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Downscaling climate impacts and decarbonisation pathways in EU islands, and enhancing socioeconomic and non-market evaluation of Climate Change for Europe, for 2050 and beyond

SoClimPact project has received funding from the European Union´s Horizon 2020 Research and Innovation Programme under Grant Agreement No 77661

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Work Package 7:

Ranking and Mapping transition pathways in islands and enabling networking and information system for regional and EU policy design

Deliverable 7.4. Final Island Reports

Coordinated by CYI (Elias Giannakis)/ ULPGC (Matías M. González Hernández) / FCiencias.ID (Ricardo Cohelo), with the participation of all IFPs and reviewed by Yen E. Lam González (ULPGC), according to the quality review internal process.

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REVISION HISTORY

Version	Date	Author	Notes
F7.4_Final_Islands_Reports_monitoring plan	30/07/2020	CYI	1st draft of monitoring plan
F7.4_Final_Islands_Reports_monitoring plan	30 / 09 / 2020	CYI	2nd draft of monitoring plan
D7.4_ Final_Islands_Reports	30 / 11 / 2020	CYI, ULPGC, FCiencias.ID	1st draft of deliverable
D7.4_ Final_Islands_Reports	30 / 12 / 2020	CYI, ULPGC, FCiencias.ID	2nd draft of deliverable
D7.4_ Final_Islands_Reports	27/01 / 2021	ULPGC	Final set of monitoring indicators and responsible organizations
D7.4_ Final_Islands_Reports	31 / 01 / 2021	CYI, ULPGC, FCiencias.ID	Final draft of deliverable

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Contents

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INTRODUCTION

This deliverable presents the final island reports. The deliverable consists of two main parts. The first part 'CASE STUDIES: EU islands and archipelagos' includes: (a) a background material of future projections of climate change (CC) impacts on islands, (b) the final matrix of adaptation and risk management options per sector (tourism, maritime transport, energy and aquaculture) and per island, (c) the final package of alternatives of adaptation pathways per sector and per island.

First, prior the analysis and rank of the selected adaptation measures, stakeholders and Island Focal Point (IFP) partners analysed future projections of CC impacts for their islands. These downscaled projections, a knowledge built by the Soclimpact project in previous stages, served as a background material for stakeholders to understand the priority risks for the islands, and the subsequent economic impacts in four blue economy sectors (tourism, maritime transport, aquaculture and energy), and the island's economic system. With this information, the assessment and ranking of adaptation measures are not only framed to the socio-economic and political context of the islands, but also to the specific CC impacts that could occur in each island. Under the Introduction section of each island's section a table with a summary of the information contained in the background material as part of the Deliverable Report D7.2 Draft Islands Report for stakeholder engagement, and delivered to the islands for stakeholders- consultation process is presented. Additionally, some islands generated new documentation for the stakeholders which was not necessarily provided by the project.

The individual adaptation measures were then evaluated by the IFPs, with the option of consulting together with their stakeholders, on a basis of five evaluation criteria: (a) cost efficiency – ability to efficiently address current or future climate hazards/risks in the most economical way; (b) environmental protection – ability to protect the environment, now and in the future; (c) mitigation win-wins and trade-offs - current ability to meet (win-win) or not (trade-off) the island/archipelago's mitigation objectives; (d) technical applicability – current ability to technically implement the measure in the island; (e) social acceptability – current social acceptability of the measure in the island.

The formulated adaptation pathways were ranked using the abovementioned evaluation of the individual adaptation measures chosen in each adaptation policy trajectory (APT), i.e., (a) Minimum intervention (MI) (low investment/low commitment), (b) Economic Capacity Expansion (ECE) (high investment/low commitment), (c) System Efficiency Enhancement (SEE) (medium investment/medium commitment), (d) System Restructuring (SR) (high investment/high commitment).

The second part of the deliverable includes a monitoring plan with indicators for each blue economy sector. First, it presents a theoretical framework of a monitoring plan for monitoring the level of implementation of the adaptation options and pathways, and then individual tables of indicators per blue economy sector and per island are presented.

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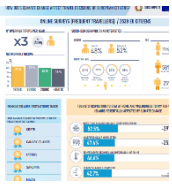
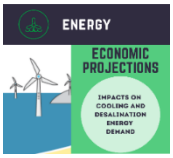
CASE STUDIES: EU islands and archipelagos

1. Azores

1.1 Introduction

Table 1 presents a summary of the future projections of CC impacts for Azores.

Table 1 - Summary of future projections of CC impacts for Azores

Topic	Presentation	Summary
Climate description		- Climate characteristics - Current climate and related risks - Significant climate events
Climate change outlook:		Hazard indicators are projected for two CC scenarios RCP 2.6 (low emissions scenario) and 8.5 (High emissions scenario) and two periods (2046-2065) and (2081-2100). Hazards were selected according to their relevance for 4 blue economy sectors: Tourism, Aquaculture, Energy and Maritime Transport.
Risk analysis, impact chains and islands 'comparison		Risks analysis was undertaken following the concept of impact chains, by considering the relationships of hazards evolution, exposure and vulnerability. The final objective is to achieve a standardized risk score that allow comparison between islands and decision making on adaptation. In this island the analysis includes: - Tourism (risk of forest fires) - Aquaculture (increased fragility of the activity due to increased temperature and extreme weather)
How do tourists react to climate change? **(Factsheets)**		Tourists visiting the island were surveyed in order to analyse their rreactions to the impacts of CC and the preferences for adaptation policies that can be implemented. This information can be utilized to measure the potential decrease in tourism arrivals and the economic impact of adaptation policies.
How do tourists react to climate change? **(videos)**		
How does CC affect travel decisions of European citizens? **(Infographic)**		2538 EU citizens (frequent travellers) were interviewed. They were asked about their disposition to stay at home and the willingness to pay to visit islands being exposed to several CC risks. Results alert on how CC would affect tourism expenditure in the EU islands. The results are useful to evaluate the priorities in terms of risks management and responsiveness to meet tourists' expectations.
Climate change impacts on energy demand for cooling and desalination		The increase in energy demand (GWh/year), needed for cooling buildings and desalinate water to produce more drinking water are estimated for the island under different RCP and time horizons.

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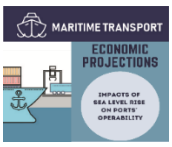
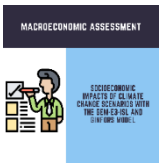
Impact of SLR on ports' operation costs		The increased depreciation (amortization) costs caused by Sea Level Rise are estimated for the island's 125 years time horizon under different RCP scenarios of climate change. No discount rate has been applied.
Socio-economic implications of CC for EU islands with cross-sectoral perspective		General Equilibrium models have been used to project socio-economic consequences of CC for the island. Changes in mean temperature, sea level and precipitation rates have been used as input to assess the effects on 14 sectors of economic activity, GDP, consumption, investments and employment
Sea level - Historical data	Sea level analyses between 1978 and 2007 indicated a statistically significant rising trend (2.5 ± 0.4 mm yr− 1; p = 0.000), while between 1996 and 2007 it was 3.3 ± 1.5 mm yr− 1 (p = 0.025), agreeing with other global sea level studies (Ng et al., 2019).	
Waves - 99th percentile of significant wave height averaged	99th percentile of significant wave height averaged for the reference period and the relative change for the RCP8.5. Global simulations produced by Hemer et al. (Hemer et al., 2013) (Collins et al., 2019).	
Hurricanes tracks	Model tracks for all storms that eventually reached category 4 or 5 intensity, for the control and the warmed 18-model ensemble conditions, as obtained using the GFDL/NWS hurricane model (Bender et al., 2010).	
Waves - Regional wave statistics using 1998 to 2011 wind record	Regional wave statistics using 1998 to 2011 wind record showed: periods ranging from 7 to 13 s (circa 83%); wave heights between 1 and 3 m (circa 60%); and increasing trends in westerly (p = 0.473), easterly (p = 0.632) and south-easterly (p = 0.932) waves (Ng et al., 2019).	
Waves – wind/wave conditions	Projected changes in wind-wave conditions 2075-2100 (compared 1980-2009): wave height, wave direction and wave period (Hemer et al., 2013)	
Temperature – Downscaled mean temperature	Mean temperature Downscaled for 2080-100 Produced by Regional Program for Climate Change (Governo dos Açores, 2018)[1]	
Reduction in overall distribution of species	Reduction in overall distribution of terrestrial species: bryophytes, vascular plants and arthropods. Compare 1961-1990 distribution with 2080-2100 potential distribution considering climate change scenarios (Ferreira et al., 2019).	
Vulnerability of cetacean species	Most vulnerable cetacean species were identified. Produced by Regional Program for Climate Change (Governo dos Açores, 2018)[1]	
Copernicus EMSN018-Hazard risk	Risk assessment products such as exposure, vulnerability and risk maps in order support the mitigation and preparedness efforts needed to minimize casualties and economic impact by setting up an effective preparedness and response mechanism concerning the following hazards: Seismic hazard, Flash Flood hazard, Tsunami and Storm Surges hazard, Landslide and Erosion hazard, Lava Flow and Coastal Erosion hazard. Produced for Copernicus: More information	

[1] Programa Regional para as Alterações Climáticas (PRAC)

1.2 Final matrix of adaptation and risk management options in Azores

Stakeholders evaluated the selected adaptation measures based on a set of five criteria: cost efficiency, environmental protection, mitigation win-wins and trade-offs, technical applicability and social acceptability. These criteria were in turn used for the characterization of the sustainability performance of each alternative adaptation pathway set by each APT context. The adaptation measures were scored against each of the five criteria, using a scale from 1 (low performance) to 4 (high performance). An unweighted average score was estimated for the evaluation of the adaptation measures and is presented per sector in the tables bellow.

1.2.1 Tourism sector

The scoring and the ranking of the adaptation options for the tourism sector is presented in Table 2. Across the 30 selected adaptation measures, the fire management plans (T21) received the highest ranking mainly due to its high ability to efficiently address current or future climate hazards in the most economical way and its high ability to meet mitigation objectives. However, this assessment is made regardless of the risk existing or not[2], something which is part of the consultation methodological framework for stakeholder consultation process (see D7.3). This result is followed by river rehabilitation and restoration (T6) and the tourist awareness campaigns (T12). On the contrary, the measures financial incentives to retreat from high-risk areas (T2) and desalination (T16) received the lowest ranking mainly due to their low current ability to meet Azores' mitigation objectives.

Table 2 - Ranking of adaptation options for the tourism sector in Azores

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
T1	Economic Policy Instruments (EPIs)	2.75	2.75	2.25	3.75	2.50	2.80
T2	Financial incentives to retreat from high-risk areas	2.25	2.50	2.00	2.75	2.00	2.30
T3	Adaptation of groundwater management	2.50	3.25	2.50	2.25	3.00	2.70
T4	Monitoring, modelling and forecasting systems	3.25	2.25	2.00	3.00	3.75	2.85
T5	Dune restoration and rehabilitation	2.50	4.00	1.75	3.00	3.50	2.95
T6	River rehabilitation and restoration	2.75	4.00	2.50	3.00	3.25	3.10
T7	Adaptive management of natural habitats	2.50	4.00	2.75	2.75	2.75	2.95
T8	Ocean pools	3.50	2.50	2.00	3.50	3.75	3.05
T9	Activity and product diversification	2.75	3.50	2.25	2.50	3.00	2.80
T10	Public awareness programmes	3.00	2.75	2.00	3.50	3.75	3.00
T11	Local circular economy	2.50	3.75	3.50	2.25	3.00	3.00
T12	Tourist awareness campaigns	2.75	3.25	2.25	3.50	3.75	3.10
T13	Local sustainable fishing	2.75	3.50	2.25	3.25	3.25	3.00
T14	Water restrictions, consumption cuts and grey-water recycling	3.25	3.25	2.50	2.50	2.00	2.70
T15	Beach nourishment	2.25	2.00	1.50	3.00	3.50	2.45
T16	Desalination	2.00	1.50	1.00	3.25	3.00	2.15

[2] The Azores islands do not have a wildfire risk in their territory. When this was the case the stakeholders had to choose the most appropriate alternative.

T17	Coastal protection structures	2.75	1.50	1.75	3.25	3.50	2.55
T18	Drought and water conservation plans	3.50	3.00	2.00	3.50	3.50	3.10
T19	Mainstreaming Disaster Risk Management (DRM)	3.25	2.25	2.00	3.25	3.50	2.85
T20	Using water to cope with heat waves	3.00	2.00	2.25	3.25	3.25	2.75
T21	Fire management plans	3.25	3.00	3.50	3.00	3.00	3.15
T22	Health care delivery systems	2.75	2.00	1.50	3.50	3.75	2.70
T23	Post-Disaster recovery funds	2.75	2.25	1.50	3.25	3.00	2.55
T24	Pre-disaster early recovery planning	3.00	2.75	1.75	3.25	3.25	2.80
T25	Adapt tourism promotion to Climate Change risks	2.75	3.00	2.75	3.50	3.00	3.00
T26	Improve Natura 2000 habitats - terrestrial, coastal and marine habitats	2.50	4.00	2.50	2.75	2.50	2.85
T27	Adapt agroforestry systems to drought conditions	3.00	3.50	3.00	2.75	2.25	2.90
T28	Create water storage reservoirs to ensure water availability without overloading natural resources in times of scarcity	3.00	2.25	2.00	3.00	3.50	2.75
T29	Create a mosquito detection information system	2.75	1.75	1.50	3.25	3.75	2.60
T30	Define protection regime for "Maximum Infiltration Zones", within the scope of the current and climate change risks	3.00	3.00	3.00	2.50	2.75	2.85

1.2.2 Maritime transport

The scoring and the ranking of the adaptation options for the maritime sector is presented in Table 3. The hybrid and full electric ship propulsion (MT5) had the highest average score due to its high ability to meet Azores' mitigation objectives and its ability to protect the environment as well as its high social acceptability, followed by the marine life friendly coastal protection structures (MT3) and the awareness campaigns for behavioural change (MT9). The least scored measures include MT26 (Evaluate and plan retreat of buildings /infrastructures from risk areas, through cost-benefit analysis) and MT2 (Financial incentives to retreat from high-risk areas) mainly due to their low social acceptance in Azores and their low ability to meet Azores' mitigation objectives.

Table 3 - Ranking of adaptation options for the maritime transport sector in Azores

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
MT1	Insurance mechanisms for ports	2.75	2.00	1.75	3.75	3.50	2.75
MT2	Financial incentives to retreat from high-risk areas	2.00	2.75	2.00	3.00	1.50	2.25
MT3	Marine life friendly coastal protection structures	2.50	4.00	3.25	2.25	3.50	3.10
MT4	Combined protection and wave energy infrastructures	3.00	2.50	4.00	2.25	3.25	3.00
MT5	Hybrid and full electric ship propulsion	2.50	3.75	4.00	2.25	3.75	3.25
MT6	Coastal protection structures	2.75	2.25	2.00	3.50	3.50	2.80
MT7	Integrate ports in urban tissue	2.75	2.25	1.75	2.25	2.75	2.35
MT8	Ocean pools	3.50	2.50	1.75	3.25	3.75	2.95
MT9	Awareness campaigns for behavioural change	3.00	2.75	2.00	3.75	3.75	3.05
MT10	Social dialogue for training in the port sector	2.50	2.25	2.25	3.25	3.00	2.65
MT11	Diversification of trade using climate resilient commodities	2.50	2.25	3.00	2.00	3.00	2.55
MT12	Climate resilient economy and jobs	2.50	2.50	3.25	2.00	3.00	2.65
MT13	Refrigeration, cooling and ventilation systems	3.00	1.75	2.25	2.75	3.75	2.70
MT14	Restrict development and settlement in low-lying areas	3.25	3.25	1.75	3.25	2.25	2.75
MT15	Sturdiness improvement of vessels	2.75	2.25	2.50	2.00	3.50	2.60
MT16	Increase operational speed and flexibility in ports	3.25	1.75	2.75	2.25	2.75	2.55
MT17	Climate proof ports and port activities	2.75	1.50	2.00	2.50	3.75	2.50
MT18	Consider expansion/retreat of ports in urban planning	3.25	2.00	2.00	2.50	2.50	2.45
MT19	Reinforcement of inspection, repair and maintenance of infrastructures	2.50	2.00	2.25	3.25	3.50	2.70
MT20	Early Warning Systems (EWS) and climate change monitoring	3.25	2.50	2.25	3.25	3.75	3.00
MT21	Intelligent Transport Systems (ITS)	3.25	2.50	2.50	2.50	3.25	2.80
MT22	Prepare for service delays or cancellations	3.25	1.75	2.25	3.00	3.25	2.70
MT23	Backup routes and infrastructures during extreme weather	3.25	1.75	2.00	3.00	3.50	2.70
MT24	Post-Disaster recovery funds	2.50	2.25	2.25	3.25	3.00	2.65
MT25	Strengthen coastal protection, giving priority to the maintenance and adaptation of urban areas and port infrastructures	2.50	2.00	1.75	3.00	3.25	2.50
MT26	Evaluate and plan retreat of buildings /infrastructures from risk areas, through cost-benefit analysis	2.50	2.75	1.75	2.50	1.75	2.25
MT27	Strengthen coastal monitoring	3.00	3.00	1.75	3.00	3.75	2.90

1.2.3 Energy

The scoring and the ranking of the adaptation options for the energy sector is presented in Table 4. Across the selected adaptation measures, the urban green corridors (E6) received the highest score mainly due to its high ability to protect the environment, followed by the energy efficiency in urban water management (E3) and the educational garden plots (E7). On the contrary, the energy-independent facilities (generators) (E22) and the energy recovery microgrids (E23) received the lowest ranking mainly due to their low ability to protect the environment.

