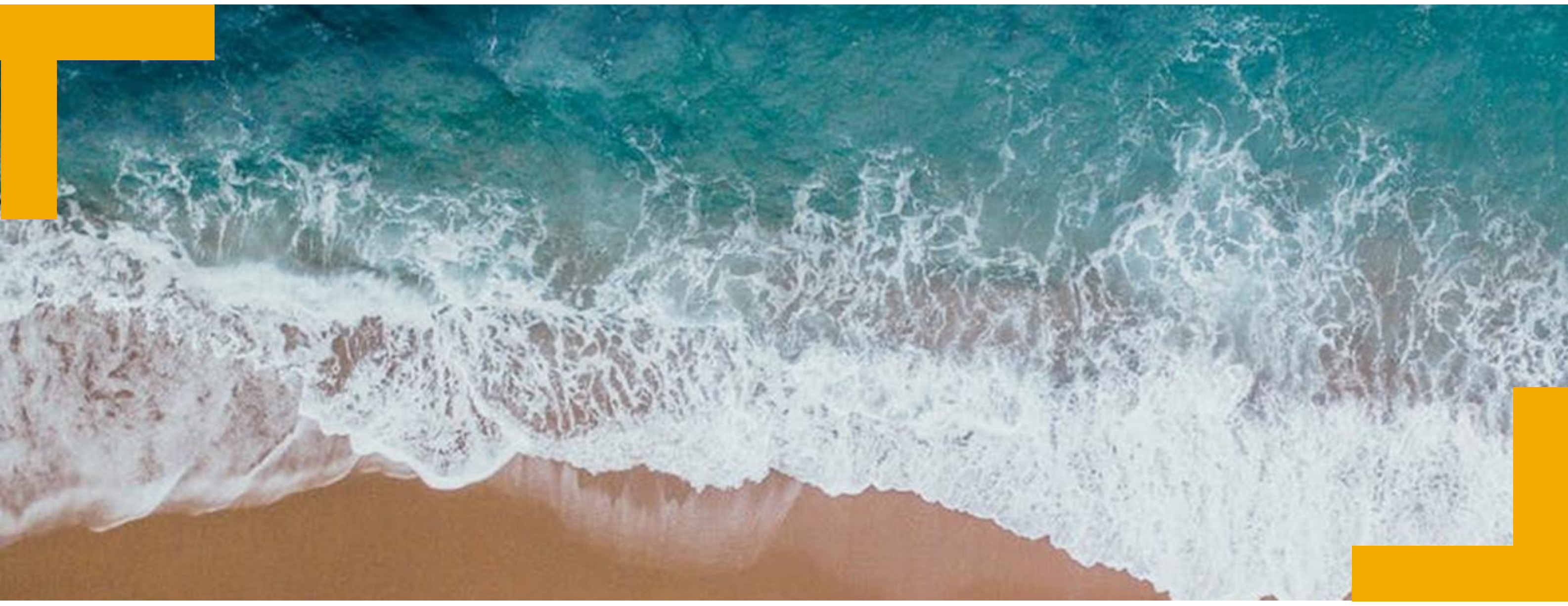


December 2025

METHODOLOGY AND THE BEST PRACTICES

Deliverable D.2.4.1

https://medsearise.interreg-euro-med.eu/

Deliverable ID

Project acronym	MedSeaRise
Project title	Supporting Adaptation to Mediterranean Sea Level Rise
Project mission	Protecting, restoring and valorising the natural environment and heritage
Project priority	Greener MED
Specific objective	RSO2.4 Promoting climate change adaptation and disaster risk prevention, resilience, taking into account eco-system based approaches
Type of project	Study project (Thematic Project)
Project duration	01/01/2024 – 31/03/2026 (27 months)

Deliverable title	Methodology and the Best Practices
Deliverable number	D.2.4.1
Deliverable type	Report
Work package number	2
Work package title	Information analyses, methodology development and tools generation
Activity name	Methodology development, supporting data, and services
Activity number	2.4
Partner in charge (author)	UM
Partners involved	ARPA FVG , UoM-IBMK, UM

Document history

Versions	Date	Document status	Delivered by
Version 1.0	29/03/2026	Final	PP6

Table of contents

Abbreviations

ANATOLIKI	Organisation for Local Development, Anatoliki S.A. – Project Partner - LP1
ARPA FVG	Regional Environmental Agency of Friuli Venezia Giulia Region- Project Partner - PP2
CCINCA	Chamber of Commerce and Industry Nice Côte d'Azur - Project Partner - PP3
UoM-IMBK	Public institution University of Montenegro - Institute of Marine Biology - Project Partner - PP4
BCC	Barcelona Chamber of Commerce - Project Partner - PP5
UM	University of Malta - Department of Geosciences- Project Partner - PP6
PP	A Project Partner, in general. Nobody specifically indicated
PPs	All Project Partners
D.2.1.2	Datasets and documentation supporting the methodology and the best practices
D.2.3.1	Benchmarks on evaluation of sea level rise anthropic impacts risk assessment
D.2.3.2	Benchmarks on evaluation of sea level rise ecosystem impacts risk assessment
D.2.4.1	Project deliverable 2.4.1: Methodology and the best practices
D.3.1.1	Methodology validation on anthropic activities impacts
D.3.2.1	Methodology validation on ecosystem impacts
D.3.3.1	Presentation of the methodology to stakeholders
D.3.4.1	White paper
D.3.4.2	Green Paper
Output 2.1	Project output 2.1: Methodology for an effective use of sea level rise scenarios in climate change impact risks assessment
GWL	Global Warming Level

Executive summary

This deliverable has been prepared within the MedSeaRise project, which contributes to the Natural Heritage mission of the Euro-MED Programme and falls under the Study Project category.

The document presents the methodology developed for the effective use of sea-level rise scenarios in climate change impact risk assessment.

The methodology provides a structured approach for selecting future sea-level scenario data and using them as inputs in risk assessment procedures, while explicitly evaluating how uncertainty in the hazard information propagates to the assessment of coastal climate change impacts.

It is suitable for both classes of impacts addressed by the project, namely those affecting human activities and those affecting ecosystems, and it is supported by benchmarks that assist users in applying the methodology and comparing results.

Although the MedSeaRise methodology was developed with the Mediterranean context in mind, its logic is not tied to a specific geographical area. It can therefore be applied to coastal areas worldwide wherever sea-level rise needs to be considered in impact assessment and adaptation planning.

The first applications of the methodology required a dataset of future sea-level scenarios. MedSeaRise provided the Project Partners with such a dataset, which is an integral part of the methodology and was developed using state-of-the-art numerical simulations and current estimates of the response of sea-level components to increasing global temperature.

Two aspects are particularly emphasized by the methodology. The first is the importance of propagating the uncertainty associated with future sea-level scenario data through the assessment workflow up to the impact calculation. The second is the presentation and interpretation of results according to the Global Warming Level perspective.

This deliverable also includes a summary of the methodology validation carried out within the project framework. The validation process is described in greater detail in the dedicated WP3 deliverables.

The MedSeaRise methodology

Introduction

Climate change is causing a progressive increase in average sea level. Sea level along the coast is naturally affected by processes acting on different time scales, including periodic tidal oscillations, episodic atmospheric forcing, and the long-term climatic trend.

The climatic trend affects mean sea level directly, but it also influences rare extreme events by modifying both their frequency and their intensity. A robust assessment of the risks associated with sea-level variations therefore requires a sound quantification of all the components that can turn sea level into a hazard.

Effective adaptation to future environmental conditions requires reliable information on climate change scenarios for mean sea-level trends. To date, many studies on coastal climate change impacts in the Mediterranean have relied on future mean sea level estimated by extrapolating trends observed in recent decades from local sea-level records or remote-sensing products.

However, this approach is not sufficient on its own, because climate change is a dynamic process and the Earth system is moving towards a new equilibrium under the more-than-linear increase in greenhouse gas concentrations in the atmosphere.

This issue is well known, and the scientific community has therefore produced a wide range of global and regional climate simulations that also include the behaviour of sea level. Nevertheless, no single projection can yet be considered fully reliable and sufficiently robust to be used on its own for impact calculations.

Climate simulations are generated by numerical models designed to represent, as effectively as possible, the dynamic and thermodynamic processes that determine the state of the oceans, semi-enclosed basins, and coastal hydrological systems. Each model can reproduce some features of reality particularly well, while being less accurate for others.

For this reason, each model output should be viewed as one plausible sampling of the future evolution of sea level within a high-dimensional state space. None of these samples should be considered in isolation, because model outputs are inherently affected by uncertainty.

As a consequence, best practice requires the collection of as many suitable model outputs as possible, using the most up-to-date approaches to climate dynamics, and the use of the resulting ensemble to describe sea-level rise trends while considering the ensemble spread as an estimate of uncertainty.

It is therefore necessary to define best practices for the use of mean sea-level rise trends within risk assessment procedures, according to the specific impact under study and the sensitivity of the assessment to the reliability of the hazard information source. These best practices should be supported by application examples that help stakeholders follow the scientific information through the logic of risk assessment.

With these needs clearly identified by the Partnership, the main output of the MedSeaRise project is the definition of a methodology that supports risk assessment and, in turn, adaptation actions related to sea-level rise under climate change scenarios, together with a first set of practical applications focused on relevant impacts affecting Mediterranean coastal areas.

At its core, the challenge addressed by MedSeaRise arises from the need to use scientific information that is still affected by considerable uncertainty in applications that already require practical implementation and decision support.

Scientific knowledge usually enters routine practical use only after the uncertainty affecting data and principles has been reduced below a threshold at which its contribution becomes marginal compared with all other sources of uncertainty involved in delivering the final practical outcome.

This is not yet the case for adaptation and resilience actions aimed at addressing the impacts of sea-level rise due to climate change. Future sea-level trends for the twenty-first century are available only as scenarios, and their uncertainty is still too large for them to be treated as simple fixed parameters in risk assessment.

At the same time, stakeholders need to decide which actions should be adopted to reduce the impacts of a sea level whose progressive increase is becoming a growing hazard year after year.

Taking these aspects into account, it becomes clear that a conventional approach based on selecting one sea-level rise estimate from the many scientific sources available and using it directly as input to a risk assessment may lead to significant errors and misinterpretations.

To avoid this potential pitfall, the project developed a method for bringing scientific information and its associated uncertainty into the risk assessment procedure itself. Within this framework, scientific information is no longer treated as a fixed and fully robust parameter, but as an explicit component of the procedure that must be selected and incorporated according to a clear and easy-to-understand methodology.

This methodology makes it possible to evaluate how sensitive the simulated impacts are to the sea-level rise information used as hazard input.

The adopted approach considers both ecosystem-related risks and impacts on human activities, thereby fostering a comprehensive methodology for addressing a hazard that requires a range of adaptation solutions. In this respect, the approach is innovative because the use of a common methodology promotes stronger connectivity between the preservation and restoration of natural ecosystems and the actions needed to reduce impacts on human activities.

The MedSeaRise methodology is described below through its main conceptual steps, while the supporting material shows how these concepts can be translated into a practical tool for impact risk assessment.

Methodology key points

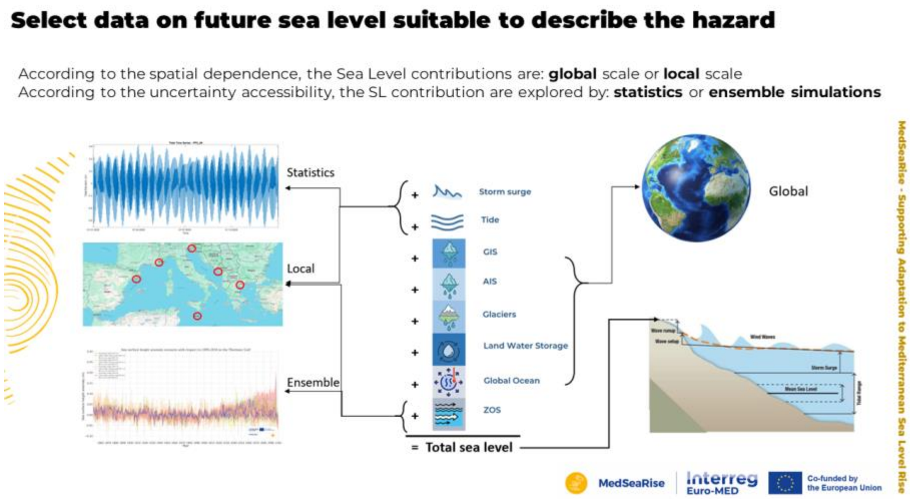
The MedSeaRise methodology for the effective use of sea-level rise scenarios in climate change impact risk assessment begins with the identification of the impact associated with the sea-level hazard. It then provides guidance on how and where to retrieve future sea-level scenario data and how to use them as inputs in risk assessment procedures together with information on exposure and vulnerability. The practical steps required to simulate the impact form the engine of the impact ensemble and depend on the type of impact being studied, as well as on the technical expertise, software, and hardware involved. The analysis of the impact ensemble completes the methodology through three essential elements: summarizing the ensemble results, assessing the sensitivity of the impact to the variation and spread of the input hazard, and presenting the results according to Global Warming Levels. Through these steps, the sensitivity of coastal climate change impacts to the uncertainty affecting the hazard input emerges naturally.

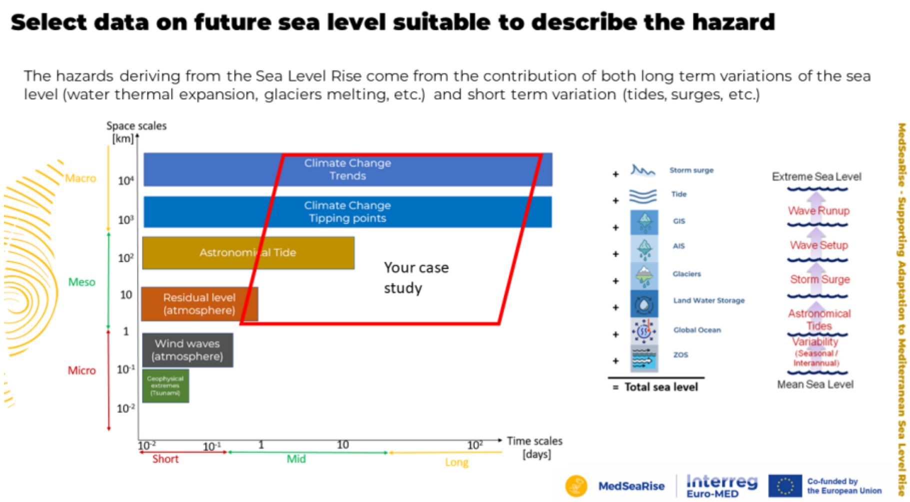
Identify the impact

This step defines exactly what is being assessed in MedSeaRise before any sea-level values are considered. The impact may concern a human asset, such as a port area, tourism facility, or critical infrastructure, or an ecosystem component, such as a wetland habitat, saltmarsh extent, or species and community response. At this stage, the endpoint to be measured, the spatial footprint, and the time frame of the assessment must be clearly established, because the choice of hazard data, exposure layers, and modelling tools depends on this definition.

Select data on future sea level

Once the impact has been defined, sea-level scenario data must be selected so that they properly represent the hazard responsible for that impact. In MedSeaRise, this means deciding whether only long-term mean sea-level rise is needed or whether short-term contributors that generate damaging coastal water levels, such as tides, storm surge, wave setup, or runup, must also be considered. It also means selecting the appropriate spatial scale, from global or regional to local, and favouring an ensemble of plausible futures rather than a single best projection, so that uncertainty is carried through the assessment instead of being hidden at the outset.



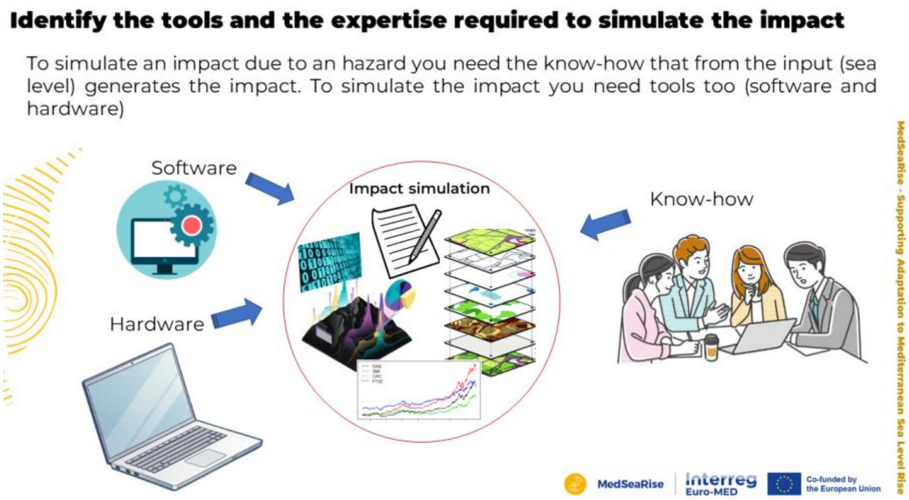


Retrieve the data on exposure and vulnerability

In this step, the datasets that describe exposure are collected and the site's susceptibility and vulnerability are defined. Typical inputs include high-resolution elevation data, shoreline or flood-pathway information, land-use layers, asset footprints, ecological maps, and any available vulnerability functions or thresholds. A key requirement is harmonisation: datasets must be made consistent in projection, resolution, vertical datum where relevant, and metadata quality, because even small mismatches can dominate the final impact signal, especially in low-lying coastal areas.

