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MedSeaRise

MedSeaRise - Supporting Adaptation to Mediterranean Sea Level Rise

Mission: Protecting, restoring and valorising the natural environment and heritage

RSO2.4: Promoting climate change adaptation and disaster risk prevention, resilience, taking into account eco-system based approaches

Case studies for evaluation of sea level rise ecosystem impacts risk

Deliverable 2.2.2

Project partner in charge: UM (PP6)

Project partners involved: ANATOLIKI S.A. (LP1)
ARPA FVG (PP2)
CCINCA (PP3)
UoM-IBMK (PP4)
BCC (PP5)

Table of contents

1. Introduction and Objectives

This document presents a specific contribution to the achievement of the general MedSeaRise WP2 objective, namely the evaluation of the likelihood of Mediterranean Sea level trends scenarios, to develop a methodology for the proper use of such data in the risk assessment processes and to provide guidelines and benchmarks for the methodology application.

Specifically, one of the results expected from Activity 2.2 is to conduct the risks and impacts analyses on a set of case studies, with the aim of identifying the key points to be included in the methodology.

To this end, selected classes of impacts, which are consequences of the sea level rise, have been considered for the risk assessment. The selection is based on data collected during the stakeholder engagement process that was organised and carried on in WP1 by each Project Partner.

The number of case studies for each selected class depends on the available information. Each case study includes the adopted assessment process, its application to the specific case and the review of the sensitivity of the resulting impact and even risk, if feasible, from the sea level trends, which are foreseen in the XXI century. Impact indexes are developed according to a few fundamental constraints, and then they are applied to best represent the impact and to explore its sensitivity to hazard uncertainty.

Due to the multidisciplinarity and the complexity of the assessment, Project Partners are supported by Associated Partners and external experts in the case study conduction and results analysis.

In the following, this deliverable reports the set of case studies dealing with sea level rise impacts potentially caused to ecosystems. Details of each case study are included as appendices since each case study has produced specific documentation and data files.

This deliverable makes synergy with deliverables D.1.2.1, D.1.2.2, D.2.3.1 and D.3.1.1 [1.1].

2. Methodology for case study conduction

Each case study has been conducted according to an approach developed in the frame of the MedSeaRise project. See [2.1] for details. The case studies have been selected during the work done as project Activity 1.2, Sea level rise risks survey and stakeholder awareness, with results collected, described and analysed by means of two deliverables, i.e. D.1.2.1 [2.2] and D.1.2.2 [2.3].

The detailed methodology is provided in Appendices A1 [2.1] and A2 [2.4]. Here, it is important to recall that the assessment of risks deriving from sea

level variations requires a robust quantification of all the elements that contribute to the sea level becoming a hazard.

The hazardous source is defined by sea level projections for the 21st century. Those data are surveyed, collected and organised in project activity 1.1, and their reliability is the result of activity 1.2.

In the case study, the method defined to assess the risk will be applied, changing the hazard input data, for each set of sea level scenarios available. The resulting risk assessment is going to be associated with the reliability of the sea level scenario used as input. These risk assessments are then used to evaluate the sensitivity of the risk to variations in the hazard and its associated uncertainty. See Figure 1.1

The core of the case study is the definition of one or more indices that will be used to quantify the impact caused by the future projections of sea level. The index is a function of the input hazard, and it can be a continuous variable or a set of classes. In both cases, the index must be ordinal, allowing values to be ranked according to the impact severity. So the computed values of the index can be ordered besides to be linked to the hazard input, leading to the study of the sensitivity of the impact to the change of the hazard, see Figure 1.2.

