constructs is important since, as Sterman (2000, p 854) states: *"Omitting structures or variables known to be important because numerical data are unavailable is actually less scientific and less accurate than using your best judgment to estimate their values*". The process of estimating, and making assumptions and simplifications needs to be transparent and consistent with the qualitative data, so that stakeholder engagement and social learning is supported (Kelly *et al*., 2013), while the possibility for quantification is maintained (Elsawah *et al*, 2015).

In COASTAL this stepwise process involved the identification of problems described by the stakeholders that guided the definition of each model's problem scope (Viaene *et al*, 2020). In addition, prior to creating

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the Dynamic system models (quantitative), the purely qualitative mental maps were transformed into semi-quantitative Fuzzy Cognitive Maps (FCMs) (WP1, D04 Tiller *et al*, 2020) used to distinguish between the *Drivers*, *Receivers* and *Central variables* of each descriptive system. FCMs can thus be used to analyse the key feedback mechanisms and causalities of systems by means of step-wise iteration (Tiller *et al*, 2020). At the same time, recognising stakeholder's problems and their causes (in term of actors and actions) as well as the actor-receptors, and the challenges faced, leads each MAL in the identification of the *Themes* of data and 3rd party models that are needed for the quantification.

Transparency in the modelling process is an important aspect of COASTAL, reflected by the project title ('knowledge exchange') and the consortium agreed to participate in the Open Research Data Pilot of Horizon 2020 and FAIR principles for use of metadata. The creation of a data inventory assists identifying the variety of quantitative factors that will be used to model the land-sea interactions for each case study. In addition it is being used to examine the availability of knowledge and data that are needed to quantify the main dynamic cause-effect synergies and define the baseline values of SD model variables for each case study. Furthermore, according to the outcome analysis of the sector workshops in each case study and the definition of the main variables that represent the land-sea interactions, the data and model inventory will be used to identify data gaps and look for proxies or determine if further research is necessary to complement the data (Luna Reyes and Andersen, 2003).

The initial identified data, models for each MAL case study are listed in the APPENDIX 1 of this deliverable. Whereas the updated inventory is included in Appendix 2: COASTAL Stock-Flow models Inventory of Data and Third Party Models.

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4 Case Studies

The case studies for the MALs differ by their problem context, spatial scale, and social-environmental conditions (Table 4-1). With this range of case studies and desk cases, COASTAL covers different spatial scales, time spaces, data conditions, locations, expectations, and targeted sectors. However, several main activities are shared between more than one case studies, thus the generic data are structured in a similar format following the categories of the socio-economic and environmental characteristics that shape its system.

Table 4-1 Characteristics of the 6 case studies

Socioeconomic aspects	Belgian Coastal Zone	SW Messinia	Norrström / Baltic	Charente River Basin	Danube Mouths – Black Sea	Mar Menor Lagoon
Scale	Regional (1000 km2)	Local-Regional (< 200 km2)	Multi-scale (20 – 400 x 1000 km2)	Regional (10.000 km2)	Local – Regional (1000 km2)	Regional (1200 km2)
Agriculture	✓	✓	✓	✓	✓	✓
Fisheries /aquaculture	✓	✓	✓	✓		✓
industry	✓	✓	✓		✓	
offshore energy	✓	✓	✓			
Tourism	✓	✓	✓	✓	✓	✓
transport	✓		✓	✓	✓	
typical barrier	Lack of synergy	Lack of synergy	Water quality	Fresh water scarcity	Economy	Water scarcity
typical opportunity	Offshore energy	Tourism /agriculture	Land and marine spatial planning	Eco-tourism	Eco-tourism	Tourism and Blue Growth

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4.1 Belgian Coastal Zone (North Sea)

4.1.1 Description of case study

The Belgian Multi-Actor Lab focuses specifically on providing business and policy opportunities for a region suffering from intensive use of space and competition for resources, combined with a fragmented governmental context (municipal, regional and federal level). The Belgian coast and harbours are a regional responsibility of the Flemish Region, whereas the Belgian North Sea is a national (federal) responsibility. Although the different administrative levels make an effort to address problems in an integrated way this need for collaboration complicates the practical implementation of solutions aimed at land-sea synergy. Along the relatively short Belgian coast (67 km length) and its hinterland rural, coastal and sea-based activities such as agriculture, fisheries, agro-food industry, transport, energy production, and recreation are closely interwoven and compete for space, resources and infrastructure. A Marine Spatial Plan is in function, and an updated version covering 2020-2026 will be issued by 2020. COASTAL has the ambition to connect and reinforce the different policies for a sustainable use of marine space, exploiting new development opportunities related to blue growth. Offshore energy production is expected to create new job opportunities and the strategic specialisation of port activities such as for Ostend makes Belgium one of the leading countries in know-how related to offshore energy production, including multi-purpose use of wind farms. Meanwhile, the quality of freshwater resources is under pressure, and land-based emissions of nutrients still exceed the EU-WFD target levels and contribute to coastal eutrophication. The quantities of fresh water are under pressure during extended periods of drought, as a result of multiple demands from industry, tourism, population and agriculture. A major stressor is the increasing salinisation of inland waters, related to human waterworks, water management, and sea level rise. Limited water resources and decreasing surface water quality put pressure on the traditional activities in the rural hinterland. A combination of factors leads to increased salinisation which poses problems for traditional agriculture but might offer an opportunity for alternative forms of agriculture or aquaculture. Based on the expertise and infrastructure of coastal tourism, developing sustainable rural and/or agro-tourism can provide additional income for the hinterland. Economic and environmental opportunities are found as well in the sectoral restructuring and modernization, improved integration in the rural food chain with diversification, changes in farming practices and other new business opportunities**.** The available data and/or models to address the issues of the Belgian case study are presented in Appendix A Table A-1.

4.1.2 Data selection Process and Inventory Update (September 2020)

After careful deliberation with the local actor partners it was decided to build the systems modelling around two cases with strong land-sea interactions requiring a holistic analysis of the problem:

- Sustainable decommissioning of offshore wind parks and life cycle management;
- Climate-resilient management of water and land resources in the Oudland polder

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Data availability is not considered a determining factor or limitation for the modelling of the Blue Industry model (decommissioning) by both the R&D and local actor partners. Statistics and reports are publicly available and accessible online. The challenge with the modelling is in the uncertain driving factors (for example innovation) for which projections need to be developed.

Also for the second model case (polder management) concerns on data availability are mainly related to uncertain effects of drivers such as politics and lifestyle. Physical processes such as the prevailing hydrology are quite well understood and field data are being collected as well as a new water balance for the region will be developed, commissioned by the local actor partner VLM (Flemish Land Agency) as part of the new Regulatory Framework to ensure climate resilience of the polder. Detailed future land-use data will be obtained at a 100 m resolution from urbanisation scenarios derived with the VITO land-use change model (RuimteModel) for the period 2020-2060.

The updated data and model inventory used in the Stock –Flow models of the Belgian case study is included in Appendix B, Table B-1

Table 4-2 Problems identified by MAL1 Stakeholders and the related models

Problem Description	What/Who Causes problem	Who is affected	Land/sea interactions relevant? (Y/N)	Which model deals with this problem? (D13)
Waste, logistics, infrastructure and skilled labor	Decommissioning and repowering of aged wind parks	Regional economy, marine environment, regional population (employment), port administrators	Y	Port and offshore activities
Climate change (sea level rise, flooding frequency, droughts)	Global population, economic activities and transport	Global population, marine environment, coastal population	Y	Port and offshore activities
Climate change – water resources	Sea level rise, droughts and salinization, use of water resources, trafficability	Regional farming	Y	Climate resilience and polder management (Oudland Polder)
Land use change - gentrification	Urbanization and gentrification of farming land leading to loss of food producing capacity	Regional farming activities, and population	Y	Climate resilience and polder management (Oudland Polder)

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4.2 Greece - South West Messina (Eastern Mediterranean Region)

4.2.1 Description of case study

Agriculture (mainly olive trees) and coastal tourism are the two major economic activities in Western Messinia, Greece. Tourism is expanding and goes hand in hand with infrastructure development (hotels, roads and airports) and can provide opportunities for diversified livelihoods, but also increases pressures on the agricultural land uses, the environment and cultural sites. These conflicts are also enhanced by the lack of a regional and local spatial plan for the coastal and rural areas. Coastal areas are also affected by agrochemicals, soil erosion, solid waste landfills, and waste waters. In particular waste products from olive production form a threat to surface and coastal water quality. Climate change is expected to increase coastal erosion and decrease the availability of freshwater, with increased risk for saltwater intrusion into coastal wetlands and aquifers. There are also plans for offshore oil and gas exploration that will have implications for the area's rich coastal biodiversity. The study area comprises several important cultural sites and Mediterranean habitats included in the reference list of the Natura 2000 initiative. The MAL will develop a number of alternative strategies for local economic development that will allow a diversification and strengthening of a sustainable local economy while minimizing the impact on the Natura 2000 sites. Long-term planning for sustainable tourism and agriculture will take into account resilience to future climatic changes, exploiting the expertise and experience of local stakeholders. The data identified as useful for the quantification of the system parameters and their links at the time of the first submission of the deliverable are presented in Appendix A– Table A-2 (*Table of Data and model themes and main descriptors of the Greek Case Study (as anticipated on December 2018 after preliminary analysis of Stakeholder concept maps*).

4.2.2 Data selection Process and Inventory Update (September 2020)

Although SW Messinia MAL is a relatively small and locally focused case study, there is still high complexity in terms of Land – Sea interactions and the environmental and social components of the relating system. This complexity is highly evident in both the problems identified by the stakeholders (Table 4-3) and the System interactions identified for D12 as part of the process to creating the System Dynamic Models (De Kok, *et al.,* 2019). The System Dynamic models created for the SW Messinia MAL were chosen to relate to the common vision agreed by our stakeholders of a *Sustainable Messinia, expanding across all sectoral practices and ensuring a collaboration among them* (D04, Tiller *et al*., 2019). Based on the problems recognized (Table 4-3) by the stakeholders we identified eight key challenges that are part of this goal:

- Improve the ecosystem status of Gialova Lagoon whilst maintaining a viable fishing activity
- Reduce the use of pesticides/fertilizers in olive groves in compliance with the Green Deal
- Expand of the tourism season and manage the numbers of beach goers in high season
- Identify opportunities for fishers and farmers to better connect with the tourism industry

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- Plan for climate change including potential sea level rise and increased dry spells
- Manage the increasing and seasonal water demand
- Reduce the bulk sales of olive oil.
- Manage the pressures for land use change in order to maintain the *Identity* of the area

The problems identified and the challenges recognized were grouped into 3 System Dynamic models for quantification the design of which was based on the CLDs co-created with the stakeholders during the sectoral (D03 Tiller, et al, 2018) and MAL workshops (D04, Tiller et al 2019).

i. Integrated Farming
ii. Lagoon Salinity
iii. Tourism

The problems identified can either be characterized as internal, caused by competition for the use of resources such as land and water, or external to the system caused by climatic changes or national policies. Many of the drivers of these problems relate to social perceptions and lifestyle choices which are difficult to quantify, whereas the lack of data monitoring has been identified by the stakeholders as a problem, which meant that for MAL 2 there was also a lack of data relating to the environmental status of the water bodies in the area. To balance this lack of data MAL2 undertook several field visits in order to define the environmental status of inland, coastal and marine water bodies. The data collected through these field visits will be subsequently used to quantify the models, and will become freely available after the end of the project, as described in the data management plan. For all other data we relied on open access databases and published papers as well as expert knowledge and inputs from our actor partners (Appendix B Table B-2).

Table 4-3 Problems identified by MAL2 Stakeholders and related models

Problem Description	What/Who Causes problem	Who is affected	land/sea interactions relevant? (Y/N)	Which model deals with this problem? (D13)
Lack of cooperatives (obstacle for: provision of knowhow and services such as smart agriculture; ISO exports;	Land fragmentation, farmers' mentality, poor cooperative management in the past, lack of vision	Farmers' income, Water resources, Exports, Local economy	N	Integrated farming
Ageing population (Youth is not interested in agriculture)	Insecurity in the farm; Job opportunities in tourism provide a more attractive lifestyle;	Agricultural sector; promotion of agri-tourism	Y	Integrated farming
Increase of diseases leading to increased use of pesticides	Increased humidity and temperatures	Farmers, Fishers, Ecosystem	Y	Integrated Farming
Increased occurrence of Invasive Species	Climate Change - Sea temperature	Fishers	N	Tourism

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Increased need for Irrigation	Climate Change - Increasing temperature, changes in precipitation events	Farmers, Local Population, Ecosystem	N	Integrated Farming
Bulk sales of Olive Oil	Increased number of non-professional farmers; Lack of cooperatives; Insecurity; Lack of vision	Olive-oil price; Branding potential; Profit from olive-oil sales;	N	Integrated Farming
Agro-Chemical Runoff	Conventional Farming Practices	Biodiversity, Water resources, Olive-oil quality; Ecosystem; Water resources; Tourism; Fishing;	Y	Integrated Farming, Lagoon Salinity & Tourism
Land Use Change Conflicts	Lack Of Spatial Planning, Building of new hotels.	Farmers, Local Population, Ecosystem	Y	Tourism
Poor Natura 2000 management	Local and Regional Governance, Unstable Natura Management Policies –National	Lagoon fishers; Tourism; Ecosystem; Water resources;	Y	Lagoon Salinity
Increased lagoon salinity	Past management efforts and man-made constructions; Climate change; Lack of water management; Increased need for groundwater resources (irrigation and domestic use) during the dry period - Poor Natura Mananagement	Fishers; Tourism; Ecosystem;	Y	Lagoon Salinity
Poor Ecosystem Status of Gialova Lagoon	Lack of management plan, farming practices	Ecosystem; Fishers	Y	Lagoon Salinity
Waste and wastewater management	System capacity vs number of visitors;	Ecosystem; Water resources; Local community; Tourism; Fishers	Y	Tourism
Lack of monitoring and data	Poor organization; lack of instruments; political will	Overall system (e.g. difficult to apply smart agriculture; limited data for water management; etc.)	Y	Lagoon Salinity, Integrated Farming
Liquid wastes from olive-mills	Outdated Olive oil production practices	Fishers; Tourism; Ecosystem; Water	Y	Integrated Farming

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		resources		
High seasonality in tourism	Tourist practices	Ecosystem; Water resources; Local community; Tourism; Fishers	Y	Tourism
Litter	Tourism, Waste Management, Population Behavior	Ecosystem, Fishers, Biodiversity, Local Population	Y	Tourism
Lack of Marine Fishing Shelters	Lack of Marine spatial Planning, National Policies, Regional Governance	Fishers	N	n/a

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4.3 Sweden - Norrström/Baltic Sea

4.3.1 Description of case study

The Baltic Sea is one of the world's largest brackish water bodies, with a land catchment area about four times larger than the sea surface area. In the Swedish part of the Baltic catchment, the Norrström drainage basin and its adjacent and surrounding coastal zones (MAL3 in COASTAL) is a key area with a large human population. It includes the Swedish capital of Stockholm as well as agricultural and industrial activities, contributes considerable nutrient loading to the Baltic Sea, and suffers from eutrophication and harmful algae blooms resulting from such loads (HELCOM, 2017) also in the MAL3 archipelago and coastal waters. International agreements and environmental regulations put in place since decades still have not managed to sufficiently decrease the nutrient loads from land to combat the severe eutrophication, hypoxia and algae bloom problems in the coastal and marine waters of the Baltic Sea. To overcome difficulties in managing and decreasing the nutrient loads from land to sea different physical and socio-economic aspects needs to be addressed, such as, uncertainties about biogeophysical system behaviour (Destouni et al., 2017; Levi et al., 2018) combined with social fairness issues (Gren and Destouni, 2012), major gaps in relevant environmental monitoring (Hannerz and Destouni, 2006; Destouni et al., 2017), and dominant nutrient legacies from historic-to-present human activities, with unclear sector responsibility for the difficult (if not practically impossible) mitigation of their considerable contributions to current nutrient loads (Destouni and Jarsjö, 2018). How to achieve sufficient management and mitigation of the nutrient loads in the short and long term, under changing human pressures and hydro-climatic conditions, is a key problem to address in MAL3 for the sustainable development of this coastal zone and its rural and urban hinterland areas, as for the entire catchment and coastal region of the whole Baltic Sea. Furthermore, also other environmental and social challenges need to be addressed and met for achieving sustainable development in this coastal region, such as managing coastal groundwater (Mazi et al., 2016), maintaining ecosystem services (Goldenberg et al., 2017) and enhancing human wellbeing (Goldenberg et al., 2018) under multiple regional changes and change drivers. The available data and support models relevant to the main issues of the Swedish case study at the time of the first submission of the deliverable are presented in Appendix A Table A-3 (*Table of data and model themes and main descriptors for the Swedish (Norrström/Baltic Sea) Case Study – The list was prepared on December 2018 based on an overall compilation of available and relevant data and support models*).

4.3.2 Data selection Process and Inventory Update (September 2020)

There is a high complexity of land-sea interactions and linkages between different system components in MAL3, as shown in the co-developed causal loop diagrams (CLDs) from sector workshops (presented and discussed in project Deliverable D12. Model Scope and Feedback Structure, submitted on January 2019). System dynamics (SD) modelling in MAL3 has focused on the policy/market-driven land-, water- and

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nutrient/eutrophication-management problems outlined in Table 4-4, using water flow as a tracer to address scenarios and impacts of possible hydroclimatic changes and local/regional developments in the MAL3 land-sea system. Various sectors and ecosystems involved in these problems are also highlighted in this table. Considering data and model (results) availability in MAL3, two sub-models are developed as: (i) Sub-model 1. Land-sea inter-sectoral water exchange; and (ii) Sub-model 2. Land-sea inter-sectoral waterborne nutrient exchange.