Table 4 - Ranking of adaptation options for the energy sector in Azores

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
E1	Financial support for buildings with low energy needs	2.75	2.25	4.00	3.00	3.25	3.05
E2	Financial support for smart control of energy in houses and buildings	3.00	2.25	4.00	2.50	3.50	3.05
E3	Energy efficiency in urban water management	3.50	2.75	3.25	2.75	3.50	3.15
E4	Underground tubes and piping in urban planning	2.75	2.00	3.25	2.25	3.00	2.65
E5	Biomass power from household waste	2.50	2.25	3.75	2.50	2.50	2.70
E6	Urban green corridors	3.00	4.00	3.50	3.00	3.50	3.40
E7	Educational garden plots	3.00	3.50	3.00	2.75	3.50	3.15
E8	Heated pools with waste heat from power plants	3.00	2.00	3.50	3.00	3.25	2.95
E9	Green jobs and businesses	2.75	2.50	2.75	2.75	3.25	2.80
E10	Public information service on climate action	3.25	2.00	2.50	4.00	3.75	3.10
E11	Small scale production and consumption (prosumers)	2.50	2.75	3.00	2.50	3.50	2.85
E12	Risk reporting platform	3.25	2.00	1.75	3.25	3.75	2.80
E13	Energy storage systems	2.50	1.75	3.50	2.75	3.50	2.80
E14	Collection and storage of forest fuel loads	2.25	2.25	3.25	2.75	3.25	2.75
E15	Seawater Air Conditioning (SWAC)	2.75	1.75	3.25	2.25	3.25	2.65
E16	Demand Side Management (DSM) of Energy	2.75	1.75	3.50	2.25	2.75	2.60
E17	Review building codes of the energy infrastructure	3.50	1.75	2.50	3.25	3.50	2.90
E18	Upgrade evaporative cooling systems	2.50	2.25	3.00	3.00	2.75	2.70
E19	Early Warning Systems (EWS)	3.50	1.75	2.50	3.50	4.00	3.05
E20	Grid reliability	2.75	1.75	2.75	3.25	3.50	2.80
E21	Study and develop energy grid connections	2.25	2.00	3.25	2.50	3.25	2.65
E22	Energy-independent facilities (generators)	2.50	1.75	2.75	2.75	3.00	2.55
E23	Energy recovery microgrids	2.25	1.75	2.75	2.25	3.00	2.40
E24	Local recovery energy outage capacity	2.50	1.75	2.50	2.75	4.00	2.70
E25	Develop risk maps for the electrical infrastructure	3.25	2.00	2.50	3.25	3.50	2.90
E26	Assess and map impacts caused in quality and power reserves through changes in climate patterns	3.25	1.75	2.75	3.00	3.00	2.75

1.2.4 Aquaculture

The scoring and the ranking of the adaptation measures for aquaculture is presented in Table 5. Awareness campaigns for behavioural change (A9) was the most preferred measure by stakeholders mainly due to its high technical applicability and social acceptability in Azores, followed by the measure A12 (Promote cooperation to local consumption) and the measure A6 (Best Management Practices). On the contrary, the submersible cages (A16) and the disease prevention methods (A19) were the least preferred adaptation measures by stakeholders mainly due to their lower ability to protect the environment and meet Azores' mitigation objectives.

Table 5 - Ranking of adaptation options for aquaculture in Azores

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
A1	Financial schemes, insurance and loans	2.50	2.00	1.75	3.50	3.50	2.65
A2	Tax benefits and subsidies	2.50	2.75	2.50	3.00	3.25	2.80
A3	Feed production	2.75	3.00	2.25	2.25	3.00	2.65
A4	Species selection	2.75	3.00	2.50	2.50	2.75	2.70
A5	Selective breeding	2.75	2.75	2.00	2.75	2.75	2.60
A6	Best Management Practices	3.25	3.25	2.50	2.75	3.25	3.00
A7	Create educational visits	3.00	2.50	2.00	3.25	3.75	2.90
A8	Promote aquaculture cuisine	3.25	2.25	1.75	3.00	3.25	2.70
A9	Awareness campaigns for behavioural change	3.25	2.75	2.00	3.75	3.50	3.05
A10	Efficient feed management	3.00	3.00	2.25	2.75	3.00	2.80
A11	Addressing consumer and environmental concerns at the local level	2.50	3.00	2.50	2.75	3.00	2.75
A12	Promote cooperation to local consumption	3.25	3.25	3.75	2.25	2.75	3.05
A13	Integrated multi-trophic aquaculture (IMTA)	2.75	3.00	2.50	2.25	3.25	2.75
A14	Short-cycle aquaculture	3.25	1.50	1.75	2.75	2.75	2.40
A15	Recirculation Aquaculture Systems (RAS)	2.75	2.50	1.50	2.50	2.75	2.40
A16	Submersible cages	2.75	2.00	2.00	2.00	2.75	2.30
A17	Climate proof aquaculture activities	3.00	2.25	1.75	2.75	3.75	2.70
A18	Risk-based zoning and site selection	3.50	2.25	2.00	2.50	3.25	2.70
A19	Disease prevention methods	3.00	1.75	1.75	2.50	3.00	2.40
A20	Environmental monitoring and Early Warning Systems (EWS)	3.25	2.50	1.75	3.00	3.50	2.80
A21	Mainstreaming Disaster Risk Management (DRM)	3.50	2.50	2.00	2.75	3.50	2.85
A22	Contingency for emergency management, early harvest and/or relocation	3.00	2.25	2.00	2.50	3.25	2.60
A23	Recovery Post-Disaster plans	3.25	3.00	1.50	3.00	3.75	2.90
A24	Recovery Post-Disaster funds	2.50	2.00	1.75	3.00	3.00	2.45

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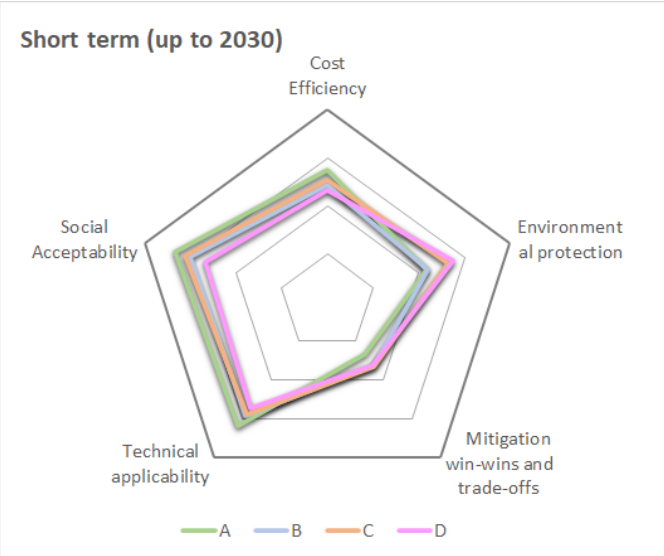
1.3 Final package of ranked adaptation pathways in Azores

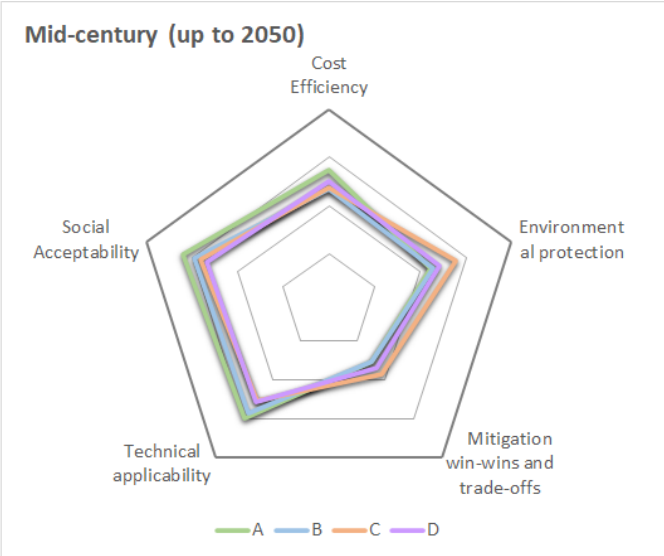
The sectors which had three or more participants were included in this analysis, namely Tourism, Maritime Transport and Energy.

1.3.1 Tourism

Figure 1. presents the final package of the ranked adaptation pathways for the tourism sector in Azores. The ranking of the four pathways set by the ATP scenarios for the tourism sector are considerably similar during the three timeframes considered. In general, ATP scenarios show a high level of social acceptability and technical applicability, a medium cost-efficiency and environmental protection and a low performance in mitigation win-wins and trade-offs. For all ATP scenarios, the performance decreases in the long term, in particular from the middle to the long term.

More specifically, the minimum intervention scenario (APT A) tends to have socially acceptable options and adaptation solutions with technical applicability. However, in this scenario the pathway has a low performance on mitigation and environmental protection which is in agreement with the level of investment and commitment characterized by in ATP A, which ultimately expresses the results on mitigation and environmental protection. The efficiency enhancement scenario (ATP C) defines a pathway with a high level of environmental protection and mitigation. On the contrary, the pathway defined in APT D (System Restructuring scenario), has the lower performance when considering all timeframes.





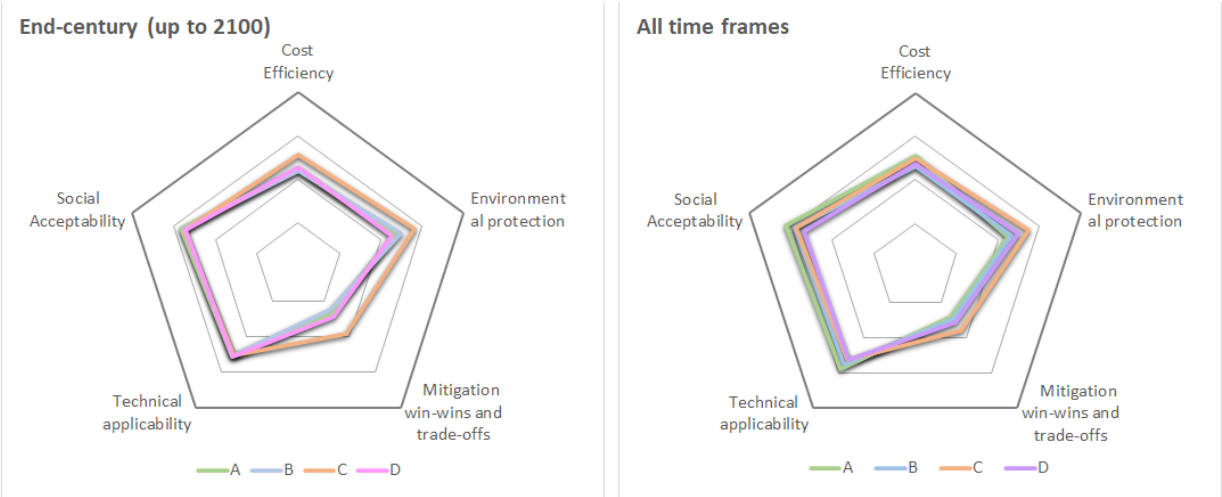


Figure 1. Ranked adaptation pathways for tourism sector in Azores considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

1.3.2 Maritime transport

Figure 2 presents the final package of the ranked adaptation pathways for the Azorean maritime transport sector. The ranking of the four pathways set by the ATP scenarios for the maritime transport sector in Azores up to 2100 presents a similar structure. The pathways are comprised of measures that have a relatively high social acceptability and medium technical acceptability and cost efficiency. However, these sector pathways will have difficulty in meeting the archipelago's mitigation objectives and will not perform well in terms of environmental protection. This is particularly relevant in APT A and D pathways, curiously those responding to scenarios with the lowest (highest) investment and policy change levels, respectively. In fact, the pathway with the highest investment and policy change levels and that preconizes a system restructuring (APT D) underperforms the other pathways in all evaluation criteria, with the noteworthy exception of technical applicability.

Figure 2. Ranked adaptation pathways for maritime transport sector in Azores considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

1.3.3 Energy

Figure 3 presents the final package of the ranked adaptation pathways for the energy sector in Azores. The four pathways set by the ATP scenarios for the energy sector have a similar ranking across the different time frames. The analysis shows no differences in the scoring of criteria as a reflection of the different ATP narratives. More specifically, the cost efficiency of the pathways is the same in all four APTs. The environmental protection has an overall low value but with differences in APT A (lower value), APT B and D (intermediate value) and APT C (highest value), while the mitigation performance is higher and shows a wider range of values; APT A (minimal intervention) has the lowest value and APT B (capacity expansion) the highest, leaving C (efficiency enhancement) and D (system restructuring) in the middle. The option for a high use of low emissions technology is coherent with a capacity expansion scenario where high investment is the

main solution for climate change challenges. Technical applicability is also similar across all APTs and has an intermediate value.

Social acceptability has the highest values with APT D having more and APT B less. It can be expected that APT D would have the most challenging options in terms of social acceptability because it is the scenario with the highest commitment to policy change. It is assumed that a higher commitment could better cope with options that have a lower social acceptance. Similarly, the APT B (low commitment) could have had a higher social acceptability result versus APT D. The respective results for APTs A and C are intermediate, which is more or less expected. In APT A, this is due to the low investment, which limits the available options, while for APT C, this is because it is an intermediate policy scenario, i.e., medium commitment with medium investment.

Figure 3. Ranked adaptation pathways for energy sector in Azores considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

SOCLIMPACT

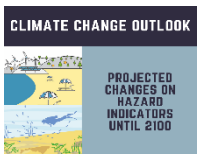
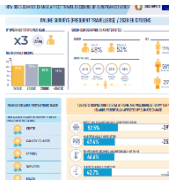
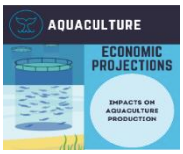
This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No776661

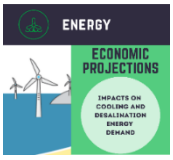
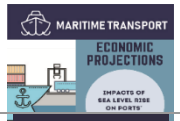
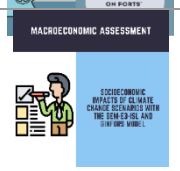
2. Balearic islands

2.1 Introduction

Table 6 presents a summary of the future projections of CC impacts for Balearic islands.

Table 6: Summary of future projections of CC impacts for Balearic islands.

Topic	Presentation	Summary
Climate description		- Climate characteristics - Current climate and related risks - Significant climate events
Climate change outlook:		Hazard indicators are projected for two CC scenarios RCP 2.6 (low emissions scenario) and 8.5 (High emissions scenario) and two periods (2046-2065) and (2081-2100). Hazards were selected according to their relevance for 4 blue economy sectors: Tourism, Aquaculture, Energy and Maritime Transport.
Risk analysis, impact chains and islands 'comparison		Risks analysis was undertaken following the concept of impact chains, by considering the relationships of hazards evolution, exposure and vulnerability. The final objective is to achieve a standardised risk score that allow comparison between islands and decision making on adaptation.. In this island the analysis includes: - Tourism (risk of forest fires, marine habitat degradation y thermal stress) - Energy (risk of increased energy demand for cooling and desalination) - Maritime transport (risk of isolation)
How do tourists react to climate change? **(Factsheets)**		Tourists visiting the island were surveyed in order to analyse their rreactions to the impacts of CC and the preferences for adaptation policies that can be implemented. This information can be utilized to measure the potential decrease in tourism arrivals and the economic impact of adaptation policies.
How do tourists react to climate change? **(videos)**		
How does CC affect travel decisions of European citizens? (Infographic)		2538 EU citizens (frequent travellers) were interviewed. They were asked about their disposition to stay at home and the willingness to pay to visit islands being exposed to several CC risks. Results alert on how CC would affect tourism expenditure in the EU islands. The results are useful to evaluate the priorities in terms of risks management and responsiveness to meet tourists' expectations.
Impact of increased sea surface temperature in aquaculture production (tons)		The effects of increased sea surface temperatures on aquaculture production were calculated using a lethal temperature threshold by specie, and considering the production share of each island, under two RCP scenarios and time horizons, which correspond to four water temperature increases.

Climate change impacts on energy demand for cooling and desalination		The increase in energy demand (GWh/year), needed for cooling buildings and desalinate water to produce more drinking water are estimated for the island under different RCP and time horizons.
Impact of SLR on ports' operation costs		The increased depreciation (amortization) costs caused by Sea Level Rise are estimated for the island's 125 years time horizon under different RCP scenarios of climate change. No discount rate has been applied.
Socio-economic implications of CC for EU islands with cross-sectoral perspective		General Equilibrium models have been used to project socio-economic consequences of CC for the island. Changes in mean temperature, sea level and precipitation rates have been used as input to assess the effects on 14 sectors of economic activity, GDP, consumption, investments and employment

2.2 Final matrix of adaptation and risk management options in Balearic islands

2.1.1 Tourism sector

The scoring and the ranking of the adaptation measures for the tourism sector is presented in Table 7. Across the 30 selected measures, the fire management plans (T21) received the highest ranking due to its high economic and environmental performance followed by the distributed electric grids powered by renewables (T27) and the residual organic matter composting to reduce methane emissions (T30). On the contrary, the beach nourishment (T15) was the least preferred measure due to its low ability to protect the environment and meet mitigation objectives followed by the desalination (T16).