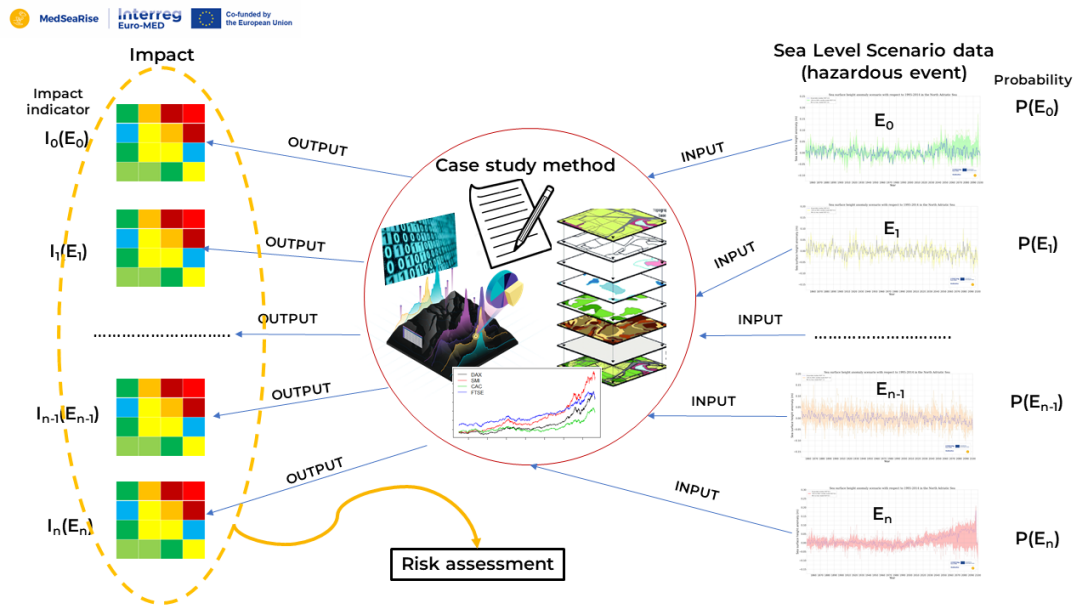

Figure 1.1: the procedure applied in the MedSeaRise case studies to assess the sensitivity of the impact to the sea level scenarios.

If, besides the impact sensitivity analysis, the risk sensitivity analysis is considered in the case study too, then the exposure and the vulnerability are used in the risk evaluation. The aim of the case study analysis is to produce a judgment supported by solid conclusions which are based on clear criteria, solid and concrete information and rational argumentation

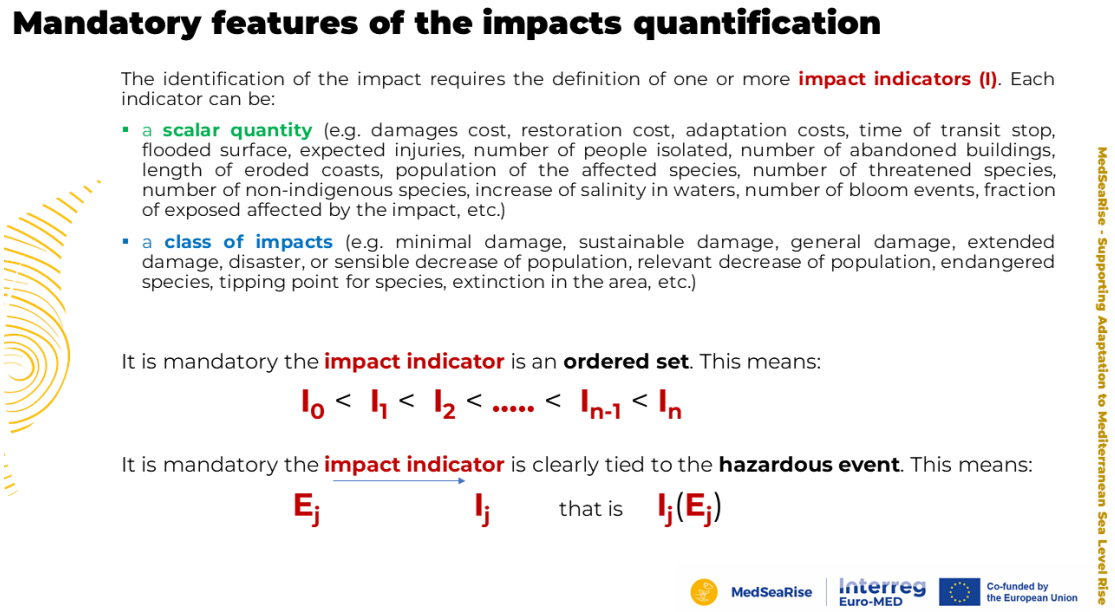

Figure 1.2: Basic and mandatory elements the impact index has to hold to be useful in the case study analysis.

Each case study includes the assessment process selection, its application to the specific case and the review of the sensitivity of the resulting risk from the sea level trends, which are foreseen in the XXI century.

In reporting the case study, a standard structure of the document has been defined, including an introduction, the case study essential information, the impact description, the impact indexes, the method and its application, to conclude with the impact analysis and results and further information.