The problem areas in Table 4-4, consider regional developments that may cause sectoral competition for land and water in MAL3, mainly involving forests and forestry, agriculture and urban areas (and also possible associated agro- and urban tourism expansions). Hydroclimatic changes (with main model focus on potential precipitation changes in different directions) also affect these sectors, seawater intrusion risks, and terrestrial and coastal-marine ecosystems through changed water through flows and availability and waterborne nutrient loads. Urbanization and associated population and tourism growth scenarios also have implications for storm water runoff and associated sector and ecosystem problems as outlined in Table 4-4. Hydroclimatic change may exacerbate both drought and waterlogging problems in agriculture and forestry, with large investment requirements for handling by drainage and irrigation infrastructure. In general, decreased water flows to the coast, possibly in combination with sea level rise on the sea side, increase the risk of seawater intrusion and limit water availability for all users of coastal groundwater. In addition to currently active sector sources of waterborne nutrient loads from land to the coast, subsurface legacy sources also contribute significantly to the total coastal nutrient loads, thereby affecting coastal-marine water quality and ecosystem status. The legacy sources and their load contributions are commonly not monitored but their influence and implications for the addressed MAL3 problems (Table 4-4) are still being accounted for in Sub-model 2. Land-sea inter-sectoral waterborne nutrient exchange.

The two developed sub-models in MAL3 can address and quantify how different types of land- and water-uses and possible shifts in these, driven by various relevant scenarios of future changes in hydroclimate, markets, or policy implementation/enforcement, can be expected to affect (i) coastal water flows, fresh-sea water interactions, and seawater intrusion risks; (ii) water through flows and availability for different sectors and terrestrial ecosystems; (iii) waterborne nutrient loads from/through various sectors and terrestrial water ecosystems to coastal-marine waters and ecosystems. These sub-models can also be used to assess how policy-driven such change scenarios may affect possible future regional developments in MAL3.

To quantify these sub-models, we have in MAL3 mainly used established openly available data, model results, and model equations reported in peer-reviewed scientific publications. The list of variables in the two SD sub-models for MAL3, and the sources of data and supporting model results and equations used to quantify these are presented in the Appendix B – Table B-3 Further details, information, and explanations of this quantification are reported in project Deliverable D13. Pilot SD Models for Coastal-Rural Interactions – Case Study Level, submitted in July 2020.

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Table 4-4 Problems identified by MAL3 Stakeholders and the related models

Problem Description	What/Who Causes problem	Who is affected?	land/sea interactions relevant? (Y/N)	Which model deals with this problem? (D13)
Land competition among urban, agriculture and forestry sectors	– Land availability	– Urban and agriculture sectors – Forests and forestry – Wood and paper industries – Users of coastal groundwater (through water flow changes and associated seawater intrusion risk) – Coastal-marine ecosystems (through water flow changes and associated nutrient loads to coast-sea)	Y	Sub-model 1: land-sea inter-sectoral and coastal water exchange & Sub-model 2: land-sea inter-sectoral and coastal waterborne nutrient exchange
Water availability for terrestrial ecosystems (through surface and subsurface water flows)	– Precipitation change (decrease) – Urban and agricultural sector developments	– Terrestrial ecosystems	N	Sub-model 1: land-sea inter-sectoral and coastal water exchange
Urban expansion, population and tourism growth, associated water availability and supply	– Urban expansion – Associated urban tourism expansion	– Urban residents, and tourists – Municipalities – Water and wastewater utilities – Terrestrial and aquatic (freshwater and coastal-marine) ecosystems – Users of coastal groundwater	Y	Sub-model 1: land-sea inter-sectoral and coastal water exchange & Sub-model 2: land-sea inter-sectoral and coastal waterborne nutrient exchange
Water availability for municipal supply	– Precipitation change (decrease) – Urban expansion – Population growth – Urban tourism expansion	– Urban residents – Municipalities – Water utilities – Urban tourism sector – Users of coastal groundwater	Y	Sub-model 1: land-sea inter-sectoral and coastal water exchange
Storm water handling in urban areas	– Precipitation change	– Urban residents – Urban tourism sector	Y	Sub-model 1:

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	– (increase) – Impervious land surface expansion under urban extension – Insufficient storm water handling capacity	– Wastewater treatment plants – Terrestrial and aquatic (freshwater and coastal-marine) ecosystems		land-sea inter-sectoral and coastal water exchange & Sub-model 2: land-sea inter-sectoral and coastal waterborne nutrient exchange
Water availability/waterlogging for agriculture and forestry	– Precipitation change (decrease or increase) – Agricultural and/or forestry expansion – Lack of irrigation infrastructure	– Farmers – Food sector – Agro-tourism sector – Forestry, wood, paper industry – Terrestrial and aquatic (freshwater and coastal-marine) ecosystems	Y	Sub-model 1: land-sea inter-sectoral and coastal water exchange & Sub-model 2: land-sea inter-sectoral and coastal waterborne nutrient exchange
Unconnected coastal wastewater handling	– Increased use of coastal houses, not connected to municipal wastewater treatment plants, for coastal tourism and/or more permanent living	– Coastal and marine ecosystems – Coastal residents – Coastal tourism sector	Y	Sub-model 2: land-sea inter-sectoral and coastal waterborne nutrient exchange
Lack of water flow and nutrient monitoring	– Lack of knowledge on main sources and spreading pathways from land to sea	– Environmental and water management authorities	Y	Sub-model 2: land-sea inter-sectoral and coastal waterborne nutrient exchange
Agricultural, food sector, energy, economic,	– Policy	– Relevant from the above	Y	Sub-model 1:

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climate, and/or environmental policy implementation and enforcement, driving any relevant above-described change scenario	– fragmentation – Potential goal conflicts	depending on policy scenario	land-sea inter-sectoral and coastal water exchange & Sub-model 2: land-sea inter-sectoral and coastal waterborne nutrient exchange

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4.4 France - Charrente River Basin (Atlantic Region)

4.4.1 Description of case study

The Charente river basin in the south-western part of France covers an area of 10,500 km², mainly comprised of rural areas. The Charente River flows into the ocean in the Pertuis Charente where it is largely influenced by the tide. At the river mouth, the Charente River supplies fresh water to the oyster basin of Marennes-Oléron composed of salt marshes and oyster fields. Marennes-Oléron bay is the biggest shellfish farming area in Europe for spat production, and also the largest in terms of the number of shellfish companies (SMEs) in France. Around 50,000 tons are sold per year, including 12,000 tons of mussels. Along the coast, fish markets in La Cotinière and La Rochelle account for around 9,000 tons of fish sold, equating to somewhere in the region of 49 million euros.

The Charente river mouth is home to three major marshes, under the control of the French Conservatoire du Littoral (the body responsible for preservation of the French coastline that watches over the protection of large natural areas of major ecological and landscape interests). Its extensive coastal marshes consist of salt marshes (150 km²) crisscrossed by an intricate network of channels and ditches, providing drainage, environmental purification, and a travel corridor for wildlife (fish, otters ...). Freshwater marshes (950km²) are located on the estuary and along Charente tributaries, partially drained and converted into meadows or crops (800km²). Continued cultivation of coastal marshes poses a real risk to biodiversity, endangering local fauna and the flora.

Other key issues in the area are restoring of the functionality of rivers and wetlands, and preventing risks of flooding and submersion further downstream in the Charente region.

Agriculture is the main hinterland activity influencing the development of the Port Atlantique-La Rochelle. Industrial activity is dominated by agri-food and wine production, around the cities of Cognac and Angoulême. At the same time, the two major trade ports in the area rely heavily on local agricultural produce. Port La Rochelle, which handles an average of 4 million tons of cereal pear year (and still growing), is the only deep-water harbor on the Atlantic coast with direct sea access. New opportunities for agriculture lay in the development of organic farming and viticulture, and related chain values. In the Charente case study, water in both coastal and inland areas is a prominent issue both in terms of quality (i.e. pollution by nitrate and pesticides notably with regard to the supply of drinking water) and quantity (impact on natural environments and availability of drinking water). In addition, particular concern relating to the availability of water has been enhanced by climate changes over the last decade. Most inland watercourses suffer from droughts and periodic low water levels. In this particular region, activities carried out inland (irrigation of crops, use of pesticides – particularly on vines used for Cognac production – and domestic use) have a significant impact on water resources. This impact is also felt downstream, in coastal areas, in significant sectors for the local economy such as tourism and shellfish farming. The region is also characterized by a contrast between the densely populated coastal fringe and inland rural areas with low population density. In addition, the continuous increase of residential elderly population on coastal zones has an important effect on land prices and changes of demand for products and services. Tourism is very

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important for the region's economy, with 8 million overnight stays recorded in 2016, mainly in the coastal area and during the summer months. All these inter-connections mean that any significant change in land use and economic activities will impact activities and employment in a number of sectors. The available data and/or models to model the issues of the French case study are presented in Appendix A Table A-4

4.4.2 Data selection Process and Inventory Update (September 2020)

The global SD model of the Charente site (MA4) has been developed using the causal loop diagrams that were co-built with stakeholders during several sectoral and multi-actor workshops and is related to the problems presented in (Table 4-5). However, the MAL4 team had to make some modifications during the development of the pilot SD sub models - water, agriculture, shellfish farming and infrastructure – to meet the constraints of dynamic modelling: some intermediate variables were added, others removed. All the data considered as the most important/relevant by our stakeholders in order to describe the land-sea system and its interdependencies have been included in APPENDIX B Table B-4.

The water model intends to link water uses in the land-sea system (and their possible evolution) and trends in water availability and water quality both in inland and coastal waters. The goal is not to replace existing hydrological models but to use the results of previous studies as an entry into our SD models. An annual time step appeared to be the most relevant for the simulations contemplated, although it does not allow seasonal variations to be taken into account in detail. Yearly time series on water flows, water fluxes and meteorological data are used as well as simulations with a SWAT model linking land use flows and nutrients fluxes.

The agricultural sub-model and the shellfish farming model considers the current systems and practices but also their possible evolution, dealing with climate change, water scarcity and land-sea interactions. Regarding the agricultural model, the transformation processes of the systems towards innovative systems that use less water or towards organic systems are considered. We use time series and expertise provided by CRANA and FRAB, and official statistics of the Ministry of Agriculture to qualify agricultural production, economical values and market trends. Average values are generated to qualify the main crops, - conventional or organic, irrigated or non-irrigated- in the area.

A sustainable coastal system requires the determination of the optimal shellfish biomass that can be produced without endangering biodiversity, which itself depends on inland coastal uses. To highlight these interactions, the shellfish farming model takes into account the 3 years production system and its dependence on the environment. The shellfish farming association (CRC) and Ifremer (research institute) are our main sources of data and expertise for the SD Shellish farming model at a yearly time step.

The infrastructure model aims at representing the development of residential coastal housing, the interaction of ports development with agricultural activity. Official statistics (government) and the management of local ports provide yearly time series and expertise as they were participants in all workshops. Water treatment plants and drinking water treatment plants will be included further with variables shared with the water sub-model, using data from the river basin agency.

A local data management plan has been initiated, allowing to describe for each variable the data source and to store it in an interoperable form (xls and csv).

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Table 4-5 Problems identified by MAL4 Stakeholders and the related models

Problem Description	What/Who Causes problem	Who is affected	land/sea interactions relevant? (Y/N)	Which model deals with this problem? (D13)
Significant environmental pressures from economic activities mainly agriculture, and tourism on water resources	Agriculture, Tourism, Increase of coastal population	water resources quality and quantity, Shellfish farming activities, Drinking water supply	Y	Sub model agriculture Sub model water Sub model shellfish farming
Competition for water and space	Urbanization, Tourism	Water resources, Sustainable Agriculture especially Organic farming, Livestock farming, Preservation of Natural areas, Shellfish farming	Y	Sub model agriculture Sub model water Sub model shellfish farming Sub model Infrastructure
Land-sea interdependencies	High dependence of downstream activities on upstream activities	Water resources, Agriculture, Natural areas, Shellfish farming, Ports	Y	Sub model agriculture Sub model water Sub model shellfish farming Sub model Infrastructure
Development of urban coastal population and tourism	Increase of residential elderly population, Increase of tourism	Water treatment plants(waste and drinking waters), Local supply chains and services, Spatial repartition of population and activities	Y	Sub model water Sub model agriculture Sub model shellfish farming
Agriculture is confronted to limitation of water availability especially in summer	Climate change, Droughts, Current agricultural business model	Irrigated agriculture, Water resources	Y	Sub model agriculture Sub model water
Sustainable development of port activities	The two major ports in the area rely on local agricultural produce for a sizeable portion of their business	Development of a more sustainable agriculture less focused on export vs intensive monoculture dedicated to export	Y	Sub model infrastructure Sub model agriculture
Impact of water quality on shellfish production (frequency of mortality, spat capture rate, viruses)	Inland activities, Urbanization	Traditional shellfish farming	Y	Sub model shellfish farming Sub model water

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Sea level rise, salinity, sea water intrusion	Flatness of the coast, Presence of important wetlands Effects of climate change	Shellfish farming, Marshes and natural areas Coastal activities (agriculture, tourism, urbanization)	Y	Sub model water Sub model infrastructure

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4.5 Romania - Danube Mouths (Black Sea)

4.5.1 Description of case study

Due to the semi-enclosed location and size of the contributing catchment area the Black Sea is vulnerable to anthropogenic pressures and pollution sources (BSC, 2008). The nutrient regime of the Danube has undergone significant changes due to increased economic activity, use of fertilizers, waste water discharges, and use of detergents, leading to changes in the Black Sea ecosystem. Eutrophication results in decreased transparency, higher quantities of organic matter decomposition and oxygen depletion with bottom waters becoming seasonally hypoxic or even anoxic. Since the early 90s decreasing nutrient inputs resulted in signs of recovery. Today the Black Sea catchment is still under pressure from excess nutrients and contaminants due to emissions from agriculture, tourism, industry and urbanization in the Danube basin. This prevents achieving the Good Environmental Status by 2020, as required by the EU-MSFD. The increased rates of eutrophication, pollution and bioaccumulation affect both the biodiversity (including Natura 2000 sites) and fishing sectors. Mass tourism is an important growth sector for the Black Sea and eco-tourism is becoming more important in the region. Approximately 65% of the Romanian coastline is located in the Danube Delta Biosphere Reserve and subject to tourism regulations, resulting in conflicts between nature conservation and economic development. Failing to resolve these conflicts has economic and political impact. Thus, the goal of the model is to explore alternative scenarios to improve the quality of life and sustainability within Danube Delta Biosphere reserve and its marine waters (Black Sea) as one of the most impacted area along the Romanian littoral. The available data and/or models to address the issues of the Romanian case study are presented in APPENDIX A Table A-5.

4.5.2 Data selection Process and Inventory Update (September 2020)

Data selection was done based on outputs of the CLDs variables derived during the sectoral workshops for Agriculture, Fishery (freshwater and marine), Tourism (rural and coastal), and Rural development. During the stakeholder meetings the ecosystem management and the environmental protection were not specified as a major concern. However, several variables (e.g. pollution, water quality, biodiversity) are part of more than one CLD, and as a result different environmental issues are related to the problems identified (Table 4-6). Additionally, one of the strategic objectives of the Danube Delta Strategy is to keep the unique natural values through an environmental management guided by science and by strengthening local communities in the role their proactive protectors of this unique world heritage (MDRAP, 2016). Accordingly, we decided to further develop a new sub model, *Ecosystem management*. It requires maintaining natural capital (water quality, biodiversity) as both a provider of economic inputs and outputs. The protection of natural systems represents not an overarching panacea for achieving economic vitality and social justice, but a necessary component of an entire system for achieving economic, social, and environmental 'sustainability', in which economic reforms and social reforms are as important (Basiago, 1999). This sub-model structure contains all relevant variables related to the environment (Danube Delta and Black Sea). These are further supplemented with some new ones like *Freshwater Quality* and *Black Sea water Quality*, *Low economic fish species*, *Birds*. The *Biodiversity* stock was moved from the Tourism sub

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model as the most important ecosystem service of the Danube Delta Biosphere. In this phase links between sub models were created as shadow variables which refer to variables defined in other sub-models: *Pollution from agriculture*, *Pollution from basic services* and *Pollution from tourism* are inputs for the rate of *decreasing freshwater quality*. We replace the *pollution* from Freshwater Fishery with *Freshwater quality* and from Marine Fishery with *Black Sea water quality*. Thus, the *freshwater quality* in the Danube Delta is calculated as function of the *upstream water quality* and *climate change* variable related to *the river flow*. The freshwater quality it is also improved through *ecological restoration* and management measures taken based on *research* and *monitoring* activities. The water quality in the Danube Delta is deteriorated by pollution from different sectors – agriculture, tourism, and basic services. The water quality is an important input to the increase in biodiversity which is the main ecosystem service of the biosphere reserve. Another important link is with the Black Sea water quality which is significantly influenced by the river's outflow not only due to freshwater but also pollutants. The updated data inventory is presented in APPENDIX B Table B-5.