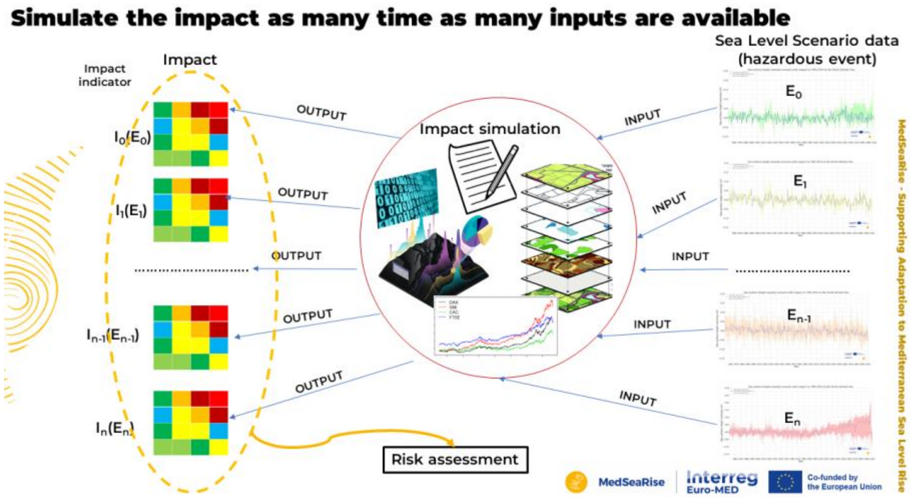
Identify tools and expertise required to simulate the impact

Translating sea-level scenarios into impacts requires both the appropriate tools and the necessary expertise. Depending on the impact under study, the workflow may range from GIS-based inundation mapping to coastal process models, statistical models, ecological response models, and scripting tools for automation and reproducibility. In MedSeaRise, this is treated as an explicit step because the selected modelling approach determines what can be simulated credibly, which assumptions are introduced, and how efficiently the procedure can be repeated across a wide range of scenario inputs in order to generate an ensemble of impact outcomes.



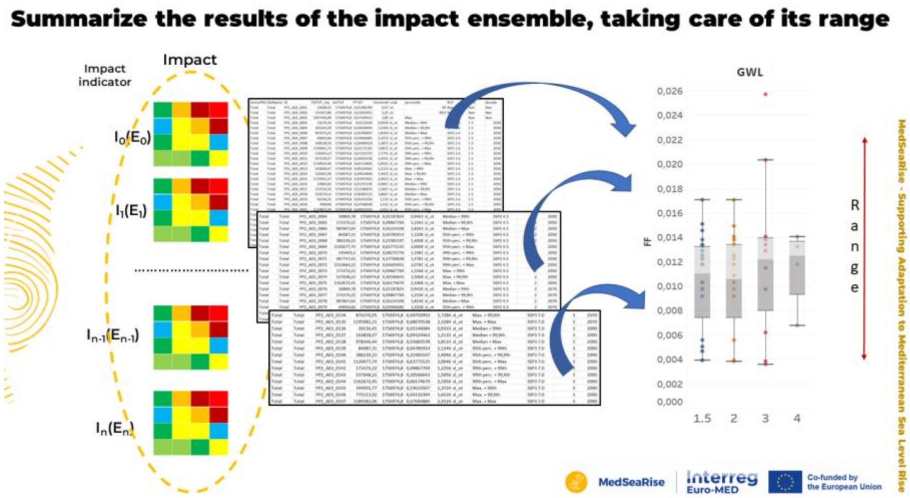
Simulate the impact and generate the ensemble

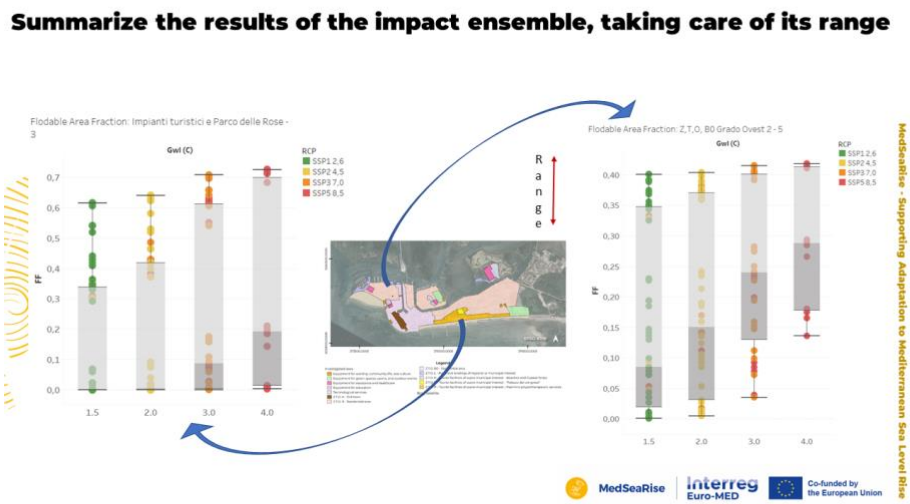
At this stage, the impact model is run repeatedly, once for each sea-level scenario or for each member of the scenario ensemble. Each sea-level input produces a corresponding impact output, and the full set of outputs forms the impact ensemble. This is the core idea of MedSeaRise: rather than producing one deterministic result, the methodology generates a distribution of plausible impacts that directly reflects the spread of the hazard inputs. That ensemble can then support risk assessment by showing not only the expected outcome but also how sensitive the impact is to the uncertainty affecting sea-level projections.



Summarize the results of the impact ensemble

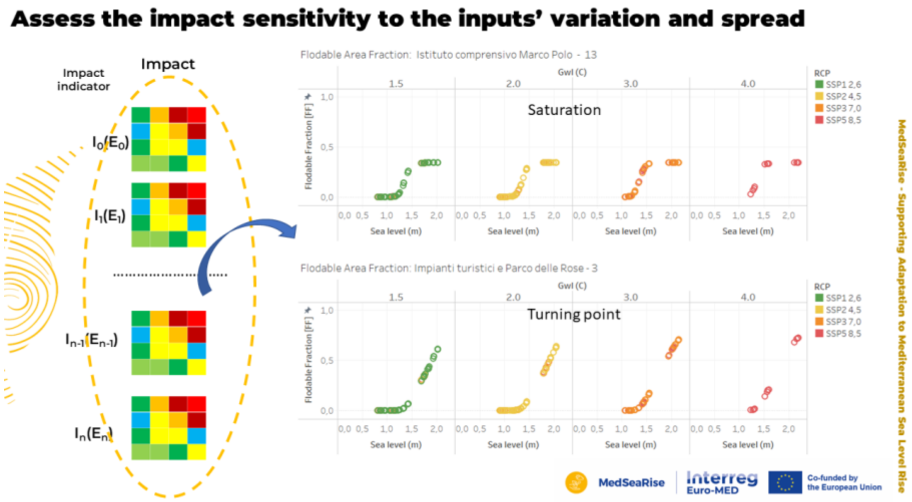
At this stage, the ensemble is condensed into stakeholder-friendly summaries without losing information on the range of outcomes. In practice, this means aggregating the multiple model runs into tables and figures, including medians, percentiles, minima and maxima, boxplots, and similar descriptors, and reporting how impact indicators change across warming levels or scenario families. The emphasis is on communicating uncertainty transparently, because two locations or two adaptation options may display the same average impact but very different spreads. In this way, the range itself becomes decision-relevant.





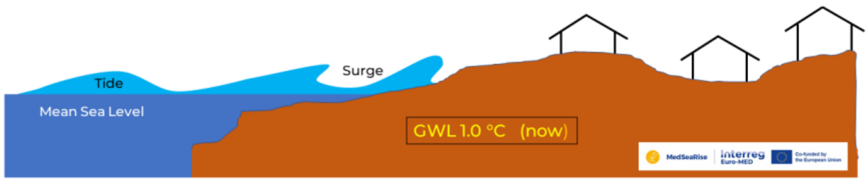
Assess the impact sensitivity to the inputs' variation and spread

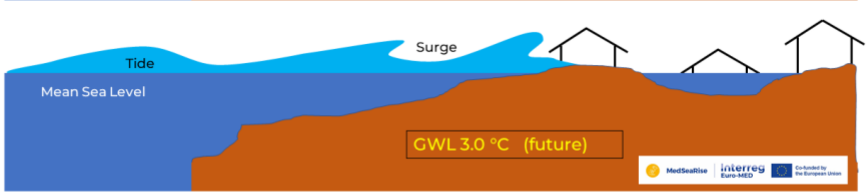
In this step, the extent to which impact results change when the sea-level inputs vary across the scenario ensemble is quantified. In practice, this means analysing the relationship between the spread in projected sea level and the spread in the simulated impact indicator, such as flooded area, affected assets, or habitat loss. The aim is to understand whether the response is approximately linear, with small input changes leading to small impact changes, or whether thresholds and step changes are present, with small variations in input leading to disproportionately large impacts. This sensitivity analysis helps identify the main drivers of uncertainty and highlights where improved data, refined modelling choices, or better local site information could most effectively reduce uncertainty in the assessment.



Present the results according to the Global Warming Levels

Rather than presenting results only by calendar year, MedSeaRise also frames impacts according to Global Warming Levels (GWLs), which is often more meaningful for decision-making. Different emissions pathways reach the same warming level at different times, so organising impacts by GWL makes results easier to compare across scenarios and links them directly to the policy-relevant temperature targets used in climate reporting. In practice, the impact ensemble is summarised at each warming level through a central estimate and a range, highlighting when key thresholds are crossed and how rapidly impacts escalate with additional warming. This framing supports clearer communication with stakeholders.





Supporting material

MedSeaRise dataset on future sea level scenarios

Data and scientific information on future sea-level climate scenarios were collected from publicly accessible sources that are widely regarded as representing the state of the art in climate simulation.

To this end, a review was carried out of the main characteristics of the numerical models that generated the sea-level rise projections for the Mediterranean Sea during the twenty-first century and that were harvested for the project purposes. The strengths and limitations of the selected numerical projections were assessed using a multi-source approach, as described in project deliverable D.2.1.2.

Within the MedSeaRise project, the future mean sea-level scenario data considered consist of monthly averages of the Mean Sea Level (MSL) field covering the period from 1850 to 2100 over the whole Mediterranean basin. These data are referred to in short as ZOS.

As many simulations as possible were downloaded for the four main SSP-RCP scenarios, namely SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5, together with their historical components. These files were selected from Coupled Model Intercomparison Project Phase 6 (CMIP6) datasets with a horizontal spatial resolution of approximately 25 km. For methodology applications, time series were extracted for the specific geographic locations of interest to each Project Partner using nearest-neighbour interpolation.

The data are organised in folders for each Project Partner, with subfolders containing the time series. One netCDF file is available for each simulation, geographic location, and scenario. Each time series combines a historical period from 1850 to 2014 with a future scenario period from 2015 to 2100.

Furthermore, for each Project Partner a CSV file named [PP]_MedSeaRise_SLR_all_components_climate_statistics.csv is available, where [PP] indicates the Project Partner ID. This file reports the main statistics of all contributions to sea-level rise relative to the reference period 1995–2014. The physical unit of the contributions is metres [m]. The file is provided in ASCII CSV format with semicolon-separated fields, and the header row describes the content of each column.

See Annex 1 for further details on the dataset.

The benchmarks

Within the MedSeaRise project, a benchmark is defined as a standard example of risk assessment for a real or ideal impact due to sea-level rise, to be used as a tool for evaluating and comparing the sensitivity of risk assessments to the input data describing future sea-level trends according to a specific metric.

A benchmark is therefore a case study characterised by a set of mandatory information elements. These concern the impact caused by sea-level rise, its assessment and quantification, the procedure and data involved in the assessment, and the sensitivity of the impact to the input data. The way in which this information is presented does not need to follow a rigid format.

The project generated and presented benchmarks according to a shared set of elements described in the case-study guidelines document and included in the reporting template prepared for the case studies.

The benchmark reports explain elements that are both useful and sufficient to support the application of the best practices presented in the MedSeaRise methodology for the effective use of sea-level rise scenarios in climate change impact risk assessment. In this sense, benchmarks are an integral support tool for the practical use of future sea-level scenario data.

Finally, to allow comparison of impact sensitivity to the inputs describing future sea-level conditions under climate change, each benchmark summarises impacts as a function of Global Warming Levels.

Since each benchmark has its own specific inputs depending on the study area and the type of impact, a common way to assess sensitivity is through the variation of the impact with respect to the GWLs. All case studies, and therefore all benchmarks, link impacts to Global Warming Levels.

See Annex 2 for further details on the benchmarks.

Methodology applications and validation

Applications of the methodology

The definition of the methodological pathway that propagates uncertainty in sea-level rise climate scenarios through the risk assessment process down to the impact projection was developed in close collaboration with stakeholders. Their contribution helped ensure that the methodology responds to the different risk-related needs emerging from Mediterranean sub-basins characterised by different vulnerabilities and coastal settings.

This goes beyond the potential of a single Project Partner, which would naturally be limited to the geographical area and impact types for which it has direct experience and expertise.

The MedSeaRise methodology therefore benefits from a multidisciplinary set of competences and has also been applied across a variety of case studies. This was an important component of the work because it allowed the methodology, the best practices, and the supporting datasets to be tested through real applications.

To this end, selected classes of impacts resulting from sea-level rise were considered for risk assessment. The selection was based on the data and information collected during the stakeholder participatory process organised and implemented within WP1 by each Project Partner.

The applications are described in detail in two project deliverables, namely D.2.2.1 and D.2.2.2.

Validation of the methodology

The methodology and the supporting tools developed through the MedSeaRise project, including datasets and benchmarks, needed to be properly presented and explained to the stakeholders who had expressed interest in the project results. This process helped ensure that stakeholders understood the ideas and methods developed by the project and could appreciate how the demonstrated applications may be replicated across a wider range of sea-level-related impacts.

The feedback collected from stakeholders and experts supported the validation of the methodology, which was based on a selected set of case studies identified through stakeholder participation and expert analysis.

During a series of dedicated meetings, the benchmarks were presented to stakeholders together with a schematic summary of the MedSeaRise methodology. In these meetings, participants followed the practical application of the conceptual steps, starting from the identification of suitable sea-level rise scenario data and proceeding through data retrieval and use, in accordance with the methodology, up to the risk assessment stage.

Stakeholders were asked to complete a questionnaire. The questions addressed the ease and difficulty of understanding and applying the methodology, as well as the opportunities that the methodology could offer in the environment in which each stakeholder might apply it and the threats that could hamper its use.

A SWOT analysis was conducted to identify which internal and external factors of the methodology should be considered sufficiently strong and which ones still require improvement. A quantitative SWOT analysis was adopted as the preferred approach. Each Project Partner produced its own SWOT analysis, and these were then combined into a comprehensive project-level assessment.

The validation procedure and its results are described in detail in deliverables D.3.1.1 and D.3.2.1.

Indicators of deliverable achievement

Deliverable indicators

The achievement of the objective described in this deliverable is summarised through the indicators reported below. For each indicator, the expected value and the actual value are presented, together with comments where relevant.

Indicator	**Expected value**	**Actual value**	**Comments**
Methodology for an effective use of sea level rise scenarios in climate change impact risks assessment	1	1	None

Conclusions

The MedSeaRise methodology provides a structured and robust framework for the effective use of sea-level rise scenarios in climate change impact risk assessment. Its main strength lies in the fact that it does not treat future sea-level information as a single deterministic input, but rather as an ensemble of plausible hazard conditions whose uncertainty is explicitly propagated through the impact assessment process. In this way, the methodology supports a more reliable interpretation of coastal risks and provides a stronger basis for adaptation and resilience planning.