Here is the description of content expected in each section of the case study report, and a template is available in Appendix A3

Introduction
Information considered useful to introduce the reader in understanding why the impact has been selected among other possible choices and why the case study is considered useful in contributing to achieving the overall project objective.

Case study essential information
A schematic summary of the case study.

Impact description
Description of the expected impact due to the sea level increase, as described by stakeholders and elaborated by PP.

Impact indexes
Description of the indices adopted to evaluate the impact sensitivity from hazard uncertainty and likelihood.

Method and its application
Description of how the adopted indices are computed starting from the sea level scenarios and all the other needed data. A step-by-step description of data, software, computation techniques, required competences, expertise, etc.

Impact analysis and results
Analysis of the achieved results according to the computed indexes, which have been adopted to evaluate the impact sensitivity from hazard uncertainty and likelihood. If it is possible, generate risk plots and curves that will be used in benchmarks. Here you can add your comments on the strengths and the weaknesses of the applied method.

Available information
Description of the available information considered relevant in conducting the study. Reference to bibliographic sources, websites and the data folder, if you think it is useful to describe the case study.

3. Case studies on ecosystem impacts

In this section, there is a summary of the case studies conducted to achieve the goals foreseen by Activity 2.2. Case studies are listed following the Project Partner ID. The full details of each case study are included in this deliverable as appendix. The set of Appendixes is linked to the following list. The main document of each case study has been generated according to the template [3.1].

PP3 - case study E01

This case study has been identified at the Cap Martin Natura 2000 site, located in the bay of Roquebrune-Cap-Martin on the French Riviera. This area is recognized for its ecological value and is part of a protected network to preserve habitats and species of European importance. The site hosts seagrass meadows (Posidonia oceanica) and rocky habitats that provide essential ecosystem services, such as coastal protection, carbon storage, and biodiversity support.

Because this case study is focused on ecosystem impacts, its conduction requires careful coordination and clarification with technical experts, including marine ecologists and conservation managers. The area has long been subject to chronic anthropogenic pressures. Anchoring of leisure boats, diving activities, and high levels of seasonal tourism have contributed to the physical degradation of seagrass beds, fragmentation of benthic habitats, and recurrent disturbances to marine fauna.

Although management measures have been implemented over the past decade, the overall pressure from tourism remains significant, particularly during summer months. These cumulative pressures reduce the resilience of the habitats and make them more vulnerable to additional climate-related impacts.

Sea level rise is expected to increase the risks. Linked to the sea level rise, more frequent and intense storm surges could damage fragile habitats through increased turbidity, sediment displacement, etc. Higher water temperatures associated with climate change also increase the risk of thermal stress that could at a long term range impact biodiversity. .

If possible the case study could conduct a scenario analysis based on climate projections, such as Representative Concentration Pathways (RCPs) of +2°C and +4°C warming scenarios. This approach will help explore how different combinations of sea level rise, temperature increases, and extreme events could affect the long-term condition of the site's ecosystems.

Stakeholder engagement will be an essential part of this process. The study plans to involve representatives from SMIAGE, CARF, local municipalities, and users (diving clubs, associations). Measures could include further restrictions on anchoring, expanded monitoring programs, restoration efforts for degraded seagrass beds, and targeted awareness campaigns for visitors. Ultimately, this case study aims to produce concrete impact indicators and recommendations that can inform management strategies at Cap Martin and serve the benchmarks of the project.

PP4 – case study E-01

The geographical focus of this case study is Tivatska Solila, a marshland area located in Tivat Bay, which is part of the larger Boka Kotorska Bay in Montenegro. The site consists of a former salt farm, composed of shallow salt evaporation ponds. Over time, the area has evolved into an ecologically valuable habitat and has been officially designated as a Special Nature Reserve, primarily aimed at protecting and preserving rare and endangered plant and animal species, particularly ornithofauna (bird species).

The reserve extends to an area of 150 km2. Founded in 2008, it has been declared an IUCN category V. Tivatska Solila is a historical saltworks site that has been turned into a Special Nature Reserve. Consequently, it is a very shallow marsh area extending to an area of 150 ha.