Table 4-6 Problems identified by MAL5 Stakeholders and the related models

Problem Description	What/Who Causes problem	Who is affected	land/sea interactions relevant? (Y/N)	Which model deals with this problem? (D13)
Lack of the area's sustainable development	Incoherent governmental and local administrations and excessive bureaucracy	Business area (business planning, lack of facilities for investors and of compensatory measures, tourism), Social area (health, incomes, protection, jobs) Ecosystem services (pollution from different sectors)	Y	Tourism Freshwater Fishery Marine fishery Ecosystem management
Conflict between Marine Protected Area (MPA) and the exploitation of resources	Incoherent governmental and local administrations and excessive bureaucracy	Fishermen Local people	Y	Freshwater Fishery
Clogged canals	Water and Danube Delta administration	Biodiversity Water availability	Y	Tourism
Illegal, Unreported and Unregulated (IUU) fishing	Lack of regulation due to unrecognized problem at the authorities' level	Fishermen Ecosystem services	Y	Freshwater Fishery Marine fishery
Aquaculture units development	Lack of legislation and investments Lack of technology due to absence of	Fishermen Business	y	Freshwater Fishery Marine fishery

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	correlation with applied research			
Aquaculture units development	Low Water quality – High nutrient concentration	Development	y	Marine Fishery
Waste management and reduced recycling	Improper infrastructure schools, connectivity,	Local population, Rural economy Environment	Y	Rural development Tourism
Fishing restrictions	Freshwater fish stock Marine fish stock	Fishermen	Y	Freshwater fishery Marine fishery
Fish migration to greater depths due to increased Seawater temperature	Climate Change Small scale subsistence fishery difficulty to adapt	Fishermen, Local Development, Rural Economy	Y	Marine fishery
Lack of facilities for fish processing	Lack of infrastructure	Development of the area and migration	Y	Rural development
Shortage of qualified workforce for economic activities	Abolition of vocational schools	Fishermen Area's development	Y	Freshwater and Marine fisheries Tourism, Agriculture
Lack of functional, specialized market – Bursa de peste	There is a project which is not functional. It was proposed e-bursa de peste (fish market) instead of classical one.	Fishermen Quality of life – fishermen welfare	y	Freshwater and Marine fisheries
Applied research for particular species for aquaculture	There is no cooperation between fish production and research	Business development Fishermen	Y	Freshwater fishery Marine fishery
Water quality (pollution) in the Danube Delta	Direct discharges of waste water	Ecosystem services – biodiversity	y	Ecosystem management
Water availability	Climate change - droughts	Farmers Tourism Naval transport Fishery	Y	Agriculture Tourism Freshwater Fishery

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Competition between operators of Mass tourism and niche tourism in Danube Delta	Lack of decision and harmonization	Ecosystem services – biodiversity	Y	Tourism Ecosystem management
Rural out migration and Aging	low economic opportunities,	Tourism, Agriculture, Fishery, Industry	N	Rural development
Lack of farmers' cooperation	Low awareness on cooperation benefits	Integrated production Closing the loop on resources use Farmers welfare	Y	Agriculture Rural development
Soil quality	Land degradation, need for agrochemical mapping	Agriculture production	Y	Agriculture
Low development of rural business	Low entrepreneurial initiatives; low capacity building initiatives	Local inhabitants Local administrations (low tax revenues)	Y	Rural development
Need for knowledge and innovation	Low share of farmers receiving support for advice, training, knowledge exchange or participation in operational groups to enhance economic, environmental, climate and resource efficiency performance	Farmers Local population	Y	Agriculture Rural development
Capital access	Decreased knowledge on funding schemes; lack of associative forms	Tourism operators Farmers Fishermen	N	Rural development Agriculture Rural Tourism
Lack of exploiting the relative advantage of the rich Cultural heritage of the area	Decreased investment in Promotion of cultural heritage in the area	Tourism	n	Rural development Rural tourism
Local people are paying for solid waste brought from upstream	Lack of awareness, solid waste management, mass tourism	Sustainable development	y	Rural development
Increased presence of low financial value fish	Clogged canals	Biodiversity	Y	Ecosystem management

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4.6 Spain – Mar Menor Coastal Lagoon (Western Mediterranean)

4.6.1 Description of case study

The Mar Menor coastal lagoon (135 km2) is located in the Region of Murcia (SE Spain). The area is characterized by multiple environmental, social-cultural and economic interests, often competing for scarce resources, water being the most important. There is a high potential for complementarity, win-win scenarios and development of sustainable business cases based on public-private collaboration, efficient use of water, and innovative farming practices and a transition to sustainable models of tourism and agriculture. The catchment draining into the Mar Menor covers an area of 1.255 km2 and is mainly covered by intensive irrigated agriculture and tree crops. The intensive and highly profitable irrigated agriculture depends on scarce low quality groundwater and water from inland inter-basin water transfers. Agriculture provides labour and income to the region, but forms a source of excessive nutrients and contamination into the Mar Menor coastal lagoon. The resulting poor water quality affects the ecology of the lagoon with severe implications for its potential function for tourism and fisheries. The coastal lagoon forms part of a Specially Protected Area of Mediterranean Importance (SPAMI). The Mar Menor is one of the hotspots for tourism in the Region of Murcia, with a total number of 346,000 tourists and 1.4 million over-night stays in 2016. Beside international visitors, the Mar Menor has an important touristic function for the regional population (1.5 million inhabitants). The availability of water for irrigation and drinking water for tourism will be further reduced under future climate conditions. As such, the Mar Menor is strongly influenced by interactions between inland agriculture on the one side, and coastal tourism and fisheries affecting natural ecological values and socioeconomic sustainability on the other side. The need to move towards sustainable modes of agriculture, fishery and tourism is increasingly recognized and recently revived strongly due to sudden increase in contamination levels resulting in a strong drop in tourism. The available data and/or models to address the issues of the Spanish case study are presented in APPENDIX A Table A-6.

4.2.2 Data selection Process and Inventory Update (September 2020)

As described in detail in Deliverable 13, the System Dynamics model of the different sectors in the Mar Menor was developed based on the causal loop diagrams that were developed in collaboration with stakeholder during the sectoral and multi-actor workshop.

Table 4-7 provides a summary of which problems identified by the stakeholders can be evaluated with the different SD sub-models. The design and set-up of the SD pilot models determined which data were finally

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needed and in which format. More details about the data used in the models can be found in the appendix of this deliverable. Most raster datasets that we initially planned to use in relation to runoff and nutrients modelling were finally not needed directly as input in the SD models since we use annual average values in the corresponding sub-models. This is so because the main goal of our model is not to quantify in detail the water and nutrients flow in the study area but to identify coastal and rural sectoral interactions in order to propose sustainable development solutions. Water and nutrients budget sub-models are needed as part of the SD model, but they are not intended to replace existing spatial hydrological and nutrient models and therefore we used field and model output literature data to feed our SD model. On the other hand, using yearly time series would require including many more variables in the model, making it much more complex, in order to be able to predict values for each single year in the future, which is also not our main goal. Our stakeholders are rather interested in the expected trends and gradual transitions, and would not be able to grasp a very complex model structure. Assessing trends also avoids bringing too much attention and critics in the model structure and helps focus on consensus solutions among stakeholders based on key socio-economic and ecological variables. Besides, some of the topics initially considered to be included in the model by us didn't finally play a major role in the causal loop diagram developed by stakeholders, so several variables initially considered important were discarded and not included in the model, such as fish catch limits, livestock heads, number of public schools, etc. The main issue we faced was due to contradicting reported values for some important model input variables, especially in relation to the water and nutrients balance. We finally solved this by systematically using reliable official, government, non-government and scientific data coming from the latest existing reports, while also documenting the different data estimates from other informal sources. The fact that we use mean annual values also helps decreasing the uncertainty in selecting data coming from different studies. We also changed the time period of the study to start before the Tagus-Segura water transfer was opened and thus be able to assess its influence and to test the robustness of the model under contrasting scenarios. Besides, instead of using different data for each municipality as initially considered as option, we decided to spatially aggregate input data values for the entire study area, focussing on coastal and rural processes and interactions. On the other hand, many variables were used as inputs and for validation purposes, as initially expected, such as: the extent of (irrigated) cropland areas; the amount of irrigation water used from the aquifer versus the water from Tajo-Segura transfer; the population working in each sector; the amount of urban wastewater effluents used for irrigation, the water consumption by hectare of irrigated croplands, etc. One of the main challenges was to be able to quantify the degradation of the Mar Menor over time since it went through a rapid and recurrent ecological collapse starting in 2016. The amount and complexity of ecological processes occurring at different scales and realms within the lagoon made it impractical to develop an accurate model of ecological processes within the lagoon. Therefore, we had to simplify the model equations and calibrate the model outputs based on observed patterns and identifying the most important causes and drivers. Finally, new variables, such as the ones related to the renewable energy sector were included in the model given that it was considered by stakeholders as a potentially important sector providing possible synergies with agriculture. The updated inventory is presented in APPENDIX B, Table B-6.

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Table 4-7 Problems identified by MAL6 Stakeholders and the related models

Problem Description	What/Who Causes problem	Who is affected	land/sea interactions relevant? (Y/N)	Which model deals with this problem? (D13)
Water availability	Water scarcity, high demand of water by agriculture, high dependency on the Tagus-Segura water transfer, climate change uncertainty.	Mostly farmers but eventually local populations and tourism sector.	N	Agricultural water balance
Excessive groundwater pumping	high amount of (illegal) groundwater extraction	Farmers	N	Agricultural water balance
Surface and groundwater pollution	Excessive use of fertilizers in irrigated agricultural areas; lack of nutrients retention measures; lack of training on the use of fertilizers and insufficient enforcement of regulations.	Mar Menor ecosystem	Y	sustainable land management practices
Mar Menor degradation	Mostly by agricultural nutrients input via surface- and groundwater.	Mar Menor ecosystem , local populations, tourism	Y	Mar Menor degradation
Excessive irrigated agricultural expansion	Illegal irrigated agricultural areas	Farmers through competition for water resources	N	Sectorial development and economic profit
Pollution of surface	desalination of	Mar Menor	Y	Agricultural

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water and coastal lagoon by brine wastes	polluted groundwater pumped producing untreated wastes	ecosystem		nutrients balance
Low sectorial diversification with dominance of the agricultural sector	Unbalanced sectoral growth due to lack of social pressure on public administrations and participatory governance (e.g. a coordinating body for the management of the Mar Menor and its catchment area)	Local populations, tourism and renewable energy economic sectors	Y	Social awareness and governance
High tourism seasonality and overall negative yearly trends	Negative effect of high intensity tourism during high season; insufficient coastal and rural off-season recreation activities; lack of integration between coastal and rural recreation activities; and poor ecological status of the lagoon	Local populations and tourism sector	Y	Coastal-rural recreation potential

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5 Discussion

The different themes of available data and/or models for the SD modelling of land-sea interactions in each case study cover the full spectrum of socioeconomic and ecological characteristics of each area in question. The data and models to be used through the next task in WP2 (Task 2.2) consist of data and models found in existing databases and reported model developments, provided and used by the actors and stakeholders participating in the Multi-Actor Labs (coastal and rural business entrepreneurs, agencies and administrations) and also some newly generated/derived data and models by the partners of COASTAL. The resulting combination of primary (generated by the partners of COASTAL), and secondary data (e.g. National Censuses) as well as model outputs (background models, developed by 3rd parties), presents both an asset and a problem with respect to data management and analysis. The use of both data and background models has the potential of increasing the level of detail and accuracy of the developed SD modelling, while, the resulting metadata inventory will be useful in socioeconomic, ecological, and integrated studies, as well as in policy and sustainability assessments. Thus, the inventory in WP2 contributes to the knowledge-exchange objective of COASTAL and increasing the potential of reusing data as well as validating the results. On the other hand, combining heterogeneous databases and models (and their results/outputs) presents a series of concerns that need to be confronted.

- The use of European secondary data sources and statistical databases compared to localised studies has the advantage of covering large areas, including all case studies for some types of data (Corinne and Eurostat data), but the level of detail and the scale of the collected data might not be enough for the needs of COASTAL case studies.
- Different country wide data bases might offer information at finer scales but the collection and presentation of data are often based on different definitions making the data incompatible if not acknowledged and harmonised.
- Social and Environmental databases relate to different scales and boundaries in their collection, presentation and analyses, which affects both qualitative and quantitative system characteristics (Gibson et al 2010, Cumming et al 2006). These differences affect also the considered spatial and temporal event/representation scales, but also the way stakeholders perceive and identify the issues of an area in question (Metcalf, 2008).

This inventory is the first step in the process of integrating and harmonizing the data and models from the different sources and for the different case studies, and involves analysis and evaluation of the availability, quality and usefulness of the data and models, as well as the spatial-temporal scales and periodicities of data and model results/outputs. Additionally, concepts and definitions also need to be harmonised and case study boundaries need to be clarified and agreed upon for each case study. Furthermore, essential differences at macro, meso and micro levels need to be handled given the variation of data and model availability and sources. Transparency in the harmonisation process as well as ability to trace back the steps taken are also important for the validity of research outcomes.

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The data selection process for each MAL has been described as part of their case study analysis within this inventory.

6 Conclusions

Mental Models are by nature (Elsawah et al, 2015) context-specific and dynamic; people build their mental models based on a particular situation at a particular point of time. As time passes and context changes, people perceive new information, and update their mental models. As the produced SD modelling in COASTAL is to be based on the sector and MAL workshop outcomes, this inventory will be updated over time in order to fulfil the needs of WP2, and also WP4. These changes are evident also in the description of the steps taken for quantification by each MAL, but also in the identified data and models included in the inventory at each step (APPENDICES A and B).

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Appendix A

Tables of Data and Model Inventories of each MAL (December 2018)

*Table A-1 Table of Data and model themes and main descriptors of the **Belgian Case Study** (more information regarding data can be found in the accompanied excel file)*

Main Theme	Sub Theme	Variable/information	Geographical Coverage
Agriculture	Biannual Agriculture & Fisheries Report (LARA / VIRA)	key indicators & trends	Flemish Region
Agriculture	Flemish agriculture data	economic indicators	Flemish Region
Climate & Weather	climate data	climate change, geographical distribution	Belgium
Climate & Weather	flood, drought, tide rainfall, with map viewer	data & short/long term forecasts	Belgium
Coastal & Marine Data	General data overview	Compendium Coast & Sea*	Belgian North Sea
Coastal & Marine Environment	Air quality	PM2.5; NO2;	Flemish Region
Coastal & Marine Environment	Remote Sensing Data (MODIS, MERIS, SEAWIFS)	Chla-a, TSM, SST	Belgian North Sea
Coastal & Marine Environment	biodiversity & invasive species		
Coastal & Marine Environment	GHG Emissions	GHG	Flemish Region
Coastal & Marine Environment	Inland water quality	N, P	Flemish Region
Coastal & Marine Environment	marine water quality (biotics & abiotics)		
Coastal & Marine Environment	Water emissions (WEISS)	9 sectors, 17 substances	Flemish Region
Coastal economy	GDP, Employment	Total employment figures	Federal – Belgium
Coastal economy	Local economic statistics and profile		Flemish Region
Coastal economy	3-monthly economic indicators		Province West Flanders

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Coastal economy	Harbor shipping	freight & person transport	Flemish Region
Demography	Population Size, Age, Gender, etc.	Total Population	Federal – Belgium
Energy	Energy Use, share renewable	Consumption per household	Federal – Belgium
Energy	Social-econ impacts of offshore energy	added value, govt income, jobs	
Energy	Offshore energy	Projects, Power Supply, Jobs	Belgian North Sea (BNS)
Fisheries & Aquaculture	Fisheries & aquaculture	oyster production	Belgium
Fisheries & Aquaculture	Fisheries & aquaculture	Production	Belgium, global
Fisheries & Aquaculture	Fisheries & aquaculture	fleet size, landings, economic value, fuel costs, …	Flemish Region
Fisheries & Aquaculture	Fisheries & aquaculture	FishFrame Regional Database	EU
Fisheries & Aquaculture	Fisheries & aquaculture	long term trends of commercial fisheries (landings, fleet size, …)	Flemish Region
Land Use	Land use status report RURA	18 indicators, 5 themes (open space, residential, work, mobility, environment)	Flemish Region
Land Use	Open Space Platform	Examining scenarios	Flemish Region
Land Use	Dynamic Land use projections	Land use type	Flemish Region
Rural Environment	Biological Evaluation & Natura 2000	Online Map Viewer	
Rural Environment	Flanders Nature Report (NARA)	key indicators & trends	Flemish Region
Rural Environment	Flanders Environment Report (MIRA)	key indicators & trends	Flemish Region
Rural Environment	Natura 2000 habitats, species & projects	Online Map Viewer	
Rural Environment	Spatial Environment Explorer (Map Viewer)	Online Map Viewer	Flemish Region
Spatial planning	Coastal atlas	activities	Belgian Coastal Zone
Spatial planning	Local spatial implementation plans		West Flanders
Spatial planning	Marine atlas & MSP	activities & zoning	Belgian Coastal Zone
Spatial planning	Marine spatial plan		
Tourism	overnight stays		Flemish Region

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Tourism	Statistics	multiple (hotel nights, origin country, trends, …)	Flemish Region
Transport	Congestion	Loss hours	Flemish Region
Transport	Shipping		
Transport	Road Traffic on main roads	Volume, congestion, travel time	Flemish Region
Transport	Transport Demand	transport indicators,	Federal - Belgium
Transport	Transport Projections	Vehicle km	Federal - Belgium

Table A-2 Data and model themes and main descriptors of the Greek Case Study (as anticipated on December 2018 after preliminary analysis of Stakeholder concept maps)

Main Theme	Sub Theme	Variable/information	Geographical Coverage
Agriculture	Census and/or tri-annual FSS	key characteristics and trends (number/size of holdings, no of employees)	Regional
Agriculture	Farm Accounts	economic indicators (economic accounts etc)	Regional
Agriculture	irrigated area	total irrigated area	Regional
Agriculture	percentage of organic crops		Regional
Agriculture	Unit size	property size	Regional
Agriculture	Crops	Production olive oil	Regional
Agriculture	Crops	Total crops input	Regional
Agriculture	Crops	Total crops output	Regional
Agriculture	Employment	Total labor input	Regional
Agriculture	Employment	Agricultural holding	Regional
Agriculture	Subsidies	Subsidies	Regional
Agriculture	Agricultural product	Farm Net Income	Regional
Agriculture	uptakes from irrigation	water uptake for irrigation	Regional
Agriculture	Total Livestock units	Livestock Unit	Regional
Agriculture	Land	Irrigated land use	Total regional catchment
Agriculture	Water use	Irrigated water use	Total regional catchment
Climate and Weather	Climate models	Various hydroclimatic outputs from climate models	National
Climate and Weather	Climate models	Surface temperature and precipitation	Total regional catchment
Climate and Weather	climate data flood, rainfall data, drought	rainfall, temp, RH, WS, Sunshine duration	Regional