An important outcome of the project is that the methodology remains valid even as future sea-level datasets improve. Its conceptual foundations do not depend on one specific dataset, but on a structured approach to selecting hazard information, combining it with exposure and vulnerability data, simulating impacts, and analysing the sensitivity of results to the spread of the input scenarios. As more complete and reliable sea-level projections become available, the methodology will produce correspondingly more robust results.

The validation activities carried out within the project showed that the methodology is a useful tool for supporting risk assessment and for helping stakeholders identify adaptation and resilience actions aimed at reducing the impacts of progressive sea-level rise driven by global warming. Its effectiveness depends both on internal methodological strengths and on external factors, including the technological context and the stakeholder environment in which it is applied.

The project applications also showed that the methodology is generally easier to apply to impacts affecting human activities, where impact indicators are often more readily defined and quantified. By contrast, applications to ecosystems require additional effort to identify suitable indicators able to describe the response of habitats, species, or ecological functions to rising mean sea level. This represents an important area for future development and will be further addressed in the project's Green Paper.

Another important strength of the methodology is its use of the Global Warming Level perspective. This offers an alternative, and in many cases more policy-relevant, framing than a purely timeline-based approach. Since future greenhouse gas emission pathways remain uncertain, while global temperature change can be measured more directly and consistently, presenting impacts as a function of warming levels provides a clearer basis for comparing scenarios and interpreting the evolution of risks.

The project applications further highlighted that, for many impacts related to future sea-level rise, conventional probabilistic interpretations based on return times should be treated with caution. While frequency analyses may still provide useful supplementary information, the impacts associated with climate-driven sea-level change are better interpreted through uncertainty propagation than through assumptions of statistical stationarity.

For this reason, the MedSeaRise methodology offers a more suitable framework for supporting effective management solutions, resilience building, and disaster risk prevention, while taking into account ecosystem-based approaches and the sustainable use of natural resources.

Overall, the project outputs, including the methodology and the supporting data and tools, are expected to foster the definition of effective management solutions and adaptation pathways aimed at limiting the impacts of progressive sea-level rise.

This output contributes directly to the Euro-MED Priority Specific Objective 2.4 because it strengthens the risk assessment basis needed to define and support climate change adaptation actions in Mediterranean coastal areas.

Annexes

Annex 1 – Dataset on future sea level scenarios

The MedSeaRise dataset on future sea level for all the six Mediterranean locations on which the methodology was applied is described in detail through the project deliverable D.2.1.2, "Datasets and documentation supporting the methodology and the best practices".

Online access to the dataset is by means of the ERDDAP service specifically developed and permanently activated.

MedSeaRise ERDDAP dataset: https://fenice.arpa.fvg.it/erddap/files/MedSeaRise/

Annex 2 – Benchmarks for impacts on anthropic activities

A set of benchmarks has been created within the MedSeaRise project to apply the methodology to sea-level rise impacts affecting anthropic activities. They are described in detail in project deliverable D.2.3.1, "Benchmarks on evaluation of sea level rise anthropic impacts risk assessment".

Annex 3 – Benchmarks for impacts on ecosystems

A set of benchmarks has been created within the MedSeaRise project to apply the methodology to sea-level rise impacts affecting ecosystems. They are described in detail in project deliverable D.2.3.2, "Benchmarks on evaluation of sea level rise ecosystem impacts risk assessment".

Annex 4 – Methodology validation

The validation of the methodology was carried out with the contribution of stakeholders and experts. A quantitative SWOT analysis was prepared by each Project Partner. Further details are available in the two deliverables specifically dedicated to this task: D.3.1.1, "Methodology validation on anthropic activities impacts", and D.3.2.1, "Methodology validation on ecosystem impacts".

Annex 1

ERDDAP
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ERDDAP > Files > MedSeaRise

ERDDAP's "files" system lets you browse a virtual file system and download source data files.
("files" documentation, including "How can I work with these files?")

Dataset Title: **Project MedSeaRise - Interreg Euro-MED** RSS
Institution: ARPA FVG (Dataset ID: MedSeaRise)
Information: Summary ? | License ? | Metadata | Background | Data Access Form | Make a graph

Name	Last modified	Size	Description
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climate_models/	-	-	
climate_statistics/	-	-	
Med_sea_level/	-	-	

4 directories, 0 files

ERDDAP, Version 2.23
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Annex 2

MedSeaRise
Interreg Euro-MED
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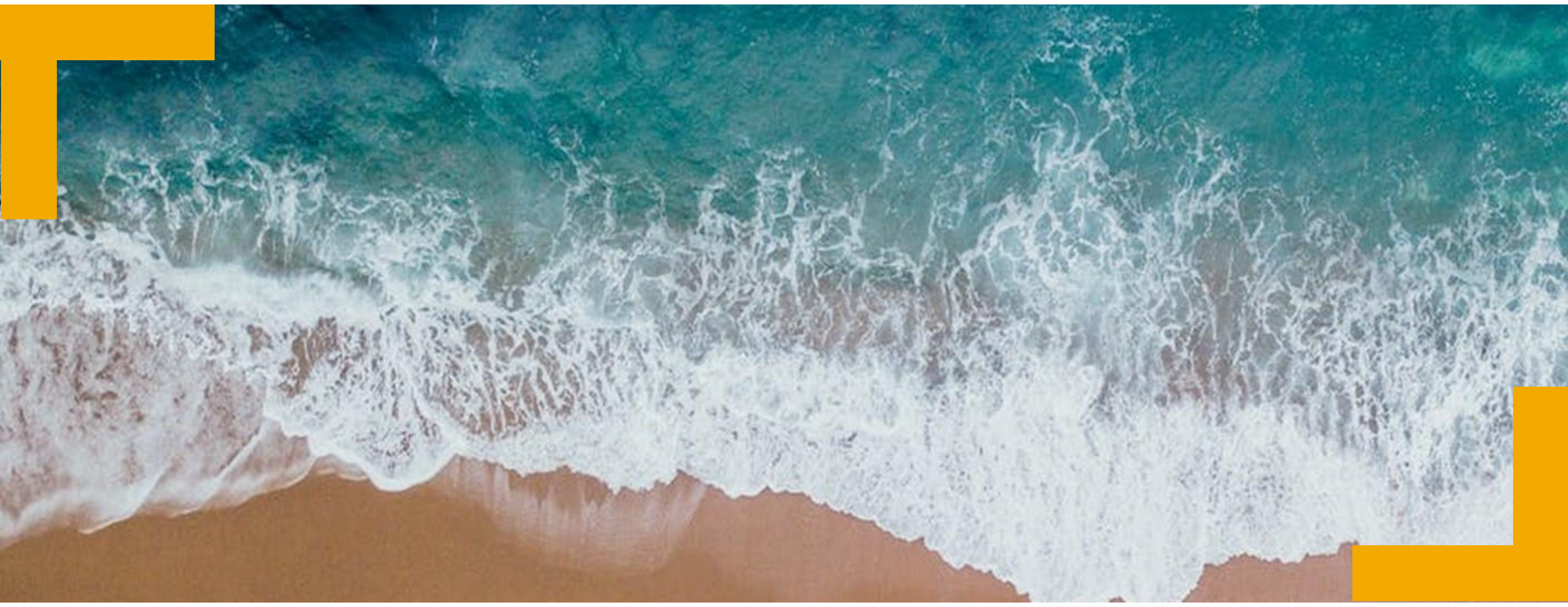

December 2025

BENCHMARKS ON EVALUATION OF SEA LEVEL RISE ANTHROPIC IMPACTS RISK ASSESSMENT

Deliverable D.2.3.1

https://medsearise.interreg-euro-med.eu/

Deliverable ID

Project acronym	MedSeaRise
Project title	Supporting Adaptation to Mediterranean Sea Level Rise
Project mission	Protecting, restoring and valorising the natural environment and heritage
Project priority	Greener MED
Specific objective	RSO2.4 Promoting climate change adaptation and disaster risk prevention, resilience, taking into account eco-system based approaches
Type of project	Study project (Thematic Project)
Project duration	01/01/2024 – 31/03/2026 (27 months)

Deliverable title	Benchmarks on evaluation of sea level rise anthropic impacts risk assessment
Deliverable number	D.2.3.1
Deliverable type	Report
Work package number	2
Work package title	Information analyses, methodology development and tools generation
Activity name	Comparative analyses and benchmarking
Activity number	2.3
Partner in charge (author)	UM
Partners involved	ANATOLIKI S.A., ARPA FVG , CCINCA, UoM-IBMK, BCC, UM

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Version 0.1	23/10/25	Draft	PP2
Version 1.0	19/12/2025	Final	PP2

Table of contents

Abbreviations

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PP	A Project Partner, in general. Nobody specifically indicated
PPs	All Project Partners
D.2.2.1	Project deliverable 2.2.1: Case studies for evaluation of sea level rise anthropic impacts risk
D.2.2.2	Project deliverable 2.2.2: Case studies for evaluation of sea level rise ecosystem impacts risk
D.2.4.1	Project deliverable 2.4.1: Methodology and the best practices
Output 2.1	Project output 2.1: Methodology for an effective use of sea level rise scenarios in climate change impact risks assessment
GWL	Global Warming Level
WPs	MedSeaRise Work packages

Executive summary

This is a deliverable of the project MedSeaRise. The project contributes to the Natural Heritage mission of the Euro-MED Programme and it belongs to the Study Project class.

The document summarizes the work done in the frame of the project activity 2.3, describing how the project partners have generated a set of analyses on the impacts expected to affect the anthropic activities, as a consequence of the progressive increase of the sea level , in the Mediterranean basin.

First, an outlook on the needs and the objectives that have stimulated the generation of specific case studies and their organization as benchmarks is presented. Furthermore details of the benchmark structure are detailed in addition with the methods specifically created to assess the sensitivity of the sea level rise related impacts to the increase of the global temperature of our planet.

The document is completed with a summary of the available benchmarks and appendixes that give further insights to specific aspects of the work done. Deliverable indicators are reported too.

The benchmarks aim

Introduction and Objectives

This document presents a specific contribution in 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 a 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 the Activity 2.3 is the generation of benchmarks suitable to evaluate the sensitivity of the risk assessment, which has been conducted applying the MedSeaRise methodology on case studies. Case studies are described in detail in project deliverables D.2.2.1 [1.1] and D.2.2.2 [1.2].

The sensitivity of the sea level rise risk analysis is explored and quantified, for each of the identified impacts. A metric was developed as part of this activity. Benchmarking has been conducted evaluating the sensitivity of the risk assessment using that metric.

Benchmarking is conducted also with the aim to support the best practices definition, furthermore benchmarks are included in the methodology as examples for a best use of data on future sea level scenarios. Then, benchmarks are an essential component of the project Output 2.1.

In summary, a benchmark is a standard example of risk assessment for an impact, due to the increase of the sea level rise, that has to be considered as a tool for the evaluation and comparison of the risk sensitivity from the input data on the sea level trends, according to a specific metric.

To generate the benchmarks, PPs have defined a guideline, which has been applied to a selection of the case studies to enrich them and then produce the benchmarks.

This deliverable describes how benchmarks for anthropic impacts have been generated, and how many they are. Each benchmark is composed of a document and supplemental files that are part and parcel of this document. The benchmarks are annexes of this deliverable and are available as archive files attached to the document.

Guideline for benchmark generation

Benchmark generation

In MedSeaRise project a benchmark is defined as standard example of risk assessment for an impact, real or ideal, due to the increase of the sea level rise, that has to be considered as a tool for the evaluation and comparison of the risk sensitivity from the input data on the sea level trends, according to a specific metric.

So, a benchmark has to be characterized by some mandatory information. Those information relate to the impact caused by the increase of the sea level, its assessment and quantification, a description of the procedure and the data involved in the impact assessment, the sensitivity of the impact to the input data. Anyway the format of the information presentation through the benchmark is not strictly defined.

Since project activity 2.3 foresees a comparison of the benchmarks sensitivity, it is straightforward all the benchmarks have to share a common set of core data on impacts sensitivity on inputs.

Starting from the above considerations, it is suggested to generate a benchmark extending a case study conducted in the frame of the activity 2.1.

In fact, case studies have been generated and presented according to a shared set of elements, which have been described in the case study guidelines document and that have been also included in the template document for the case study reporting.

To a case study document, it is important to add a further section reporting elements useful and sufficient to support the best practices application, which are presented in the MedSeaRise methodology for an effective use of sea level rise scenarios in climate change impact risks assessment (D.2.4.1 and project Output 2.1) [2.1]. We need to recall that benchmarks will be included in the methodology for a best use of data on future sea level scenarios.

In the next paragraph a template of that section is presented.

Finally, to allow the comparison of the impacts sensitivity to the inputs describing the future sea level condition, in the frame of the present climate change, it is important the benchmark summarizes the impacts as a function of the GWLs.

Since each benchmark has its own specific inputs, according to the area and the kind of impact, a common way to assess the sensitivity is by means of the variation of the impact with respect to the GWLs. In fact, all the case studies, thus the benchmarks, link the impacts to the GWLs.

The last section describes how each benchmark sensitivity to the sea level will be compared.

How to evolve a case study into a benchmark

Starting from the document detailing a case study, that is one of those realized in the frame of the project activity 2.1, see deliverables D.2.1.1 [1.1] and D.2.1.2 [1.2] the benchmark have to bring all the analyses and the results produced for the case study and to include a further section reporting information suitable to understand how to reproduce the study of the sea level rise related impact, step by step.

This specific section, whose title is named “Description of the tools and data used to carry on the case study”, is composed of key points with a brief description of the essential elements one has to consider in reproducing the case study or to use it as an example for another similar case.

Here below each of the key points are reported together with a guide on how to fill in the information on each of them.

Description of the tools and data used to carry out the case study

In the benchmark, explain in a very summary what was done, once identified the impact to be studied. The information has been retrieved and how they were processed. Here are guidelines on how to proceed.

Data on future sea level used for the case study

(Describe what inputs on future mean sea level you have retrieved from those let available in the frame of the project. Furthermore, describe what further data of sea level you have used, for example tides simulations, sea level gauges measurements, etc. including their sources too.)

Data on the exposed subject used for the case study

(Describe what are the inputs concerning the subject the case study has considered for the impact, including the sources of those data too. For example the Digital Elevation Model of the coast, the database of commercial assets potentially impacted, scientific papers and datasets reporting data on ecosystems, etc.)

Resources used to conduct the case study

(Describe what kind of resources you have employed to conduct the risk assessment in the case study. For example, personnel internal to the PP, external experts, specific software, computational resources, etc..)

Procedure adopted to employ data and resources to generate the impact

(A very brief description on how data and resources have been involved in the case study to assess the impact. It is advised to use a presentation by points or an image with a sketch of steps followed to compute the impacts.)

Notes of results presentation

(A very summary on the motivations led you to adopt the presentation of the results accessible in the case study. For example unique table which is part of the document, a series of plots and images, a set of separate files attached to the case study document, etc.)

Preparation of case study outputs suitable for sensitivity analysis

The comparison of the benchmarks sensitivity, which in turn means the sensitivity of the impact to the input data, requires the benchmark outputs be presented as a function of the GWLs. This means that the quantity describing the impact has to be linked to the GWLs of the input. The most simple way is a tabular form. See annexes from 1 to 7.

Benchmark sensitivity method

To the highest extent, the sensitivity analysis of the risk assessment, conducted by means of the benchmark results, requires a shared metric linking the sea level hazard uncertainty and reliability with the impacts. Thanks to the MedSeaRise activities, conducted analysis shows that it is hard to define such a metric meaningful for all the possible classes, at least before the project conclusion.

Instead, it is possible to classify the sensitivity of the impact with respect to the GWLs. In fact, all the case studies, thus the benchmarks, link the impacts to the GWLs.

Using the sensitivity of the impact on the variations of the GWLs allows the comparison of sensitivity among classes of impacts very different from each other, in addition to impacts inside the same class. Of course, it is a sensitivity of the impact with respect to the GWL evolution and it is not respect the uncertainty and the reliability of the input data.

In addition, this kind of sensitivity adds more information to those available for the decision making. In fact, it is helpful to know the response of the impact to the increase of the GWL, in the frame of decisions to be taken to enhance the resilience of the coastal areas or to choose adaptation solutions to reduce the vulnerability or even the exposure to the sea level hazard.

For this reason the following metric has been defined. It allows placing the impact response to the GWL change into one of the classes representing the spectrum of responses. The classes are common to all kinds of impacts and this means that it is possible to compare impacts having quite different features and dependencies.

Consider **I** to indicate the impact and **GWL** the Global warming level. Then the variation of the impact with respect the change in the GWL is named the sensitivity **S**; it is defined as follow:

$$\mathbf{S} = (\mathbf{I}(B) - \mathbf{I}(A))/(\mathbf{GWL}(B) - \mathbf{GWL}(A))$$

A and B are two different simulations of the impact. Each of them are associated to the corresponding GWL.