Table 7: Ranking of adaptation options for the tourism sector in Balearic islands

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
T1	Economic Policy Instruments (EPIs)	4.00	3.00	3.00	4.00	3.00	3.40
T2	Financial incentives to retreat from high-risk areas	2.00	1.00	2.00	3.00	2.00	2.00
T3	Adaptation of groundwater management	4.00	3.00	3.00	4.00	4.00	3.60
T4	Monitoring, modelling and forecasting systems	4.00	3.00	3.00	4.00	3.00	3.40
T5	Dune restoration and rehabilitation	4.00	4.00	2.00	3.00	3.00	3.20
T6	River rehabilitation and restoration	3.00	4.00	3.00	3.00	2.00	3.00
T7	Adaptive management of natural habitats	4.00	4.00	4.00	3.00	3.00	3.60
T8	Ocean pools	3.00	1.00	2.00	4.00	3.00	2.60
T9	Activity and product diversification	4.00	3.00	2.00	3.00	3.00	3.00
T10	Public awareness programmes	3.00	3.00	3.00	3.00	3.00	3.00
T11	Local circular economy	3.00	4.00	4.00	3.00	3.00	3.40
T12	Tourist awareness campaigns	3.00	3.00	3.00	3.00	3.00	3.00
T13	Local sustainable fishing	2.00	4.00	3.00	3.00	4.00	3.20

T14	Water restrictions, consumption cuts and grey-water recycling	2.00	3.00	3.00	2.00	1.00	2.20
T15	Beach nourishment	2.00	1.00	1.00	3.00	2.00	1.80
T16	Desalination	2.00	2.00	1.00	3.00	2.00	2.00
T17	Coastal protection structures	3.00	1.00	1.00	4.00	3.00	2.40
T18	Drought and water conservation plans	4.00	3.00	3.00	2.00	2.00	2.80
T19	Mainstreaming Disaster Risk Management (DRM)	4.00	3.00	3.00	2.00	3.00	3.00
T20	Using water to cope with heat waves	3.00	2.00	2.00	3.00	3.00	2.60
T21	Fire management plans	4.00	4.00	4.00	3.00	4.00	3.80
T22	Health care delivery systems	4.00	2.00	2.00	3.00	4.00	3.00
T23	Post-Disaster recovery funds	2.00	1.00	1.00	3.00	4.00	2.20
T24	Pre-disaster early recovery planning	4.00	4.00	2.00	3.00	4.00	3.40
T25	Thermal isolation of buildings	4.00	3.00	4.00	3.00	3.00	3.40
T26	Zero sewage discharge to the sea	3.00	4.00	3.00	4.00	3.00	3.40
T27	Distributed electric grids powered by renewables	4.00	4.00	4.00	3.00	4.00	3.80
T28	Forest fire prevention	3.00	4.00	4.00	3.00	3.00	3.40
T29	Effective plan of water demand management and investment in reducing losses along the water distribution system	3.00	4.00	3.00	3.00	3.00	3.20
T30	Residual organic matter composting to reduce methane emissions, restorate degraded landscapes and enhance soil fertility	4.00	4.00	4.00	4.00	3.00	3.80

2.1.2 Maritime transport

The scoring and the ranking of the adaptation options for the maritime transport sector is presented in Table 8. The Early Warning Systems and climate change monitoring measure (MT20) received the highest score by the stakeholders due to its high ability to protect the environment as well as its high cost-efficiency, technical applicability and social acceptability followed by the measures MT25 (development of an adaptation plan to adequate infrastructure to climate threats) and MT3 (Marine life friendly coastal protection structures). The least preferred measures include the diversification of trade using climate resilient commodities (MT11) and the restriction of development and settlement in low-lying areas (MT14) mainly due to their low ability to protect the environment and their low ability to efficiently address current or future climate hazards in the most economical way.

Table 8: Ranking of adaptation options for maritime transport in Balearic islands

ID	Name	Cost Efficiency	Environmental protection	Mitigation (GHG emissions) win-wins and trade-offs	Technical applicability	Social Acceptability	Average
MT1	Insurance mechanisms for ports	3.00	3.00	2.00	3.00	4.00	3.00
MT2	Financial incentives to retreat from high-risk areas	3.00	2.00	2.00	3.00	2.00	2.40
MT3	Marine life friendly coastal protection structures	3.00	4.00	3.00	3.00	4.00	3.40
MT4	Combined protection and wave energy infrastructures	2.00	2.00	3.00	2.00	3.00	2.40

MT5	Hybrid and full electric ship propulsion	3.00	3.00	3.00	2.00	4.00	3.00
MT6	Coastal protection structures	2.00	2.00	2.00	3.00	3.00	2.40
MT7	Integrate ports in urban tissue	3.00	2.00	2.00	4.00	4.00	3.00
MT8	Ocean pools	2.00	2.00	2.00	3.00	3.00	2.40
MT9	Awareness campaigns for behavioural change	2.00	2.00	2.00	4.00	3.00	2.60
MT10	Social dialogue for training in the port sector	3.00	2.00	2.00	4.00	3.00	2.80
MT11	Diversification of trade using climate resilient commodities	2.00	2.00	3.00	2.00	3.00	2.40
MT12	Climate resilient economy and jobs	2.00	3.00	4.00	3.00	3.00	3.00
MT13	Refrigeration, cooling and ventilation systems	2.00	2.00	2.00	4.00	3.00	2.60
MT14	Restrict development and settlement in low-lying areas	2.00	2.00	2.00	3.00	3.00	2.40
MT15	Sturdiness improvement of vessels	3.00	3.00	3.00	3.00	3.00	3.00
MT16	Increase operational speed and flexibility in ports	3.00	2.00	3.00	2.00	3.00	2.60
MT17	Climate proof ports and port activities	3.00	3.00	2.00	4.00	3.00	3.00
MT18	Consider expansion/retreat of ports in urban planning	4.00	3.00	2.00	4.00	4.00	3.40
MT19	Reinforcement of inspection, repair and maintenance of infrastructures	4.00	3.00	2.00	4.00	4.00	3.40
MT20	Early Warning Systems (EWS) and climate change monitoring	4.00	4.00	2.00	4.00	4.00	3.60
MT21	Inteligent Transport Systems (ITS)	3.00	3.00	3.00	3.00	3.00	3.00
MT22	Prepare for service delays or cancellations	3.00	2.00	2.00	3.00	3.00	2.60
MT23	Backup routes and infrastructures during extreme weather	3.00	3.00	2.00	4.00	3.00	3.00
MT24	Post-Disaster recovery funds	3.00	3.00	2.00	4.00	3.00	3.00
MT25	Development of an adaptation plan to adequate infrastructure to climate threats	3.00	3.00	4.00	4.00	4.00	3.60
MT26	Improve and ensure operational safety in ship repair	3.00	2.00	3.00	4.00	3.00	3.00
MT27	Develop the potential of maritime navigation between the Balearic Islands and the Mediterranean region	4.00	2.00	3.00	4.00	3.00	3.20
MT28	Strengthen and prepare the provisioning system to heat waves	3.00	2.00	3.00	4.00	4.00	3.20
MT29	Improve monitoring systems	4.00	3.00	2.00	4.00	4.00	3.40
MT30	Encourage the adaptation of recreational marinas to the main climate change hazards	3.00	2.00	2.00	3.00	3.00	2.60

2.1.3 Energy

The scoring and the ranking of the adaptation measures for the energy sector is presented in Table 9. The most highly ranked adaptation measure is the financial support for buildings with low energy needs (E1) due to its high environmental and economic performance followed by the financial support for smart control of energy in houses and buildings (E2) and biomass power from household waste (E5). The local recovery energy outage capacity (E24) and the energy-independent facilities (generators) (E22) received the lowest ranking due to their low economic and environmental performance.

Table 9: Ranking of adaptation options for energy sector in Balearic islands

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
E1	Financial support for buildings with low energy needs	4.00	4.00	4.00	4.00	3.00	3.80
E2	Financial support for smart control of energy in houses and buildings	4.00	3.00	3.00	4.00	4.00	3.60
E3	Energy efficiency in urban water management	3.00	2.00	4.00	3.00	3.00	3.00
E4	Underground tubes and piping in urban planning	3.00	2.00	3.00	4.00	4.00	3.20
E5	Biomass power from household waste	3.00	4.00	3.00	4.00	3.00	3.40
E6	Urban green corridors	2.00	4.00	4.00	3.00	4.00	3.40
E7	Educational garden plots	3.00	4.00	3.00	4.00	3.00	3.40
E8	Heated pools with waste heat from power plants	3.00	3.00	3.00	4.00	3.00	3.20
E9	Green jobs and businesses	4.00	4.00	3.00	2.00	4.00	3.40
E10	Public information service on climate action	4.00	2.00	3.00	4.00	3.00	3.20
E11	Small scale production and consumption (prosumers)	4.00	3.00	3.00	4.00	3.00	3.40
E12	Risk reporting platform	3.00	2.00	3.00	4.00	3.00	3.00
E13	Energy storage systems	2.00	2.00	3.00	4.00	3.00	2.80
E14	Collection and storage of forest fuel loads	3.00	3.00	3.00	2.00	3.00	2.80
E15	SeaWater Air Conditioning (SWAC).	2.00	2.00	3.00	3.00	3.00	2.60
E16	Demand Side Mangement (DSM) of Energy	4.00	3.00	3.00	3.00	3.00	3.20
E17	Review building codes of the energy infrastructure	4.00	2.00	3.00	3.00	3.00	3.00
E18	Upgrade evaporative cooling systems	4.00	2.00	3.00	3.00	3.00	3.00
E19	Early Warning Systems (EWS)	3.00	4.00	3.00	3.00	3.00	3.20
E20	Grid reliability	3.00	3.00	3.00	4.00	3.00	3.20
E21	Study and develop energy grid connections	4.00	3.00	3.00	4.00	3.00	3.40
E22	Energy-independent facilities (generators)	1.00	1.00	3.00	3.00	3.00	2.20
E23	Energy recovery microgrids	4.00	2.00	4.00	4.00	3.00	3.40
E24	Local recovery energy outage capacity	2.00	2.00	2.00	3.00	2.00	2.20
E25	Promotion of domestic and small-scale photovoltaic solar energy	3.00	3.00	3.00	3.00	4.00	3.20
E26	Financial support for the energy rehabilitation of buildings	3.00	2.00	3.00	3.00	4.00	3.00
E27	Mass development of the public transport network powered by renewable energies	2.00	2.00	3.00	3.00	3.00	2.60
E28	Encourage electric individual transport and car-sharing	2.00	2.00	3.00	3.00	4.00	2.80
E29	Training development in installation and thermal insulation of buildings	4.00	3.00	3.00	3.00	3.00	3.20
E30	Promoting storage systems for renewable energy installations	3.00	3.00	3.00	3.00	4.00	3.20

2.3 Final package of ranked adaptation pathways in Balearic Islands

2.3.1 Tourism

Figure 4 presents the final package of the ranked adaptation pathways for the tourism sector in Balearic islands. The selected adaptation pathways, APT C (Efficiency Enhancement) and APT D (System Restructuring), have almost an identical evaluation across all timeframes. Moreover, the analysis shows no significant differences in the scoring of criteria as a reflection of these two different ATP narratives. The cost efficiency of the pathways received the highest score, while the rest received a medium score. In conclusion, there are not many differences between the APTs for the tourism sector in Balearic islands.

Figure 4. Ranked adaptation pathways for tourism sector in Balearic islands considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

2.3.2 Maritime transport

Figure 5 presents the final package of the ranked adaptation pathways for the maritime transport sector in Balearic islands. All four adaptation pathways show a similar structure across the three

timeframes considered. Social acceptability and technical applicability exhibit the highest ranking. On the contrary, the rest three criteria, i.e., cost efficiency, environmental protection and mitigation win-wins and trade-offs, show a medium score. The end-century time frame seems to clearly variate versus the rest time frames, where environmental protection scores the lowest for APT C.

Figure 5. Ranked adaptation pathways for maritime transport sector in Balearic islands considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

2.3.3 Energy

For the energy sector in the Balearic Islands only the APT D (System Restructuring) is selected (Figure 6). All four adaptation pathways reveal a similar structure during the three timeframes considered, that is, a high score in four criteria (cost efficiency, social acceptability, technical applicability and mitigation wins-wins and trade-offs) except for the short-term scenario, where the environmental protection criterion also is highly ranked. Under this scenario, the five criteria score similarly, whereas in the other two scenarios the environmental protection scores the lowest by a considerable difference.

Figure 6. Ranked adaptation pathways for energy sector in Balearic islands considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

SOCLIMPACT

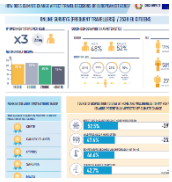
This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No776661

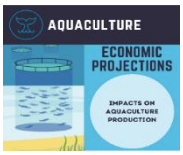
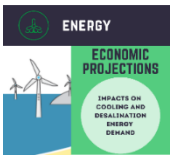
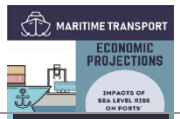
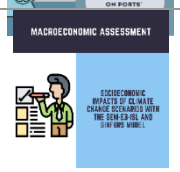
3. Canary Islands

3.1 Introduction

Table 10 presents a summary of the future projections of CC impacts for Canary Islands.

Table 10: Summary of future projections of CC impacts for Canary islands

Topic	Presentation	Summary
Climate description		- Climate characteristics - Current climate and related risks - Significant climate events
Climate change outlook:		Hazard indicators are projected for two CC scenarios RCP 2.6 (low emissions scenario) and 8.5 (High emissions scenario) and two periods (2046-2065) and (2081-2100). Hazards were selected according to their relevance for 4 blue economy sectors: Tourism, Aquaculture, Energy and Maritime Transport.
Risk analysis, impact chains and islands 'comparison		Risks analysis was undertaken following the concept of impact chains, by considering the relationships of hazards evolution, exposure and vulnerability. The final objective is to achieve a standardised risk score that allow comparison between islands and decision making on adaptation.. In this island the analysis includes: - Tourism (risk of forest fires, marine habitat degradation y thermal stress) - Energy (risk of increased energy demand for cooling and desalination) - Maritime transport (risk of isolation)
How do tourists react to climate change? **(Factsheets)**		Tourists visiting the island were surveyed in order to analyse their rreactions to the impacts of CC and the preferences for adaptation policies that can be implemented. This information can be utilized to measure the potential decrease in tourism arrivals and the economic impact of adaptation policies.
How do tourists react to climate change? **(videos)**		
How does CC affect travel decisions of European citizens? (Infographic)		2538 EU citizens (frequent travellers) were interviewed. They were asked about their disposition to stay at home and the willingness to pay to visit islands being exposed to several CC risks. Results alert on how CC would affect tourism expenditure in the EU islands. The results are useful to evaluate the priorities in terms of risks management and responsiveness to meet tourists' expectations.
Big Data Analysis		A specific tool (Google Cloud Vision) is used to scan the content of images posted by tourists on Instagram, while they are on holiday in the islands. Instagram geotagged posts from these islands are scanned according to tourists' publications (identified by a travel-related hashtag, such as #visit #holiday #travel, etc) during summer 2019 (from June to Septem - ber). The map of the island shows the word cloud stemming from the analysis of the pictures' content.

Impact of increased sea surface temperature in aquaculture production (tons)		The effects of increased sea surface temperatures on aquaculture production were calculated using a lethal temperature threshold by specie, and considering the production share of each island, under two RCP scenarios and time horizons, which correspond to four water temperature increases.
Climate change impacts on energy demand for cooling and desalination		The increase in energy demand (GWh/year), needed for cooling buildings and desalinate water to produce more drinking water are estimated for the island under different RCP and time horizons.
Impact of SLR on ports' operation costs		The increased depreciation (amortization) costs caused by Sea Level Rise are estimated for the island's 125 years time horizon under different RCP scenarios of climate change. No discount rate has been applied.
Socio-economic implications of CC for EU islands with cross-sectoral perspective		General Equilibrium models have been used to project socio-economic consequences of CC for the island. Changes in mean temperature, sea level and precipitation rates have been used as input to assess the effects on 14 sectors of economic activity, GDP, consumption, investments and employment

3.2 Final matrix of adaptation and risk management options in Canary Islands

3.2.1 Tourism

The scoring and the ranking of the adaptation measures for the tourism sector is presented in Table 11. The distributed electric grids powered by renewables (T27) received the highest score due to its high economic and environmental performance followed by the residual organic matter composting to reduce methane emissions (T30) and the fire management plans (T21). On the contrary the financial incentives to retreat from high-risk areas (T2) received the lowest ranking due to it low ability to protect the environment and its low social acceptability followed by the beach nourishment (T15) measure.

Table 11: Ranking of adaptation options for the tourism sector in Canary islands

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
T1	Economic Policy Instruments (EPIs)	4.00	3.00	3.00	3.00	1.00	2.80
T2	Financial incentives to retreat from high-risk areas	2.00	1.00	2.00	2.00	1.00	1.60
T3	Adaptation of groundwater management	3.00	3.00	3.00	2.00	2.00	2.60
T4	Monitoring, modelling and forecasting systems	4.00	3.00	3.00	4.00	2.00	3.20
T5	Dune restoration and rehabilitation	4.00	4.00	2.00	3.00	3.00	3.20
T6	River rehabilitation and restoration	3.00	4.00	3.00	2.00	1.00	2.60

T7	Adaptive management of natural habitats	4.00	4.00	4.00	1.00	2.00	3.00
T8	Ocean pools	3.00	2.00	2.00	4.00	4.00	3.00
T9	Activity and product diversification	3.00	2.00	2.00	3.00	3.00	2.60
T10	Public awareness programmes	3.00	3.00	3.00	2.00	2.00	2.60
T11	Local circular economy	3.00	4.00	4.00	2.00	3.00	3.20
T12	Tourist awareness campaigns	3.00	3.00	3.00	3.00	3.00	3.00
T13	Local sustainable fishing	1.00	3.00	1.00	2.00	3.00	2.00
T14	Water restrictions, consumption cuts and grey-water recycling	3.00	3.00	3.00	2.00	1.00	2.40
T15	Beach nourishment	2.00	1.00	1.00	3.00	2.00	1.80
T16	Desalination	2.00	2.00	1.00	4.00	4.00	2.60
T17	Coastal protection structures	3.00	1.00	1.00	4.00	3.00	2.40
T18	Drought and water conservation plans	4.00	3.00	3.00	2.00	2.00	2.80
T19	Mainstreaming Disaster Risk Management (DRM)	4.00	2.00	2.00	1.00	2.00	2.20
T20	Using water to cope with heat waves	3.00	2.00	2.00	3.00	3.00	2.60
T21	Fire management plans	3.00	4.00	4.00	3.00	4.00	3.60
T22	Health care delivery systems	3.00	1.00	1.00	3.00	4.00	2.40
T23	Post-Disaster recovery funds	2.00	1.00	1.00	3.00	4.00	2.20
T24	Pre-disaster early recovery planning	4.00	4.00	2.00	2.00	4.00	3.20
T25	Passive, low carbon adaptation of tourist buildings to longer extreme heat periods	3.00	3.00	4.00	3.00	3.00	3.20
T26	Zero sewage discharge to the sea	3.00	4.00	3.00	4.00	3.00	3.40
T27	Distributed electric grids powered by renewables	4.00	4.00	4.00	3.00	4.00	3.80
T28	Forest fire prevention	3.00	4.00	4.00	3.00	3.00	3.40
T29	Bottom-up managed marine protected micro-areas	3.00	4.00	3.00	3.00	3.00	3.20
T30	Residual organic matter composting to reduce methane emissions, restorate degraded landscapes and enhance soil fertility	4.00	4.00	4.00	4.00	3.00	3.80

3.2.2 Maritime transport

The scoring and the ranking of the adaptation measures for the maritime transport is presented in Table 12. The adaptation of infrastructure to climate threats (MT25) received the highest ranking due to its high ability to meet mitigation objectives as well as its high technical applicability and social acceptability followed by the reinforcement of inspection, repair and maintenance of infrastructures (MT19) and Early Warning Systems and climate change monitoring (MT20). On the contrary, the restriction of development and settlement in low-lying areas (MT14) and the increase of operational speed and flexibility in ports (MT16) received the lowest ranking due to their low environmental and economic performance.