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Climate and Weather	Heat Wave days	T >35 C	
Climate and Weather	Dry Days	Precipitation < 0.5 mm	
Climate and Weather	Tropical Nights	T<20 C	
Coastal & Marine Environment	Wildlife sanctuaries	identifier	National - Greece
Coastal & Marine Environment	Natura 2000 habitats/species/projects/	identifier	local
Coastal & Marine Environment	Protected area management body zone	identifier	
Coastal & Marine Environment	Contours (depth)		Regional
Coastal & Marine Environment	Contours (height)		Regional
Coastal & Marine Environment	Coastal and Marine Water quality	Nutrients, chlorophyll, sediments, phenols etc	
Coastal & Marine Environment	Salt water intrusion	General model for saltwater intrusion management	
Coastal economy	Employment	sectoral employment, unemployment, economically active population	
Coastal economy	Taxation changes		
Demography	population size and characteristics	total population	National – Greece
Demography	Population change (return, ageing)	total population	
Fisheries & Aquaculture	fisheries (vessels)	number of vessels	National – Greece
Fisheries & Aquaculture	Fisheries & aquaculture	fleet size, landings, economic value, fuel costs, …	National – Greece
Fisheries & Aquaculture	Fisheries & aquaculture	Monthly catch size by species	National – Greece
Governance	Settlements	identifier/name	Region
Governance	settlement limits	identifier	Region
Governance	administrative areas limits	identifier	Region
Infrastracture	Wastewater Treatment (location, population coverage)		Region
Infrastracture	irrigation network	identifier	Region

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Infrastracture	road network	identifier	Region
Infrastracture	Waste sites (location number condition)	identifier	Region
Infrastracture	Ports		Region
Infrastracture	location, number and size of olive oil mills		Region
Infrastracture	Programmes and infrastructure of adult /farmers education	Adult educational activities	Region
Infrastracture	Participation of population in adult education programms	Adult educational activities	Region
Infrastracture	Tourist carrying capacity	Number of beds and camping sites	Region
Land Use / Land Cover	Corine 2000/ 2012	code	
Land Use / Land Cover	Corine 2000/ 2012	code	
Land Use / Land Cover	land cover	Code	
Land Use / Land Cover	Burnt areas	Code	
Regulations	Habitats directive (Natura 2000)	Name	Greece
Regulations	Birds directive (Natura 2000)	Name	Greece
Rural and Land Environment	Runoff	River runoff	Total regional catchment
Rural and Land Environment	Variables related to water balance	Evapotranspiration and runoff (data and general model)	Total regional catchment
Rural and Land Environment	River	River network	Total regional catchment
Rural Environment	soil characteristics	soil physical features and type	
Rural Environment	dessertification	soil quality	
Rural Environment	fertilizers pesticides usage (tons bought)		national – Greece
Rural Environment	Inland water quality	T, pH, cond, DO, Turb, N, P	10 sites across the Region
Rural Environment	Dams and lagoons	Name	Gialova region
Social	education	total population	National - Greece

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Social	Annual / Seasonal Water Demand	Monthly water demand	Regional catchment
Social	cultural/archeological sites	Name / location	Region
Tourism	arrivals, length of stay	Number of beds/ average stay/trends	Region
Tourism	Statistics	multiple (hotel nights, origin country, trends))	Messinia Region
Tourism	Tourist carrying capacity	tourist accommodation	Region
Tourism	Tourist carrying capacity	camping piches	Region
Tourism	Tourist carrying capacity	Hotels	Region
Tourism	Tourist carrying capacity	nights	Region

Table A-3 Data and model themes and main descriptors for the Swedish (Norrström/Baltic Sea) (as anticipated on December 2018 after preliminary analysis of Stakeholder concept maps)

Main Theme	Sub Theme	Variable	Geographical Coverage
Rural and Land Environment	Water quality	Input and output nutrients for municipal wastewater treatment plants	Whole Sweden country
Rural and Land Environment	Water quality	Population connected to sewage network	Whole Sweden country
Rural and Land Environment	Water quality	General diagnostic test model (including data sources for Norrström) for legacy sources of nitrogen and phosphorus (and other types of pollutants)	Norrström catchment and whole Sweden country
Rural and Land Environment	Water quality	Nitrogen and phosphorus concentrations and loads- data inventory and analysis with given data sources	Norrström catchment and whole Sweden country
Rural and Land Environment	Water quality	Various variables	
Rural and Land Environment	Water quantity	Various variables	
Rural and Land Environment	Runoff	Water discharge related to nitrogen and phosphorus loads- data inventory and analysis with given data sources	Norrström catchment and whole Sweden country
Rural and Land Environment	Runoff	Total river runoff	Norrström catchment
Rural and Land Environment	Water use	Total water extraction	Whole Sweden country

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Rural and Land Environment	Water use	Municipal water extraction	Whole Sweden country
Rural and Land Environment	Water use	Agricultural water extraction	Whole Sweden country
Rural and Land Environment	Water use	Industrial water extraction	Whole Sweden country
Rural and Land Environment	Water use	Total water use	Whole Sweden country
Rural and Land Environment	Water use	Municipal water use	Whole Sweden country
Rural and Land Environment	Water use	Agricultural water use	Whole Sweden country
Rural and Land Environment	Water use	Industrial water use	Whole Sweden country
Rural and Land Environment	Water use	Population connected to water network	Whole Sweden country
Rural and Land Environment	Ecosystem	Vegetation types and areas	Whole Sweden country
Rural and Land Environment	Ecosystem	Farm animals' population	Whole Sweden country
Rural and Land Environment	Ecosystem	Protected nature areas	Whole Sweden country
Rural and Land Environment	Ecosystem	Protected water areas	Whole Sweden country
Rural and Land Environment	Ecosystem	Ecosystem services (local climate regulation, stormwater regulation)	Norrström catchment
Rural and Land Environment	Ecohydrology	Various variables relevant to ecohydrology and land use changes within the Norrström catchment as a demonstration site in UNESCO	Norrström catchment
Rural & Inland Activities	Tourism	Number of tourists	Whole Sweden country
Rural & Inland Activities	Trade	Export and import	Whole Sweden country
Rural & Inland Activities	Agriculture	Correlation between nutrient concentrations and loads to the Baltic and population density and farmland share (data and general multi-regional model)	Whole Baltic region and Sweden country
Rural & Inland Activities	Transportation	Transport infrastructure according to socio-economic background and land cover conditions	Norrström catchment

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Land Use / Cover	Lakes and wetlands	Nutrient/pollutant retention (ecosystem service)- data inventory and general model	Norrström catchment and whole Northern Baltic Proper Water Management District and Northern Baltic Proper Water Management District
Land Use / Cover	Lakes and wetlands	Flow variability/flood risk regulation- data inventory with given open access sources	Norrström catchment and whole Northern Baltic Proper Water Management District and Northern Baltic Proper Water Management District
Land Use / Cover	Land cover	Transport infrastructure according to socio-economic background and land cover conditions	Norrström catchment
Land Use / Cover	Ecosystem	Ecosystem services (local climate regulation, stormwater regulation)	Norrström catchment
Agriculture	Crops	Crop areas for arable lands	Whole Sweden country
Agriculture	Crops	Crop yield	Whole Sweden country
Agriculture	Crops	Total crop production	Whole Sweden country
Agriculture	Land	Agricultural land use areas	Whole Sweden country
Agriculture	Land	Correlation between nutrient concentrations and loads to the Baltic and population density and farmland share (data and general multi-regional model)	Whole Baltic region and Sweden country
Agriculture	Water use	Agricultural water extraction	Whole Sweden country
Agriculture	Water use	Agricultural water use	Whole Sweden country
Agriculture	Consumptive water use	Water consumption driven by extended/intensified agriculture and/or hydropower production	Norrström and several more catchments across Sweden country
Demography	Current population	Total size	Whole Sweden country
Demography	Current population	Population growth	Whole Sweden country
Demography	Current population	Age distribution	Whole Sweden country
Demography	Current population	Density	Whole Sweden country
Demography	Current population	Coastal population	Whole Sweden country
Demography	Current population	Population distribution	Whole Baltic drainage basin including Norrström catchment

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Demography	Current population	Transport infrastructure according to socio-economic background and land cover conditions	Norrström catchment
Demography	Current population	Correlation between nutrient concentrations and loads to the Baltic and population density and farmland share (data and general multi-regional model)	Whole Baltic region and Sweden country
Demography	Projected population	Total size	Whole Sweden country
Demography	Projected population	Age distribution	Whole Sweden country
Energy	Energy use	Energy use	Whole Sweden country
Energy	Energy use	Electricity use	Whole Sweden country
Energy	Energy use	Fuel use	Whole Sweden country
Energy	Energy supply	Gross supply (Net supply + Own use of generators)	Whole Sweden country
Energy	Energy supply	Electricity production	Whole Sweden country
Energy	Consumptive water use	Water consumption driven by extended/intensified agriculture and/or hydropower production	Norrström and several more catchments across Sweden country
Energy	Consumptive water use	Water use and carbon emissions related to energy use	Whole Sweden country including Norrström catchment
Social	Lifestyle	Type of housing	Whole Sweden country
Social	Lifestyle	Level of education	Whole Sweden country
Social	Income	Total income	Whole Sweden country
Social	Income	Average household income	Whole Sweden country
Social	Income	Transport infrastructure according to socio-economic background and land cover conditions	Norrström catchment
Social	Ethnicity/nationality	Transport infrastructure according to socio-economic background and land cover conditions	Norrström catchment
Social	Job market	Employed population	Whole Sweden country
Social	Job market	Unemployed population	Whole Sweden country
Social	Job market	Labor force	Whole Sweden country
Social	Gini index	Calculated distribution of nutrient abatement costs and abatement requirement fairness	Whole Baltic region including Norrström catchment
Climate	Climate models	Various hydroclimatic outputs from climate models	Whole Baltic region

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Climate	Climate models	Various hydroclimatic outputs from climate models	Norrström catchment and Baltic region
Coastal & Marine Environment	Water quality	Correlation between nutrient concentrations and loads to the Baltic and population density and farmland share (data and general multi-regional model)	Whole Baltic region and Sweden country
Coastal & Marine Environment	Water quality	Temperature, salinity, nitrogen, phosphorus, and chlorophyll a.- model for Baltic Sea and coastal water quality and observed data with given sources and model outputs	Whole Baltic Sea and Coastal Archipelago
Coastal & Marine Environment	Salt water intrusion	General model for saltwater intrusion management	
Coastal & Marine Environment	Baltic ecosystem health	Various variables	
Coastal & Marine Activities	Transportation	Traffic (Type and number of passing ships)	Whole Baltic region
Coastal & Marine Activities	Fishery	Catch statistics by type of fish	Whole Baltic Sea
Coastal & Marine Activities	Fishery	Recreational fishing catches	Whole Sweden country
Aquaculture	Species	Production	Whole Sweden country
Aquaculture	Species	Value (Price)	Whole Sweden country

i. Table A-4 Data and model themes and main descriptors of the French (Charente) Case Study ((as anticipated on December 2018 after preliminary analysis of Stakeholder concept maps))

Main Theme	Sub Theme	Variable	Geographical Coverage
Aquaculture	Shellfish farming	Overall production	Charente-Maritime department
Aquaculture	Oysters	Production	Charente-Maritime department
Aquaculture	Oyster farms	areas	Charente-Maritime department
Aquaculture	Mussels	Production	Charente-Maritime department
Aquaculture	Shellfish farming cadastre (surface)	Shellfish farming by type of production	Charente-Maritime department
Aquaculture	Shellfish farming cadastre (linear)	Shellfish farming by type of production	Charente-Maritime department

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Aquaculture	Shellfish farming companies	Number of companies	Charente-Maritime department
Aquaculture	Shellfish activity	direct employment	Charente-Maritime department
Aquaculture	Shellfih sector	turn over	Charente-Maritime department
Coastal economy	Trading Port Development	Overall Gross Tonnage (OGT)	La Rochelle
Coastal economy	Trading Port Development	tonnage by commodities	La Rochelle
Coastal economy	Trading Port Development	Tonnage out	La Rochelle
Coastal economy	Trading Port Development	Tonnage in	La Rochelle
Coastal economy	Trading Port Development	Overall Gross Tonnage (OGT)	Rochefort / TonnayCharente
Coastal economy	Trading Port Development	tonnage by commodities	Rochefort / TonnayCharente
Coastal economy	Trading Port Development	Tonnage out	Rochefort / TonnayCharente
Coastal economy	Trading Port Development	Tonnage in	Rochefort / TonnayCharente
Coastal economy	Fishing Port Development	Tonnage	La Cotinière
Coastal economy	Fishing Port Development	price (average)	La Cotinière
Coastal economy	Trading ports	Name	Charente and Charente-Maritime departments
Coastal economy	Fishing ports	Name	Oléron Island
Coastal economy	Fishing activity	Nb of boats	Charente-Maritime department
Coastal economy	Fishing activity	direct and indirect jobs	Charente-Maritime department
Coastal economy	Fishing activity	Turnover fish markets	Charente-Maritime department
Coastal economy	Fishing activity	direct employment	Charente-Maritime department
Coastal economy	Yacht marinas	Number of boats	Charente-Maritime department
Coastal economy	Shipbuilding	Number of boats	Charente-Maritime department

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Regulations	National marine park	Name	Coastal municipalities in CM department
Tourism	Tourist carrying capacity	tourist accommodation	Coastal municipalities in CM department
Tourism	Tourist carrying capacity	secondary residence	Coastal municipalities in CM department
Tourism	Tourist carrying capacity	Hotels	Coastal municipalities in CM department
Tourism	Tourist carrying capacity	nights	Coastal municipalities in CM department
Tourism	Tourist carrying capacity	camping piches	Coastal municipalities in CM department
Coastal economy	Fishing activity	No of fishers	Charente-Maritime department
Agriculture - Crop Farming	Crops	Production	NA Region
Agriculture - Crop Farming	Crops	Yield	NA Region
Agriculture - Crop Farming	Crops	Total Utilised Agricultural Area	Charente basin watershed
Agriculture - Crop Farming	Crop rotations	crops	Charente basin watershed
Agriculture - Crop Farming	Crops	Total crops input	
Agriculture - Crop Farming	Crops	Total crops output	
Agriculture - Crop Farming	employment	Total labor input	
Agriculture - Crop Farming	employment	Agricultural holding	
Agriculture - Crop Farming	Subsidies	Subsidies by crop	
Agriculture - Crop Farming	Agricultural product	Product at farm gate prices	Charente basin watershed
Agriculture - Crop Farming	Agricultural product	Farm Net Income	
Agriculture - Crop Farming	Employment in the agricultural sector	labour input	
Agriculture - Crop Farming	Subsidies	Crop subsidies	

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Agriculture - Crop Farming	Viticulture	agricultural holdings	
Agriculture - Crop Farming	Viticulture sector	Cognac production by volume	
Agriculture - Crop Farming	Viticulture sector	Cognac production in value	
Agriculture - Crop Farming	Viticulture sector	Cognac shipments by volume	
Agriculture - Crop Farming	Viticulture sector	Cognac shipments in value	
Agriculture - Crop Farming	uptakes from irrigation	water uptake for irrigation	Charente basin watershed
Agriculture - Livestock	Total Livestock units	Livestock Unit	Charente basin watershed
Agriculture - Livestock	Breeding sector	Livestock Unit	Charente basin watershed
Agriculture - Livestock	Breeding sector	Stocking density	
Agriculture - Livestock	Breeding sector	Animal production	Charente basin watershed
Agriculture - Livestock	subsidies	Livestock subsidies	
Agriculture - Livestock	Breeding sector	Total livestock output / LU	
Demography	Population	Total Population	Charente basin watershed
Demography	Population	population by age classes	Charente basin watershed
Demography	Population	Density	France
Demography	increase population	natural rate of increase	France
Demography	Towns	Name	Charente basin watershed/Oléron Island/Charente-Maritime department
Energy	Energy Use	Consumption per household	Charente basin watershed
Energy	Energy production	Water demand for hydroelectricity	Charente basin watershed
Energy	Offshore wind turbines park	Name	Atlantic ocean
Energy	Onshore wind turbines	Identifier	Poitou-Charentes region

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Hydrology	CARTHAGE database/Rivers	Name	France
Hydrology	CARTHAGE database/Hydrographic sectors	Name	France
Hydrology	CARTHAGE database/Hydrographic sub-sectors	Name	France
Hydrology	CARTHAGE database/Hydrographic zones	Name	France
Hydrology	reservoirs (projects)	Identifier	Charente basin watershed
Hydrology	reservoirs (projects)	Volume planned	Charente basin watershed
Land Use	Current Land Use	Land use type	Charente basin watershed
Land Use	Graphic parcel register	Crop	Nouvelle-Aquitaine region
Land Use	Corine Land Cover/dunes and beaches	Code	France
Land Use	Corine Land Cover/water bodies, intertidal zones, estuaries, rivers, ocean, coastal lagoons	Code	France
Land Use	Corine Land Cover/heterogeneous agricultural area	Code	France
Land Use	Corine Land Cover/great culture	Code	France
Land Use	Corine Land Cover/vineyards	Code	France
Land Use	Corine Land Cover/grasslands	Code	France
Land Use	Corine Land Cover/forests	Code	France
Land Use	Corine Land Cover/heathlands	Code	France
Land Use	Corine Land Cover/orchards	Code	France
Land Use	Corine Land Cover/anthropic areas	Code	France

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Model Input	Water	Water consumption	Charente watershed basin
Model Input	Water	Water consumption	Charente watershed basin
Model Input	soil quality & quantity	Soil bio-physical features	Charente watershed basin
Model Input	Nitrogen	Nitrogen (fertilizers)	Charente watershed basin
Model Input	Phosphorus	Phosphorus (fertilizers)	Charente watershed basin
Model Input	Pesticides	Pesticides (crop protection)	Charente watershed basin
Model Input	Dam releases	Water flows (upstream)	Charente watershed basin
Model output	Flow	Water flow	Charente watershed basin
Model output	Nitrogen	concentration	Charente watershed basin
Model output	Water flows	Water flows	Charente watershed basin
Model output	Water quality	Nitrate	Charente watershed basin
Model output	Water quality	Phosphorus	Charente watershed basin
Model output	Water quality	Sediments	Charente watershed basin
Model output	Water quality	Pesticides	Charente watershed basin
Model output	Water quality	Nitrate	Charente watershed basin
Model output	Water quality	Phosphorus	Charente watershed basin
Model output	Water quality	Sediments	Charente watershed basin
Model output	Water flows	Water flows	Charente watershed basin
other (please specify)	Climate	Precipitations, temperatures min & max, humidity, wind speed, solar radiation	Charente watershed basin
other (please specify)	Climate	Precipitations, temperatures	Charente watershed basin