The sensitivity has the meaning of impact for units of GWL, that is it tells you how fast the variation of the impact is when our planes move from one Global Warming Level to the next.

In the MedSeaRise project, we have generated input data belonging to four GWLs, namely 1.5 °C, 2.0 °C, 3.0 °C and 4.0 °C, so it is possible to compute three values of sensitivity. Specifically, the sensitivity to the change from GWL 1.5 °C to 2.0 °C, that from 2.0 °C to 3.0 °C and finally from 3.0 °C to 4.0 °C. In case of less sensitivity values it is still possible to associate a sensitivity class to the impact.

Once the sensitivity **S** is computed, the evolution of the sensitivity with respect to the GWLs allows to assign a class to the impact **I** according to seven classes. They are:

1. not sensitive,
2. variable,
3. linear,
4. more than linear,
5. exponential,
6. turning point
7. saturation

Classes are independent from the type of impact, because they have been built on the behaviour of the sensitivity **S** with respect to the increase of the warming of our planet.

To find the suitable class for the impact explored through a benchmark, it is necessary to look at the evolution of both the sensitivity and the impact when the GWL increases.

In the annexes from 1 to 7 each class is described with the aid of a table and a graph. With these tools it should be easy to link the class to the benchmark.

The comparison of the benchmarks through the classes they belong to implement the comparative analyses and benchmarking foreseen by activity 2.3

Benchmarks

Summary of benchmarks on anthropic impacts

MedSeaRise activity 2.3 has produced several benchmarks, with the objective to complement the methodology developed in the frame of the project and to give examples of the best practices application on the selection and use of sea level rise data for the risk assessment of impacts affecting anthropic activities.

They are listed here below. For each benchmark essential information is presented, whereas in the appendixes it is available a short summary of the impact the benchmark is focused on together with the reference to the associated file storing all the details.

Benchmark ID	**Project Partner**	**Appendix**
A-01_PP6	PP6 - UM	Annex 8
A-01_PP2	PP2 – ARPA FVG	Annex 9
A-03_PP2	PP2 – ARPA FVG	Annex 10
A-01_LP1	LP1 – ANATOLIKI S.A.	Annex 11
A-02_PP3	PP3 – CCINCA	Annex 12
A-01_PP4	PP4 - UoM-IBMK	Annex 13
A-01_PP5	PP5 - BCC	Annex 14

Indicators of deliverable achievement

Deliverable indicators

The achievement of the objective described in this deliverable is summarized by means of the indicators reported here 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 benchmarks	1	7	Benchmarks focusing on anthropic impacts

For each benchmark, a specific document is available as appendix. Furthermore, benchmark includes files and or reference do access files that are suitable to reproduce the benchmark.

Conclusions

Conclusions

One of the most intensive and work demanding tasks, carried on by each MedSeaRise project partner, was the identification of the sea level rise impacts and their analysis in detail, applying the methodology developed in the frame of the project.

Such individual work, which was coordinated at Work Package level thanks to the efforts made by the WPs leaders, results in a set of case studies sharing the same conceptual approach to assess the consequences of the progressive increase of the sea level, due to climate change.

A selection of case studies is presented in detail and, each of them, with a schematic guideline that leads to the reproduction of the case study as it is or the application of the scheme to other similar impacts.

This presentation of a selected case study makes it a benchmark against which to compare further applications of the MedSeaRise methodology.

Furthermore the sensitivity method used in the benchmark, to assess the response of the impact to the increase of global warming, supports the stakeholders in making decisions on possible adaptation or resilience solutions aimed to minimize the risk to get the impact.

The benchmark sensitivity to the variations of the GWLs, which is described in this deliverable, is expected to stimulate the comparison of the impact sensitivity among classes of impacts very different from each other, besides those belonging to the same type.

Finally, the benchmarks collected in this deliverable have the ambition to enrich the set of studies focused on some of the issues the Mediterranean coastal areas are going to face in a rapid change of the climate. Furthermore, following the purposes of the Natural Heritage study project type, it is expected the benchmarks make the amplification of the results achieved in the frame of the MedSeaRise project easier.

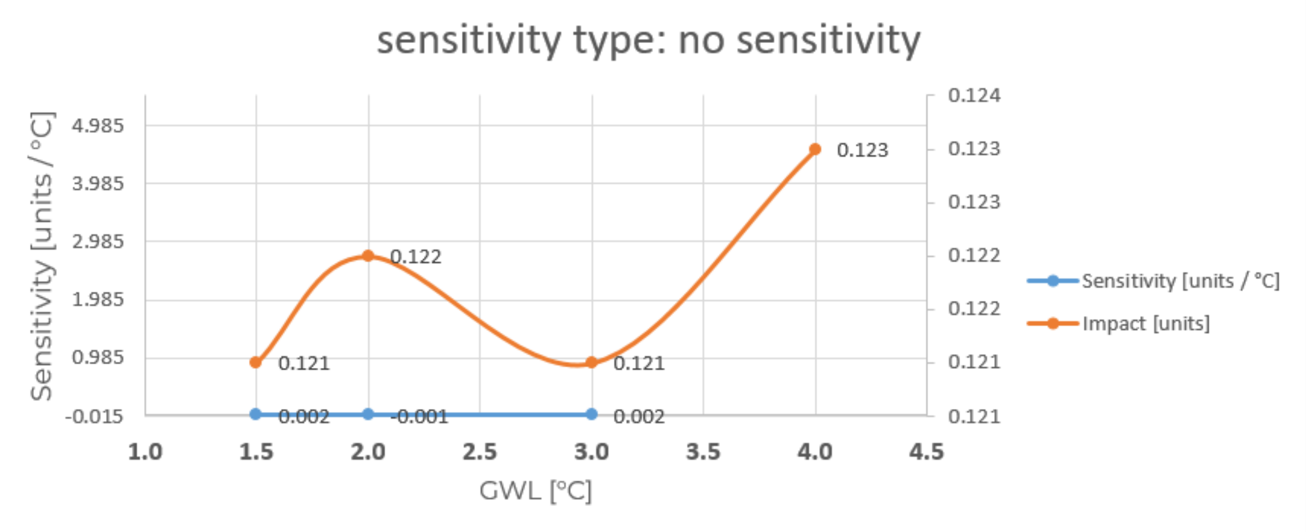
Annexes

Annex 1 – Example of sensitivity type: no sensitivity

Example of impact not sensitive to the GWLs change.

Sensitivity (**S**) is almost zero. Impact (**I**) changes without any trend.

Sensitivity type:	**no sensitivity**			
GWL [°C]	Impact [units]	Δ GWL [°C]	Δ Impact [units]	Sensitivity [units / °C]
1.5	0.121	0.5	0.001	0.002
2.0	0.122	1.0	-0.001	-0.001
3.0	0.121	1.0	0.002	0.002
4.0	0.123			

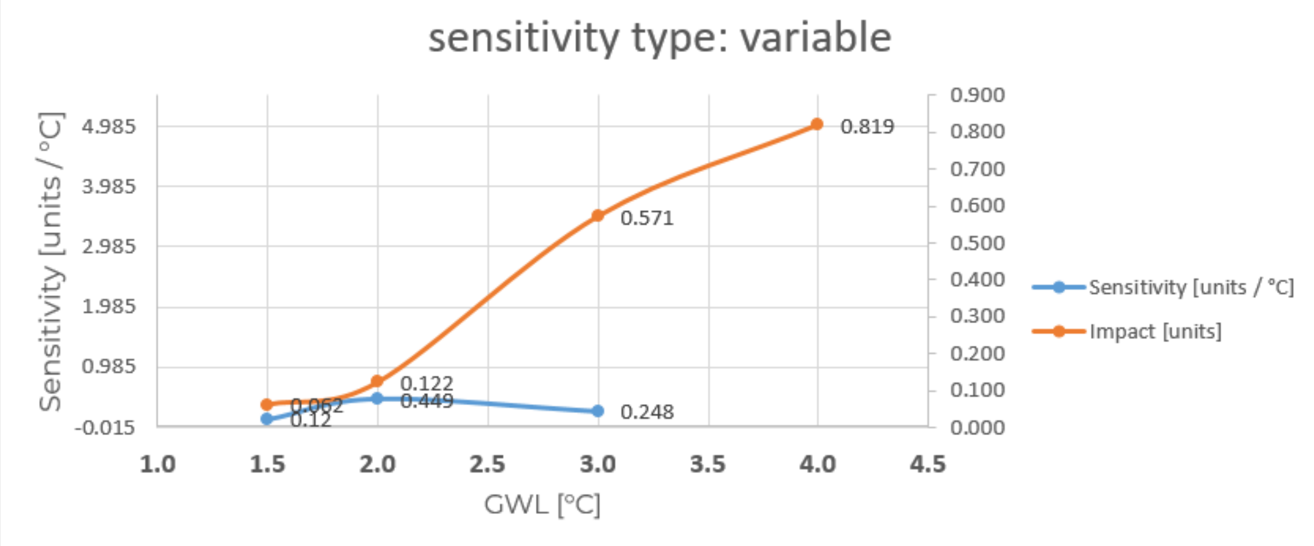


Annex 2 – Example of sensitivity type: variable

Example of impact variable with respect to the GWLs change.

Sensitivity (**S**) is positive and smoothly changes. Impact (**I**) changes with a no clear trend.

Sensitivity type:	**variable**			
GWL [°C]	Impact [units]	Δ GWL [°C]	Δ Impact [units]	Sensitivity [units / °C]
1.5	0.062	0.5	0.060	0.12
2.0	0.122	1.0	0.449	0.449
3.0	0.571	1.0	0.248	0.248
4.0	0.819			

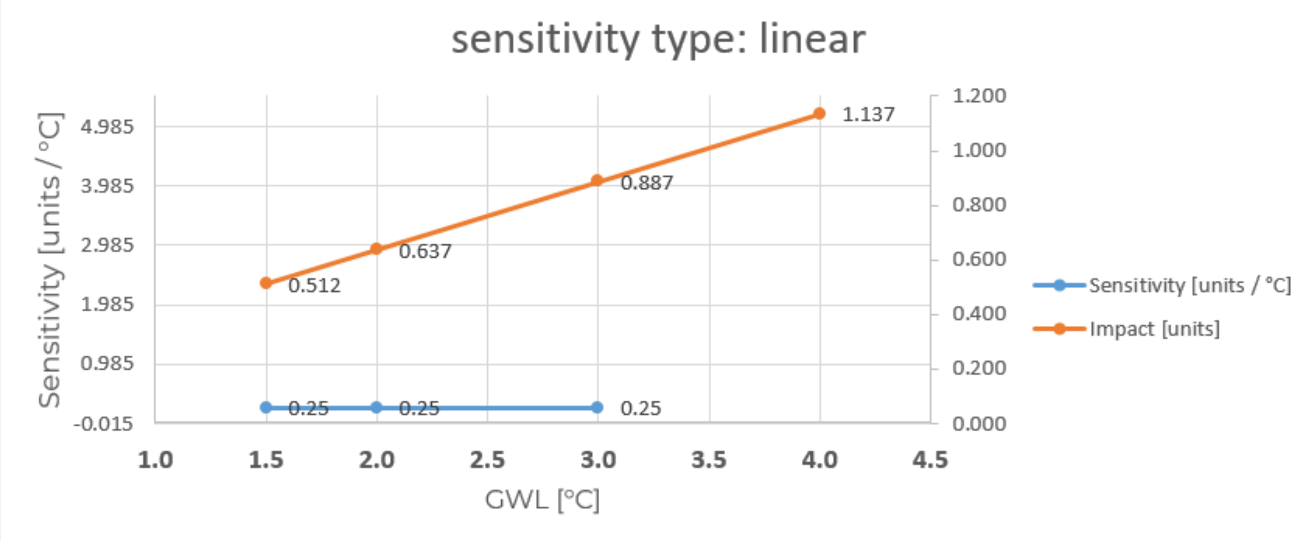


Annex 3 – Example of sensitivity type: linear

Example of impact linear with respect to the GWLs change.

Sensitivity (**S**) is constant and different from zero. Impact (**I**) changes according to a linear trend.

Sensitivity type:	**linear**			
GWL [°C]	Impact [units]	Δ GWL [°C]	Δ Impact [units]	Sensitivity [units / °C]
1.5	0.512	0.5	0.125	0.25
2.0	0.637	1.0	0.250	0.25
3.0	0.887	1.0	0.250	0.25
4.0	1.137			

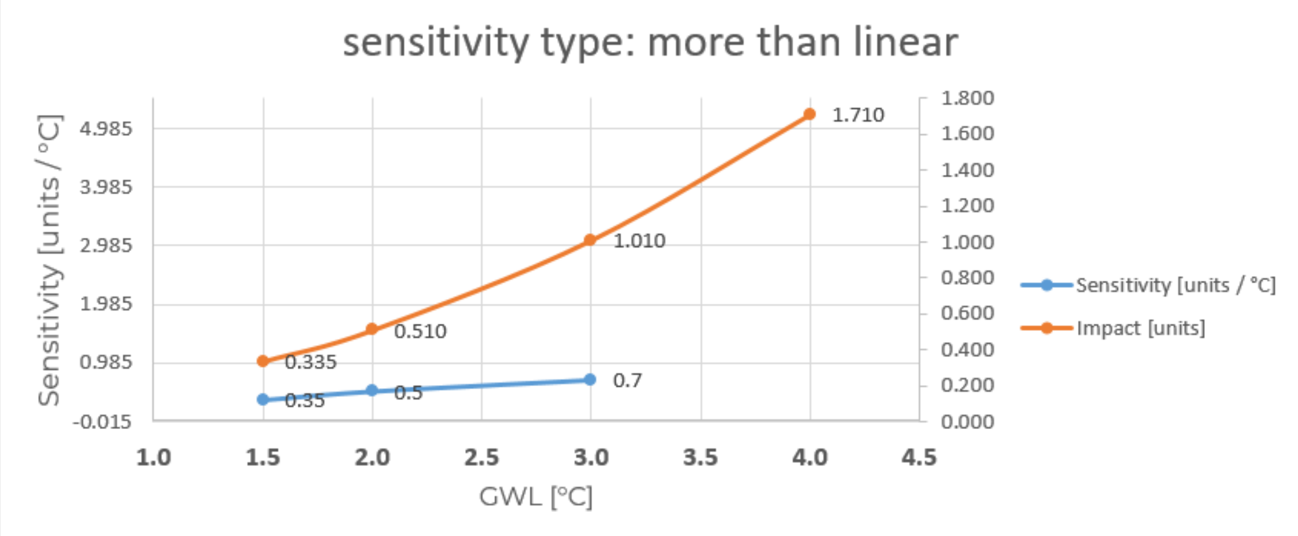


Annex 4 – Example of sensitivity type: more than linear

Example of impact more than linear with respect to the GWLs change.

Sensitivity (**S**) is increasing. Impact (**I**) changes according to a power of GWL.

Sensitivity type:	**more than linear**			
GWL [°C]	Impact [units]	Δ GWL [°C]	Δ Impact [units]	Sensitivity [units / °C]
1.5	0.335	0.5	0.175	0.35
2.0	0.510	1.0	0.500	0.5
3.0	1.010	1.0	0.700	0.7
4.0	1.710			

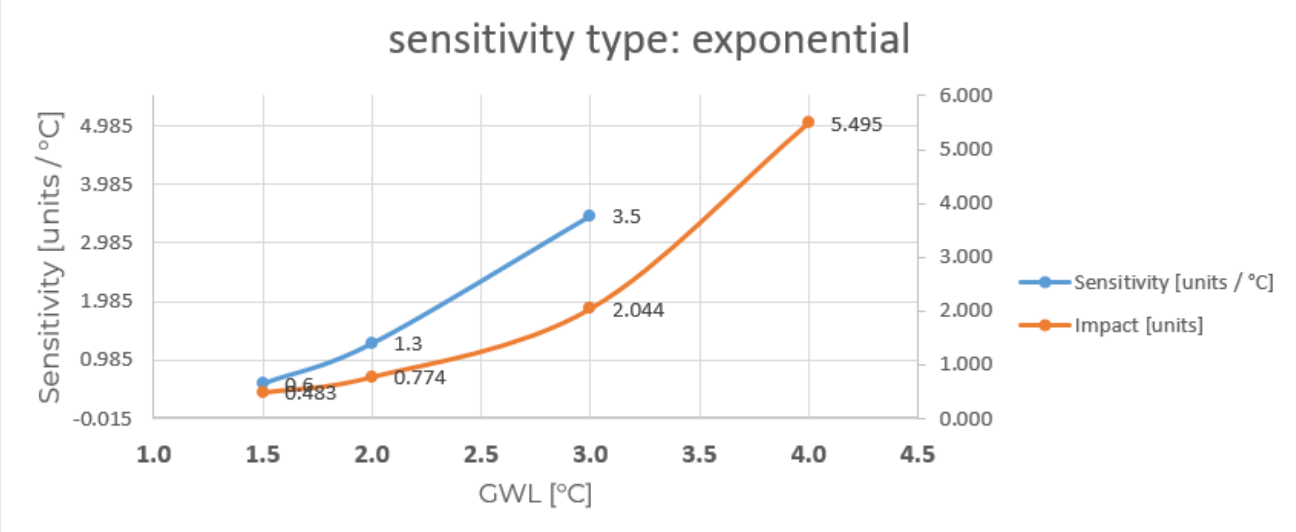


Annex 5 – Example of sensitivity type: exponential

Example of impact exponential with respect to the GWLs change.