Table 12: Ranking of adaptation options for the maritime transport in Canary Islands

ID	Name	Cost Efficiency	Environmental protection	Mitigation (GHG emissions) win-wins and trade-offs	Technical applicability	Social Acceptability	Average
MT1	Insurance mechanisms for ports	3.00	3.00	2.00	3.00	4.00	3.00
MT2	Financial incentives to retreat from high-risk areas	3.00	3.00	2.00	3.00	2.00	2.60
MT3	Marine life friendly coastal protection structures	2.00	4.00	3.00	2.00	4.00	3.00
MT4	Combined protection and wave energy infrastructures	3.00	2.00	4.00	2.00	3.00	2.80
MT5	Hybrid and full electric ship propulsion	3.00	3.00	3.00	2.00	4.00	3.00
MT6	Coastal protection structures	3.00	2.00	2.00	4.00	3.00	2.80
MT7	Integrate ports in urban tissue	2.00	2.00	2.00	3.00	3.00	2.40
MT8	Ocean pools	3.00	2.00	2.00	3.00	4.00	2.80
MT9	Awareness campaigns for behavioural change	2.00	2.00	2.00	4.00	3.00	2.60
MT10	Social dialogue for training in the port sector	3.00	2.00	2.00	4.00	3.00	2.80
MT11	Diversification of trade using climate resilient commodities	3.00	3.00	3.00	2.00	4.00	3.00
MT12	Climate resilient economy and jobs	2.00	3.00	4.00	2.00	2.00	2.60
MT13	Refrigeration, cooling and ventilation systems	3.00	2.00	2.00	4.00	4.00	3.00
MT14	Restrict development and settlement in low-lying areas	2.00	2.00	2.00	3.00	2.00	2.20
MT15	Sturdiness improvement of vessels	3.00	2.00	3.00	2.00	3.00	2.60
MT16	Increase operational speed and flexibility in ports	2.00	2.00	3.00	2.00	2.00	2.20
MT17	Climate proof ports and port activities	3.00	2.00	2.00	3.00	3.00	2.60
MT18	Consider expansion/retreat of ports in urban planning	3.00	3.00	2.00	3.00	3.00	2.80
MT19	Reinforcement of inspection, repair and maintenance of infrastructures	4.00	3.00	2.00	3.00	4.00	3.20
MT20	Early Warning Systems (EWS) and climate change monitoring	4.00	3.00	2.00	4.00	3.00	3.20
MT21	Intelligent Transport Systems (ITS)	3.00	2.00	3.00	3.00	2.00	2.60
MT22	Prepare for service delays or cancellations	3.00	2.00	2.00	2.00	3.00	2.40
MT23	Backup routes and infrastructures during extreme weather	3.00	2.00	2.00	4.00	3.00	2.80
MT24	Post-Disaster recovery funds	3.00	3.00	2.00	3.00	4.00	3.00
MT25	Adapt infrastructure to climate threats	3.00	3.00	4.00	4.00	4.00	3.60
MT26	Improve and ensure operational safety in ship repair	3.00	2.00	2.00	4.00	3.00	2.80
MT27	Develop the potential of maritime navigation between the Canary Islands and North-West Africa	4.00	2.00	3.00	4.00	3.00	3.20
MT28	Strengthen and improve the bunkering facilities	3.00	2.00	3.00	4.00	2.00	2.80

MT29	To plan the expansion of the port linked to the locational rent of the island in areas not exposed to risks	3.00	3.00	2.00	3.00	4.00	3.00
MT30	Encourage the adaptation of recreational marinas to the main climate change hazards	3.00	2.00	2.00	3.00	3.00	2.60

3.2.3 Energy

The scoring and the ranking of the adaptation options for the energy sector is presented in Table 13. The financial support for buildings with low energy needs (E1) received the highest ranking due to its high economic and environmental performance followed by the shared self-consumption facilities (E28) and the financial support for smart control of energy in houses and buildings (E2). On the contrary, the underwater tubes and piping in urban planning (E4) measure received the lowest ranking due to its low ability to protect the environment as well as its low cost-efficiency and social acceptability followed by the Seawater Air Conditioning measure (E15).

Table 13: Ranking of adaptation options for the energy sector in Canary Islands

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
E1	Financial support for buildings with low energy needs	4.00	4.00	4.00	4.00	3.00	3.80
E2	Financial support for smart control of energy in houses and buildings	3.00	3.00	3.00	4.00	4.00	3.40
E3	Energy efficiency in urban water management	3.00	2.00	4.00	3.00	3.00	3.00
E4	Underground tubes and piping in urban planning	1.00	1.00	2.00	2.00	1.00	1.40
E5	Biomass power from household waste	3.00	4.00	3.00	4.00	3.00	3.40
E6	Urban green corridors	2.00	4.00	4.00	3.00	4.00	3.40
E7	Educational garden plots	2.00	4.00	3.00	3.00	3.00	3.00
E8	Heated pools with waste heat from power plants	1.00	1.00	3.00	2.00	2.00	1.80
E9	Green jobs and businesses	4.00	4.00	3.00	2.00	4.00	3.40
E10	Public information service on climate action	4.00	2.00	3.00	4.00	3.00	3.20
E11	Small scale production and consumption (prosumers)	4.00	3.00	3.00	4.00	3.00	3.40
E12	Risk reporting platform	3.00	2.00	3.00	4.00	3.00	3.00
E13	Energy storage systems	2.00	2.00	4.00	4.00	3.00	3.00
E14	Collection and storage of forest fuel loads	3.00	3.00	3.00	2.00	3.00	2.80
E15	SeaWater Air Conditioning (SWAC).	1.00	2.00	3.00	1.00	1.00	1.60
E16	Demand Side Mangement (DSM) of Energy	4.00	3.00	3.00	3.00	3.00	3.20
E17	Review building codes of the energy infrastructure	4.00	2.00	3.00	3.00	3.00	3.00
E18	Upgrade evaporative cooling systems	4.00	2.00	3.00	3.00	3.00	3.00
E19	Early Warning Systems (EWS)	3.00	4.00	3.00	3.00	3.00	3.20
E20	Grid reliability	3.00	3.00	3.00	4.00	3.00	3.20
E21	Study and develop energy grid connections	3.00	3.00	3.00	4.00	3.00	3.20

E22	Energy-independent facilities (generators)	1.00	1.00	3.00	3.00	4.00	2.40
E23	Energy recovery microgrids	4.00	2.00	4.00	4.00	3.00	3.40
E24	Local recovery energy outage capacity	2.00	2.00	2.00	3.00	2.00	2.20
E25	Hydrogen as energy vector	2.00	4.00	3.00	4.00	2.00	3.00
E26	Renewable technology hybridization	3.00	3.00	3.00	3.00	3.00	3.00
E27	Low and high enthalpy geothermal energy	3.00	3.00	4.00	3.00	3.00	3.20
E28	Shared self-consumption facilities	4.00	4.00	3.00	4.00	4.00	3.80
E29	Promote cogeneration	3.00	2.00	2.00	3.00	3.00	2.60
E30	Micro smart grids	3.00	2.00	3.00	4.00	4.00	3.20

3.2.4 Aquaculture

The scoring and the ranking of the adaptation options for the aquaculture is presented in Table 14. The most highly preferred adaptation measures, according to stakeholders' preferences, are feed production (A3), Best Management Practices (A6) and the creation of educational visits (A7) due to their high economic and environmental performance. On the contrary, the least preferred measure by the stakeholders is the Recirculation Aquaculture Systems (A15) due to its low ability to protect the environment as well as its low ability to efficiently address current or future climate hazards in the most economical way followed by the Mainstreaming Disaster Risk Management (A21).

Table 14: Ranking of adaptation options for aquaculture in Canary islands

ID	Name	Cost Efficiency	Environmental protection	Mitigation (GHG emissions) win-wins and trade-offs	Technical applicability	Social Acceptability	Average
A1	Financial schemes, insurance and loans	4.00	3.00	3.00	4.00	3.00	3.40
A2	Tax benefits and subsidies	4.00	3.00	3.00	4.00	3.00	3.40
A3	Feed production	4.00	4.00	3.00	4.00	3.00	3.60
A4	Species selection	4.00	3.00	3.00	4.00	3.00	3.40
A5	Selective breeding	3.00	3.00	3.00	4.00	2.00	3.00
A6	Best Management Practices	4.00	3.00	3.00	4.00	4.00	3.60
A7	Create educational visits	4.00	3.00	3.00	4.00	4.00	3.60
A8	Promote aquaculture cuisine	4.00	3.00	3.00	4.00	4.00	3.60
A9	Awareness campaigns for behavioural change	3.00	3.00	3.00	4.00	4.00	3.40
A10	Efficient feed management	4.00	4.00	3.00	4.00	3.00	3.60
A12	Promote cooperation to local consumption	3.00	3.00	3.00	3.00	4.00	3.20
A13	Integrated multi-trophic aquaculture (IMTA)	2.00	4.00	3.00	2.00	4.00	3.00
A14	Short-cycle aquaculture	4.00	4.00	3.00	4.00	3.00	3.60
A15	Recirculation Aquaculture Systems (RAS)	1.00	1.00	2.00	4.00	3.00	2.20

A16	Submersible cages	4.00	3.00	3.00	3.00	4.00	3.40
A17	Climate proof aquaculture activities	4.00	3.00	3.00	3.00	4.00	3.40
A18	Risk-based zoning and site selection	3.00	3.00	3.00	1.00	3.00	2.60
A19	Disease prevention methods	4.00	4.00	3.00	4.00	3.00	3.60
A20	Environmental monitoring and Early Warning Systems (EWS)	4.00	3.00	3.00	4.00	3.00	3.40
A21	Mainstreaming Disaster Risk Management (DRM)	3.00	3.00	3.00	1.00	3.00	2.60
A22	Contingency for emergency management, early harvest and/or relocation	3.00	3.00	3.00	2.00	3.00	2.80
A23	Recovery Post-Disaster plans	3.00	3.00	3.00	3.00	3.00	3.00
A24	Recovery Post-Disaster funds	3.00	3.00	3.00	3.00	3.00	3.00
A25	Increase POSEI and REF incentives	4.00	2.00	2.00	4.00	3.00	3.00
A26	Knowledge transfer and financial support of emerging industries	4.00	3.00	3.00	3.00	3.00	3.20
A27	Review and streamline administrative processes	4.00	2.00	3.00	2.00	4.00	3.00
A28	Promote tourist and non-tourist consumption	3.00	4.00	4.00	3.00	4.00	3.60
A29	Favour the development of off-shore aquaculture	4.00	3.00	2.00	3.00	4.00	3.20
A30	Reformulate the POEM (Zoning)	3.00	2.00	3.00	4.00	3.00	3.00

3.3 Final package of ranked adaptation pathways in Canary Islands

3.3.1 Tourism

Figure 7 presents the final package of the ranked adaptation pathways for the tourism sector in Canary islands. In general, all four APT scenarios for the tourism sector show a high level of cost efficiency, environmental protection and technical applicability, and medium mitigation win-wins and trade-offs. Social acceptability has the lowest performance and the greatest variation across the different APTs. For the short-term, the minimum intervention scenario (APT A) and the economic capacity expansion scenario (APT B) tend to have socially acceptable options and adaptation solutions with technical applicability, but lower mitigation win-wins and trade-offs. On the contrary, the efficiency enhancement scenario (APT C) and the system restructuring scenario (APT D) tend to have higher cost-efficiency, higher environmental protection and higher mitigation win-wins and trade-offs. For the mid-century (up to 2050), the structure of the spider diagram is similar, but the difference between ATPs decreases. Finally, at the end of the century, the APT A has higher scores on social acceptability, environmental protection and mitigation win-wins and trade-offs than the rest of APTs. APT B scores lowest in all criteria used to evaluate the adaptation pathways performance, while APT D scores highest in technical applicability.

Figure 7. Ranked adaptation pathways for tourism sector in Canary islands considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

3.3.2 Maritime transport

Figure 8 presents the final package of the ranked adaptation pathways for the maritime transport sector in Canary islands. In particular, the only pathway selected is APT C (Efficiency Enhancement). All four adaptation pathways for the Canarian maritime transport sector reveal a similar structure during the three timeframes considered. Social acceptability exhibits the highest score, while technical applicability and cost efficiency show medium score, and environmental protection and mitigation win-wins and trade-offs the lowest. Moreover, except for the cost efficiency criterion, all the criteria score equal or lower over time.

Figure 8. Ranked adaptation pathways for maritime transport in Canary islands considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

3.3.3 Energy

Figure 9 presents the final package of the ranked adaptation pathways for the energy sector in Canary Islands. All four APTs exhibit a similar structure across the different timeframes. In particular, there is no difference in the scoring of criteria across the different ATPs. The cost efficiency of the pathways is the same in all APTs. The environmental protection has an overall low value with the lowest value appearing in APT D. Mitigation performance is higher for APT D in the short-term, but similar for the rest; this difference increases by the end of the century, having a higher score for APTs D and C. Technical Applicability and Social Acceptability are similar across all APTs and have an intermediate value, with the former presenting small differences by mid-century in APT B.

Figure 9. Ranked adaptation pathways for energy sector in Canary Islands considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

3.3.4 Aquaculture

Figure 10 presents the final package of the ranked adaptation pathways for aquaculture in Canary Islands. The APT B (Economic Capacity Expansion) and APT C (Efficiency Enhancement) pathways exhibit a similar ranking across all timeframes, while there are no significant differences in the scoring of the criteria between the two different ATPs. The cost efficiency of the pathways, which is the criterion receiving the highest score, is the same in all APTs followed by social acceptability and technical applicability. Environmental protection and mitigation win-wins and trade-offs obtained medium scores, which decreases slightly over time for the case of mitigation performance. In general, there are not many differences across APTs.

Figure 10. Ranked adaptation pathways for aquaculture in Canary Islands considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

SOCLIMPACT

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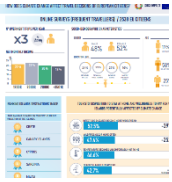
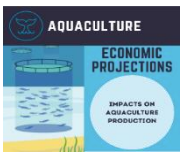
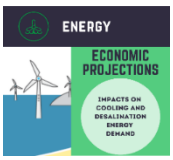
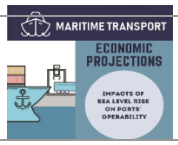
4. Corsica

4.1 Introduction

Table 15 presents a summary of the future projections of CC impacts for Corsica.

Table 15: Summary of future projections of CC impacts for Corsica.

Topic	Presentation	Summary
Climate description		- Climate characteristics - Current climate and related risks - Significant climate events
Climate change outlook:		Hazard indicators are projected for two CC scenarios RCP 2.6 (low emissions scenario) and 8.5 (High emissions scenario) and two periods (2046-2065) and (2081-2100). Hazards were selected according to their relevance for 4 blue economy sectors: Tourism, Aquaculture, Energy and Maritime Transport.
Risk analysis, impact chains and islands 'comparison		Risks analysis was undertaken following the concept of impact chains, by considering the relationships of hazards evolution, exposure and vulnerability. The final objective is to achieve a standardised risk score that allow comparison between islands and decision making on adaptation.. In this island the analysis includes: - Tourism (risk of forest fires) - Energy (risk of increased energy demand for cooling and desalination) - Maritime transport (risk of isolation)
How does CC affect travel decisions of European citizens? (Infographic)		2538 EU citizens (frequent travellers) were interviewed. They were asked about their disposition to stay at home and the willingness to pay to visit islands being exposed to several CC risks. Results alert on how CC would affect tourism expenditure in the EU islands. The results are useful to evaluate the priorities in terms of risks management and responsiveness to meet tourists' expectations.
Impacts of increased temperatures on hotels' prices and revenues		Current weather conditions posted on several weather forecast were analysed, as well as daily prices posted on Booking.com by hotels in the island. The link between daily temperature and daily price was estimated, and then projected for the increase in the number of days with excessive temperature projected for the future in two scenarios (RCP2.6 and RCP8.5) and in two time horizons (near future, about 2050; distant future, about 2100).
Impact of increased sea surface temperature in aquaculture production (tons)		The effects of increased sea surface temperatures on aquaculture production were calculated using a lethal temperature threshold by specie, and considering the production share of each island, under two RCP scenarios and time horizons, which correspond to four water temperature increases.
Climate change impacts on energy demand for cooling a		The increase in energy demand (GWh/year), needed for cooling buildings is estimated for the island under different RCP and time horizons.

Impact of SLR on ports' operation costs		The increased depreciation (amortization) costs caused by Sea Level Rise are estimated for the island's 125 years time horizon under different RCP scenarios of climate change. No discount rate has been applied.

4.2 Final matrix of adaptation and risk management options in Corsica

4.2.1 Tourism sector

The scoring and the ranking of the adaptation options for the tourism sector is presented in Table 16. The most highly ranked measures in the sector are the river rehabilitation and restoration (T6) and the adaptive management of natural habitats due to their high ability to protect the environment and meet mitigation objectives as well as their high social acceptability and cost efficiency. The least scored measure is the financial incentives to retreat from high-risk areas (T2) due to their low ability to meet mitigation objectives and their low technical applicability and social acceptability followed by the post-disaster recovery funds (T23) measure.