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Regulations	Primary drinking water protection areas (AAC)	Name, type	Nouvelle-Aquitaine region
Regulations	Boutonne water development and management scheme	Name	Boutonne water development and management scheme ?
Regulations	Charente water development and management scheme	Name	Charente water development and management scheme ?
Regulations	GEOFLA database/Departmental boundaries	Name	France
Regulations	GEOFLA database/Municipal boundaries	Name	France
Regulations	Habitats directive (Natura 2000)	Name	France
Regulations	National nature park	Name	France
Regulations	France boundaries	Name	France
Regulations	Drinking water catchments	Name	Charente basin watershed
Regulations	Birds directive (Natura 2000)	Name	France
Regulations	Coastline conservation authority sites	Name	France
Regulations	National nature reserve	Name	France
Rural Environment	Water storage	Volume stored in reservoirs	Charente basin watershed
Rural Environment	Water uptake	Water uptake	Charente basin watershed
Rural Environment	Dams	Name	Charente basin watershed
Rural Environment	Soils	Soil type	Charente basin watershed
Tourism	Tourist carrying capacity	tourist accommodation	rural municipalities in CM department
Tourism	Tourist carrying capacity	campings on the farm	rural municipalities in CM department
Tourism	Tourist carrying capacity	camping piches	rural municipalities in CM department
Tourism	Tourist carrying capacity	Hotels	rural municipalities in CM department

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Tourism	Tourist carrying capacity	nights	rural municipalities in CM department
Transports	TOPO database/Roads	Identifier, name	Nouvelle-Aquitaine region
Transports	TOPO database/Railroads	Identifier	Nouvelle-Aquitaine region

ii. Table A-5 of Data and model themes and main descriptors of the Romanian (Danube Mouth) Case Study (as anticipated on December 2018 after preliminary analysis of Stakeholder concept maps))

Main Theme	Sub Theme	Variable/information	Geographical Coverage
Agriculture	Statistics	key indicators & trends	Romania
Climate & Weather	Climate	data & short/long term forecasts	Romania
Coastal & Marine Environment	Black Sea Ecosystem Processes And Forecasting / Operational Database Management System	Physics, Biological and chemical parameters	Black Sea
Coastal & Marine Environment	Remote Sensing Data (MODIS, MERIS, SEAWIFS)	Chla-a, TSM, SST	Black Sea
Coastal & Marine Environment	Coastal and marine biodiversity	Natura 2000 network, habitats and species distribution (art. 17 Habitats Directive), birds distribution (art. 12 Birds Directive)	Romania
Coastal economy	Coastal economy	GDP, employment, industry, agriculture, tourism	Romania
Coastal economy	Naval transport and ports activity - volume of port traffic and shipping flow	Number of visiting vessels in port per year; Total number of incoming and out coming passengers; Intensity of naval transport: volume of type of cargo	Romania
Demography	Population size, sex, age, demographic growth	Total Population	Romania
	Population density	Density	Romania
Social	Average working force	Total Population	Romania
Social	Schools	Number	Romania
Social	Hospitals	Number	Romania
Energy	Energy Use, share renewable	Resources	Romania
Energy	Energy generation and transport	Resources	Romania

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Energy	Energy generation and transport	Resources	Romania
Energy	Renewable energy	Resources	Romania
Fisheries & Aquaculture	Fisheries & aquaculture		
Fisheries & Aquaculture	Fisheries & aquaculture	Resources	Romania
Other (please specify)	Inland waters	Danube GIS	Danube Region
Other (please specify)	Inland waters	Danube water quality database	Danube Region
Land Use	Land Cover	CORINE land cover	Global/european
Land Use	Land use	Land cover map	Romania, Bulgaria
Rural Environment	Biological Evaluation & Natura 2000	Online Map Viewer	
Spatial planning	Coastal atlas	activities, coastal and marine environment	Romania, Bulgaria
Tourism	Touristic infrastructure	Touristic and leisure structures, touristic accommodation capacity	Romania
Tourism	Number of tourist/overnight stays	Touristic flows (arrivals, overnight stays)	Romania
Transport	Shipping	Type of goods	Romania
Transport	Ports activity - volume of port traffic and shipping flow	Number of visiting vessels in port per year; Total number of incoming and out coming passengers; Intensity of naval transport: volume of type of cargo	Romania

iii. Table A-6 Data and model themes and main descriptors of the Spanish (Mar-Menor) Case Study (as anticipated on December 2018 after preliminary analysis of Stakeholder concept maps)

Main Theme	Sub Theme	Variable	Geographical Coverage
Agriculture - Crop Farming	Runoff and nutrients modelling	Digitil Elevation Model	Campo de Cartagena catchment
Agriculture - Crop Farming	Runoff and nutrients modelling	Soil properties	Campo de Cartagena catchment
Agriculture - Crop Farming	Runoff and nutrients modelling	Precipitation	Campo de Cartagena catchment
Agriculture - Crop Farming	Runoff and nutrients modelling	Temperature	Campo de Cartagena catchment

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Agriculture - Crop Farming	Runoff and nutrients modelling	NDVI	Campo de Cartagena catchment
Land Use	Current land use	Land use type	Campo de Cartagena catchment
Demography		local population in coastal areas	Campo de Cartagena catchment
Tourism		number of tourists in coastal areas	Campo de Cartagena catchment
Agriculture - Crop Farming	water	water consumption by hectare of each cropland type	Campo de Cartagena catchment
other (please specify)	water	per capita monthly water consumption	Campo de Cartagena catchment
other (please specify)	water	consumption of fertilizers by hectare of each cropland type	Campo de Cartagena catchment
Agriculture - Crop Farming	water	water desalination monetary cost per litter	Campo de Cartagena catchment
Agriculture - Crop Farming	water	Segura water transfer price per litter	Campo de Cartagena catchment
Social	employment	population working in each sector in coastal areas	Campo de Cartagena catchment
Social	employment	population working in each sector in rural areas	Campo de Cartagena catchment
Coastal & Marine Environment	wetlands	area of wetlands around the MM	Campo de Cartagena catchment
Agriculture - Crop Farming	Crops	Crop areas	Campo de Cartagena catchment
Coastal & Marine Environment	Water/sediment/soil quality & quantity, Pollutants (fertilisers, pesticides, other), Plastics, Ecosystem, Biodiversity, etc.	Pollutant concentration	Mar Menor lagoon
Agriculture - Livestock	Animal types	Animal population	Campo de Cartagena catchment
Social	Wellbeing	Average household income	Campo de Cartagena catchment
Social	Wellbeing	Unemployment rate by municipality	Campo de Cartagena catchment
Social	Wellbeing	Percentage of immigrant population	Campo de Cartagena catchment
Social	Wellbeing	Number of public health care facilities	Campo de Cartagena catchment

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Social	Wellbeing	Number of public schools	Campo de Cartagena catchment
other (please specify)	Fisheries	Number of fisher boats	Mar Menor lagoon
Tourism		Number of recreational boats	Mar Menor lagoon
other (please specify)	Fisheries	Fish catch limits	Mar Menor lagoon
other (please specify)	Economy	% of regional GDP from agriculture, tourism and fisheries	Campo de Cartagena catchment
other (please specify)	Economy	% of municipal GDP from agriculture, tourism and fisheries	Campo de Cartagena catchment
Agriculture - Crop Farming	water	Groundwater desalination monetary cost per litter	Campo de Cartagena catchment
Agriculture - Crop Farming	water	Sea water desalination monetary cost per litter	Campo de Cartagena catchment
Agriculture - Crop Farming	water	% of wastewater reuse for irrigation	Campo de Cartagena catchment
Agriculture - Crop Farming	water	% irrigation water from aquifer versus water from Tajo-Segura transfer	Campo de Cartagena catchment

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APPENDIX B

COASTAL Stock-Flow models Inventory of Data and Third Party Models. (September 2020)

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COASTAL Collaborative Land-Sea Integration Platform

COLLABORATIVE LAND-SEA INTEGRATION PLATFORM

DATA AND MODEL INVENTORY
DELIVERABLE D6

WP2 Knowledge Transition T2.1 - Data and Model Base
Lead Beneficiary: HCMR and SU
Guidelines:

Sheet Contents	Description
Explanation of Columns	Contains all explanation of all columns used for each case study inventory
MAL1	Data/model Inventory used for quantification of the SD models developed for identified problems in the Belgian Sea Case Study
MAL2	Data/model Inventory used for quantification of the SD models developed for identified problems in the SW Messinia (Greece) Case Study
MAL3	Data/model Inventory used for quantification of the SD models developed for identified problems in the Norrström/Baltic Sea (Sweden) Case Study
MAL4	Data/model Inventory used for quantification of the SD models developed for identified problems in the Charente River Case Study
MAL5	Data/model Inventory used for quantification of the SD models developed for identified problems in ther Danube Mouths-Black Sea case study
MAL6	Data/model Inventory used for quantification of the SD models developed for identified problems in the Mar Menor (Spain) Case Study

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Column name	Explanation
Main Theme	Main Theme of data needed (Select from dropdown list)
Sub Theme	Sub Theme
SF Model Identification	Stock - Flow Model where the dataset will be used (D13)
Variable Name	Variable name in SF model (D13)
Unit of	Unit of what is beeing measured (Select from dropdown list)
Unit	Unit of measurement
Geographical Coverage	Full extent of data coverage (Select from dropdown list)
Spatial Resolution/Unit of observation	Spatial Resolution of data or statistical observation unit (Select from dropdown list)
Time Coverage	Time coverage of dataset
Time Resolution	Frequency of data collection (Select from dropdown list)
Data value Category (Generation)	How was the data value generated (Select from dropdown list)
File type	What is the format of the datafile (Select from dropdown list)
Accessibility	Is the data freely accesible or are there restrictions
Data/Model Owner	Who is the data/model owner
URL	The url of the data/model provider or the database where the data is found

Table B - 1 models developed for identified problems in the Belgian Sea Case Study

Main Theme	Sub Theme	SF Model Identification	Variable name in SF model	Unit of	Unit	Geographical Coverage	Spatial Resolution (Geographical Extent)	Time Coverage	Time Resolution	Data Category (Generation)	File type	Accessibility	Data/Model Owner	URL
Energy	Offshore Energy	Decommissioning of Wind Parks	Wind Park Capacity	Quantity	MegaWattHour	Region	Case Study Area	2009-2060	Annual	Database	pdf	Public - on demand	to be decided	DecomTools project
		Decommissioning of Wind Parks	Wind Park Area	Area	ha	Region	Case Study Area	2009-2060	Annual	Database	pdf	Public - on demand	to be decided	windeurope.org
		Decommissioning of Wind Parks	Services	Money	EUR/year	Region	Case Study Area	2009-2060	Annual	Database	pdf	Public - on demand	to be decided	
		Decommissioning of Wind Parks	Employment	Population	FTE	Region	Case Study Area	2009-2060	Annual	Database	pdf	Public - on demand	to be decided	
		Decommissioning of Wind Parks	Infrastructure	not applicable	present or not	Region	Case Study Area	2009-2060	Annual	Database	pdf	Public - on demand	to be decided	
		Decommissioning of Wind Parks												
Rural and inland activities	Water Management	Oudland Polder	Groundwater Level	Quantity	m	Region	Case Study Area	2000-2050	month	Field Data		Restricted	Flemish Land Agency	
		Oudland Polder	Discharge	Rate	m3/month	Region	Case Study Area	2000-2050	month	Field Data		Restricted	Flemish Land Agency	
		Oudland Polder	Supply	Rate	m3/month	Region	Case Study Area	2000-2050	month	Field Data		Restricted	Flemish Land Agency	
		Oudland Polder	Precipitation	Rate	m/month	Region	Case Study Area	2000-2050	month	Field Data		Restricted	Flemish Land Agency	
		Oudland Polder	Evapotranspiration	Rate	m/month	Region	Case Study Area	2000-2050	month	Field Data		Restricted	Flemish Land Agency	
		Oudland Polder	Land use	Area	ha	Region	Case Study Area	2000-2050	month	Field Data		Restricted	Flemish Land Agency	
		Oudland Polder	Sealevel	Length	m	Region	Case Study Area	2000-2050	month	Field Data		Restricted	Flemish Land Agency	
		Oudland Polder	Salinity	Concentration	kg/m3	Region	Case Study Area	2000-2050	month	Field Data		Restricted	Flemish Land Agency	
		Oudland Polder	Number of Farms	Quantity	dimensionless	Region	Case Study Area	2000-2050	month	Field Data		Restricted	Flemish Land Agency	
		Oudland Polder	Property value	Money	EUR/ha	Region	Case Study Area	2000-2050	month	Field Data		Restricted	Flemish Land Agency	
		Oudland Polder	Urbanisation	Quantity	dimensionless	Region	Case Study Area	2000-2050	month	Field Data		Restricted	Flemish Land Agency	

Table B - 2	Data/model Inventory used for quantification of the SD models developed for identified problems in the SW Messinia (Greece) Case Study													
Main Theme	Sub Theme	SF Model Identification	Variable name in SF model	Unit of	Unit	Geographical Coverage	Spatial Resolution (Geographical Extent)	Time Coverage	Time Resolution	Data Category (Generation)	File type	Accessibility	Data/Model Owner	URL
Climate		Lagoon Salinity	Temperature	Temperature	oC	Region	point	From 2016	month	Database	xlx	Public - open access	National Observatory of Athens	https://www.meteo.gr/climatic.cfm
Climate		Lagoon Salinity	Evaporation	Rate	mm/day	Local	point	From 2016	month	Model	xlx	Public - open access	NEO/SU	https://doi.org/10.5194/hess-24-3557-2020
Climate		Lagoon Salinity	Evapotranspiration	Rate	mm/day	Local	point	From 2016	month	Model	xlx	Restricted	Model SWAT / HCMR	
Climate		Lagoon Salinity	Precipitation	Rate	mm/day	Region	point	From 2016	month	Database	xlx	Public - open access	National Observatory of Athens	https://www.meteo.gr/climatic.cfm
Coastal Environment	Hydrology	Lagoon Salinity	Groundwater level	Volume	m3	Local	30m grid	From 2016	month	Model	xlx	Restricted	Model SWAT / HCMR; NEO/SU	
Coastal Environment	Hydrology	Lagoon Salinity	Groundwater discharge at Tyflomitis	Rate	m3/s	Local	point	From 2015	month	Model	xlx	Restricted	Model SWAT / HCMR	
Coastal Environment	Hydrology	Lagoon Salinity	Surface water discharge at Xerolagados	Rate	m3/s	Local	point	From 2015	month	Model	xlx	Restricted	Model SWAT / HCMR	
Water Resources	Rural activities	Lagoon Salinity	Water demand for domestic use	Volume	m3 per season	Local	point	from 2008	month	Report/Paper	xlx	restricted	TEMES, NEO/SU	
Agriculture	Water Resources	Lagoon Salinity	Water demand for irrigation	Volume	m3 per season	Local	point	from 2008	month	Report/Paper	xlx	restricted	TEMES, NEO/SU	
Coastal Environment	Runoff	Lagoon Salinity	Freshwater outputs	Volume	m3 per season	Local	point	From 2016	month	Model	xlx	Public - open access	NEO/SU	https://doi.org/10.5194/hess-24-3557-2020
Coastal Environment	Water quality	Lagoon Salinity	Saline water outputs to sea	Volume	m3 per season	Local	point	From 2016	month	Model	xlx	Public - open access	NEO/SU	https://doi.org/10.5194/hess-24-3557-2020
Coastal Environment	Water quality	Lagoon Salinity	Water inputs from sea	Volume	m3 per season	Local	point	From 2016	month	Model	xlx	Public - open access	NEO/SU	https://doi.org/10.5194/hess-24-3557-2020
Coastal Environment	Ecosystem Status	Lagoon Salinity	Lagoon Salinity (salt concentration)	Concentration	PSU	Local	30m grid	From 2016	month	Model	xlx	Public - open access	NEO/SU	https://doi.org/10.5194/hess-24-3557-2020
Fisheries & Aquaculture	Ecosystem Status	Lagoon Salinity	Harvestable lagoon fish	Mass	kg	Local	point	From 1997	month	Database	xlx	Restricted	NEO/SU	
Fisheries & Aquaculture	Ecosystem Status	Lagoon Salinity	fishing yield	Quantity	kg	Local	point	From 2015	month	Model	xlx	Restricted		
Coastal Environment	Runoff	Lagoon Salinity	Fresh-water inputs from catchment	Volume	m3	Local	point	From 2015	month	Model	xlx	Public - open access	NEO/SU	https://doi.org/10.5194/hess-24-3557-2020
Coastal Environment	Runoff	Lagoon Salinity	Water volume from Tyflomitis diverted to sea	Volume	m3	Local	point	From 2015	month	Report/Paper	xlx	Public - open access		
Coastal Environment	Runoff	Lagoon Salinity	Water volume from Xerolagados diverted to sea	Volume	m3	Local	point	From 2015	month	Report/Paper	xlx	Public - open access		
Coastal Environment	Biodiversity	Tourism	Logheaded turtle nesting capacity	Quantity		Local	not applicable		season	Report/Paper	doc	Restricted	Archaelon	
Tourism	Coastal Environment	Tourism	Beach Space	Area	ha	Europe	25ha	From 1990	Other (Please specify)	Database	GIS vector	Public - open access	Copernicus Land Monitoring Service	https://www.copernicus.eu/en/services/land
Tourism	Coastal Environment	Tourism	Beach Crowdness	Population	number of car	Local	not applicable		season	Field Data	xlx	Public - on demand	NEO/SU	
Tourism	Rural activities	Tourism	Golf area	Area	Ha	Local			not applicable	Report/Paper	doc	Restricted	TEMES	
Economy	Population	Tourism	local economy	Money	Euros	Country	Nuts Level 3	2010	annual	Survey	xlx	Public - open access	ELSTAT - National Statistics	
Coastal Environment		Tourism	Beach/Marine Litter	Quantity		Local	Sample site	2018	not applicable	Field Data	xlx	Restricted	HCMR	
Marine Environment	Water quality	Tourism	Marine ecosystem health index		Dimensionless	Local	Sample site	2018	season	Field Data	xlx	Restricted	HCMR	
Economy	Rural Development	Tourism	Fraction of budget for marine tourism activities	Money	Euros	Region	Nuts Level 3		Annual	Interviews			Messinia Development Agency	
Marine Environment	Water quality	Tourism	Pollution	Concentration		Local	Point	2018	season	Field Data	Xlx	Restricted	HCMR	
Fisheries & Aquaculture	Population	Tourism	Fishers Income	Money	Euros	Local	not applicable		Season					