Sensitivity (**S**) is rapidly increasing. Impact (**I**) changes according to an exponential law.

Sensitivity type:	exponential			
GWL [°C]	Impact [units]	Δ GWL [°C]	Δ Impact [units]	Sensitivity [units / °C]
1.5	0.483	0.5	0.291	0.6
2.0	0.774	1.0	1.270	1.3
3.0	2.044	1.0	3.451	3.5
4.0	5.495			

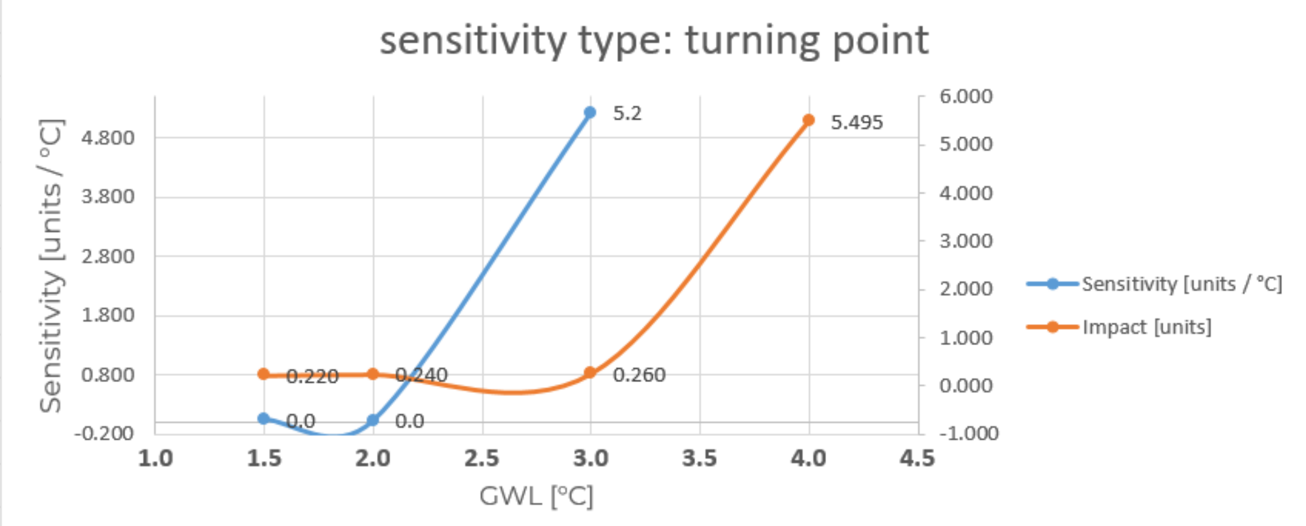


Annex 6 – Example of sensitivity type: turning point

Example of impact having a turning point with respect to the GWLs change.

Sensitivity (**S**) is almost zero up to the turning point, then has a jump. Impact (**I**) does not change much up to the turning point, then jumps up.

Sensitivity type:	**turning point**			
GWL [°C]	Impact [units]	Δ GWL [°C]	Δ Impact [units]	Sensitivity [units / °C]
1.5	0.220	0.5	0.020	0.0
2.0	0.240	1.0	0.020	0.0
3.0	0.260	1.0	5.235	5.2
4.0	5.495			

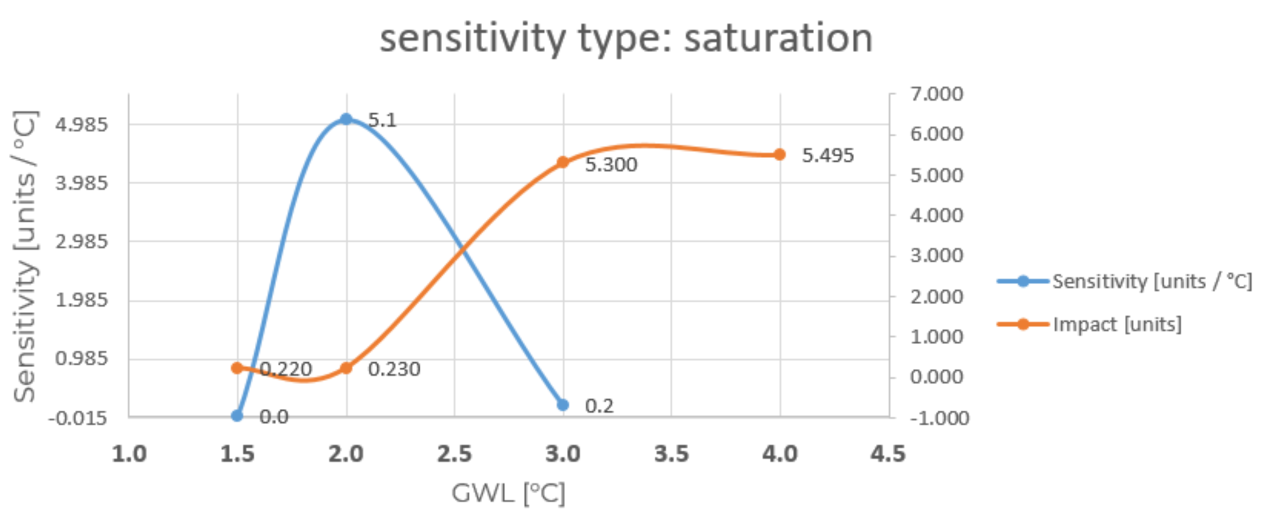


Annex 7 – Example of sensitivity type: saturation

Example of impact having a saturation with respect to the GWLs change.

Sensitivity (**S**) increases up to a point, then back to zero. Impact (**I**) increases rapidly up to a plateau, then does not change any more.

Sensitivity type:	**saturation**			
GWL [°C]	Impact [units]	Δ GWL [°C]	Δ Impact [units]	Sensitivity [units / °C]
1.5	0.220	0.5	0.010	0.0
2.0	0.230	1.0	5.070	5.1
3.0	5.300	1.0	0.195	0.2
4.0	5.495			



Annex 8 – MedSeaRise_benchmark_A-01_PP6

MedSeaRise project partner PP6 benchmark A-01.

The case study will focus on Msida, a low-lying coastal town in Malta. Msida is already vulnerable to flooding, not only from heavy rainfall but also from temporary sea level increases caused by atmospheric pressure changes (seiches). These events are expected to become more problematic with long-term sea level rise, making Msida a valuable site for studying the combined impacts of climate change.

File: **Act_2.3_MedSeaRise_benchmark_A-01_PP6.zip**

Annex 9 – MedSeaRise_benchmark_A-01_PP2

MedSeaRise project partner PP2 benchmark A-01.

Flooding of archaeological assets within the UNESCO site of Aquileia. The city of Aquileia sits at the confluence of two rivers that merge before flowing into the lagoon as a single waterway. Located just 4 kilometers from the river mouth, Aquileia is directly affected by tidal fluctuations and sea level rise, which influence water levels in both rivers—particularly the Natissa, which runs closest to the city. The Natissa has already flooded archaeological areas and nearby portions of the city during extreme tidal and rainfall events, and rising sea levels are expected to increase both the frequency and severity of such flooding.

Stakeholders have also reported problems with rising groundwater levels, which are causing archaeological sites to flood from below. As water levels continue to rise, previously unexplored archaeological remains risk being submerged and deteriorating before they can be properly studied and documented.

These combined factors are projected to significantly increase the costs of protecting, maintaining, and restoring archaeological assets, while likely rendering some areas of archaeological potential permanently inaccessible before they can be explored.

File: **Act_2.3_MedSeaRise_benchmark_A-01_PP2.zip**

Annex 10 – MedSeaRise_benchmark_A-03_PP2

MedSeaRise project partner PP2 benchmark A-03.

Flooding of the urban area of Grado town. The city of Grado, situated on Italy's north-eastern coast, is especially vulnerable to sea level rise due to its low elevation, its proximity to tidal lagoons, and its exposure to the dynamics of the Adriatic Sea. As Mediterranean sea levels continue to rise, the city is likely to experience more frequent and intense flooding. This could lead to the shrinking of beaches that are vital for the tourism and economy of the city, while also damaging urban areas and infrastructure. Consequently, maintenance costs would rise, and property values could decline, affecting both private owners and public administrations.

File: **Act_2.3_MedSeaRise_benchmark_A-03_PP2.zip**

Annex 11 – MedSeaRise_benchmark_A-01_LP1

MedSeaRise project partner LP1 benchmark A-01.

Kalamaria Municipality comprises the broader metropolitan area of eastern Thessaloniki, the 2nd largest city in Greece (Central Macedonia), with its coastal waterfront comprising the most significant part of the northeastern Thermaikos Gulf littoral areas (northwestern Aegean Sea), i.e., the neighbourhoods of Karabournalki, Kodra Camp, Kouri, Aretsou, Nea Krini, Agios Georgios, and Mikra, which are administratively part of it.

Sea level rise and extreme storm surge or tidal events pose a significant threat to the coastal zone of the Kalamaria waterfront, with the potential to inundate critical littoral areas. This endangers not only urban assets but also natural habitats and essential infrastructure linked to air and maritime transport, water supply, and public utilities. The resulting socio-economic losses and associated costs are highlighted in this case study.

File: **Act_2.3_MedSeaRise_benchmark_A-01_LP1.zip**

Annex 12 – MedSeaRise_benchmark_A-02_PP3

MedSeaRise project partner PP3 benchmark A-02.

Saint-Laurent-du-Var is a coastal municipality located directly to the west of Nice, in the Alpes-Maritimes department of southeastern France. As one of the most urbanized sections of the coastline, it combines major economic infrastructures, such as the Cap 3000 shopping center located next to the Airport of Nice. There are recreational beaches, restaurants...

The area faces a unique set of challenges due to its low elevation, the influence of the Var River delta, and increasing human pressure linked to tourism and development.

Given its strategic importance and vulnerability, Saint-Laurent-du-Var was selected as a case study to better understand how sea level rise and related climate hazards could affect both economic activities and natural systems over the coming decades.

The study aims to combine environmental data from partners of MedSeaRise and local data, risk modelling, and stakeholder input to identify priority zones and assess potential impacts under different climate scenarios. The findings will contribute to the broader goal of MedSeaRise: benchmarks and Mediterranean coastal adaptations plans with practical tools and knowledge.

File: **Act_2.3_MedSeaRise_benchmark_A-02_PP3.zip**

Annex 13 – MedSeaRise_benchmark_A-01_PP4

MedSeaRise project partner PP4 benchmark A-01.

Boka Kotorska Bay, a UNESCO World Heritage site, is a unique bay on the Adriatic, known for its specific natural characteristics, dramatic landscapes, rich cultural heritage, and centuries-old coastal towns. The entire area, including the bays of Kotor and Risan, is subject to impacts due to the sea level rise, as detailed in the following sections.

Four likely future impacts due to following causes are considered: sea level rise, increase of seawater temperature, increase of salinity and a change in aquatic fish distribution due to more intensive immigration rate of tropical fish.

File: **Act_2.3_MedSeaRise_benchmark_A-01_PP4.zip**

Annex 14 – MedSeaRise_benchmark_A-01_PP5

MedSeaRise project partner PP5 benchmark A-01.

In the framework of the MedSeaRise project, the Barcelona case study focuses on the Delta del Llobregat. The area combines high ecological value with critical socio-economic infrastructure, including the Port of Barcelona. Sea level rise and extreme marine events may flood key areas of the Delta del Llobregat, threatening natural assets and key infrastructure related to transport. This could result in economic losses analysed under this case study.

File: **Act_2.3_MedSeaRise_benchmark_A-01_PP5.zip**

References

Bibliography and Sitography

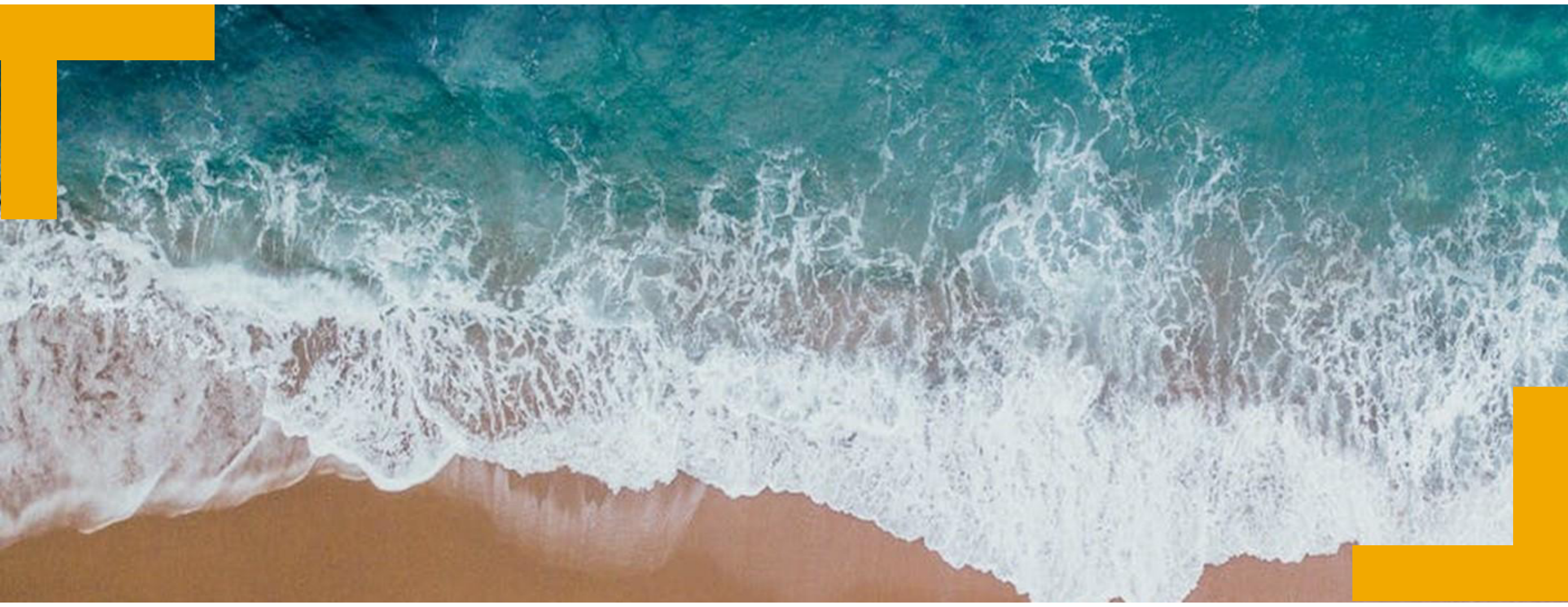
[1.1] MedSeaRise deliverable D.2.2.1 Case studies for evaluation of sea level rise anthropic impacts risk

[1.2] MedSeaRise deliverable D.2.2.2 Case studies for evaluation of sea level rise ecosystem impacts risk

[2.1] MedSeaRise deliverable D.2.4.1 Methodology and the best practices

Annex 3

MedSeaRise | Interreg Euro-MED | Co-funded by the European Union



December 2025

BENCHMARKS ON EVALUATION OF SEA LEVEL RISE ECOSYSTEM IMPACTS RISK ASSESSMENT

Deliverable D.2.3.2

https://medsearise.interreg-euro-med.eu/

ANATOLIKI | arpa FVG | CCI NICE CÔTE D'AZUR | Cambra | L-Università ta' Malta

Deliverable ID

Project acronym	MedSeaRise
Project title	Supporting Adaptation to Mediterranean Sea Level Rise
Project mission	Protecting, restoring and valorising the natural environment and heritage
Project priority	Greener MED
Specific objective	RSO2.4 Promoting climate change adaptation and disaster risk prevention, resilience, taking into account eco-system based approaches
Type of project	Study project (Thematic Project)
Project duration	01/01/2024 – 31/03/2026 (27 months)

Deliverable title	Benchmarks on evaluation of sea level rise ecosystem impacts risk assessment
Deliverable number	D.2.3.2
Deliverable type	Report
Work package number	2
Work package title	Information analyses, methodology development and tools generation
Activity name	Comparative analyses and benchmarking
Activity number	2.3
Partner in charge (author)	UM
Partners involved	ANATOLIKI S.A., ARPA FVG , CCINCA, UoM-IBMK, BCC, UM

Document history

Versions	Date	Document status	Delivered by
Version 0.1	23/10/25	Draft	PP2
Version 1.0	19/12/2025	Final	PP2

Table of contents

Abbreviations

ANATOLIKI	Organisation for Local Development, Anatoliki S.A. – Project Partner - LP1
ARPA FVG	Regional Environmental Agency of Friuli Venezia Giulia Region- Project Partner - PP2
CCINCA	Chamber of Commerce and Industry Nice Côte d'Azur - Project Partner - PP3
UoM-IMBK	Public institution University of Montenegro - Institute of Marine Biology - Project Partner - PP4
BCC	Barcelona Chamber of Commerce - Project Partner - PP5
UM	University of Malta - Department of Geosciences- Project Partner - PP6
PP	A Project Partner, in general. Nobody specifically indicated
PPs	All Project Partners
D.2.2.1	Project deliverable 2.2.1: Case studies for evaluation of sea level rise anthropic impacts risk
D.2.2.2	Project deliverable 2.2.2: Case studies for evaluation of sea level rise ecosystem impacts risk
D.2.4.1	Project deliverable 2.4.1: Methodology and the best practices
Output 2.1	Project output 2.1: Methodology for an effective use of sea level rise scenarios in climate change impact risks assessment
GWL	Global Warming Level
WPs	MedSeaRise Work packages

Executive summary

This is a deliverable of the project MedSeaRise. The project contributes to the Natural Heritage mission of the Euro-MED Programme and it belongs to the Study Project class.