Table 16: Ranking of adaptation options for the tourism sector in Corsica

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
T1	Economic Policy Instruments (EPIs)	3.00	3.00	4.00	2.00	3.00	3.00
T2	Financial incentives to retreat from high-risk areas	2.00	2.00	1.00	1.00	1.00	1.40
T3	Adaptation of groundwater management	3.00	3.00	3.00	3.00	3.00	3.00
T4	Monitoring, modelling and forecasting systems	4.00	3.00	3.00	3.00	4.00	3.40
T5	Dune restoration and rehabilitation	2.00	3.00	3.00	3.00	4.00	3.00
T6	River rehabilitation and restoration	4.00	4.00	4.00	3.00	4.00	3.80
T7	Adaptive management of natural habitats	4.00	4.00	4.00	3.00	4.00	3.80
T8	Ocean pools	3.00	3.00	2.00	4.00	4.00	3.20
T9	Activity and product diversification	3.00	2.00	2.00	2.00	3.00	2.40
T10	Public awareness programmes	2.00	3.00	3.00	4.00	4.00	3.20
T11	Local circular economy	4.00	4.00	4.00	2.00	1.00	3.00
T12	Tourist awareness campaigns	2.00	3.00	3.00	3.00	3.00	2.80
T13	Local sustainable fishing	2.00	3.00	3.00	3.00	2.00	2.60
T14	Water restrictions, consumption cuts and grey-water recycling	4.00	4.00	4.00	3.00	1.00	3.20
T15	Beach nourishment	2.00	1.00	2.00	4.00	4.00	2.60
T16	Desalination	2.00	4.00	1.00	4.00	4.00	3.00
T17	Coastal protection structures	3.00	3.00	3.00	4.00	4.00	3.40
T18	Drought and water conservation plans	3.00	3.00	4.00	3.00	3.00	3.20
T19	Mainstreaming Disaster Risk Management (DRM)	3.00	3.00	3.00	3.00	4.00	3.20
T20	Using water to cope with heat waves	4.00	3.00	2.00	3.00	4.00	3.20
T21	Fire management plans	4.00	4.00	3.00	3.00	4.00	3.60

T22	Health care delivery systems	2.00	2.00	3.00	3.00	4.00	2.80
T23	Post-Disaster recovery funds	2.00	1.00	2.00	3.00	4.00	2.40
T24	Pre-disaster early recovery planning	4.00	3.00	3.00	3.00	4.00	3.40

4.2.2 Aquaculture

The scoring and the ranking of the adaptation options for the aquaculture is presented in Table 17. The best management practices (A6) and the creation of educational visits had the highest average scores due to their high environmental and economic performance. The least scored measure is the tax benefits and subsidies (A2) due to its very low ability to meet mitigation objectives and its low social acceptability and technical applicability followed by the measure A23 (recovery post-disaster plans).

Table 17: Ranking of adaptation options for aquaculture in Corsica

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
A1	Financial schemes, insurance and loans	3.00	3.00	4.00	2.00	3.00	3.00
A2	Tax benefits and subsidies	2.00	2.00	1.00	1.00	1.00	1.40
A3	Feed production	3.00	3.00	3.00	3.00	3.00	3.00
A4	Species selection	4.00	3.00	3.00	3.00	4.00	3.40
A5	Selective breeding	2.00	3.00	3.00	3.00	4.00	3.00
A6	Best Management Practices	4.00	4.00	4.00	3.00	4.00	3.80
A7	Create educational visits	4.00	4.00	4.00	3.00	4.00	3.80
A8	Promote aquaculture cuisine	3.00	3.00	2.00	4.00	4.00	3.20
A9	Awareness campaigns for behavioural change	3.00	2.00	2.00	2.00	3.00	2.40
A10	Efficient feed management	2.00	3.00	3.00	4.00	4.00	3.20
A11	Addressing consumer and environmental concerns at the local level	4.00	4.00	4.00	2.00	1.00	3.00
A12	Promote cooperation to local consumption	2.00	3.00	3.00	3.00	3.00	2.80
A13	Integrated multi-trophic aquaculture (IMTA)	2.00	3.00	3.00	3.00	2.00	2.60
A14	Short-cycle aquaculture	4.00	4.00	4.00	3.00	1.00	3.20
A15	Recirculation Aquaculture Systems (RAS)	2.00	1.00	2.00	4.00	4.00	2.60
A16	Submersible cages	2.00	4.00	1.00	4.00	4.00	3.00
A17	Climate proof aquaculture activities	3.00	3.00	3.00	4.00	4.00	3.40
A18	Risk-based zoning and site selection	3.00	3.00	4.00	3.00	3.00	3.20
A19	Disease prevention methods	3.00	3.00	3.00	3.00	4.00	3.20
A20	Environmental monitoring and Early Warning Systems (EWS)	4.00	3.00	2.00	3.00	4.00	3.20
A21	Mainstreaming Disaster Risk Management (DRM)	4.00	4.00	3.00	3.00	4.00	3.60
A22	Contingency for emergency management, early harvest and/or relocation	2.00	2.00	3.00	3.00	4.00	2.80
A23	Recovery Post-Disaster plans	2.00	1.00	2.00	3.00	4.00	2.40

A24	Recovery Post-Disaster funds	4.00	3.00	3.00	3.00	4.00	3.40

4.3 Final package of ranked adaptation pathways in Corsica

4.3.1 Tourism

Figure 11 presents the final package of the ranked adaptation pathways for the tourism sector in Corsica. The ranking of the four APTs is considerably similar across the three timelines considered. In general, social acceptability and technical applicability received a high score, the cost efficicency and environmental protection received a medium score, while the mitigation win-wins and trade-offs had a lower performance. The APTA (minimal intervention) scenarios tends to have a higher acceptability (since little action is taken) compared to the rest scenarios, while the APTD (system restructuring) contributes more to environmental protection, which is expected, since this is a very voluntarist scenario. The APT C (system efficiency) has a better score for mitigation.

Figure 11. Ranked adaptation pathways for tourism sector in Corsica considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C-

Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

4.3.2 Aquaculture

Figure 12 presents the final package of the ranked adaptation pathways for the aquaculture in Corsica. The APTA (minimal intervention) exhibits a higher social acceptability (since little action is taken) and cost efficiency, at short and medium term, while the APTD (system restructuring) underperforms under all criteria. The APT B (Economic Capacity Expansion) seems very efficient on the medium term, while the APT C (Efficiency enhancement) on the long term.

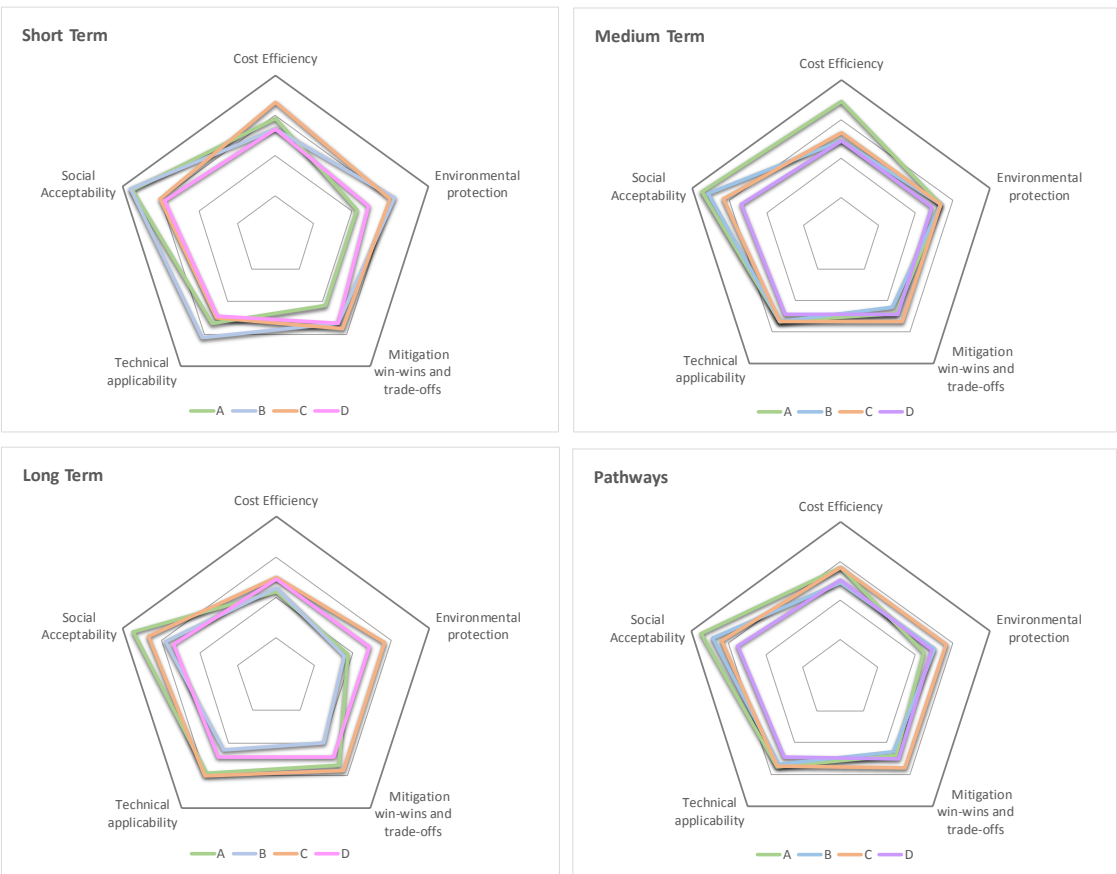


Figure 12. Ranked adaptation pathways for aquaculture in Corsica considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

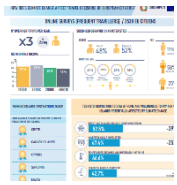
This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No776661

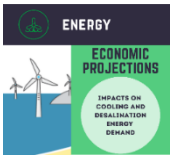
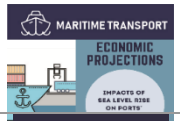
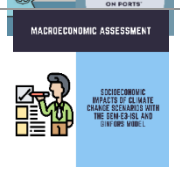
5. Crete

5.1 Introduction

Table 18 presents a summary of the future projections of CC impacts for Crete.

Table 18: Summary of future projections of CC impacts for Crete.

Topic	Presentation	Summary
Climate description		- Climate characteristics - Current climate and related risks - Significant climate events
Climate change outlook:		Hazard indicators are projected for two CC scenarios RCP 2.6 (low emissions scenario) and 8.5 (High emissions scenario) and two periods (2046-2065) and (2081-2100). Hazards were selected according to their relevance for 4 blue economy sectors: Tourism, Energy and Maritime Transport.
Risk analysis, impact chains and islands 'comparison		Risks analysis was undertaken following the concept of impact chains, by considering the relationships of hazards evolution, exposure and vulnerability. The final objective is to achieve a standardised risk score that allow comparison between islands and decision making on adaptation.. In this island the analysis includes: - Tourism (risk of forest fires) - Energy (risk of increased energy demand for cooling and desalination) - Maritime transport (risk of isolation)
How do tourists react to climate change? **(Factsheets)** How do tourists react to climate change? **(videos)**	 	Tourists visiting the island were surveyed in order to analyse their rreactions to the impacts of CC and the preferences for adaptation policies that can be implemented. This information can be utilized to measure the potential decrease in tourism arrivals and the economic impact of adaptation policies.
How does CC affect travel decisions of European citizens? (Infographic)		2538 EU citizens (frequent travellers) were interviewed. They were asked about their disposition to stay at home and the willingness to pay to visit islands being exposed to several CC risks. Results alert on how CC would affect tourism expenditure in the EU islands. The results are useful to evaluate the priorities in terms of risks management and responsiveness to meet tourists' expectations.
Big Data Analysis		A specific tool (Google Cloud Vision) is used to scan the content of images posted by tourists on Instagram, while they are on holiday in the islands. Instagram geotagged posts from these islands are scanned according to tourists' publications (identified by a travel-related hashtag, such as #visit #holiday #travel, etc) during summer 2019 (from June to Septem - ber). The map of the island shows the word cloud stemming from the analysis of the pictures' content.

Climate change impacts on energy demand for cooling and desalination		The increase in energy demand (GWh/year), needed for cooling buildings and desalinate seawater is estimated for the island under different RCP and time horizons.
Impact of SLR on ports' operation costs		The increased depreciation (amortization) costs caused by Sea Level Rise are estimated for the island's 125 years time horizon under different RCP scenarios of climate change. No discount rate has been applied.
Socio-economic implications of CC for EU islands with cross-sectoral perspective		General Equilibrium models have been used to project socio-economic consequences of CC for the island. Changes in mean temperature, sea level and precipitation rates have been used as input to assess the effects on 14 sectors of economic activity, GDP, consumption, investments and employment

5.2 Final matrix of adaptation and risk management options in Crete

5.2.1 Tourism sector

The scoring and the ranking of the adaptation options for the tourism sector is presented in Table 19. The public awareness programmes (T10) is the most highly ranked measure due to its high cost efficiency, technical applicability and social acceptability followed the measures T9 (activity and product diversification) and T11 (local circular economy). The least scored measure is the economic policy instruments (T1) due to its low ability to protect the environment and meet mitigation objectives as well as its low technical applicability and social acceptability followed by another financial measure, that is, financial incentives to retreat from high risk areas (T2).

Table 19: Ranking of adaptation options for the tourism sector in Crete

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
T1	Economic Policy Instruments (EPIs)	2.00	1.00	1.00	1.00	1.00	1.20
T2	Financial incentives to retreat from high-risk areas	1.00	3.00	3.00	1.00	1.00	1.80
T3	Adaptation of groundwater management	2.00	4.00	3.00	2.00	2.00	2.60
T4	Monitoring, modelling and forecasting systems	2.00	2.00	2.00	3.00	4.00	2.60
T5	Dune restoration and rehabilitation	2.00	4.00	3.00	2.00	2.00	2.60
T6	River rehabilitation and restoration	3.00	4.00	3.00	3.00	3.00	3.20
T7	Adaptive management of natural habitats	3.00	4.00	3.00	3.00	2.00	3.00
T8	Ocean pools	3.00	4.00	3.00	2.00	3.00	3.00
T9	Activity and product diversification	3.00	4.00	4.00	2.00	4.00	3.40
T10	Public awareness programmes	4.00	3.00	3.00	4.00	4.00	3.60
T11	Local circular economy	4.00	4.00	4.00	3.00	2.00	3.40
T12	Tourist awareness campaigns	3.00	4.00	4.00	3.00	3.00	3.40
T13	Local sustainable fishing	3.00	3.00	3.00	2.00	1.00	2.40

T14	Water restrictions, consumption cuts and grey-water recycling	3.00	4.00	2.00	2.00	2.00	2.60
T15	Beach nourishment	2.00	2.00	2.00	2.00	3.00	2.20
T16	Desalination	2.00	2.00	2.00	2.00	3.00	2.20
T17	Coastal protection structures	3.00	3.00	2.00	3.00	3.00	2.80
T18	Drought and water conservation plans	3.00	3.00	3.00	3.00	3.00	3.00
T19	Mainstreaming Disaster Risk Management (DRM)	3.00	3.00	3.00	2.00	1.00	2.40
T20	Using water to cope with heat waves	2.00	2.00	2.00	3.00	3.00	2.40
T21	Fire management plans	3.00	4.00	3.00	4.00	3.00	3.40
T22	Health care delivery systems	2.00	2.00	2.00	1.00	3.00	2.00
T23	Post-Disaster recovery funds	2.00	2.00	2.00	2.00	3.00	2.20
T24	Pre-disaster early recovery planning	4.00	4.00	4.00	2.00	2.00	3.20

5.2.2 Maritime transport

The scoring and the ranking of the adaptation options for the maritime transport sector is presented in Table 20. The Early Warning Systems and climate change monitoring (MT20) is the most highly ranked measure mainly due to its higher social acceptability compared to the rest adaptation options followed by the marine life friendly coastal protection structures (MT3) and the coastal protection structures (MT6). The least ranked measure is the integration of ports in urban tissue (MT7) due to its overall low economic, environmental and technical performance and applicability followed by the measure MT2 (financial incentives to retreat from high-risk areas).

Table 20: Ranking of adaptation options for maritime transport in Crete

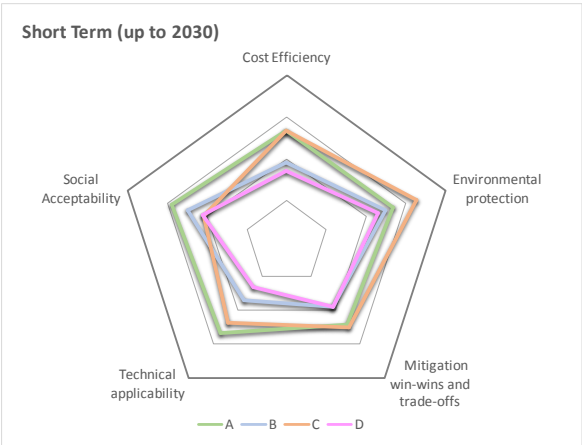
ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
MT1	Insurance mechanisms for ports	3.00	2.00	3.00	3.00	3.00	2.80
MT2	Financial incentives to retreat from high-risk areas	2.00	2.00	2.00	1.00	1.00	1.60
MT3	Marine life friendly coastal protection structures	3.00	3.00	3.00	3.00	3.00	3.00
MT4	Combined protection and wave energy infrastructures	3.00	3.00	3.00	2.00	2.00	2.60
MT5	Hybrid and full electric ship propulsion	2.00	3.00	3.00	2.00	3.00	2.60
MT6	Coastal protection structures	3.00	3.00	3.00	3.00	3.00	3.00
MT7	Integrate ports in urban tissue	1.00	1.00	1.00	1.00	3.00	1.40
MT8	Ocean pools	3.00	3.00	3.00	2.00	3.00	2.80
MT9	Awareness campaigns for behavioural change	3.00	2.00	2.00	3.00	3.00	2.60
MT10	Social dialogue for training in the port sector	3.00	2.00	2.00	2.00	2.00	2.20
MT11	Diversification of trade using climate resilient commodities	2.00	2.00	3.00	2.00	2.00	2.20
MT12	Climate resilient economy and jobs	2.00	3.00	3.00	1.00	2.00	2.20
MT13	Refrigeration, cooling and ventilation systems	3.00	3.00	3.00	2.00	3.00	2.80
MT14	Restrict development and settlement in low-lying areas	3.00	3.00	3.00	1.00	1.00	2.20
MT15	Sturdiness improvement of vessels	2.00	3.00	3.00	2.00	2.00	2.40

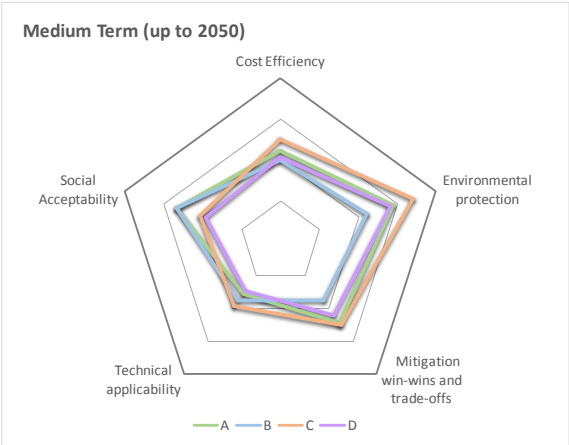
MT16	Increase operational speed and flexibility in ports	3.00	3.00	3.00	2.00	2.00	2.60
MT17	Climate proof ports and port activities	3.00	3.00	3.00	3.00	3.00	3.00
MT18	Consider expansion/retreat of ports in urban planning	2.00	2.00	2.00	2.00	2.00	2.00
MT19	Reinforcement of inspection, repair and maintenance of infrastructures	2.00	3.00	2.00	3.00	3.00	2.60
MT20	Early Warning Systems (EWS) and climate change monitoring	3.00	3.00	3.00	3.00	4.00	3.20
MT21	Intelligent Transport Systems (ITS)	3.00	3.00	3.00	3.00	3.00	3.00
MT22	Prepare for service delays or cancellations	3.00	2.00	2.00	3.00	3.00	2.60
MT23	Backup routes and infrastructures during extreme weather	2.00	2.00	2.00	2.00	3.00	2.20
MT24	Post-Disaster recovery funds	3.00	3.00	2.00	3.00	4.00	3.00

5.3 Final package of ranked adaptation pathways in Crete

5.3.1 Tourism

Figure 13 presents the final package of the ranked adaptation pathways for the tourism sector in Crete. The four APTs for the tourism sector up to 2100 have a similar ranking. In general, the APTs exhibit a relatively high social acceptability and low technical acceptability and cost efficiency but performs well in terms of future environmental protection. These sector pathways will have difficulty in meeting the archipelago's mitigation objectives although they perform well in terms of future environmental protection because they have low technical applicability up to 2100. This is particularly relevant for APTs A and D pathways. We should note that the pathway with the highest investment and policy change levels and that preconizes a system restructuring (APT D) underperforms the other pathways in all sustainability criteria.