Fisheries & Aquaculture	Biodiversity	Tourism	Fish Harvested at Sea	Quantity	Tonnes	Region				Report/Paper	Doc			
Marine Environment	Water quality	Tourism	Wastewater treatment capacity							Report/Paper	Doc	Public - open access		
Economy	Rural Development	Tourism	Fraction of budget for agrotourism activities	Money	Euros	Region	Nuts Level 3		Annual				Messinia Development Agency	
Agriculture	Runoff	Tourism	Agricultural runoff	Rate	m3/s	Local	point	From 2015	month	Model	xlx	Restricted	Model SWAT / HCMR	
Spatial Planning	Policy	Tourism	waste management capacity	Quantity	Tones	Local	Nuts Level 3	From 2010	not applicable	Report/Paper	Doc	Public - open access	Pylos Municipality	
Tourism	Population	Tourism	Nights Spent	Quantity	Days	Region	Nuts Level 3	From 2010	month	Survey	xlx	Public - open access	SETE-Greek Tourism Confederation	https://sete.gr/en/
Tourism	Rural activities	Tourism	available beds	Quantity	Beds	Local		From 2000	Annual	Survey	xlx	Public - open access	SETE-Greek Tourism Confederation	
Tourism	Rural activities	Tourism	normal tourist population	Population	people	Region	Nuts Level 3	From 2000	month	Survey	xlx	Public - open access	SETE-Greek Tourism Confederation	
Tourism	Rural activities	Tourism	2home occupancy	Quantity		Region	Nuts Level 3	From 2000	Month	Survey	xlx	Public - open access	ELSTAT - National Statistics	
Land Use	Agriculture	Tourism	Agriculture and conservation Land	Area	ha								Corinne	
Social	Demography	Tourism	local population	Population	people	Region	Nuts Level 3	From 1990	Decade	Census	xlx	Public - open access	ELSTAT - National Statistics	
Spatial Planning	Rural Development	Tourism	National and Regional Budget in support of tourism development	Money	Euros	Region	Nuts Level 3		Annual				Messinia Development Agency	
Land Use	Agriculture	Integrated Agriculture	total olive-land	Area	ha	Local	Case study area		annual	Database	xlx	Public - open access	NEO/SU	
Agriculture	Soil Quality	Integrated Agriculture	% of land treated-with-synthetic-fertilizers	Rate		Local	Case study area		Annual	Report/Paper		Public - open access	NEO/SU	https://doi.org/10.3390/horticulturae4030015
Agriculture	Soil Quality	Integrated Agriculture	% of land treated-with-pesticides	Rate		Local	Case study area		Annual					https://doi.org/10.3390/horticulturae4030015
Agriculture	Soil Quality	Integrated Agriculture	% of land treated-with-herbicides	Rate		Local	Case study area		Annual	Report/Paper				https://doi.org/10.3390/horticulturae4030015
Agriculture	Soil Quality	Integrated Agriculture	% of land treated-with-tillage&herbicides	Rate		Local	Case study area		Annual	Report/Paper				https://doi.org/10.3390/horticulturae4030015
Agriculture	Rural Economy	Integrated Agriculture	Cost of production -	Money	Euros	Country		from 2017	annual	Report/Paper		Public - open access		https://doi.org/10.3390/horticulturae4030016; DOI:10.15835/buasvmcn-hort: 2018.0044
Agriculture	Rural Economy	Integrated Agriculture	Farmers' profit -	Money	Euros	Country		from 2018	annual	Report/Paper		Public - open access		https://doi.org/10.3390/horticulturae4030016; DOI:10.15835/buasvmcn-hort: 2018.0045
Agriculture	Rural Economy	Integrated Agriculture	Olive-oil price -	Money	Euros	Europe		from 2010	week	Database	xlx	Public - open access		https://data.europa.eu/euodp/en/data/dataset/olive-oil-market-prices
Industry	Rural Economy	Integrated Agriculture	Bulk/ ISO labelled sales -	Volume	Tones	Europe		from 2011	Annual	Database	xlx			https://data.europa.eu/euodp/en/data/dataset/olive-oil-trade-data; https://www.oliveoiltimes.com/olive-oil-industry-data-dashboard
Agriculture	Rural Economy	Integrated Agriculture	Current members	Other (Please :	number	Local	Case study area	present		Interviews				
Economy	Rural activities	Integrated Agriculture	Employment opprtunity -	Population	people	Country	Nuts Level 3	2000	season	Survey	Xlx	Public - open access	ELSTAT - National Statistics	

Agriculture	Land Use	Integrated Agriculture	Farm diversity -	Density	species per ha	Local	Case study area			Report/Paper			NEO/SU	Impact of Olive Cultivation on Biodiversity in Messenia, Greece; Biodiversity in olive plantations – the importance of variety in the landscape
Economy	Rural Economy	Integrated Agriculture	labour work cost	Money	Euros	Country								https://doi.org/10.3390/horticulturae4030016; DOI:10.15835/buasvmcn-hort: 2018.0045

Table B-3 **Data/model Inventory used for quantification of the SD models developed for identified problems in the Norrström/Baltic Sea (Sweden) Case Study**

Main Theme	Sub Theme	SF Model Identification	Variable name in SF model	Unit of	Unit	Geographical Coverage	Spatial Resolution (Geographical Extent)	Time Coverage	Time Resolution	Data Category (Generation)	File type	Accessibility	Data/Model Owner	URL
Rural Environment	Runoff	Sub-model 1. Land-sea inter-sectoral and coastal water exchange & Sub-model 2. Land-sea inter-sectoral and coastal waterborne nutrient exchange	Sectoral (agriculture, forest (ecosystem) and forestry, municipal water supply, urban surface runoff, industry, wastewater treatment plant, and unconnected coastal wastewater) water flow	Flow	m3/year	Region	Norrström catchment, main part of the case study area	2005	Annual average	Report/Paper	pdf	Public - open access	Published data and modeling approach in peer-reviewed scientific paper and master thesis: - Baresel, C., and Destouni, G. (2005) Novel quantification of coupled natural and cross-sectoral water and nutrient/pollutant flows for environmental management. Environmental Science and Technology, 39(16), 6182-6190 (accessibility: Publich - open access) - Cseh, M. (2009) Multi-approach comparison of nutrient flow modeling in the Norrström drainage basin. Master thesis in Environmental Engineering, Budapest University of Technology and Economics, Budapest, Hungary, and	https://pubmed.ncbi.nlm.nih.gov/16173579/
Water Resources	Runoff	Sub-model 1. Land-sea inter-sectoral and coastal water exchange & Sub-model 2. Land-sea inter-sectoral and coastal waterborne nutrient exchange	Natural water system (surface, subsurface, evapotranspiration and coastal) flow	Flow	m3/year	Region	Norrström catchment, main part of the case study area	2005	Annual average	Report/Paper	pdf	Public - open access	Published data and modeling approach in peer-reviewed scientific paper and master thesis: - Baresel, C., and Destouni, G. (2005) Novel quantification of coupled natural and cross-sectoral water and nutrient/pollutant flows for environmental management. Environmental Science and Technology, 39(16), 6182-6190 (accessibility: Publich - open access) - Cseh, M. (2009) Multi-approach comparison of nutrient flow modeling in the Norrström drainage basin. Master thesis in Environmental Engineering, Budapest University of Technology and Economics, Budapest, Hungary, and	https://pubmed.ncbi.nlm.nih.gov/16173579/
Rural Environment	Climate	Sub-model 1. Land-sea inter-sectoral and coastal water exchange & Sub-model 2. Land-sea inter-sectoral and coastal waterborne nutrient exchange	Precipitation and its projected changes	Quantity	mm/year	Region	Norrström catchment, main part of the case study area	Precipitation: 1860 - 2009 Projection: 2100	Annual average	Report/Paper	pdf	Public - open access	Published data and projections in a national database of the Swedish Meteorological and Hydrological Institute (SMHI)	https://www.smhi.se/en/climate/climate-indicators/climate-indicators-precipitation-1.91462 https://www.smhi.se/en/climate/future-climate/climate-scenarios/sweden/basin/norrstrom/rcp85/year/precipitation
Coastal Environment	Water quality	Sub-model 1. Land-sea inter-sectoral and coastal water exchange	Proxy of critical seawater intrusion risks - General model for saltwater intrusion management	DML Index	not applicable	General	Coastal groundwater aquifers	General	Annual average	Report/Paper	pdf	Public - open access	Published modeling approach in a peer-reviewed scientific paper: - Mazi, K., Koussis, A. D., and Destouni, G. (2016) Quantifying a sustainable management space for human use of coastal groundwater under multiple change pressures. Water Resources Management, 30, 4063-4080.	https://link.springer.com/article/10.1007/s11269-016-1363-1
Spatial Planning	Land use	Sub-model 1. Land-sea inter-sectoral and coastal water exchange & Sub-model 2. Land-sea inter-sectoral and coastal waterborne nutrient exchange	Various land use types (agriculture, forest, urban, and inland water surface)	Area	km2	Region	Case study area	2009	Annual average	Report/Paper	pdf	Public - on demand	Published data in a master thesis: - Cseh, M. (2009) Multi-approach comparison of nutrient flow modeling in the Norrström drainage basin. Master thesis in Environmental Engineering, Budapest University of Technology and Economics, Budapest, Hungary, and Stockholm University, Stockholm, Sweden (accessibility: Public - on demand)	
Rural Environment	Water quality	Sub-model 2. Land-sea inter-sectoral and coastal waterborne nutrient exchange	Input and output nitrogen (N) and phosphorus (P) concentrations for municipal wastewater treatment plants	Concentration	mg/lit	Region	Case study area	2016	Annual average	Report/Paper	pdf	Public - open access	Published data in a national report by the Swedish Environmental Protection Agency (Naturvårdsverket): - Wastewater treatment in Sweden (2016)	https://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-8809-5.pdf?pid=22471
Rural and inland activities	Water quality	Sub-model 2. Land-sea inter-sectoral and coastal waterborne nutrient exchange	Input nitrogen (N) and phosphorus (P) concentrations for inland and coastal surface flows from monitored coastal regions to the sea (Cm for N and P)	Concentration	mg/lit	Region	Case study area	2013	Annual average	Report/Paper	pdf	Public - open access	Published data in a peer-reviewed scientific paper and an international report by Helsinki Commission: - Bring, A., Rogberg, P., and Destouni, G. (2015) Variability in climate change simulations affects needed long-term riverine nutrient reductions for the Baltic Sea. AMBIO, 44(Suppl. 3). S381-S391. - Review of the fifth Baltic Sea pollution load compilation for the 2013 HELCOM Ministrial Meeting. No. 141 (2013)	https://pubmed.ncbi.nlm.nih.gov/26022321/ https://www.helcom.fi/wp-content/uploads/2019/08/BSEP141.pdf
Coastal Environment	Water quality	Sub-model 2. Land-sea inter-sectoral and coastal waterborne nutrient exchange	Notion of reletive temporal constancy in subsurface nutrient concentrations due to legacy sources in unmonitored coastal regions	Concentration	mg/lit	Region	Case study area	1998-2015	Annual average	Report/Paper	pdf	Public - open access	Published notion and modelling approach in a peer-reviewed scientific paper: - Destouni, G., and Jarsjö, J. (2018) Zones of untreatable water pollution call for better appreciation of mitigation limits and opportunities. WIREs Water (WILEY), 5(6), e1312.	https://onlinelibrary.wiley.com/doi/epdf/10.1002/wat2.1312
Rural and inland activities	Water quality	Sub-model 2. Land-sea inter-sectoral and coastal waterborne nutrient exchange	Input nitrogen (N) and phosphorus (P) concentrations for subsurface flows from unmonitored coastal regions to the sea (based on regressions on population density ≈ 5Cm – 1.7648 for N and ≈ 5Cm – 0.0952 for P, or based on regressions on farmland share ≈ 5Cm – 0.3204 for N and ≈ 5Cm – 0.0692 for P)	Concentration	mg/lit	Baltic and Balkan regions	Case study area	2018	Annual average	Report/Paper	pdf	Public - open access	Published modelling approach and regressions established in a peer-reviewed scientific paper: - Levi, L., Cvetkovic, V., and Destouni, G. (2018). Data-driven analysis of nutrient inputs and transfers through nested catchments. Science of the Total Environment, 610-611, 482-494.	https://www.sciencedirect.com/science/article/pii/S0048969717320016
Demography	Current population	Sub-model 2. Land-sea inter-sectoral and coastal waterborne nutrient exchange	Population distribution between monitored and unmonitored coastal catchments	Density	people/km2	Region	Baltic drainage basin including case study area	2002	Annual average	Report/Paper	pdf	Public - open access	Published data and modelling approach in peer-reviewed scientific papers and an open-access database: - Hannerz, F., and Destouni, G. (2006) Spatial characterization of the Baltic Sea drainage basin and its unmonitored catchments. AMBIO, 35(5), 214-219. - Destouni, G., Hannerz, F., Prieto, C., Jarsjö, J., and Shibuo, Y. (2008) Small unmonitored near-coastal catchment areas yielding large mass loading to the sea. Global Biogeochemical Cycles, 22, GB4003. - Hannerz, F. (2008) Database of Spatial characterization of the Baltic Sea drainage basin and its unmonitored catchments. Bolin Centre for Climate Research Database.	https://pubmed.ncbi.nlm.nih.gov/16989505/ https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2008GB003287 https://bolin.su.se/data/hannerz-bsdbs
Coastal Environment	Water quality	Sub-model 2. Land-sea inter-sectoral and coastal waterborne nutrient exchange	Relationships between input nutrient concentrations for monitored and unmonitored coastal areas	Concentration	mg/lit	Region	Baltic drainage basin including case study area	1997-2005	Annual average	Report/Paper	pdf	Public - open access	Published data and modelling approach in a peer-reviewed scientific paper: - Destouni, G., Hannerz, F., Prieto, C., Jarsjö, J., and Shibuo, Y. (2008) Small unmonitored near-coastal catchment areas yielding large mass loading to the sea. Global Biogeochemical Cycles, 22, GB4003.	https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2008GB003287
Marine Environment	Water quality	Sub-model 2. Land-sea inter-sectoral and coastal waterborne nutrient exchange	Policy/Agreement required nutrient load reductions	Load	tonnes/year	Region	Swedish water management district, Northern Baltic Proper including case study area	2007-2021	Annual average	Report/Paper	pdf	Public - open access	Published data in an international report by Helsinki Commission: - HELCOM Baltic Sea Action Plan (2007)	https://helcom.fi/baltic-sea-action-plan/