The document summarizes the work done in the frame of the project activity 2.3, describing how the project partners have generated a set of analyses on the impacts expected to affect the ecosystems, as a consequence of the progressive increase of the sea level , in the Mediterranean basin.

First, an outlook on the needs and the objectives that have stimulated the generation of specific case studies and their organization as benchmarks is presented. Furthermore details of the benchmark structure are detailed in addition with the methods specifically created to assess the sensitivity of the sea level rise related impacts to the increase of the global temperature of our planet.

The document is completed with a summary of the available benchmarks and appendixes that give further

The benchmarks aim

Introduction and Objectives

This document presents a specific contribution in 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 a proper use of such data in the risk assessment processes and to provide guidelines and benchmarks for the methodology application.

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The sensitivity of the sea level rise risk analysis is explored and quantified, for each of the identified impacts. A metric was developed as part of this activity. Benchmarking has been conducted evaluating the sensitivity of the risk assessment using that metric.

Benchmarking is conducted also with the aim to support the best practices definition, furthermore benchmarks are included in the methodology as examples for a best use of data on future sea level scenarios. Then, benchmarks are an essential component of the project Output 2.1.

In summary, a benchmark is a standard example of risk assessment for an impact, due to the increase of the sea level rise, that has to be considered as a tool for the evaluation and comparison of the risk sensitivity from the input data on the sea level trends, according to a specific metric.

To generate the benchmarks, PPs have defined a guideline, which has been applied to a selection of the case studies to enrich them and then produce the benchmarks.

This deliverable describes how benchmarks for impacts on ecosystems have been generated, and how many they are. Each benchmark is composed of a document and supplemental files that are part and parcel of this document. The benchmarks are annexes of this deliverable and are available as archive files attached to the document.

Guideline for benchmark generation

Benchmark generation

In MedSeaRise project a benchmark is defined as standard example of risk assessment for an impact, real or ideal, due to the increase of the sea level rise, that has to be considered as a tool for the evaluation and comparison of the risk sensitivity from the input data on the sea level trends, according to a specific metric.

So, a benchmark has to be characterized by some mandatory information. Those information relate to the impact caused by the increase of the sea level, its assessment and quantification, a description of the procedure and the data involved in the impact assessment, the sensitivity of the impact to the input data. Anyway the format of the information presentation through the benchmark is not strictly defined.

Since project activity 2.3 foresees a comparison of the benchmarks sensitivity, it is straightforward all the benchmarks have to share a common set of core data on impacts sensitivity on inputs.

Starting from the above considerations, it is suggested to generate a benchmark extending a case study conducted in the frame of the activity 2.1.

In fact, case studies have been generated and presented according to a shared set of elements, which have been described in the case study guidelines document and that have been also included in the template document for the case study reporting.

To a case study document, it is important to add a further section reporting elements useful and sufficient to support the best practices application, which are presented in the MedSeaRise methodology for an effective use of sea level rise scenarios in climate change impact risks assessment (D.2.4.1 and project Output 2.1) [2.1]. We need to recall that benchmarks will be included in the methodology for a best use of data on future sea level scenarios.

In the next paragraph a template of that section is presented.

Finally, to allow the comparison of the impacts sensitivity to the inputs describing the future sea level condition, in the frame of the present climate change, it is important the benchmark summarizes the impacts as a function of the GWLs.

Since each benchmark has its own specific inputs, according to the area and the kind of impact, a common way to assess the sensitivity is by means of the variation of the impact with respect to the GWLs. In fact, all the case studies, thus the benchmarks, link the impacts to the GWLs.

The last section describes how each benchmark sensitivity to the sea level will be compared.

How to evolve a case study into a benchmark

Starting from the document detailing a case study, that is one of those realized in the frame of the project activity 2.1, see deliverables D.2.1.1 [1.1] and D.2.1.2 [1.2] the benchmark have to bring all the analyses and the results produced for the case study and to include a further section reporting information suitable to understand how to reproduce the study of the sea level rise related impact, step by step.

This specific section, whose title is named "Description of the tools and data used to carry on the case study", is composed of key points with a brief description of the essential elements one has to consider in reproducing the case study or to use it as an example for another similar case.

Here below each of the key points are reported together with a guide on how to fill in the information on each of them.

Description of the tools and data used to carry out the case study

In the benchmark, explain in a very summary what was done, once identified the impact to be studied. The information has been retrieved and how they were processed. Here are guidelines on how to proceed.

Data on future sea level used for the case study

(Describe what inputs on future mean sea level you have retrieved from those let available in the frame of the project. Furthermore, describe what further data of sea level you have used, for example tides simulations, sea level gauges measurements, etc. including their sources too.)

Data on the exposed subject used for the case study

(Describe what are the inputs concerning the subject the case study has considered for the impact, including the sources of those data too. For example the Digital Elevation Model of the coast, the database of commercial assets potentially impacted, scientific papers and datasets reporting data on ecosystems, etc.)

Resources used to conduct the case study

(Describe what kind of resources you have employed to conduct the risk assessment in the case study. For example, personnel internal to the PP, external experts, specific software, computational resources, etc..)

Procedure adopted to employ data and resources to generate the impact

(A very brief description on how data and resources have been involved in the case study to assess the impact. It is advised to use a presentation by points or an image with a sketch of steps followed to compute the impacts.)

Notes of results presentation

(A very summary on the motivations led you to adopt the presentation of the results accessible in the case study. For example unique table which is part of the document, a series of plots and images, a set of separate files attached to the case study document, etc.)

Preparation of case study outputs suitable for sensitivity analysis

The comparison of the benchmarks sensitivity, which in turn means the sensitivity of the impact to the input data, requires the benchmark outputs be presented as a function of the GWLs. This means that the quantity describing the impact has to be linked to the GWLs of the input. The most simple way is a tabular form. See annexes from 1 to 7.

Benchmark sensitivity method

To the highest extent, the sensitivity analysis of the risk assessment, conducted by means of the benchmark results, requires a shared metric linking the sea level hazard uncertainty and reliability with the impacts. Thanks to the MedSeaRise activities, conducted analysis shows that it is hard to define such a metric meaningful for all the possible classes, at least before the project conclusion.

Instead, it is possible to classify the sensitivity of the impact with respect to the GWLs. In fact, all the case studies, thus the benchmarks, link the impacts to the GWLs.

Using the sensitivity of the impact on the variations of the GWLs allows the comparison of sensitivity among classes of impacts very different from each other, in addition to impacts inside the same class. Of course, it is a sensitivity of the impact with respect to the GWL evolution and it is not respect the uncertainty and the reliability of the input data.

In addition, this kind of sensitivity adds more information to those available for the decision making. In fact, it is helpful to know the response of the impact to the increase of the GWL, in the frame of decisions to be taken to enhance the resilience of the coastal areas or to choose adaptation solutions to reduce the vulnerability or even the exposure to the sea level hazard.

For this reason the following metric has been defined. It allows placing the impact response to the GWL change into one of the classes representing the spectrum of responses. The classes are common to all kinds of impacts and this means that it is possible to compare impacts having quite different features and dependencies.

Consider **I** to indicate the impact and **GWL** the Global warming level. Then the variation of the impact with respect the change in the GWL is named the sensitivity **S**; it is defined as follow:

$$\mathbf{S} = (\mathbf{I}(B) - \mathbf{I}(A))/(\mathbf{GWL}(B) - \mathbf{GWL}(A))$$

A and B are two different simulations of the impact. Each of them are associated to the corresponding GWL.

The sensitivity has the meaning of impact for units of GWL, that is it tells you how fast the variation of the impact is when our planes move from one Global Warming Level to the next.

In the MedSeaRise project, we have generated input data belonging to four GWLs, namely 1.5 °C, 2.0 °C, 3.0 °C and 4.0 °C, so it is possible to compute three values of sensitivity. Specifically, the sensitivity to the change from GWL 1.5 °C to 2.0 °C, that from 2.0 °C to 3.0 °C and finally from 3.0 °C to 4.0 °C. In case of less sensitivity values it is still possible to associate a sensitivity class to the impact.

Once the sensitivity **S** is computed, the evolution of the sensitivity with respect to the GWLs allows to assign a class to the impact **I** according to seven classes. They are:

1. not sensitive,
2. variable,
3. linear,
4. more than linear,
5. exponential,
6. turning point
7. saturation

Classes are independent from the type of impact, because they have been built on the behaviour of the sensitivity **S** with respect to the increase of the warming of our planet.

To find the suitable class for the impact explored through a benchmark, it is necessary to look at the evolution of both the sensitivity and the impact when the GWL increases.

In the annexes from 1 to 7 each class is described with the aid of a table and a graph. With these tools it should be easy to link the class to the benchmark.

The comparison of the benchmarks through the classes they belong to implement the comparative analyses and benchmarking foreseen by activity 2.3

Benchmarks

Summary of benchmarks on ecosystem impacts

MedSeaRise activity 2.3 has produced two benchmarks, with the objective to complement the methodology developed in the frame of the project and to give examples of the best practices application on the selection and use of sea level rise data for the risk assessment of impacts affecting ecosystems.

They are listed here below. For each benchmark essential information is presented, whereas in the appendixes it is available a short summary of the impact the benchmark is focused on together with the reference to the associated file storing all the details.

Benchmark ID	Project Partner	Appendix
E-03_PP2	PP2 – ARPA FVG	Annex 8
E-01_PP4	PP4 - UoM-IBMK	Annex 9

Indicators of deliverable achievement

Deliverable indicators

The achievement of the objective described in this deliverable is summarized by means of the indicators reported here 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 benchmarks	1	2	Benchmarks focusing on ecosystem impacts

For each benchmark, a specific document is available as appendix. Furthermore, benchmark includes files and or reference do access files that are suitable to reproduce the benchmark.

Conclusions

Conclusions

One of the most intensive and work demanding tasks, carried on by each MedSeaRise project partner, was the identification of the sea level rise impacts and their analysis in detail, applying the methodology developed in the frame of the project.

Such individual work, which was coordinated at Work Package level thanks to the efforts made by the WPs leaders, results in a set of case studies sharing the same conceptual approach to assess the consequences of the progressive increase of the sea level, due to climate change.

A selection of case studies is presented in detail and, each of them, with a schematic guideline that leads to the reproduction of the case study as it is or the application of the scheme to other similar impacts.

This presentation of a selected case study makes it a benchmark against which to compare further applications of the MedSeaRise methodology.

Furthermore the sensitivity method used in the benchmark, to assess the response of the impact to the increase of global warming, supports the stakeholders in making decisions on possible adaptation or resilience solutions aimed to minimize the risk to get the impact.

The benchmark sensitivity to the variations of the GWLs, which is described in this deliverable, is expected to stimulate the comparison of the impact sensitivity among classes of impacts very different from each other, besides those belonging to the same type.

Finally, the benchmarks collected in this deliverable have the ambition to enrich the set of studies focused on some of the issues the Mediterranean coastal areas are going to face in a rapid change of the climate. Furthermore, following the purposes of the Natural Heritage study project type, it is expected the benchmarks make the amplification of the results achieved in the frame of the MedSeaRise project easier.

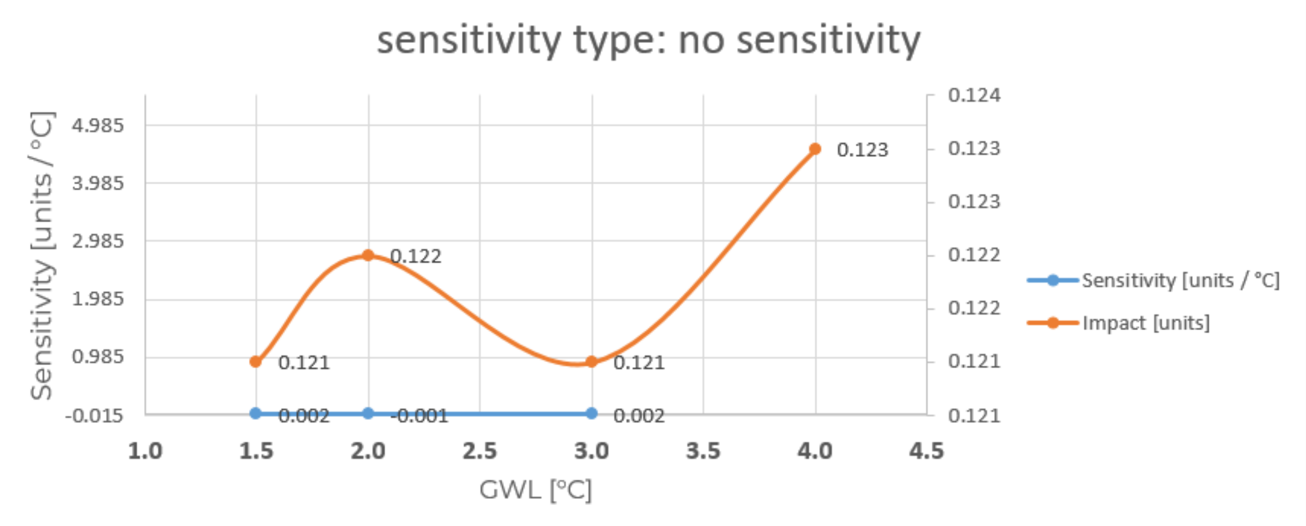
Annexes

Annex 1 – Example of sensitivity type: no sensitivity

Example of impact not sensitive to the GWLs change.

Sensitivity (**S**) is almost zero. Impact (**I**) changes without any trend.