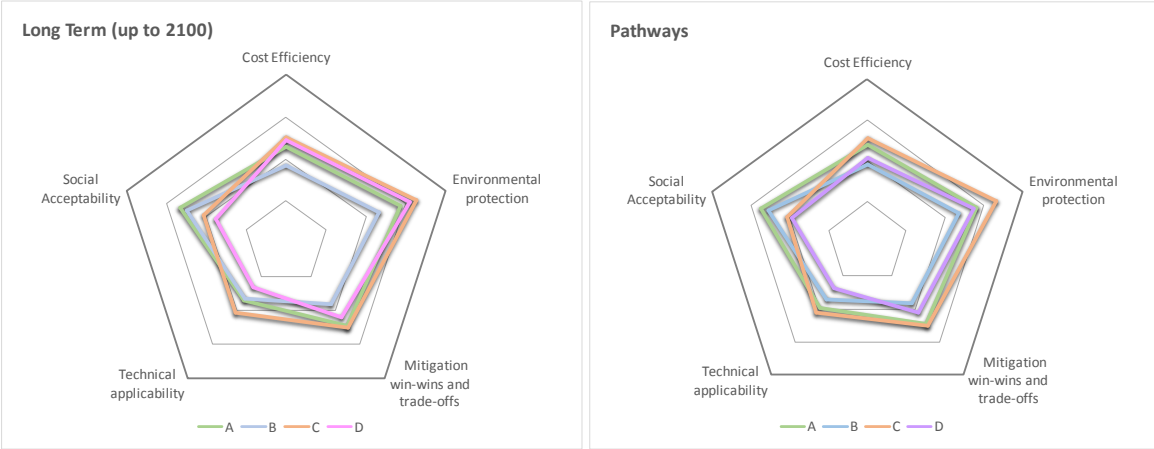
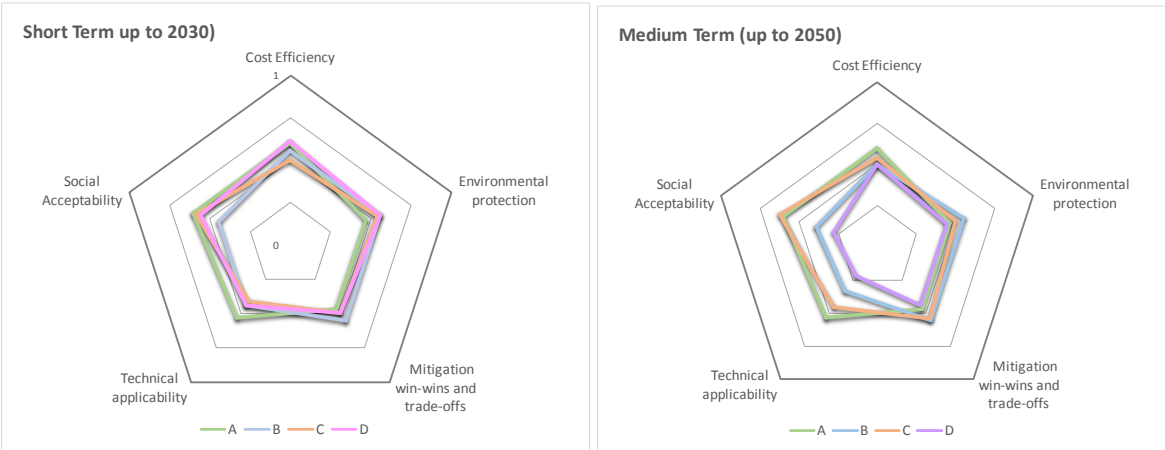


Figure 13. Ranked adaptation pathways for tourism sector in Crete considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

5.3.2 Maritime transport

Figure 14 presents the final package of the ranked adaptation pathways for the maritime transport in Crete. Similar to the tourism sector, all four APTs for the Crete's maritime transport sector exhibit a similar ranking up to 2100. In general, the APTs exhibit a medium social acceptability and cost efficiency and a low technical acceptability. The low technical applicability, which is particularly relevant in APTs B, C and D, will have negative effect in their performance in terms of environmental protection. The APT D, i.e., the pathway with the highest investment and policy change levels and that preconizes a system restructuring, underperforms the other pathways in all evaluation criteria.



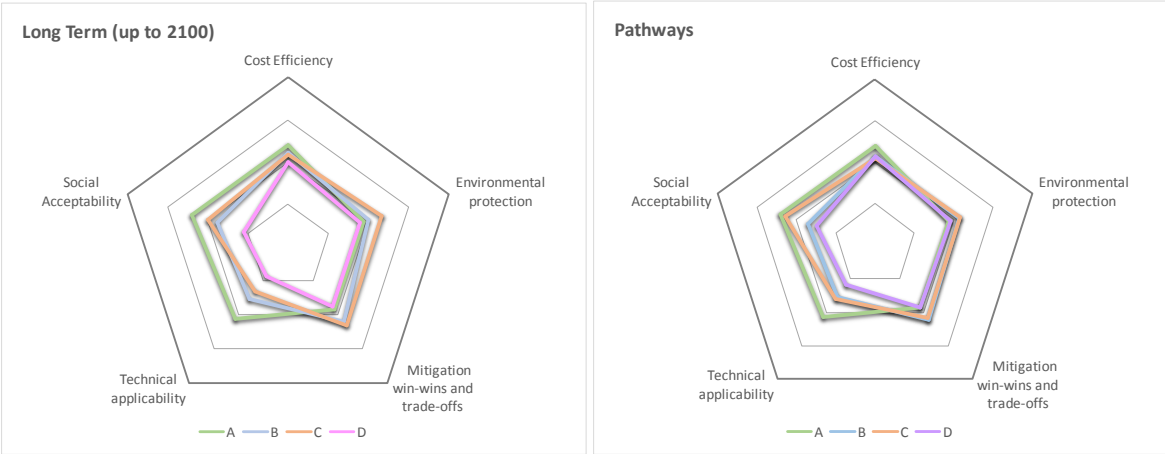


Figure 14. Ranked adaptation pathways for maritime transport sector in Crete considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

SOCLIMPACT

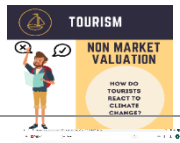
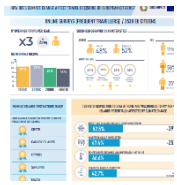
This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No776661

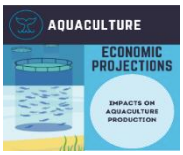
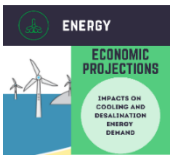
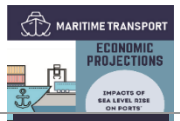
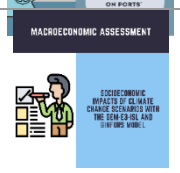
6. Cyprus

6.1 Introduction

Table 21 presents a summary of the future projections of CC impacts for Cyprus.

Table 21: Summary of future projections of CC impacts for Cyprus.

Topic	Presentation	Summary
Climate description		- Climate characteristics - Current climate and related risks - Significant climate events
Climate change outlook:		Hazard indicators are projected for two CC scenarios RCP 2.6 (low emissions scenario) and 8.5 (High emissions scenario) and two periods (2046-2065) and (2081-2100). Hazards were selected according to their relevance for 4 blue economy sectors: Tourism, Aquaculture, Energy and Maritime Transport.
Risk analysis, impact chains and islands 'comparison		Risks analysis was undertaken following the concept of impact chains, by considering the relationships of hazards evolution, exposure and vulnerability. The final objective is to achieve a standardised risk score that allow comparison between islands and decision making on adaptation. In this island the analysis includes: - Tourism (risk of forest fires, marine habitat degradation y thermal stress) - Energy (risk of increased energy demand for cooling and desalination) - Maritime transport (risk of isolation) - Aquaculture (increased fragility of the activity due to increased temperature and extreme weather)
How do tourists react to climate change? **(Factsheets)**		Tourists visiting the island were surveyed in order to analyse their rreactions to the impacts of CC and the preferences for adaptation policies that can be implemented. This information can be utilized to measure the potential decrease in tourism arrivals and the economic impact of adaptation policies.
How do tourists react to climate change? **(videos)**		
How does CC affect travel decisions of European citizens? (Infographic)		2538 EU citizens (frequent travellers) were interviewed. They were asked about their disposition to stay at home and the willingness to pay to visit islands being exposed to several CC risks. Results alert on how CC would affect tourism expenditure in the EU islands. The results are useful to evaluate the priorities in terms of risks management and responsiveness to meet tourists' expectations.
Big Data Analysis		A specific tool (Google Cloud Vision) is used to scan the content of images posted by tourists on Instagram, while they are on holiday in the islands. Instagram geotagged posts from these islands are scanned according to tourists' publications (identified by a travel-related hashtag, such as #visit #holiday #travel, etc) during summer 2019 (from June to Septem - ber). The map of the island shows the word cloud stemming from the analysis of the pictures' content.

Impact of increased sea surface temperature in aquaculture production (tons)		The effects of increased sea surface temperatures on aquaculture production were calculated using a lethal temperature threshold by specie, and considering the production share of each island, under two RCP scenarios and time horizons, which correspond to four water temperature increases.
Climate change impacts on energy demand for cooling and desalination		The increase in energy demand (GWh/year), needed for cooling buildings and desalinate seawater is estimated for the island under different RCP and time horizons.
Impact of SLR on ports' operation costs		The increased depreciation (amortization) costs caused by Sea Level Rise are estimated for the island's 125 years time horizon under different RCP scenarios of climate change. No discount rate has been applied.
Socio-economic implications of CC for EU islands with cross-sectoral perspective		General Equilibrium models have been used to project socio-economic consequences of CC for the island. Changes in mean temperature, sea level and precipitation rates have been used as input to assess the effects on 14 sectors of economic activity, GDP, consumption, investments and employment

6.2 Final matrix of adaptation and risk management options in Cyprus

6.2.1 Tourism sector

The scoring and the ranking of the adaptation options for the tourism sector is presented in Table 22. The most highly ranked measure is the local circular economy (T11) due to its high ability to protect the environment and meet mitigation objectives as well as its high technical applicability and social acceptability followed by the economic policy instruments (T1) and the pre-disaster early recovery planning (T24). The least ranked measure is the adaptation of groundwater management (T3) mainly due to its very low ability to meet mitigation objectives followed by the financial incentives to retreat from high risk areas.

Table 22: Ranking of adaptation options for the tourism sector in Cyprus

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
T1	Economic Policy Instruments (EPIs)	4.00	4.00	3.00	3.00	3.00	3.40
T2	Financial incentives to retreat from high-risk areas	2.00	3.00	2.00	2.00	2.00	2.20
T3	Adaptation of groundwater management	2.00	4.00	1.00	2.00	2.00	2.20
T4	Monitoring, modelling and forecasting systems	3.00	3.00	3.00	3.00	4.00	3.20
T5	Dune restoration and rehabilitation	3.00	3.00	2.00	3.00	4.00	3.00
T6	River rehabilitation and restoration	3.00	3.00	2.00	3.00	4.00	3.00
T7	Adaptive management of natural habitats	3.00	4.00	3.00	3.00	3.00	3.20
T8	Ocean pools	3.00	3.00	2.00	2.00	4.00	2.80
T9	Activity and product diversification	3.00	4.00	3.00	3.00	3.00	3.20
T10	Public awareness programmes	4.00	3.00	2.00	4.00	3.00	3.20

T11	Local circular economy	3.00	4.00	4.00	4.00	4.00	3.80
T12	Tourist awareness campaigns	3.00	3.00	2.00	3.00	4.00	3.00
T13	Local sustainable fishing	3.00	4.00	2.00	3.00	3.00	3.00
T14	Water restrictions, consumption cuts and grey-water recycling	3.00	4.00	2.00	3.00	2.00	2.80
T15	Beach nourishment	2.00	3.00	2.00	3.00	4.00	2.80
T16	Desalination	2.00	2.00	2.00	4.00	3.00	2.60
T17	Coastal protection structures	2.00	2.00	2.00	3.00	3.00	2.40
T18	Drought and water conservation plans	3.00	3.00	2.00	3.00	3.00	2.80
T19	Mainstreaming Disaster Risk Management (DRM)	3.00	4.00	3.00	2.00	3.00	3.00
T20	Using water to cope with heat waves	3.00	2.00	2.00	3.00	4.00	2.80
T21	Fire management plans	4.00	3.00	3.00	2.00	4.00	3.20
T22	Health care delivery systems	3.00	2.00	2.00	3.00	4.00	2.80
T23	Post-Disaster recovery funds	3.00	2.00	1.00	3.00	4.00	2.60
T24	Pre-disaster early recovery planning	4.00	4.00	2.00	3.00	4.00	3.40

6.2.2 Energy

The scoring and the ranking of the adaptation options for the energy sector is presented in Table 23. The financial support for buildings with low energy needs (E1) has the highest average score mainly due to its higher ability to protect the environment versus the rest adaptation measures followed by the public information service on climate action measure (E10). The local recovery energy outage capacity (E24) has the lowest rank due to its poor economic and environmental performance.

Table 23: Ranking of adaptation options for energy in Cyprus

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
E1	Financial support for buildings with low energy needs	3.00	4.00	3.00	3.00	3.00	3.20
E2	Financial support for smart control of energy in houses and buildings	3.00	2.00	3.00	3.00	3.00	2.80
E3	Energy efficiency in urban water management	3.00	3.00	2.00	3.00	3.00	2.80
E4	Underground tubes and piping in urban planning	3.00	3.00	3.00	2.00	2.00	2.60
E5	Biomass power from household waste	2.00	3.00	4.00	2.00	2.00	2.60
E6	Urban green corridors	2.00	4.00	3.00	2.00	3.00	2.80
E7	Educational garden plots	2.00	2.00	2.00	3.00	3.00	2.40
E8	Heated pools with waste heat from power plants	2.00	2.00	3.00	2.00	3.00	2.40
E9	Green jobs and businesses	3.00	3.00	2.00	3.00	3.00	2.80
E10	Public information service on climate action	3.00	2.00	2.00	4.00	4.00	3.00
E11	Small scale production and consumption (prosumers)	3.00	3.00	3.00	3.00	3.00	3.00
E12	Risk reporting platform	2.00	2.00	1.00	3.00	3.00	2.20
E13	Energy storage systems	2.00	3.00	4.00	3.00	3.00	3.00
E14	Collection and storage of forest fuel loads	3.00	3.00	3.00	3.00	3.00	3.00

E15	SeaWater Air Conditioning (SWAC)	1.00	3.00	3.00	2.00	2.00	2.20
E16	Demand Side Management (DSM) of Energy	3.00	3.00	3.00	2.00	3.00	2.80
E17	Review building codes of the energy infrastructure	3.00	3.00	3.00	3.00	3.00	3.00
E18	Upgrade evaporative cooling systems	2.00	3.00	3.00	2.00	3.00	2.60
E19	Early Warning Systems (EWS)	2.00	3.00	3.00	3.00	4.00	3.00
E20	Grid reliability	2.00	2.00	3.00	3.00	3.00	2.60
E21	Study and develop energy grid connections	2.00	3.00	3.00	2.00	3.00	2.60
E22	Energy-independent facilities (generators)	2.00	3.00	3.00	3.00	3.00	2.80
E23	Energy recovery microgrids	2.00	2.00	3.00	2.00	2.00	2.20
E24	Local recovery energy outage capacity	2.00	2.00	2.00	2.00	3.00	2.20

6.3 Final package of ranked adaptation pathways in Cyprus

6.3.1 Tourism

Figure 15 presents the final package of the ranked adaptation pathways for the tourism sector in Cyprus. The ranking of the four APTs is similar across all three timeframes with respect to each evaluation criterion. In general, the four APT scenarios have a low-to-average level of mitigation win-wins and trade-offs, while they exhibit an average-to-high performance with regards to cost efficiency, technical applicability, and social acceptability. All APTs seem to have a high level of environmental protection. Given that APT A is characterized by low investment and low commitment it is expected that the measures included in this scenario are not ranked highly with respect to their ability to mitigate emissions and protect the environment. On the contrary, the APT D consists of measures that are rated highly with respect to environmental protection, which is in line with the high commitment and high investment assumed in this pathway trajectory.