As a low-lying and shallow wetland, Tivatska Solila is highly vulnerable to sea level rise. For this reason, the study evaluates potential impacts under three sea level rise scenarios, each associated with a different level of probability. These locally adjusted projections, which consider tectonic uplift and historical tide gauge data, include the following:

Scenario 1: sea level rise of 7.5 cm, with a probability of 0.25; Scenario 2: sea level rise of 17.5 cm, with a probability of 0.5; Scenario 3: sea level rise of 37.5 cm, with a probability of 0.25.

For each scenario, the extent of inundated area within the reserve is estimated, representing the exposure. This includes both permanent inundation and temporary flooding caused by extreme events such as storm surges or seasonal high tides. The resulting impacts are expected to include: loss of above-sea-level habitat; destruction or displacement of bird nesting sites; Accelerated decomposition of vegetation currently located above water; Shifts in marine species abundance and distribution due to changing salinity and ecosystem dynamics.

Finally, a monetary value is assigned to a portion of the lost natural resources, allowing for a quantitative risk estimate expressed in thousands of Euros (kEUR). This provides a more concrete basis for future conservation planning, environmental management, and adaptation strategies for the Tivatska Solila Special Nature Reserve in the context of climate change and rising sea levels.

4. Deliverable indicators

This deliverable is summarised by means of the indicators reported below. For each of them, the expected indicator value and the actual one are presented. In addition, comments are reported too, if any.

Indicator	Expected value	Actual value	Comments
Number of case studies conducted	1	2	Case study focusing on ecosystem impacts

For each case study, a specific summary document is available as an appendix. Furthermore, the full documentation for each case study is available on the project Google Drive shared area [4.1], due to the number of files required to describe the case study.

5. Conclusions

MedSeaRise Activity 2.2 is expected to be conducted from the 2nd project period to the 4th, and in the 3rd period delivered this document. So, the majority of the work has been completed by the deliverable deadline. Anyway, this document acts as the deliverable describing the set of case studies conducted by the Project Partners, that is the whole work done in the frame of Activity 2.2.

According to the interactions foreseen by the MedSeaRise project between the Work Package 2 and the Work Package 3, the case studies summarised in this deliverable are presented to stakeholders and validated thanks to their feedback, up to the project end, that is the 4th period.

Furthermore, case studies are the foundations for the benchmarks realisation, Activity 2.3, which are going to support the MedSeaRise methodology on the selection and use of the sea level data on future climate scenarios, Activity 2.4.

It is expected that the case studies will be further refined following this deliverable, particularly during the final project phase. The improvements, if any, are going to affect the deliverable appendix only.

This deliverable contributes to achieving the goal of Activity 2.2, which is summarised as providing the project with the analysis of the sea level rise impacts on classes of anthropic activities and ecosystems.

Specifically, this deliverable collects all the case studies focusing on potential consequences on ecosystems.

6. References to additional material

[1.1] Basecamp Key Production WP1

[1.2] Google Drive MedSeaRise shared area (MedSeaRise_Interreg Euro-MED)

[2.1] Advices on case study preparation and conduction. Document available as Appendix A1

[2.2] MedSeaRise deliverable D.1.2.1 Stakeholders of risks affecting ecosystems

[2.3] MedSeaRise deliverable D.1.2.2 Stakeholders of risks affecting ecosystems

[2.4] Slides of presentation used during the Activity 2.2 meeting for PPs and experts on case study guidelines. Document available as Appendix A2

[3.1] Template file used to generate the documentation of the case study. Document available as Appendix A3

[4.1] MedSeaRise Google Drive share area in which the full information on case studies is stored Activity 2.2

7. Appendixes

Appendix A1:

Advices on case study preparation and conduction. The file in PDF format is available in the folder attached to this deliverable. File name: **Act_2.2_D.2.2.2_case_study_guidelines_appendix_A1.docx**

Appendix A2:

Slides of presentation used during the Activity 2.2 meeting for PPs and experts on case study guidelines. These slides describe schematically the main concepts of the case study impact analysis. File name: **Act_2.2_D.2.2.2_case_study_on_ecosystems_impacts_appendix_A2.pdf**

Appendix A3:

Template file used to generate the main documentation of the case study. The case study is reported according to this file section. File name: **Act_2.2_D.2.2.2_case_study_on_ecosystems_impacts_appendix_A3.docx**

Appendix B1:

Case study **E-01** by Project Partner **PP3** full documentation and data: files are available following this link: PP3 CCINCA.

Appendix B2:

Case study **E-01** by Project Partner **PP4** full documentation and data: files are available following this link: PP4 UoM-IBMK.