Sensitivity type:	**no sensitivity**			
GWL [°C]	Impact [units]	Δ GWL [°C]	Δ Impact [units]	Sensitivity [units / °C]
1.5	0.121	0.5	0.001	0.002
2.0	0.122	1.0	-0.001	-0.001
3.0	0.121	1.0	0.002	0.002
4.0	0.123			

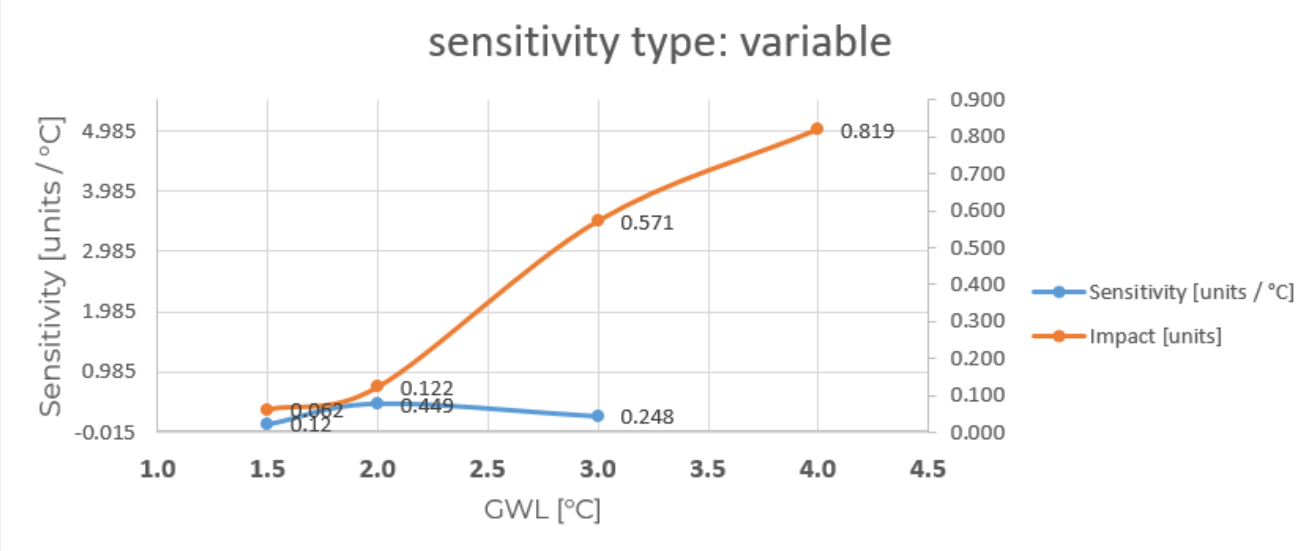


Annex 2 – Example of sensitivity type: variable

Example of impact variable with respect to the GWLs change.

Sensitivity (**S**) is positive and smoothly changes. Impact (**I**) changes with a no clear trend.

Sensitivity type:	**variable**			
GWL [°C]	Impact [units]	Δ GWL [°C]	Δ Impact [units]	Sensitivity [units / °C]
1.5	0.062	0.5	0.060	0.12
2.0	0.122	1.0	0.449	0.449
3.0	0.571	1.0	0.248	0.248
4.0	0.819			

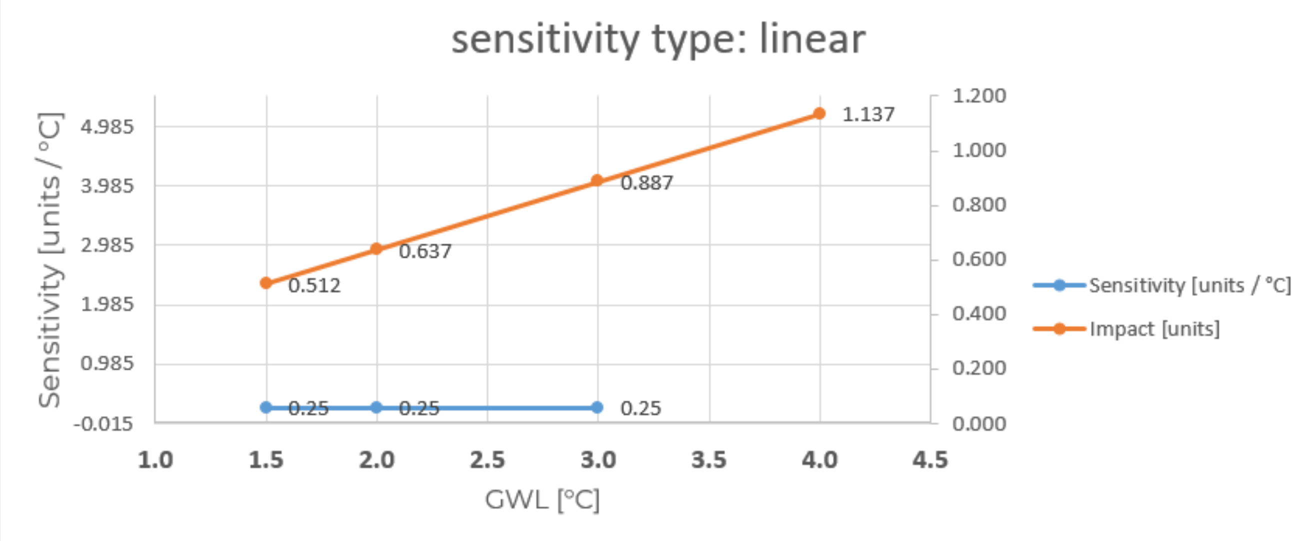


Annex 3 – Example of sensitivity type: linear

Example of impact linear with respect to the GWLs change.

Sensitivity (**S**) is constant and different from zero. Impact (**I**) changes according to a linear trend.

Sensitivity type:	**linear**			
GWL [°C]	Impact [units]	Δ GWL [°C]	Δ Impact [units]	Sensitivity [units / °C]
1.5	0.512	0.5	0.125	0.25
2.0	0.637	1.0	0.250	0.25
3.0	0.887	1.0	0.250	0.25
4.0	1.137			

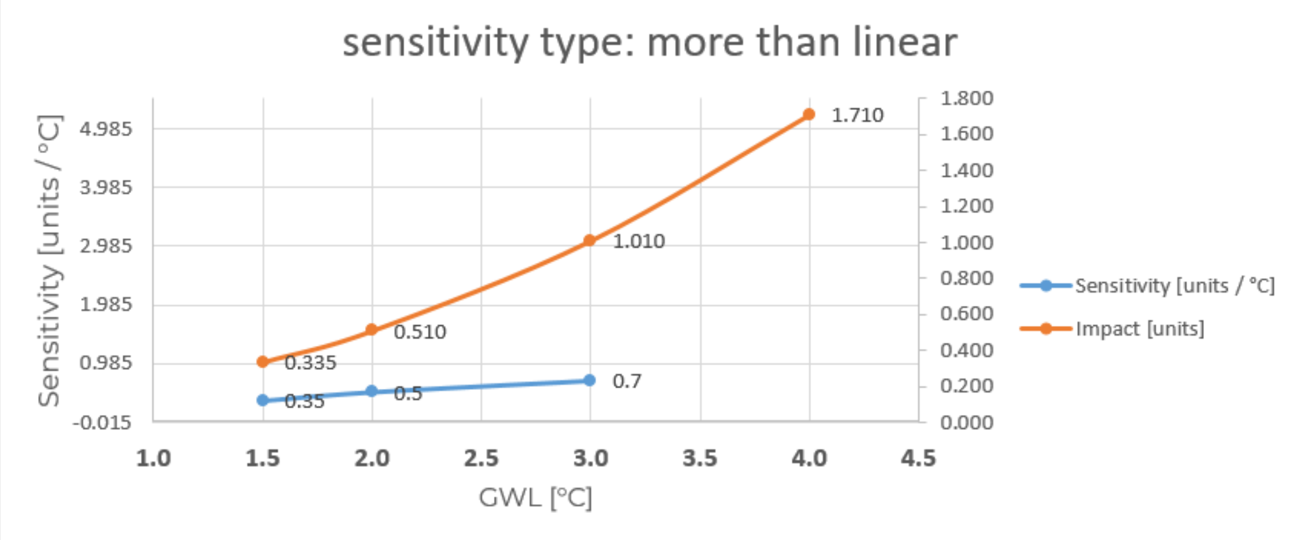


Annex 4 – Example of sensitivity type: more than linear

Example of impact more than linear with respect to the GWLs change.

Sensitivity (**S**) is increasing. Impact (**I**) changes according to a power of GWL.

Sensitivity type:	**more than linear**			
GWL [°C]	Impact [units]	Δ GWL [°C]	Δ Impact [units]	Sensitivity [units / °C]
1.5	0.335	0.5	0.175	0.35
2.0	0.510	1.0	0.500	0.5
3.0	1.010	1.0	0.700	0.7
4.0	1.710			

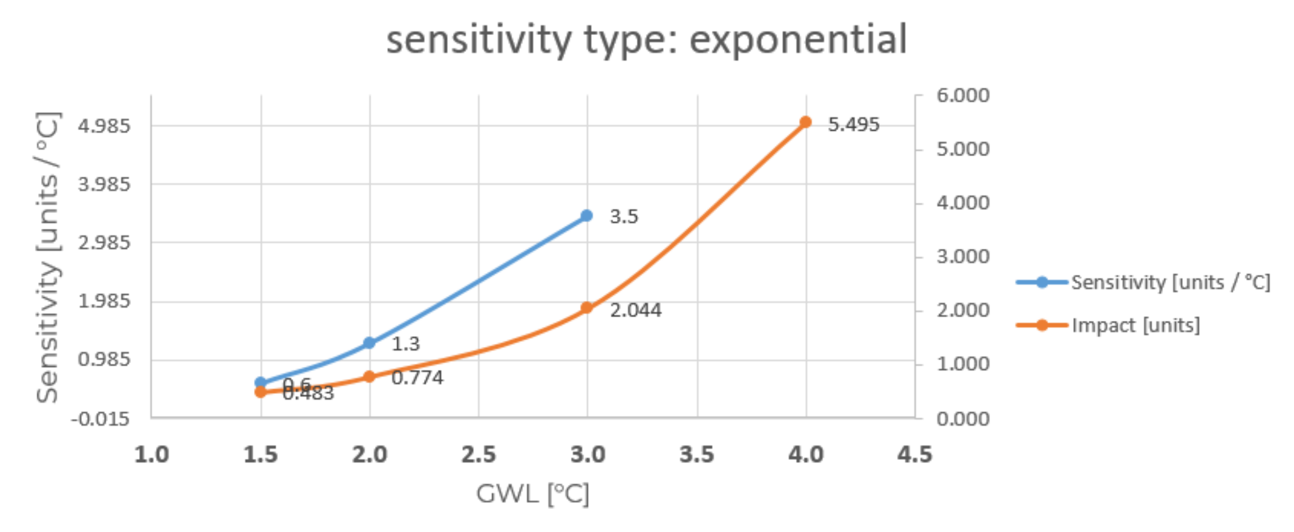


Annex 5 – Example of sensitivity type: exponential

Example of impact exponential with respect to the GWLs change.

Sensitivity (**S**) is rapidly increasing. Impact (**I**) changes according to an exponential law.

Sensitivity type:	exponential			
GWL [°C]	Impact [units]	Δ GWL [°C]	Δ Impact [units]	Sensitivity [units / °C]
1.5	0.483	0.5	0.291	0.6
2.0	0.774	1.0	1.270	1.3
3.0	2.044	1.0	3.451	3.5
4.0	5.495			

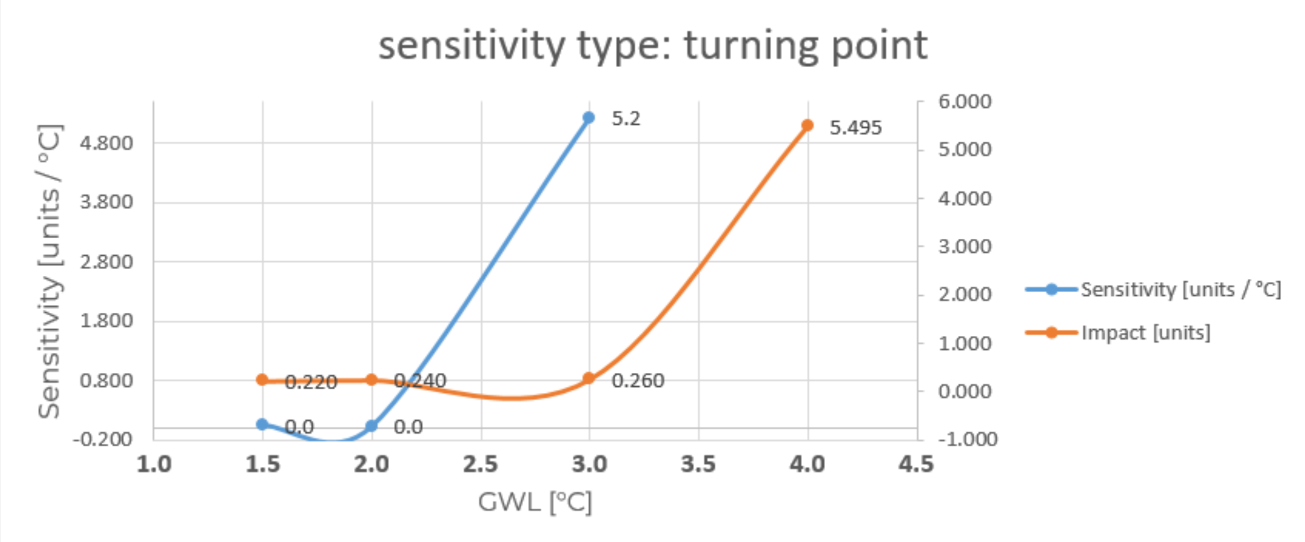


Annex 6 – Example of sensitivity type: turning point

Example of impact having a turning point with respect to the GWLs change.

Sensitivity (**S**) is almost zero up to the turning point, then has a jump. Impact (**I**) does not change much up to the turning point, then jumps up.

Sensitivity type:	**turning point**			
GWL [°C]	Impact [units]	Δ GWL [°C]	Δ Impact [units]	Sensitivity [units / °C]
1.5	0.220	0.5	0.020	0.0
2.0	0.240	1.0	0.020	0.0
3.0	0.260	1.0	5.235	5.2
4.0	5.495			

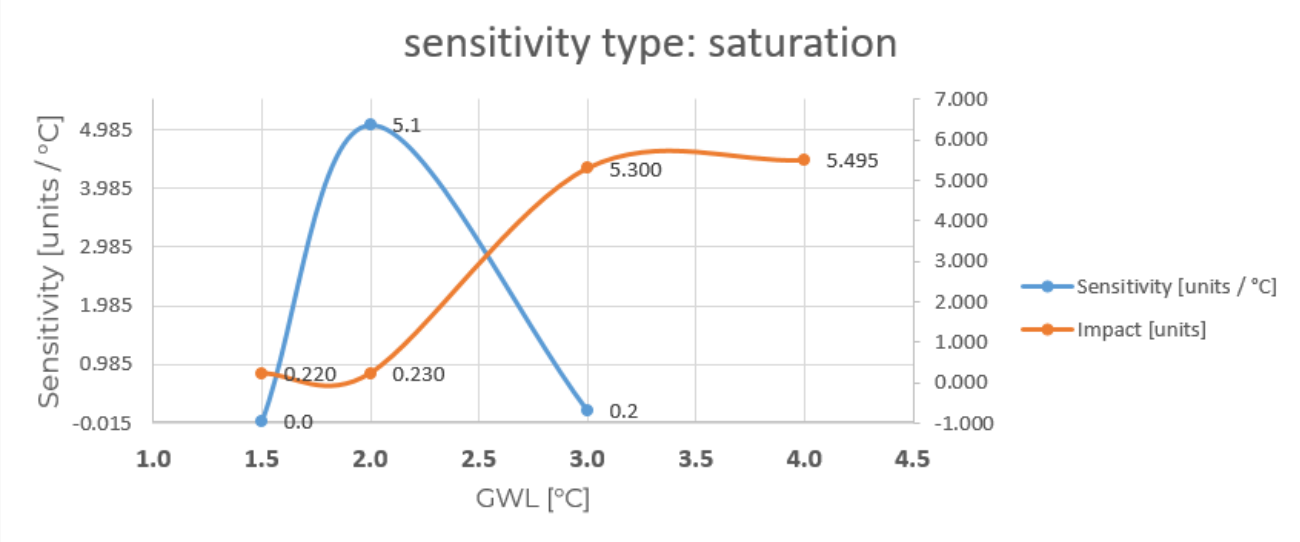


Annex 7 – Example of sensitivity type: saturation

Example of impact having a saturation with respect to the GWLs change.

Sensitivity (**S**) increases up to a point, then back to zero. Impact (**I**) increases rapidly up to a plateau, then does not change any more.

Sensitivity type:	**saturation**			
GWL [°C]	Impact [units]	Δ GWL [°C]	Δ Impact [units]	Sensitivity [units / °C]
1.5	0.220	0.5	0.010	0.0
2.0	0.230	1.0	5.070	5.1
3.0	5.300	1.0	0.195	0.2
4.0	5.495			



Annex 8 – MedSeaRise_benchmark_E-03_PP2

MedSeaRise project partner PP2 benchmark E-03.

The Grado and Marano Lagoon is undergoing a process of marinization, which refers to the transformation of a lagoon environment into a more marine-like system, primarily due to increased seawater inflow caused by sea level rise. This process alters the lagoon's salinity, water circulation, and sediment dynamics, furthermore it is impacting the vegetation and consequently the animals living in that area.

Biodiversity is particularly affected: the rising salinity and temperature of the lagoon waters are disrupting the ecological balance, making the environment more suitable for species adapted to marine conditions. As a result, species that once thrived in the lagoon are now struggling due to both the changes in the physical and chemical properties of the water and the increased competition from species better suited to the new conditions.