Table B-4	Data/model Inventory used for quantification of the SD models developed for identified problems in the Charente River Case Study													
Main Theme	Sub Theme	SF Model Identification	Variable name in SF model	Unit of	Unit	Geographical Coverage	Spatial Resolution (Geographical Extent)	Time Coverage	Time Resolution	Data Category (Generation)	File type	Accessibility	Data/Model Owner	URL
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	Oyster_under_productic	Mass	ton	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	CRC	http://www.src-poitoucharentes.com/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	mortality	Mass	ton/year	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	CRC	http://www.src-poitoucharentes.com/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	selling	Mass	ton/year	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	CRC	http://www.src-poitoucharentes.com/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	spat_capture	Mass	ton/year	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	CRC	http://www.src-poitoucharentes.com/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	average_export_price	Money	euros/tonne	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	CRC	http://www.src-poitoucharentes.com/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	average_local_retail_pri	Money	euros/tonne	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	CRC	http://www.src-poitoucharentes.com/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	average_profits	Money	euros/tonne	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	CRC	http://www.src-poitoucharentes.com/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	average_time_from_spa	Time	year	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	CRC	http://www.src-poitoucharentes.com/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	average_time_to_respo	Time	year	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	CRC	http://www.src-poitoucharentes.com/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	duration	Time	year	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	CRC	http://www.src-poitoucharentes.com/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	epuration_costs	Cost	euros/tonne	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	CRC	http://www.src-poitoucharentes.com/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	export	Mass	ton/year	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	CRC	http://www.src-poitoucharentes.com/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	export_market_demand	Mass	Tonnes	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	CRC	http://www.src-poitoucharentes.com/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	export_sales_profits	Money	Euros	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	CRC	http://www.src-poitoucharentes.com/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	mortality frequency_occ	Frequency	1/year	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	CRC	http://www.src-poitoucharentes.com/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	initial_oyster_under_pro	Mass	ton	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	CRC	http://www.src-poitoucharentes.com/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	initial_production	Mass	ton	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	CRC	http://www.src-poitoucharentes.com/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	local_market_demand	Mass	ton	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	CRC	http://www.src-poitoucharentes.com/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	local_sales	Mass	ton/year	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	CRC	http://www.src-poitoucharentes.com/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	local_sales_profits	Money	Euros*Tons/Years	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	CRC	http://www.src-poitoucharentes.com/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	part_export	DML Index	Dmnl	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	CRC	http://www.src-poitoucharentes.com/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	production_costs	Cost	euros/tonne	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	CRC	http://www.src-poitoucharentes.com/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	production_gap	Mass	ton	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	CRC	http://www.src-poitoucharentes.com/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	sale_period	Time	year	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	CRC	http://www.src-poitoucharentes.com/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	Shellfish_profits	Money	Euros	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	CRC	http://www.src-poitoucharentes.com/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	transport_costs	Cost	euros/tonne	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	CRC	http://www.src-poitoucharentes.com/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	virus_frequencies	Frequency	1/year	Region	Case study area		Annual	Report/Paper	pdf	Public - open acces	Ifremer	https://archimer.ifremer.fr/
Fisheries & Aquaculture	Shellfish_farming	Oyster_farming	volume_mortality	Mass	ton	Region	Case study area		Annual	Report/Paper	pdf	Public - open acces	Ifremer	https://archimer.ifremer.fr/
Agriculture	Agricultural development	Agriculture	Building_storage_faciliti	Mass	Tonnes	Region	Case study area	2000-2019	Annual	Report/Paper	xlx	Public - open acces		https://publications.passioncereales.fr
Agriculture	Agricultural development	Agriculture	Conventional_field_crop	Area	hectare	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	new_vineyard(t)	Area	hectare	Region	Case study area	2000-2019	Annual	Database	xlx	Public - open acces	government	https://agreste.agriculture.gouv.fr/ag
Agriculture	Agricultural development	Agriculture	organic_farming_area(t)	Area	hectare	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	government	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	Organic_storage_facilitie	Mass	Tonnes	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	government	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	transition_field_cropare	Area	hectare	Region	Case study area	2000-2020	Annual	Database	xlx	Public - on demanc	government	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	vineyard_under_produc	Area	hectare	Region	Case study area	2000-2021	Annual	Database	xlx	Public - on demanc	government	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	grubbing-up	Area	hectare/year	Region	Case study area		Annual	Report/Paper	xlx	Public - on demanc	BNIC	www.bnic.fr
Agriculture	Agricultural development	Agriculture	Organic_abandonment	Area	hectare/year	Region	Case study area		Annual	Interviews	xlx	Not available	FRAB	
Agriculture	Agricultural development	Agriculture	production	Area	hectare/year	Region	Case study area	2000-2019	Annual	Report/Paper	xlx	Public - open acces	government	https://agreste.agriculture.gouv.fr/ag
Agriculture	Agricultural development	Agriculture	vine_planting_rate	Area	hectare/year	Region	Case study area	2000-2019	Annual	Report/Paper	xlx	Public - on demanc	CRANA	https://nouvelle-aquitaine.chambres-a
Agriculture	Agricultural development	Agriculture	agricultural_water_dem	Volume	Mm3	Region	Case study area	2000-2019	Annual	Report/Paper	xlx	Public - on demanc	CRANA	https://nouvelle-aquitaine.chambres-a
Agriculture	Agricultural development	Agriculture	authorized_production_	Volume	Hl/ha	Region	Case study area	2000-2019	Annual	Report/Paper	xlx	Public - on demanc	BNIC	www.bnic.fr

Agriculture	Agricultural development	Agriculture	average_conventional_y	Mass	tons/hectare	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	average_irrigation_neec	Volume	m3/hectare	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	average_Nfertilizers_use	Mass	Kg/ha	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	average_organic_grains_	Mass	tons/hectare	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	average_Organic_Nferti	Mass	Kg/ha	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	average_summer_tempe	Temperature	Celsius degree	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	cereal_share	DML Index	Dmnl	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	cereals_area	Area	hectare	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	Cognac_production	Volume	Hl per year	Region	Case study area	2000-2019	Annual	Report/Paper	xlx	Public - on demanc	CRANA	https://charente-maritime.chambre-a
Agriculture	Agricultural development	Agriculture	demand_for_organic_pr	Mass	tons	Region	Case study area		Annual	Report/Paper	xlx	Public - open acces	agence bio	https://www.agencebio.org/vos-outils
Agriculture	Agricultural development	Agriculture	desired_Cognac_produc	Volume	Hl	Region	Case study area		Annual	Interviews	xlx	Public - on demanc	BNIC	www.bnic.fr
Agriculture	Agricultural development	Agriculture	effect_of_Gross_Margin	DML Index	Dmnl	Region	Case study area		Annual	Interviews	xlx	Public - on demanc	CRANA/FRAB	https://www.bionouvelleaquitaine.co
Agriculture	Agricultural development	Agriculture	Fertilizers_use	Mass	Kilograms	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	Fertilizers_used_in_orga	Mass	Kg/ha	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	grassland	Area	hectare	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	impact_prices_on_crops	DML Index	Dmnl	Region	Case study area		Annual	Interviews	xlx	Public - on demanc	CRANA/FRAB	
Agriculture	Agricultural development	Agriculture	increase_demand_for_o	DML Index	Dmnl	Region	Case study area		Annual	Interviews	xlx	Public - on demanc	FRAB	https://www.bionouvelleaquitaine.co
Agriculture	Agricultural development	Agriculture	increasing_rate	DML Index	Dmnl	Region	Case study area		Annual	Interviews	xlx	Public - on demanc	FRAB	https://www.bionouvelleaquitaine.co
Agriculture	Agricultural development	Agriculture	indicative_organic_price	Money	euros/ton	Region	Case study area		Annual	Interviews	xlx	Public - on demanc	FRAB	https://www.bionouvelleaquitaine.co
Agriculture	Agricultural development	Agriculture	initial_conventional_fiel	Area	hectare	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	initial_new_vineyard	Area	hectare	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	initial_Organic_area	Area	hectare	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	initial_vineyard_area	Area	hectare	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	irrigated_Conventional_	Area	hectare	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	irrigated_mais	Area	hectare	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	irrigated_other_crops	Area	hectare	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	irrigated_vineyards	Area	hectare	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	maize_area	Area	hectare	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	maize_share	DML Index	Dmnl	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	market_demand	Volume	Hl	Region	Case study area		Annual	Interviews	xlx	Public - on demanc	CRANA/FRAB	
Agriculture	Agricultural development	Agriculture	need_for_Organic_stora	Mass	Tonnes	Region	Case study area		Annual	Interviews	xlx	Public - on demanc	CRANA/FRAB	
Agriculture	Agricultural development	Agriculture	Organic_cereals	Area	hectare	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr

Agriculture	Agricultural development	Agriculture	Organic_irrigated	Area	hectare	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	Organic_new_crops	Area	hectare	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Agriculture	Agricultural development	Agriculture	other_crops	Area	hectare	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Water Resources	Agricultural development	Agriculture	planting_rights	Area	hectare	Region	Case study area		Annual	Interviews	xlx	Public - on demanc	CRANA/FRAB	
Water Resources	Agricultural development	Agriculture	price_cereals	Money	euros/ton	Region	Case study area	2000-2019	Annual	Database	xlx	Public - open acces	government	https://agreste.agriculture.gouv.fr/ag
Water Resources	Agricultural development	Agriculture	price_conventional_grai	Money	euros/ton	Region	Case study area	2000-2019	Annual	Database	xlx	Public - open acces	government	https://agreste.agriculture.gouv.fr/ag
Water Resources	Agricultural development	Agriculture	price_maize	Money	euros/ton	Region	Case study area	2000-2019	Annual	Database	xlx	Public - open acces	government	https://agreste.agriculture.gouv.fr/ag
Water Resources	Agricultural development	Agriculture	price_organic_grains	Money	euros/ton	Region	Case study area	2000-2019	Annual	Database	xlx	Public - open acces	government	https://agreste.agriculture.gouv.fr/ag
Water Resources	Agricultural developi	Agriculture	production_gap	Volume	Hl	Region	Case study area	2000-2019	Annual	Database	xlx	Public - open acces	government	https://agreste.agriculture.gouv.fr/ag
Water Resources	Agricultural developi	Agriculture	production_increase	Area	hectare	Region	Case study area	2000-2019	Annual	Database	xlx	Public - open acces	government	https://agreste.agriculture.gouv.fr/ag
Water Resources	Agricultural developi	Agriculture	production_of_organic_	Mass	tons	Region	Case study area		Annual	Database	xlx	Public - open acces	government	https://agreste.agriculture.gouv.fr/ag
Water Resources	Agricultural developi	Agriculture	relative_part_of_irrigate	DML Index	Dmnl	Region	Case study area	2000-2019	Annual	Report/Paper	xlx	Public - on demanc	CRANA	https://charente-maritime.chambre-a
Water Resources	Agricultural developi	Agriculture	relative_price_between_	DML Index	Dmnl	Region	Case study area		Annual	Interviews	xlx	Public - on demanc	CRANA/FRAB	
Water Resources	Agricultural developi	Agriculture	relative_yield_between_	DML Index	Dmnl	Region	Case study area		Annual	Interviews	xlx	Public - on demanc	CRANA/FRAB	
Water Resources	Agricultural developi	Agriculture	replacement_rate	DML Index	Dmnl	Region	Case study area		Annual	Interviews	xlx	Public - on demanc	CRANA/FRAB	
Water Resources	Agricultural developi	Agriculture	share_irrigated_maize	DML Index	Dmnl	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Water Resources	Agricultural developi	Agriculture	share_irrigated_other_c	DML Index	Dmnl	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Water Resources	Agricultural developi	Agriculture	share_Organic_irrigated	DML Index	Dmnl	Region	Case study area	2000-2019	Annual	Database	xlx	Public - on demanc	inrae	www.stratus.irstea.fr
Water Resources	Agricultural developi	Agriculture	storage_gap	Mass	Tonnes	Region	Case study area	2000-2019	Annual	Database	xlx	Public - open acces	government	https://agreste.agriculture.gouv.fr/ag
Water Resources	Agricultural developi	Agriculture	summer_temperatures	Temperature	Celsius degree	Region	Case study area	2000-2020	Annual	Database	xlx	Restricted	meteo France	https://meteofrance.com/
Water Resources	Agricultural developi	Agriculture	time_for_transition	Time	year	Region	Case study area		Annual	Interviews	xlx	Public - on demanc	CRANA/FRAB	
Water Resources	Agricultural developi	Agriculture	time_to_build	Time	year	Region	Case study area		Annual	Interviews	xlx	Public - on demanc	CRANA/FRAB	
Water Resources	Agricultural developi	Agriculture	time_to_plan	Time	year	Region	Case study area		Annual	Interviews	xlx	Public - on demanc	CRANA/FRAB	
Water Resources	Agricultural developi	Agriculture	time_to_respond_to_de	Time	year	Region	Case study area		Annual	Interviews	xlx	Public - on demanc	CRANA/FRAB	
Water Resources	Agricultural developi	Agriculture	vineyard_av_production	Volume	Hl/ha	Region	Case study area	2000-2019	Annual	Report/Paper	xlx	Public - on demanc	government	https://agreste.agriculture.gouv.fr/ag
Water Resources	Agricultural developi	Agriculture	vineyard_extension	Area	hectare	Region	Case study area	2000-2019	Annual	Report/Paper	xlx	Public - on demanc	CRANA	https://charente-maritime.chambre-a
Water Resources	Agricultural developi	Agriculture	vineyard_water_demanc	Volume	m3	Region	Case study area	2000-2019	Annual	Report/Paper	xlx	Public - on demanc	CRANA	https://charente-maritime.chambre-a
Water Resources	Agricultural developi	Agriculture	vineyard_water_needs	Volume	m3/hectare	Region	Case study area	2000-2019	Annual	Report/Paper	xlx	Public - on demanc	CRANA	https://charente-maritime.chambre-a
Water Resources	Water uses	Water	dam_water_storage(t)	Volume	Mcubicmeters	Region	Case study area	2000-2019	month	Database	xlx	Public - on demanc	EPTB	www.stratus.irstea.fr
Water Resources	Water uses	Water	groundwater(t)	Volume	Mcubicmeters	Region	Case study area	2000-2019	month	Model	xlx	Public - on demanc	INRAE	www.stratus.irstea.fr
Water Resources	Water uses	Water	population(t)	Population	person	Region	Case study area	2000-2019	month	Report/Paper	xlx	Public - on demanc	INSEE	https://www.insee.fr/fr/statistiques/1
Water Resources	Water uses	Water	reservoir_water_storage	Volume	Mcubicmeters	Region	Case study area	2000-2019	month	Database	xlx	Public - on demanc	EPTB	www.stratus.irstea.fr
Water Resources	Water uses	Water	surface_water(t)	Volume	Mcubicmeters	Region	Case study area	2000-2019	month	Model	xlx	Public - on demanc	INRAE	www.stratus.irstea.fr
Water Resources	Water uses	Water	Tourists(t)	Population	person	Region	Case study area	2000-2019	month	Report/Paper	xlx	Public - on demanc	Government	https://ree.developpement-durable.g
Water Resources	Water uses	Water	Waste_water_treatmen	Volume	Mcubicmeters	Region	Case study area	2000-2019	month	Report/Paper	xlx	Public - on demanc	AEAG	www.stratus.irstea.fr
Water Resources	Water uses	Water	Water_in_marshes(t)	Volume	Mcubicmeters	Region	Case study area	2000-2019	month	Model	xlx	Public - on demanc	INRAE	www.stratus.irstea.fr
Water Resources	Water uses	Water	groundwater_recharge	Flow	Mcubicmeters/Mc	Region	Case study area	2000-2019	month	Model	xlx	Public - on demanc	EPTB	www.stratus.irstea.fr
Water Resources	Water uses	Water	GWater_withdrawal	Flow	Mcubicmeters/Mc	Region	Case study area	2000-2019	month	Database	xlx	Public - on demanc	EPTB	www.stratus.irstea.fr
Water Resources	Water uses	Water	inflows_to_dams	Flow	Mcubicmeters/Mc	Region	Case study area	2000-2019	month	Database	xlx	Public - on demanc	EPTB	www.stratus.irstea.fr
Water Resources	Water uses	Water	residential_population_	net_growth	person/Month	Region	Case study area	2000-2019	month	Report/Paper	xlx	Public - on demanc	INSEE	https://www.insee.fr/fr/statistiques/1
Water Resources	Water uses	Water	seepage	Flow	Mcubicmeters/Mc	Region	Case study area	2000-2019	month	Model	xlx	Public - on demanc	INRAE	www.stratus.irstea.fr
Water Resources	Water uses	Water	tourist_arrival	Flow	person/Month	Region	Case study area	2000-2019	month	Report/Paper	xlx	Public - on demanc	Charentes-Tourism	https://charentestourisme.com/
Water Resources	Water uses	Water	tourist_departure	Flow	person/Month	Region	Case study area	2000-2019	month	Report/Paper	xlx	Public - on demanc	Charentes-Tourism	https://charentestourisme.com/
Water Resources	Water uses	Water	Treated_waste_water_f	Flow	Mcubicmeters/Mc	Region	Case study area	2000-2019	month	Database	xlx	Public - on demanc	EPTB	www.stratus.irstea.fr
Water Resources	Water uses	Water	water_release	Flow	Mcubicmeters/Mc	Region	Case study area	2000-2019	month	Database	xlx	Public - on demanc	EPTB	www.stratus.irstea.fr
Water Resources	Water uses	Water	basin_area		hectare	Region	Case study area	2000-2019	month	Database	xlx	Public - on demanc	INRAE	www.stratus.irstea.fr
Water Resources	Water uses	Water	capacity_drinking_wate	Volume	Mcubicmeters	Region	Case study area	2000-2019	month	Database	xlx	Public - on demanc	AEAG	www.stratus.irstea.fr
Water Resources	Water uses	Water	capacity_storage	Volume	Mcubicmeters	Region	Case study area	2000-2019	month	Database	xlx	Public - on demanc	AEAG	www.stratus.irstea.fr
Water Resources	Water uses	Water	capacity_WWTP	Population	person	Region	Case study area	2000-2019	month	Database	xlx	Public - on demanc	EPTB	www.stratus.irstea.fr
Water Resources	Water uses	Water	coastal_population_frac	Flow	person/Month	Region	Case study area	2000-2019	month	Database	xlx	Public - on demanc	INSEE	https://ree.developpement-durable.g
Water Resources	Water uses	Water	coastal_salinity	DML Index	Dmnl	Region	Case study area	2000-2019	month	Database	xlx	Public - on demanc	Government	https://www.eaufrance.fr/les-eaux-cc
Water Resources	Water uses	Water	comsumption_per_capita		Mcubicmeters/(pe	Region	Case study area	2000-2019	month	Database	xlx	Public - on demanc	AEAG	www.stratus.irstea.fr
Water Resources	Water uses	Water	crops	Area	hectare	Region	Case study area	2000-2019	month	Database	xlx	Public - on demanc	Government	www.stratus.irstea.fr
Water Resources	Water uses	Water	dam_area	Area	hectare	Region	Case study area	2000-2019	month	Database	xlx	Public - on demanc	EPTB	www.stratus.irstea.fr
Water Resources	Water uses	Water	data_inflows2dam	Flow	Mcubicmeters/Mc	Region	Case study area	2000-2019	month	Database	xlx	Public - on demanc	EPTB	www.stratus.irstea.fr
Water Resources	Water uses	Water	Data_Kc	DML Index	Dmnl	Region	Case study area	2000-2019	month	Database	xlx	Public - on demanc	INRAE	www.stratus.irstea.fr