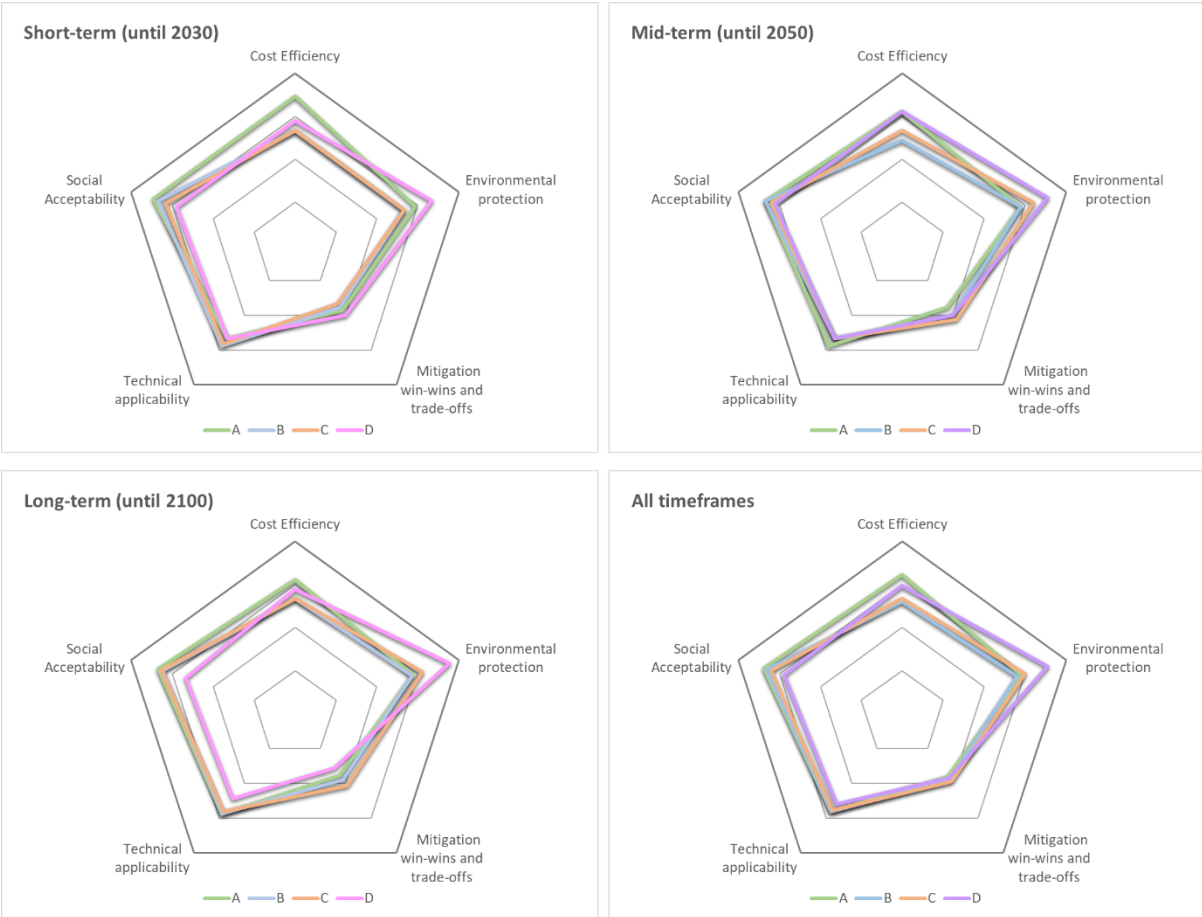


Figure 15. Ranked adaptation pathways for the tourism sector in Cyprus considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

6.3.2 Energy

Figure 16 presents the final package of the ranked adaptation pathways for the energy sector in Cyprus. The APTs A and B have a similar ranking in the short-term, while the same holds for APTs C and D. The structure of the APTs for the mid- and long-term are similar. Overall, all four APTs exhibit a low-to-average cost efficiency but an average mitigation and social applicability performance in all three timeframes. On the contrary, scenarios with low levels of investment contain measures that have low technical applicability.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No776661

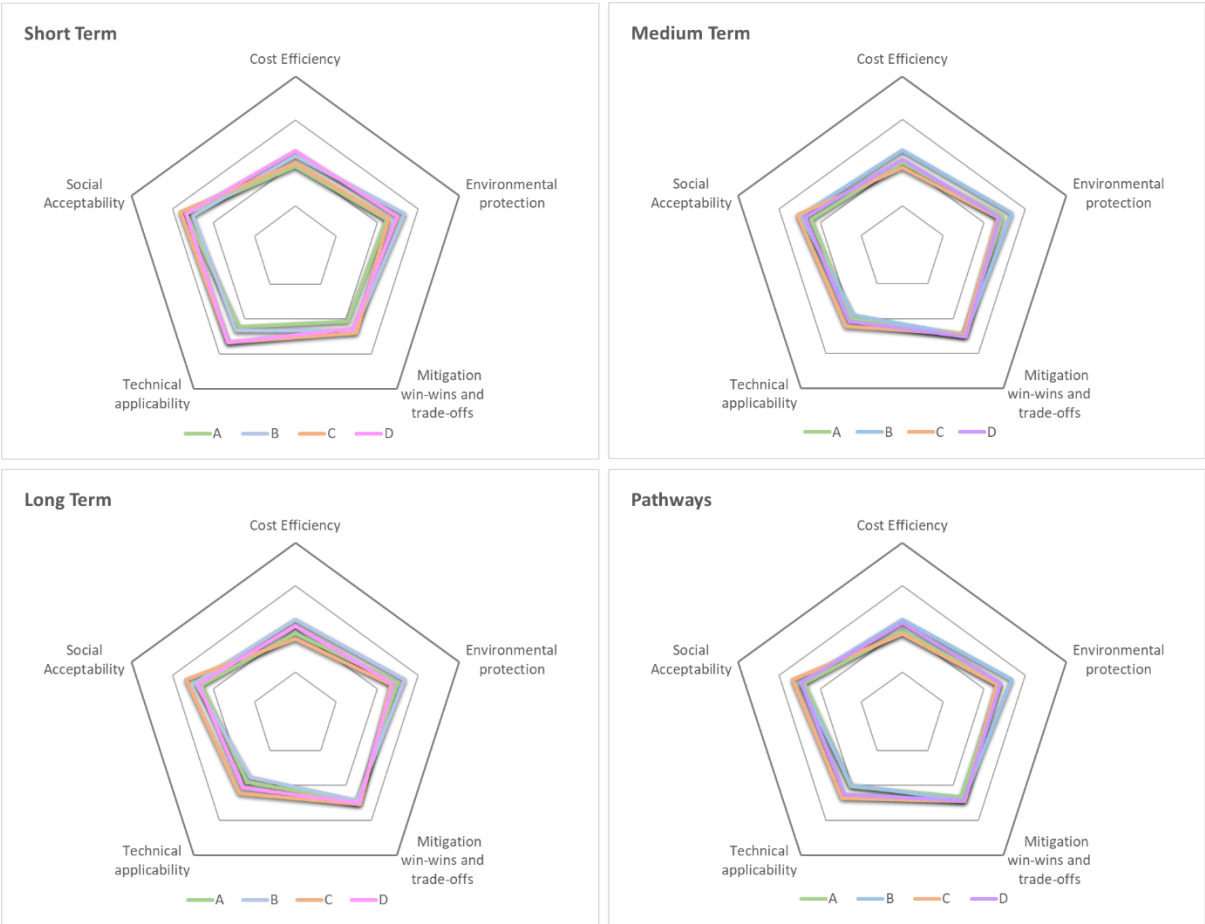


Figure 16. Ranked adaptation pathways for the energy sector in Cyprus considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

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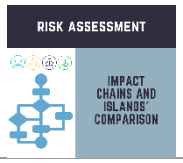
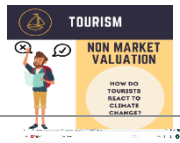
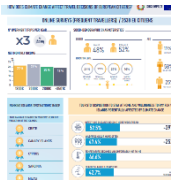
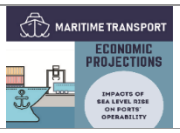
7. Fehmarn

7.1 Introduction

Table 24 presents a summary of the future projections of CC impacts for Fehmarn.

Table 24: Summary of future projections of CC impacts for Fehmarn.

Topic	Presentation	Summary
Climate description		- Climate characteristics - Current climate and related risks - Significant climate events
Climate change outlook:		Hazard indicators are projected for two CC scenarios RCP 2.6 (low emissions scenario) and 8.5 (High emissions scenario) and two periods (2046-2065) and (2081-2100). Hazards were selected according to their relevance for 4 blue economy sectors: Tourism, Aquaculture, Energy and Maritime Transport.
Risk analysis, impact chains and islands 'comparison		Risks analysis was undertaken following the concept of impact chains, by considering the relationships of hazards evolution, exposure and vulnerability. The final objective is to achieve a standardised risk score that allow comparison between islands and decision making on adaptation.. In this island the analysis includes: - Energy (risk of increased energy demand for cooling and desalination)
How do tourists react to climate change? (Factsheets) How do tourists react to climate change? (videos)	 	Tourists visiting the island were surveyed in order to analyse their rreactions to the impacts of CC and the preferences for adaptation policies that can be implemented. This information can be utilized to measure the potential decrease in tourism arrivals and the economic impact of adaptation policies.
How does CC affect travel decisions of European citizens? (Infographic)		2538 EU citizens (frequent travellers) were interviewed. They were asked about their disposition to stay at home and the willingness to pay to visit islands being exposed to several CC risks. Results alert on how CC would affect tourism expenditure in the EU islands. The results are useful to evaluate the priorities in terms of risks management and responsiveness to meet tourists' expectations.
Impact of SLR on ports' operation costs		The increased depreciation (amortization) costs caused by Sea Level Rise are estimated for the island's 125 years time horizon under different RCP scenarios of climate change. No discount rate has been applied.

7.2 Final matrix of adaptation and risk management options in Fehmarn

7.2.1 Tourism sector

The scoring and the ranking of the adaptation options for the tourism sector is presented in Table 25. Across the selected adaptation measures, the fire management plans (T21) received the highest

ranking due to its higher ability to protect the environment as well as it high cost-efficiency, technical applicability and social acceptability followed by the local circular economy measure (T11) and the adaptive management of natural habitats (T7). The least scored measure is the desalination (T16) mainly due to its low ability to protect the environment through the discharge of high-salinity brines and the emission of air pollutants followed by the beach nourishment measure (T15).

Table 25: Ranking of adaptation options for the tourism sector in Fehmarn

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
T1	Economic Policy Instruments (EPIs)	3.00	2.00	3.00	4.00	2.00	2.80
T2	Financial incentives to retreat from high-risk areas	3.00	1.00	1.00	4.00	2.00	2.20
T3	Adaptation of groundwater management	3.00	2.00	1.00	2.00	4.00	2.40
T4	Monitoring, modelling and forecasting systems	2.00	1.00	1.00	3.00	4.00	2.20
T5	Dune restoration and rehabilitation	2.00	3.00	1.00	4.00	3.00	2.60
T6	River rehabilitation and restoration	2.00	3.00	2.00	4.00	4.00	3.00
T7	Adaptive management of natural habitats	3.00	3.00	2.00	4.00	4.00	3.20
T8	Ocean pools	2.00	4.00	1.00	4.00	3.00	2.80
T9	Activity and product diversification	3.00	1.00	1.00	4.00	3.00	2.40
T10	Public awareness programmes	2.00	2.00	2.00	4.00	4.00	2.80
T11	Local circular economy	3.00	4.00	4.00	2.00	4.00	3.40
T12	Tourist awareness campaigns	1.00	2.00	1.00	4.00	3.00	2.20
T13	Local sustainable fishing	3.00	4.00	3.00	3.00	2.00	3.00
T14	Water restrictions, consumption cuts and grey-water recycling	3.00	3.00	2.00	3.00	2.00	2.60
T15	Beach nourishment	2.00	1.00	1.00	4.00	3.00	2.20
T16	Desalination	2.00	1.00	1.00	3.00	3.00	2.00
T17	Coastal protection structures	3.00	2.00	1.00	3.00	3.00	2.40
T18	Drought and water conservation plans	4.00	3.00	2.00	4.00	2.00	3.00
T19	Mainstreaming Disaster Risk Management (DRM)	4.00	1.00	2.00	4.00	2.00	2.60
T20	Using water to cope with heat waves	2.00	1.00	1.00	4.00	4.00	2.40
T21	Fire management plans	4.00	4.00	3.00	4.00	4.00	3.80
T22	Health care delivery systems	3.00	1.00	1.00	3.00	4.00	2.40
T23	Post-Disaster recovery funds	3.00	1.00	1.00	4.00	4.00	2.60
T24	Pre-disaster early recovery planning	4.00	2.00	1.00	3.00	4.00	2.80

7.3 Final package of ranked adaptation pathways in Fehmarn

7.3.1 Tourism

Figure 17 presents the final package of the ranked adaptation pathways for the tourism sector in Fehmarn. The APT A scenario exhibits the highest social acceptability, while the rest APTs exhibit an average score. In general, the technical applicability was ranked relatively high across all APTs,

considering that a lot of the proposed technologies are already available in Germany. The APT C exhibits the greatest environmental protection (average values), while in all other scenarios the environmental protection is evaluated as low. Finally, the APT A exhibits the highest cost efficiency followed by the APT D scenario for the long-term frame.

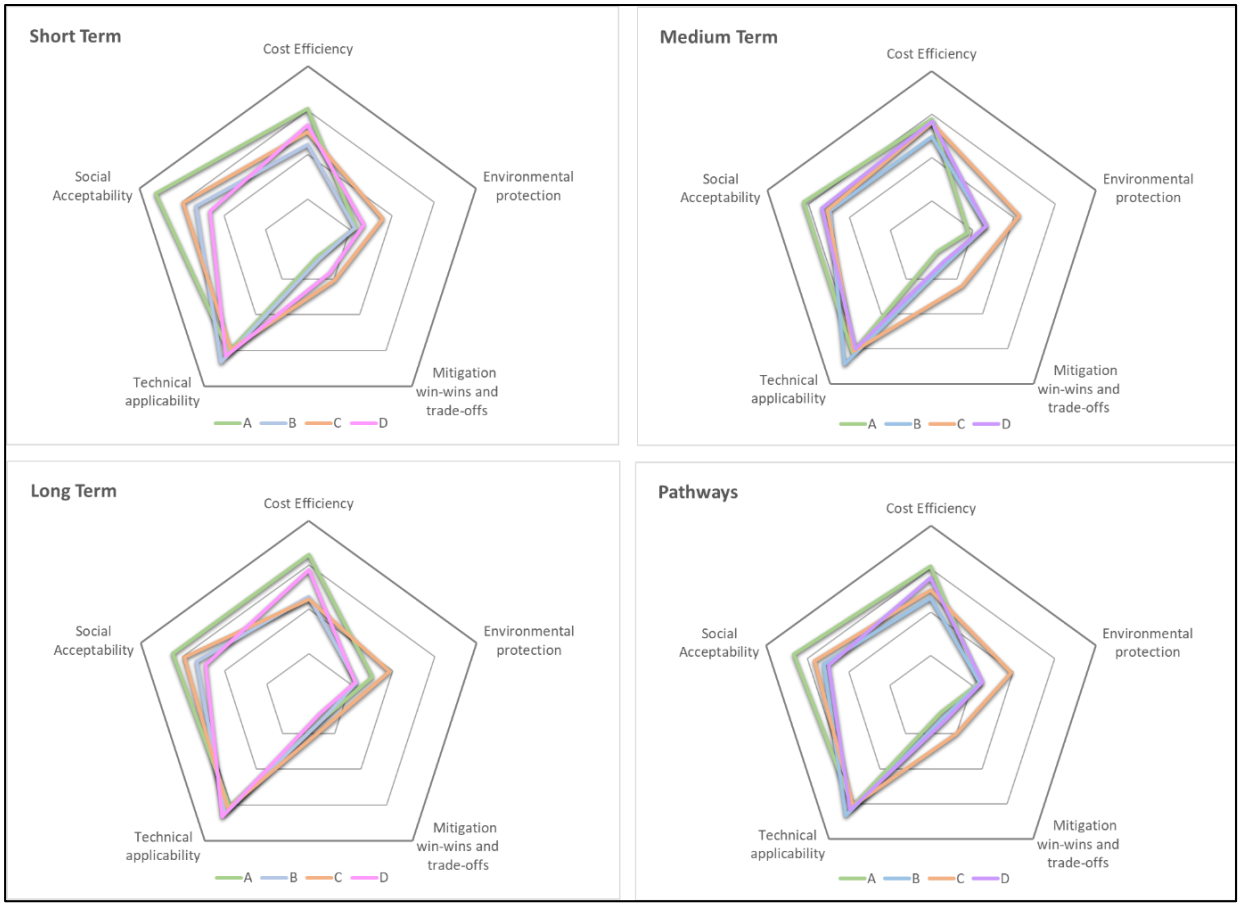


Figure 17. Ranked adaptation pathways for the tourism sector in Fehmarn considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

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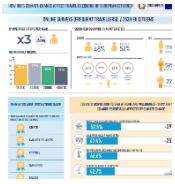
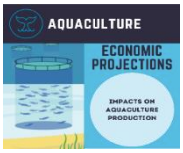
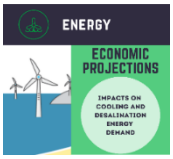
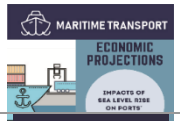
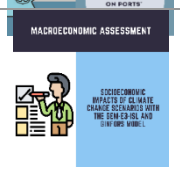
8. Madeira

8.1 Introduction

Table 26 presents a summary of the future projections of CC impacts for Madeira.

Table 26: Summary of future projections of CC impacts for Madeira.