This is the case of the common reed, Phragmites australis. This species forms dense populations along the most natural and well-preserved shores of the Friuli Venezia Giulia Regional Authority (RAFVG) and represents a characteristic habitat of the region.

It is known that Phragmites australis is sensitive to high salinity and prolonged submersion, which lead to reduced growth and reproductive rates. The decline in reproduction is largely due to the depletion of carbohydrate reserves in the rhizomes and a lower success rate in seed germination.

File: **Act_2.3_MedSeaRise_benchmark_E-03_PP2.zip**

Annex 9 – MedSeaRise_benchmark_E-01_PP4

MedSeaRise project partner PP4 benchmark E-01.

This case study examines the impact of sea level rise on Tivat Solila. The impacts are affecting the historic salt evaporation farm. A wider environment around the farm with an area of 150 km^2 has been declared a special nature reserve. It is an area vulnerable to flooding that is often a result by meteo-tsunamis accompanied by heavy precipitation and strong persistent wind.

The impact will affect marsh vegetation and associated fauna. Seawater temperature will rise, which will induce faster decomposition of future submerged organic matter. Due to expected smaller precipitation and higher evaporation, salinity will rise which will favour more salinity tolerant plant and fauna species. Warmer and saltier seawater will change species distribution in the ecosystem which will have an impact on fishery.

File: **Act_2.3_MedSeaRise_benchmark_E-01_PP4.zip**

References

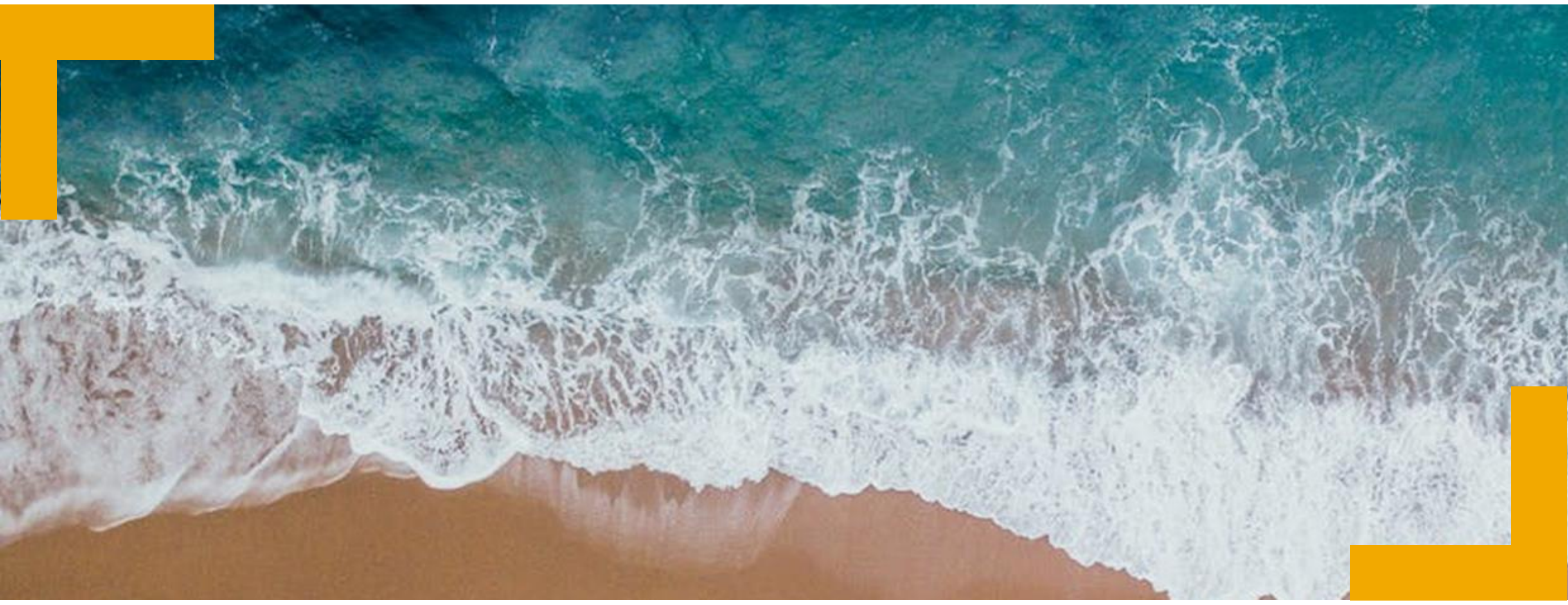
Bibliography

[1.1] MedSeaRise deliverable D.2.2.1 Case studies for evaluation of sea level rise anthropic impacts risk

[1.2] MedSeaRise deliverable D.2.2.2 Case studies for evaluation of sea level rise ecosystem impacts risk

[2.1] MedSeaRise deliverable D.2.4.1 Methodology and the best practices

Annex 4



October 2025

MedSeaRise methodology validation guidelines

This document contributes to both deliverables D.3.1.1 and D.3.2.1 because the methodology validation approach is the same

https://medsearise.interreg-euro-med.eu/

Deliverable ID

Project acronym	MedSeaRise
Project title	Supporting Adaptation to Mediterranean Sea Level Rise
Project mission	Protecting, restoring and valorising the natural environment and heritage
Project priority	Greener MED
Specific objective	RSO2.4 Promoting climate change adaptation and disaster risk prevention, resilience, taking into account eco-system based approaches
Type of project	Study project (Thematic Project)
Project duration	01/01/2024 – 31/03/2026 (27 months)

Deliverable title	Methodology validation (Anthropic and Ecosystems)
Deliverable number	D.3.1.1 and D.3.2.1
Deliverable type	Report, study…
Work package number	3
Work package title	Methodology validation, capacity building and amplification
Activity name	Validation of methodology on anthropic risk classes
Activity number	Activity 3.1
Partner in charge (author)	ANATOLIKI S.A., ARPA FVG , CCINCA, UoM-IBMK, BCC, UM
Partners involved	All

Document history

Versions	Date	Document status	Delivered by
Version 0.1	02/10/25	Draft	PP2
Version 1.0	04/11/25	Draft	PP2

Table of contents

Abbreviations

ANATOLIKI	Organisation for Local Development, Anatoliki S.A. – Project Partner LP1
ARPA FVG	Regional Environmental Agency of Friuli Venezia Giulia Region- Project Partner PP2
CCINCA	Chamber of Commerce and Industry Nice Côte d'Azur - Project Partner PP3
UoM-IMBK	Public institution University of Montenegro - Institute of Marine Biology - Project Partner PP4
BCC	Barcelona Chamber of Commerce - Project Partner PP5
UM	University of Malta - Department of Geosciences- Project Partner PP6
PP	A Project Partner, in general. Nobody specifically indicated
PPs	All Project Partners
SWOT	Strengths, Weaknesses, Opportunities, Threats

Additional abbreviations may be added, if needed.

Executive summary

The executive summary can be up to 5 pages, depending on the length and complexity of the deliverable.

Basic concepts of methodology validation

Introduction

The methodology developed in the frame of MedSeaRise project is meant for an effective use of sea level rise scenarios in climate change impact risk assessment. It is validated through the involvement of stakeholders, associated partners and experts.

This means that each PP collects the feedback from the involved actors. Those information are harvested organizing meetings with stakeholders, associated partners and experts, if the latter are needed.

During those meetings, the methodology is presented in a short summary, by points, or in detail; that is up to the meeting organizers. Furthermore, one or more benchmarks are shown and commented to describe the application of the methodology, step by step.

Naturally, the benchmarks are chosen among those the PP has generated for the area on which it has focused the case studies. Anyway, it is possible a PP uses benchmarks generated by other PPs.

Benchmarks presentation is important because it allows to explain, with the aid of methodology applications, what sets of data on sea level rise scenarios are suitable, from where data are accessible, what are the other data required to define the impact indicators related to the specific exposed and vulnerable target in the benchmark, what is the sensitivity of the impact from the variations in input data, what are the hardest steps found in methodology implementation and so on and so forth.

After the methodology and benchmark presentation, the stakeholders, associated partners and experts are requested to answer a set of questions. Through those questions, the PP collects the information useful to conduct the methodology validation.

In case the actors have already received information on methodology and benchmarks, it is possible to bypass the meetings and to ask them to fill in the questionnaire only.

Easiness and difficulties in applying the methodology are collected from all the PPs questionnaires and a SWOT analysis [1.1] is conducted with the aim to pick up which of the external and internal factors of the methodology have to be considered good enough and those requiring further improvements.

A quantitative SWOT analysis [1.2], [1.3], is the preferred approach. Each PP can provide its own SWOT analysis and a comprehensive one is going to be conducted including all the

PPs contributions. There will be an analysis on results coming from the methodology application to anthropic risks and another to its application to the risks affecting ecosystems.

To make the harvesting of the information and the preparation of the questionnaire easier, in the next section there is a set of suggested questions and their link to the corresponding area of SWOT analysis. Certainly each PP may enrich the set of questions according to the special points to be explored; of course, they are welcome.

To make the results coming from each PP suitable to feed a general SWOT analysis, the score given to each question will be normalized by the total number and weights of the adopted question. Also in this case a detailed description is presented later.

Questions suggested to address to the audience

Here below, there are questions and the associated area of SWOT analysis. A **value** is given to each question and it ranges from 0 worst and 10 best. Furthermore a **weight** can be given to the question by the questionnaire organizers. The weight ranges from 0 to 1. So the quantitative score given to an answer is the product **value** x **weight**. In case of more than one answer to the same question, that is there is more than one actor answering, then the average of the values shall summarize the result of the questionnaire.

To **mitigate possible imbalances** between the Strengths and Weaknesses, as for Opportunities and Threats, **the weights assigned to each value have to sum to the same total.** This means the sum of the weights used for Strengths equals that of the weights used for Weaknesses, as well as the sum of the weights used for Opportunities and that for Threats. This is very important to get a quantitative SWOT analysis useful for quality assessment.

Questions related to methodology Strengths

Questions on Strengths are meant to collect information on aspects and features **internal** to the methodology that are considered valuable and improving the process of impact assessment, besides to make the job of quality assessment easier. Here are some questions that may be used for the purpose.

1. How clear and understandable do you find the methodology to be?
2. Would you have the methodology be applied in the assessment of risk you consider relevant?
3. Could you apply the methodology with the involvement of human resources available inside your staff?
4. Do you consider it useful to have the results of the impacts expressed as a function of the Global Warming Levels?

5. Do you consider it useful to have the impacts presented with the range of uncertainties?
6. Do you consider the methodology to have a wide range of applications?

Questions related to methodology Weaknesses

Questions on Weaknesses are meant to collect information on aspects and features **internal** to the methodology that are considered limiting or worsening the process of impact assessment and the job to assess heavier. Here are some questions that may be used for the purpose.

1. Does the methodology require specific know-how to be understood?
2. Does the methodology application require too many resources (time, economical or human) in comparison to your availability?
3. Does the methodology application require hiring experts outside your staff?
4. Do you think it is difficult to interpret the uncertainty of an impact due to sea level rise?
5. How difficult is it for you to see the link between the increase of the sea level and the impacts on your asset?

Questions related to methodology Opportunities

Questions on Opportunities are meant to collect information on actual or potential elements **external** to the methodology, for example the environment or the context in which the methodology is used, that may leverage the efficacy and efficiency of methodology in assessing the impact, besides to let the job to assess easier. Here are some questions that may be used for the purpose.

1. Does your sector or asset consider the risk assessment in decision making valuable?
2. Is the methodology a new or innovative tool in the sectors you are working on?
3. Do you think that many other operators of the sector you are working in could be interested in learning about and using the methodology?
4. Is there an adaptation strategy in which the methodology can be helpful?
5. Would you base your strategic plans on the methodology?
6. Would you propose the methodology for the application to other sectors than yours?

Questions related to methodology Threats

Questions on Threats are meant to collect information on actual or potential elements **external** to the methodology, for example the environment or the context in which the methodology is used, that may hinder the efficacy and efficiency of methodology in assessing the impact, besides to let the job to assess heavier. Here are some questions that may be used for the purpose.

1. Are external experts hard to find in order to apply the methodology?
2. Is the cost of the methodology a burden for its application, even for a case of your interest?
3. Do you think the methodology is too complicated for the environment where you are operating and working?
4. Do you think there is a lack of data to assess the impacts of sea level rise in your asset?
5. Is it possible that the results of the methodology are not taken into consideration in defining adaptation planning related to progressive sea level rise?

At the end, add an open question on advice and suggestions. Example, do you see any barrier in applying the methodology?

Method for the general SWOT analysis

To proceed with quantitative SWOT analysis we need to define some quantities we are going to use.

With S, W, O, and T we represent the sum of the values coming from questions belonging to Strengths, Weaknesses, Opportunities, and Threats, respectively. Those are all values greater than or equal to zero.

The total SWOT score (**D**) is the sum of the difference between Strengths and Weaknesses and the difference between Opportunities and Threats

$$\mathbf{D = (S - W) + (O - T)}$$

D represents the net balance between positive (Strengths and Opportunities) and negative (Weaknesses and Threats) factors.

The total score magnitude (**M**) is the sum of all the values. Those

$$\mathbf{M = S + W + O + T}$$

The relative SWOT analysis score (**R**) is the ratio between the total SWOT score (**D**) and total scores magnitude (**M**), that is:

R = D/M

For a SWOT analysis completely positive, no Weaknesses at all (W=0) and no Threats at all (T=0), the relative SWOT analysis score is **+1**. While for completely negative analysis, that is no Strengths at all (S=0) and no Opportunities at all (O=0), the relative SWOT analysis score is **-1**. In a general case R ranges from -1 to +1. Values of R > 0 accounts for a general positive analysis result, while values of R < 0 reports a general negative analysis result.

R > 0 Positive SWOT analysis result

R < 0 Negative SWOT analysis result

For R=0, the analysis show that Strengths balance the Weaknesses and the Opportunities the Threats.

Where to store files with stakeholders feedback results

When each partner will meet the stakeholders and receive the feedback on the methodology application, that information is going to be stored in files. Those files are required to report the work done in achieving the results foreseen in project activities 3.1 and 3.2.

Besides the list of participants, with signatures, the slides used during the meetings and the photos, it is expected there is **a summary of the filled in questionnaires, together with the analysis of the questionnaire outcomes**, that is at least the excel file with the SWOT analysis. Of course, each questionnaire can be added to the set of saved files too.

To make the SWOT analysis easier, there is the template spreadsheet file **SWOT_analysis_example.xlsx** that is available in the same folder where this document is.

It is important to split the feedback result files according to the kind of impact you have used to describe the methodology, that is impacts on anthropic activities and impacts on ecosystems.

For feedback related to **anthropic impacts,** which belong to the project **Activity 3.1**, each PP is requested to store the files in the subfolder of **WP3/Activity_3.1** which is named with the PP ID.

For feedback related to **ecosystem impacts,** which belong to the project **Activity 3.2**, each PP is requested to store the files in the subfolder of **WP3/Activity_3.2** which is named with the PP ID.

Conclusions

Annex

Annex 1 – Example of positive quantitative SWOT Analysis

Example of positive quantitative SWOT analysis

Type	Question	Value	Weight	Score
S	Alpha	10	0,45	**4,50**
S	Beta	10	0,45	**4,50**
S	Gamma	2	0,10	**0,20**
W	Omega	2	0,45	**0,90**
W	Zetta	5	0,55	**2,75**
O	Sound	10	0,75	**7,50**
O	Melody	5	0,25	**1,25**
T	Noise	5	0,35	**1,75**
T	Cry	3	0,30	**0,90**
T	pain	5	0,35	**1,75**

S	W	S-W
9,2	3,65	5,55
O	**T**	**O-T**
8,75	4,4	4,35

D	9,9
M	26

R	**0,3808**

Annex 2 – Example of negative quantitative SWOT Analysis

Example of negative quantitative SWOT analysis

Type	Question	Value	Weight	Score
S	Alpha	2	0,75	**1,50**
S	Beta	10	0,75	**7,50**
S	Gamma	10	0,50	**5,00**
W	Omega	2	0,20	**0,40**
W	Jotta	8	0,85	**6,80**
W	Zetta	9	0,95	**8,55**
O	Sound	5	1,00	**5,00**
O	Opera	7	0,20	**1,40**
O	Melody	5	0,80	**4,00**
T	Noise	5	1,00	**5,00**
T	Cry	8	0,35	**2,80**
T	Shy	10	0,50	**5,00**
T	pain	5	0,15	**0,75**

S	W	S-W
14	15,75	-1,75
O	**T**	**O-T**
10,4	13,55	-3,15

D	-4,9
M	53,7

R	**-0,0912**

References and Bibliography

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