Water Resources	Water uses	Water	data_rain	Volume	mm	Region	Case study area	2000-2019	month	Database	xlx	Restricted	MeteoFrance	www.stratus.irstea.fr
Water Resources	Water uses	Water	data_tourists_frequenta	DML Index	Dmnl	Region	Case study area	2000-2019	month	Report/Paper	xlx	Public - on demand	Charentes-Tourism	https://charentestourisme.com/
Water Resources	Water uses	Water	domestic_water_deman	Volume	Mcubicmeters	Region	Case study area	2000-2019	month	Report/Paper	xlx	Public - on demand	AEAG	www.stratus.irstea.fr
Water Resources	Water uses	Water	ET	Volume	mm	Region	Case study area	2000-2019	month	Database	xlx	Restricted	Meteo France	www.stratus.irstea.fr
Water Resources	Water uses	Water	evaporation	Volume	Mcubicmeters	Region	Case study area	2000-2019	month	Model	xlx	Public - on demand	INRAE	www.stratus.irstea.fr
Water Resources	Water uses	Water	frequentation_rate	DML Index	Dmnl	Region	Case study area	2000-2019	month	Report/Paper	xlx	Public - on demand	Charentes-Tourism	https://charentestourisme.com/
Water Resources	Water uses	Water	instream_flow_requiren	Flow	Mcubicmeters/Mc	Region	Case study area	2000-2019	month	Report/Paper	xlx	Public - on demand	Government	https://www.eaufrance.fr
Water Resources	Water uses	Water	irrigated_crops	Area	hectare	Region	Case study area	2000-2019	month	Database	xlx	Public - on demand	AEAG	www.stratus.irstea.fr
Water Resources	Water uses	Water	irrigation_needs	Volume	Mcubicmeters	Region	Case study area	2000-2019	month	Database	xlx	Public - on demand	INRAE	www.stratus.irstea.fr
	Water uses	Water	Kc	DML Index	Dmnl	Region	Case study area	2000-2019	month	Database	xlx	Public - on demand	INRAE	www.stratus.irstea.fr
	Water uses	Water	LowWater_Target_Flow	Volume	Mcubicmeters	Region	Case study area	2000-2019	month	Report/Paper	xlx	Public - on demand	Government	https://www.eaufrance.fr
	Water uses	Water	natural_recharge_flows	Volume	Mcubicmeters	Region	Case study area	2000-2019	month	Model	xlx	Public - on demand	INRAE	www.stratus.irstea.fr
	Water uses	Water	part_groundwater_with	DML Index	Dmnl	Region	Case study area	2000-2019	month	Report/Paper	xlx	Public - on demand	EPTB	www.stratus.irstea.fr
	Water uses	Water	part_groundwater_with	DML Index	Dmnl	Region	Case study area	2000-2019	month	Report/Paper	xlx	Public - on demand	EPTB	www.stratus.irstea.fr
	Water uses	Water	part_irrigated_crops	DML Index	Dmnl	Region	Case study area	2000-2019	month	Model	xlx	Public - on demand	INRAE	www.stratus.irstea.fr
	Water uses	Water	part_reservoir	DML Index	Dmnl	Region	Case study area	2000-2019	month	Model	xlx	Public - on demand	INRAE	www.stratus.irstea.fr
	Water uses	Water	part_Surface_water_wit	DML Index	Dmnl	Region	Case study area	2000-2019	month	Database	xlx	Public - on demand	EPTB	www.stratus.irstea.fr
	Water uses	Water	part_Surface_water_wit	DML Index	Dmnl	Region	Case study area	2000-2019	month	Database	xlx	Public - on demand	EPTB	www.stratus.irstea.fr
	Water uses	Water	period_filling_reservoir	Time	Month	Region	Case study area	2000-2019	month	Report/Paper	xlx	Public - on demand	INRAE	www.stratus.irstea.fr
	Water uses	Water	rainfall	Volume	Mcubicmeters	Region	Case study area	2000-2019	month	Database	xlx	Restricted	Meteo France	www.stratus.irstea.fr
	Water uses	Water	reservoir_use	Time	Month	Region	Case study area	2000-2019	month	Model	xlx	Public - on demand	EPTB	www.stratus.irstea.fr
	Water uses	Water	rural_population_fractio	Flow	person/Month	Region	Case study area	2000-2019	month	Database	xlx	Public - on demand	INSEE	https://www.insee.fr/fr/statistiques/2
	Water uses	Water	surface_water_inflows	Volume	Mcubicmeters	Region	Case study area	2000-2019	month	Model	xlx	Public - on demand	INRAE	www.stratus.irstea.fr
	Water uses	Water	total_population	Population	person	Region	Case study area	2000-2019	month	Database	xlx	Public - on demand	INSEE	https://www.insee.fr/fr/statistiques/1
	Water uses	Water	tourist_capacity	Population	person	Region	Case study area	2000-2019	month	Report/Paper	xlx	Public - on demand	Charentes-Tourism	https://charentestourisme.com/
	Water uses	Water	tourists_on_vacation	Population	person	Region	Case study area	2000-2019	month	Report/Paper	xlx	Public - on demand	Charentes-Tourism	https://charentestourisme.com/

Table B-5 Data/model Inventory used for quantification of the SD models developed for identified problems in ther Danube Mouths-Black Sea case study

Main Theme	Sub Theme	SF Model Identification	Variable name in SF model	Unit of	Unit	Geographical Coverage	Spatial Resolution (Geographical Extent)	Time Coverage	Time Resolution	Data Category (Generation)	File type	Accessibility	Data/Model Owner	URL
Fisheries & Aquaculture	Marine fishery	Marine Fishery	Climate change (seawate	Temperature	oC	Local	Sample site	1959-2019	day	Database	xlx	Public - on demand	NIMRD	www.rmri.ro
Fisheries & Aquaculture	Marine fishery	Marine Fishery	Consumption seafood (ar	Mass	kg/capita/yr	Country	person	1961-2017	Annual	Database	csv	Public - open access	FAO	https://ourworldindata.org/grapher/fish-and-seafood-consumption-per-capita?showSelectedOnly=1
Fisheries & Aquaculture	Marine fishery	Marine Fishery	Marine Aquaculture prod	Mass	t	Country	Case Study Area	2009-2018	Annual	Database	csv	Public - open access	EU	https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do
Fisheries & Aquaculture	Marine fishery	Marine Fishery	Fishing (Capture fishery p	Mass	t	Country	Case Study Area	1960-2016	Annual	Database	csv	Public - open access	FAO	https://ourworldindata.org/seafood-production#the-world-now-produces-more-seafood-from-fish-farms-than-wild-catch
Fisheries & Aquaculture	Marine fishery	Marine Fishery	Fishing (Black Sea catche	Mass	t	Country	Case Study Area	2000-2019	Annual	Database	xlx	Public - open access	EU	https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do
Fisheries & Aquaculture	Freshwater fishery	Freshwater fishery	Freshwater Aquaculture p	Mass	t	Country	Case Study Area	2009-2018	Annual	Database	xlx	Public - open access	EU	https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do
Fisheries & Aquaculture	Freshwater fishery	Freshwater fishery	Climate change (River flo	Flow	km3/yr	Europe	Case Study Area	1996-2016	Annual	Database	xlx	Public - open access	ICPDR	https://www.icpdr.org/wq-db/wq/overview
Fisheries & Aquaculture	Freshwater fishery	Freshwater fishery	Upstream danube water (	Concentration	mg/L	Country	Case Study Area	2003-2017	month	Database	xlx	Public - open access	ICPDR	https://www.icpdr.org/wq-db/wq/overview
Fisheries & Aquaculture	Marine fishery	Marine Fishery	IUU (fishing index)	not applicable	dmnl	Country	Case Study Area	2018	Annual	Report/Paper	pdf	Public - open access	Global Initiative Against T	https://iuufishingindex.net/
Fisheries & Aquaculture	Fishery	Fishery	jobs (average number of	Population	dmnl	Region	Case Study Area	1990-2019	Annual	Database	xlx	Public - open access	INSSE	http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table
Tourism	Tourism	Tourism	Empoyees (average numb	Population	dmnl	Region	Case Study Area	1990-2019	Annual	Database	xlx	Public - open access	INSSE	http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table
Tourism	Tourism	Tourism	Entrepreneurship (Establi	Quantity	dmnl	Region	Case Study Area	1990-2020	Annual	Database	xlx	Public - open access	INSSE	http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table
Coastal Environment	Ecosystem management	Ecosystem management	Black Sea water quality (S	not applicable	dmnl	Region	Case Study Area	1991-2017	Annual	Database	xlx	Public - open access	INSSE	http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table
Rural and inland activities	Rural development	Rural development	Population connected to	Population	dmnl	Region	Case Study Area	2006-2019	Annual	Database	xlx	Public - open access	INSSE	http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table
Rural and inland activities	Rural development	Rural development	Unemployment (Employr	Population	dmnl	Region	Case Study Area	1990-2019	Annual	Database	xlx	Public - open access	INSSE	http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table
Agriculture	Agriculture	Agriculture	Agriculture production	Quantity	tonnes/ha	Region		2008-2018	Annual	Database	xlx	Public - open access	NIS	http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table
Agriculture	Agriculture	Agriculture	Crops	Quantity	tonnes	Region		2008-2018	Annual	Database	xlx	Public - open access	NIS	http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table
Demography		Agriculture; Tourism, Rural development	Population	Population	number inhabitants	Region		2008-2018	Annual	Database	xlx	Public - open access	NIS	http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table
Economy	Rural development	Rural development	Entrepreneuship	Quantity	number of SME/OTHER	Region		2008-2018	Annual	Database	xlx	Public - open access	NIS	http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table
Rural and inland activities	Rural development	Rural development; tourism	Infrastructure	Quantity	Number of hospitals, schools	Region		2008-2018	not applicable	Database	xlx	Public - open access	NIS	http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table
Rural and inland activities	Rural development	Rural development	Infrastructure	Length	lenghth of roads	Region		2008-2018	not applicable	Database	xlx	Public - open access	NIS	http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table
Rural and inland activities	Rural development	Rural development	Infrastructure	Population	nr inhab conncted to sewage system	Region		2008-2018	not applicable	Database	xlx	Public - open access	NIS	http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table
Other (please specify)	all	all	legislation	Quantity	nr of regulatory docs	Region		2008-2018	not applicable	Survey		Public - open access		http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table
Agriculture	agriculture	agriculture	livestock	Quantity	number of animals	Region		2008-2018	Annual	Database	xlx	Public - open access	NIS	http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table
Agriculture	agriculture	agriculture	manure	Quantity	tonnes/ha	Region		2008-2018	Annual	Database	xlx	Public - open access	NIS	http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table
Rural and inland activities	rural develoment	rural develoment	organic agriculture	Area	ha	Region		2008-2018	Annual	Database	xlx	Public - open access	NIS	http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table
Tourism	tourism	tourism	rural turism	Quantity	nr accomodation houses	Region		2008-2018	Annual	Database	xlx	Public - open access	NIS	http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table
Demography	Agriculture;Tourism; Rural development	Agriculture;Tourism; Rural development	workforce	Population	nr persons occupied	Region		2008-2018	Annual	Database	xlx	Public - open access	NIS	http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table

Table B-6 Data/model Inventory used for quantification of the SD models developed for identified problems in the Mar Menor (Spain) Case Study

Main Theme	Sub Theme	SF Model Identification	Variable name in SF model	Unit of	Unit	Geographical Coverage	Spatial Resolution (Geographical Extent)	Time Coverage	Time Resolution	Data Category (C	File type	Accessibility	Data/Model Ow	URL
Agriculture	water	Agricultural water balance	agricultural water demand per hectare	Volume	Hm3/Ha*year	Local	Case Study Area	1961-2020	Annual	Report/Paper	pdf	Public - open access	MITECO	ica/vcerommenor/docsdescarga/esiavertidocero_tcm30-451137.pdf
Agriculture	water	Agricultural water balance	annual groundwater pumping by well	Volume	hm3/well	Local	Case Study Area	1961-2020	Annual	Report/Paper	pdf	Public - open access	Soto et al., 2014	https://repositorio.upct.es/handle/10317/4069
Agriculture	water	Agricultural water balance	CRCC share of ATS	Volume	Percentage	Local	Case Study Area	1961-2020	Annual	Report/Paper	pdf	Public - open access	MITECO	ica/vcerommenor/docsdescarga/esiavertidocero_tcm30-451137.pdf
Agriculture	water	Agricultural water balance	other post TS water sources	Rate	Hm3/year	Local	Case Study Area	1961-2020	Annual	Report/Paper	pdf	Public - open access	MITECO	ica/vcerommenor/docsdescarga/esiavertidocero_tcm30-451137.pdf
Agriculture	water	Agricultural water balance	sea water desalination	Rate	Hm3/year	Local	Case Study Area	1961-2020	Annual	Report/Paper	pdf	Public - open access	MITECO	ica/vcerommenor/docsdescarga/esiavertidocero_tcm30-451137.pdf
Agriculture	water	Agricultural water balance	rban wastewater treatment plant effluent	Rate	Hm3/year	Local	Case Study Area	1961-2020	Annual	Report/Paper	pdf	Restricted	ESAMUR	
Agriculture	water	Agricultural water balance	VCpumpedH20	Rate	Hm3/year	Local	Case Study Area		Annual	Report/Paper	pdf	Public - open access	MITECO	ica/vcerommenor/docsdescarga/esiavertidocero_tcm30-451137.pdf
Tourism		Sectorial develop-ment and economic profit	erage number of overnights per tourist a y	Rate	of overnights/tou	Local	Case Study Area	1961-2020	Annual	Report/Paper	pdf	Public - open access	CARM	170,11530
Tourism		Sectorial develop-ment and economic profit	Daily average expenditure per tourist	Money	EUR/person/day	Local	Case Study Area	1961-2020	Annual	Report/Paper	pdf	Public - open access	CARM	170,11530
Tourism		Sectorial develop-ment and economic profit	Initial nr of tourists	Population	people	Local	Case Study Area	1999	Annual	Report/Paper	pdf	Public - open access	CARM	https://econet.carm.es/web/crem/inicio/-/crem/sicrem/PU12/sec0.html
Agriculture		Sectorial develop-ment and economic profit	observed growth rate of agriculture	Rate	Percentage/Year	Local	Case Study Area	1961-2020	Annual	Model	GIS raster	Public - open access	Carreño et al., 2015	https://zenodo.org/record/237068
Industry		Sectorial develop-ment and economic profit	observed growth rate of REs	Rate	Percentage/Year	Local	Case Study Area	2012-2020	Annual	Report/Paper	xlx	Public - open access	CARM	https://econet.carm.es/web/crem/inicio/-/crem/sicrem/PU177/sec10.html
Industry		Sectorial develop-ment and economic profit	initial MW installed	Quantity	Mw	Local	Case Study Area	2012	Annual	Report/Paper	xlx	Public - open access	CARM	https://econet.carm.es/web/crem/inicio/-/crem/sicrem/PU177/sec10.html
Tourism		Sectorial develop-ment and economic profit	observed growth rate of tourism	Rate	Percentage/Year	Local	Case Study Area	1999-2020	Annual	Report/Paper	pdf	Public - open access	CARM	https://econet.carm.es/web/crem/inicio/-/crem/sicrem/PU12/sec0.html
Agriculture	nutrients	Sustainable land manage-ment practices	average excess of fertilizer use	Mass	Kg N/ha*year	Local	Case Study Area	1961-2020	Annual	Report/Paper	pdf	Public - open access	MITECO	https://www.chsegura.es/handle404?exporturi=/export/descargas/servicios/informacionpubl ica/vcerommenor/docsdescarga/esiavertidocero_tcm30-451137.pdf
Agriculture	nutrients	Sustainable land manage-ment practices	ctiveness in nutrients reduction of Vegetat	Mass	Percentage	Local	Case Study Area		Annual	Report/Paper	pdf	Public - open access	Rey-Benayas et al., 2017	https://www.canalmarmenor.es/documents/20182/23016/Informe.pdf/26ec0d7f-b7fc-495c-af12-c1e173bb5ad6
Agriculture	nutrients	Agricultural nutrients balance	empirical aver NO3 concentration in aquife	Concentration	Ton/Hm3	Local	Case Study Area	1961-2020	Annual	Report/Paper	pdf	Public - open access	MITECO	https://www.chsegura.es/handle404?exporturi=/export/descargas/servicios/informacionpubl ica/vcerommenor/docsdescarga/esiavertidocero_tcm30-451137.pdf
Agriculture	nutrients	Agricultural nutrients balance	ed percentage of nutrients reaching the MI	Rate	Percentage/Year	Local	Case Study Area		Annual	Report/Paper	pdf	Public - open access	MITECO	https://www.chsegura.es/handle404?exporturi=/export/descargas/servicios/informacionpubl ica/vcerommenor/docsdescarga/esiavertidocero_tcm30-451137.pdf
Agriculture	nutrients	Agricultural nutrients balance	gw2brine ratio	Mass	Percentage	Local	Case Study Area		Annual	Report/Paper	pdf	Public - open access	MITECO	https://www.miteco.gob.es/es/agua/temas/concesiones-y-autorizaciones/Mar-Menor-Campo-de-Cartagena-Vertido-Cero.aspx

Drop Down Lists							
Main Theme	**Unit of**	**Geographical Coverage**	**Spatial Resolution (Geographical Extent) / unit of observation**	**Time Resolution**	**Value Data Category (Generation)**	**File type**	**Accessibility**
Agriculture	Angle	Worldwide	10m grid	second	Census	xlx	Public - open access
Climate	Area	Europe	300m grid	minute	Survey	csv	Public - on demand
Coastal Environment	Concentration	Country	30m grid	hour	Field Data	doc	Restricted
Demography	Cost	Region	3m grid	day	Model	pdf	Confidential
Economy	Density	Local	household	week	Database	GIS raster	Not available
Energy	Distance	Other (Please specify)	Nuts level 1	month	Interviews	GIS vector	new estimates - to be published
Fisheries & Aquaculture	Force	General	Nuts level 2	season	Questionaires	Other (Please specify)	Other (Please specify)
Land Use	Frequency	Baltic and Balkan regions	Nuts Level 3	Annual	Report/Paper		
Marine Environment	Flow		person	Bi-annual			
Rural Environment	Length		point	Decade	Other (Please specify)		
Social	Mass		25ha	not applicable			
Spatial Planning	Population		not applicable	Other (Please specify)			
Tourism	Quantity		Other (Please specify)	Annual average			
Other (please specify)	Rate		Sample site				
Industry	Speed		Case study area				
Water Resources	Temperature		Norrström catchment, main part of the case study area				
Table B-3	Time		Swedish water management district, Northern Baltic Proper including case study area				
Table B-6	Velocity		Baltic drainage basin including case study area				
Table B-4	Volume		Coastal groundwater aquifers				

	Weight						
	Money						
	Other (Please specify)						
	not applicable						
	Load						
	DML Index						
	acoustic index						