Topic	Presentation	Summary
Climate description		- Climate characteristics - Current climate and related risks - Significant climate events
Climate change outlook:		Hazard indicators are projected for two CC scenarios RCP 2.6 (low emissions scenario) and 8.5 (High emissions scenario) and two periods (2046-2065) and (2081-2100). Hazards were selected according to their relevance for 4 blue economy sectors: Tourism, Aquaculture, Energy and Maritime Transport.
Risk analysis, impact chains and islands 'comparison		Risks analysis was undertaken following the concept of impact chains, by considering the relationships of hazards evolution, exposure and vulnerability. The final objective is to achieve a standardised risk score that allow comparison between islands and decision making on adaptation.. In this island the analysis includes: - Tourism (risk of forest fires) - Energy (risk of increased energy demand for cooling and desalination) - Aquaculture (increased fragility of the activity due to increased temperature and extreme weather)
How do tourists react to climate change? (Factsheets) How do tourists react to climate change? (videos)	 	Tourists visiting the island were surveyed in order to analyse their rreactions to the impacts of CC and the preferences for adaptation policies that can be implemented. This information can be utilized to measure the potential decrease in tourism arrivals and the economic impact of adaptation policies.
How does CC affect travel decisions of European citizens? (Infographic)		2538 EU citizens (frequent travellers) were interviewed. They were asked about their disposition to stay at home and the willingness to pay to visit islands being exposed to several CC risks. Results alert on how CC would affect tourism expenditure in the EU islands. The results are useful to evaluate the priorities in terms of risks management and responsiveness to meet tourists' expectations.
Impact of increased sea surface temperature in aquaculture production (tons)		The effects of increased sea surface temperatures on aquaculture production were calculated using a lethal temperature threshold by specie, and considering the production share of each island, under two RCP scenarios and time horizons, which correspond to four water temperature increases.

Climate change impacts on energy demand for cooling and desalination		The increase in energy demand (GWh/year), needed for cooling and desalination is estimated for the island under different RCP and time horizons.
Impact of SLR on ports' operation costs		The increased depreciation (amortization) costs caused by Sea Level Rise are estimated for the island's 125 years time horizon under different RCP scenarios of climate change. No discount rate has been applied.
Socio-economic implications of CC for EU islands with cross-sectoral perspective		General Equilibrium models have been used to project socio-economic consequences of CC for the island. Changes in mean temperature, sea level and precipitation rates have been used as input to assess the effects on 14 sectors of economic activity, GDP, consumption, investments and employment
Other climate projections		Precipitation Variation, Temperature Variation Hydric resources Hydric Energy Heat waves Hydrogeomorphology risks Meteorological fire risk Air quality and vector born diseases Source: Estratégia Clima Madeira (More information)
Other economic projections		Monthly energy consumption for climatization Source: Estratégia Clima Madeira (More information)

8.2 Final matrix of adaptation and risk management options in Madeira

8.2.1 Tourism

The scoring and the ranking of the adaptation options for the tourism sector is presented in Table 27. The river rehabilitation and restoration (T6) received the highest score among the adaptation measures due to its high economic and environmental performance followed by the economic policy instruments (T1) and the adaptation of groundwater management (T3) measures. The least ranked measure is the financial incentives to retreat from high-risk areas mainly due to its very low ability to protect the environment followed by the coastal protection structures measure (T17).

Table 27: Ranking of adaptation options for the tourism sector in Madeira

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
T1	Economic Policy Instruments (EPIs)	4.00	4.00	3.00	4.00	4.00	3.80
T2	Financial incentives to retreat from high-risk areas	2.00	1.00	2.00	3.00	2.00	2.00
T3	Adaptation of groundwater management	4.00	4.00	4.00	3.00	4.00	3.80
T4	Monitoring, modelling and forecasting systems	3.00	4.00	3.00	4.00	4.00	3.60
T5	Dune restoration and rehabilitation	3.00	3.00	4.00	3.00	4.00	3.40
T6	River rehabilitation and restoration	4.00	4.00	4.00	4.00	4.00	4.00
T7	Adaptive management of natural habitats	3.00	2.00	4.00	4.00	4.00	3.40

T8	Ocean pools	4.00	1.00	1.00	4.00	2.00	2.40
T9	Activity and product diversification	4.00	2.00	4.00	4.00	3.00	3.40
T10	Public awareness programmes	2.00	4.00	4.00	4.00	3.00	3.40
T11	Local circular economy	3.00	2.00	4.00	3.00	2.00	2.80
T12	Tourist awareness campaigns	2.00	3.00	4.00	4.00	4.00	3.40
T13	Local sustainable fishing	2.00	3.00	4.00	4.00	2.00	3.00
T14	Water restrictions, consumption cuts and grey-water recycling	4.00	3.00	4.00	4.00	2.00	3.40
T15	Beach nourishment	4.00	2.00	1.00	4.00	2.00	2.60
T16	Desalination	3.00	2.00	1.00	4.00	3.00	2.60
T17	Coastal protection structures	3.00	1.00	1.00	4.00	3.00	2.40
T18	Drought and water conservation plans	3.00	2.00	3.00	3.00	4.00	3.00
T19	Mainstreaming Disaster Risk Management (DRM)	4.00	4.00	3.00	3.00	4.00	3.60
T20	Using water to cope with heat waves	4.00	2.00	3.00	4.00	4.00	3.40
T21	Fire management plans	3.00	2.00	3.00	4.00	4.00	3.20
T22	Health care delivery systems	3.00	1.00	2.00	4.00	4.00	2.80
T23	Post-Disaster recovery funds	3.00	1.00	3.00	4.00	4.00	3.00
T24	Pre-disaster early recovery planning	4.00	2.00	3.00	4.00	4.00	3.40
T25	Rehabilitation and conservation of islands natural habitats key assets for Islands tourism agriculture, fisheries, and food security	4.00	4.00	4.00	3.00	3.00	3.60
T26	Diversification of economic activities to reduce the dependence from tourism activities	4.00	3.00	4.00	4.00	3.00	3.60
T27	Promote islands as telework tourism destinations	3.00	1.00	4.00	4.00	4.00	3.20
T28	Increase knowledge and modelling tools on climate change for islands	4.00	3.00	3.00	4.00	4.00	3.60
T29	Control measures for terrestrial and maritime tourist activities	4.00	3.00	4.00	4.00	2.00	3.40
T30	Implement waste reduction and management procedures to reduce dependence from exterior and pressures in natural ecosystems	2.00	4.00	4.00	3.00	3.00	3.20

8.2.2 Maritime transport

The scoring and the ranking of the adaptation options for the maritime transport sector is presented in Table 28. Across the selected adaptation measures, the intelligent transport systems (MT21) received the highest ranking mainly due to its high ability to address climate hazards in the most economical way and its high ability to meet mitigation objectives as well as its high technical applicability and social acceptability followed by the early warning systems (MT20) and the increase of knowledge and modelling tools on climate change for islands (MT27). The least scored measure includes the preparation for service delays or cancellations (MT22) mainly due to its very low ability to protect the environment followed by the expansion/retreat of ports in urban planning (MT18) and the sturdiness improvement of vessels (MT15).

Table 28: Ranking of adaptation options for the maritime transport in Madeira

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
MT1	Insurance mechanisms for ports	2.00	1.00	3.00	4.00	4.00	2.80
MT2	Financial incentives to retreat from high-risk areas	3.00	1.00	3.00	3.00	3.00	2.60
MT3	Marine life friendly coastal protection structures	3.00	4.00	4.00	3.00	3.00	3.40
MT4	Combined protection and wave energy infrastructures	3.00	3.00	4.00	2.00	2.00	2.80
MT5	Hybrid and full electric ship propulsion	2.00	1.00	4.00	3.00	3.00	2.60
MT6	Coastal protection structures	4.00	2.00	1.00	4.00	2.00	2.60
MT7	Integrate ports in urban tissue	2.00	1.00	3.00	3.00	4.00	2.60
MT8	Ocean pools	4.00	2.00	1.00	4.00	3.00	2.80
MT9	Awareness campaigns for behavioural change	2.00	3.00	4.00	4.00	3.00	3.20
MT10	Social dialogue for training in the port sector	3.00	3.00	4.00	4.00	3.00	3.40
MT11	Diversification of trade using climate resilient commodities	4.00	2.00	4.00	4.00	2.00	3.20
MT12	Climate resilient economy and jobs	4.00	3.00	4.00	3.00	3.00	3.40
MT13	Refrigeration, cooling and ventilation systems	3.00	1.00	2.00	4.00	4.00	2.80
MT14	Restrict development and settlement in low-lying areas	3.00	1.00	4.00	4.00	2.00	2.80
MT15	Sturdiness improvement of vessels	3.00	1.00	3.00	2.00	3.00	2.40
MT16	Increase operational speed and flexibility in ports	4.00	1.00	4.00	3.00	2.00	2.80
MT17	Climate proof ports and port activities	3.00	2.00	2.00	4.00	3.00	2.80
MT18	Consider expansion/retreat of ports in urban planning	2.00	2.00	3.00	3.00	2.00	2.40
MT19	Reinforcement of inspection, repair and maintenance of infrastructures	3.00	3.00	2.00	4.00	4.00	3.20
MT20	Early Warning Systems (EWS) and climate change monitoring	4.00	3.00	3.00	4.00	4.00	3.60
MT21	Intelligent Transport Systems (ITS)	4.00	3.00	4.00	4.00	4.00	3.80
MT22	Prepare for service delays or cancellations	2.00	1.00	3.00	3.00	2.00	2.20
MT23	Backup routes and infrastructures during extreme weather	4.00	3.00	1.00	4.00	3.00	3.00
MT24	Post-Disaster recovery funds	2.00	1.00	3.00	4.00	4.00	2.80
MT25	Specific requirements to increase climate change resilience of maritime transports services in islands	3.00	4.00	4.00	3.00	2.00	3.20
MT26	Prepare islands ports to supply alternative fuels and electricity	2.00	3.00	4.00	3.00	3.00	3.00
MT27	Increase knowledge and modelling tools on climate change for islands	4.00	3.00	3.00	4.00	4.00	3.60
MT28	City ports as coastal protection infrastructures against extreme climate events (sea level rise combined with sea storm)	4.00	4.00	2.00	3.00	4.00	3.40

8.2.3 Energy

The scoring and the ranking of the adaptation options for the energy sector is presented in Table 29. The urban green corridors measures (E6) has the highest average score due to its high ability to protect the environment and meet mitigation objectives as well as its high technical applicability and social acceptability followed the by the measures E14 (collection and storage of forest fuel loads) and E10 (public information service on climate action). The least scored measure is the electrification of energy demand (E30) due to its low economic and environmental performance followed by the demand side management of energy (E16).

Table 29: Ranking of adaptation options for the energy sector in Madeira

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
E1	Financial support for buildings with low energy needs	2.00	1.00	4.00	3.00	3.00	2.60
E2	Financial support for smart control of energy in houses and buildings	2.00	1.00	4.00	2.00	2.00	2.20
E3	Energy efficiency in urban water management	2.00	3.00	2.00	2.00	3.00	2.40
E4	Underground tubes and piping in urban planning	3.00	2.00	4.00	2.00	3.00	2.80
E5	Biomass power from household waste	3.00	3.00	3.00	3.00	2.00	2.80
E6	Urban green corridors	3.00	4.00	4.00	4.00	4.00	3.80
E7	Educational garden plots	2.00	1.00	2.00	4.00	4.00	2.60
E8	Heated pools with waste heat from power plants	1.00	2.00	1.00	2.00	3.00	1.80
E9	Green jobs and businesses	3.00	3.00	2.00	3.00	2.00	2.60
E10	Public information service on climate action	3.00	3.00	3.00	4.00	3.00	3.20
E11	Small scale production and consumption (prosumers)	2.00	3.00	3.00	3.00	2.00	2.60
E12	Risk reporting platform	3.00	1.00	1.00	3.00	2.00	2.00
E13	Energy storage systems	2.00	2.00	3.00	2.00	3.00	2.40
E14	Collection and storage of forest fuel loads	3.00	3.00	3.00	4.00	4.00	3.40
E15	SeaWater Air Conditioning (SWAC)	2.00	2.00	1.00	2.00	3.00	2.00
E16	Demand Side Management (DSM) of Energy	2.00	1.00	2.00	2.00	1.00	1.60
E17	Review building codes of the energy infrastructure	3.00	2.00	3.00	2.00	3.00	2.60
E18	Upgrade evaporative cooling systems	3.00	1.00	2.00	2.00	3.00	2.20
E19	Early Warning Systems (EWS)	3.00	4.00	1.00	3.00	4.00	3.00
E20	Grid reliability	2.00	2.00	3.00	2.00	4.00	2.60
E21	Study and develop energy grid connections	3.00	2.00	4.00	2.00	4.00	3.00
E22	Energy-independent facilities (generators)	3.00	2.00	1.00	2.00	3.00	2.20
E23	Energy recovery microgrids	2.00	1.00	2.00	2.00	3.00	2.00
E24	Local recovery energy outage capacity	1.00	1.00	2.00	2.00	3.00	1.80
E25	Minimize islands energy dependence from imported fossil fuels to increase resilience to climate change	3.00	3.00	3.00	2.00	3.00	2.80

E26	Diversification on energy supply and electricity generation	1.00	1.00	3.00	3.00	3.00	2.20
E27	Implement electricity prices for renewable energy generation on islands based on actual local costs to stimulate the RES generation	1.00	3.00	4.00	2.00	4.00	2.80
E28	Modelling and forecasting of supply and demand	1.00	1.00	4.00	1.00	2.00	1.80
E29	Promote electric mobility integrated in smart grids with smart-charging and vehicle-to-grid infrastructure	1.00	1.00	4.00	3.00	2.00	2.20
E30	Electrification of energy demand	1.00	1.00	1.00	2.00	3.00	1.60

8.2.4 Aquaculture

The scoring and the ranking of the adaptation options for the aquaculture is presented in Table 30. The feed production (A3) received the highest ranking due to its high cost-efficiency, technical applicability and social acceptability although its low performance in meeting mitigation objectives. Other highly ranked measures include the climate proof aquaculture activities (A17) and the promotion of aquaculture cuisine (A8). The least ranked measure is the selective breeding (A5) due to its low ability to protect the environment and meet mitigation objectives followed by the tax benefits and subsidies (A2).

Table 30: Ranking of adaptation options for aquaculture in Madeira

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
A1	Financial schemes, insurance and loans	2.00	1.00	1.00	3.00	4.00	2.20
A2	Tax benefits and subsidies	3.00	2.00	1.00	2.00	3.00	2.20
A3	Feed production	4.00	4.00	1.00	4.00	4.00	3.40
A4	Species selection	3.00	1.00	1.00	4.00	3.00	2.40
A5	Selective breeding	2.00	1.00	1.00	3.00	3.00	2.00
A6	Best Management Practices	4.00	3.00	3.00	2.00	3.00	3.00
A7	Create educational visits	2.00	2.00	3.00	4.00	4.00	3.00
A8	Promote aquaculture cuisine	3.00	3.00	4.00	4.00	2.00	3.20
A9	Awareness campaigns for behavioural change	1.00	2.00	3.00	4.00	3.00	2.60
A10	Efficient feed management	3.00	2.00	3.00	2.00	4.00	2.80
A11	Addressing consumer and environmental concerns at the local level	3.00	4.00	3.00	2.00	3.00	3.00
A12	Promote cooperation to local consumption	2.00	3.00	3.00	3.00	2.00	2.60
A13	Integrated multi-trophic aquaculture (IMTA)	3.00	4.00	3.00	2.00	3.00	3.00
A14	Short-cycle aquaculture	3.00	1.00	4.00	3.00	4.00	3.00
A15	Recirculation Aquaculture Systems (RAS)	2.00	1.00	4.00	2.00	4.00	2.60
A16	Submersible cages	3.00	1.00	3.00	3.00	4.00	2.80
A17	Climate proof aquaculture activities	4.00	3.00	3.00	3.00	4.00	3.40
A18	Risk-based zoning and site selection	4.00	1.00	4.00	3.00	4.00	3.20
A19	Disease prevention methods	4.00	1.00	4.00	3.00	4.00	3.20
A20	Environmental monitoring and Early Warning Systems (EWS)	4.00	2.00	1.00	4.00	4.00	3.00

A21	Mainstreaming Disaster Risk Management (DRM)	4.00	2.00	2.00	3.00	4.00	3.00
A22	Contingency for emergency management, early harvest and/or relocation	3.00	2.00	3.00	2.00	3.00	2.60
A23	Recovery Post-Disaster plans	2.00	1.00	3.00	4.00	4.00	2.80
A24	Recovery Post-Disaster funds	3.00	1.00	3.00	4.00	4.00	3.00
A25	Long-term environmental data collection and management at regional	1.00	3.00	3.00	4.00	4.00	3.00
A26	Implementation of local sanitary programs at regional scale	1.00	3.00	3.00	4.00	4.00	3.00
A27	Aquaculture and circular economy	3.00	4.00	3.00	2.00	3.00	3.00
A28	Implement measures for increasing local industry self-sufficiency	3.00	3.00	3.00	3.00	4.00	3.20
A29	Aquaculture as an alternative to fishing	3.00	4.00	3.00	4.00	2.00	3.20

8.3 Final package of ranked adaptation pathways in Madeira

8.3.1 Tourism

Figure 18 presents the final package of the ranked adaptation pathways for the tourism sector in Madeira. In general, on the short-term frame, the APT A exhibits better social acceptability performance, the APT B has a better technical applicability and cost efficiency performance and the APT C exhibits a better mitigation and environmental protection performance. On the medium-term frame, the APT A has a better technical applicability performance, while the APT C exhibits a better mitigation, social acceptability, cost efficiency and environmental protection performance. On the long-term frame, the APT A has a better technical applicability and social acceptability performance, the APT B has a better environmental protection performance and the APT C has a better mitigation and cost efficiency performance.

In general, the technical applicability for all four APTs remains almost the same for all time frames. Overall, the APT C is the scenario with the best cost efficiency and environmental protection performance, and higher contribution for the regional mitigation objectives of reduce at least 40% of GHG emissions for 2030 and achieve climate resilience and carbon neutrality (85% GHG emissions reduction) by 2050, according the Sustainable Energy and Climate Action Plan under development. The APT A is the scenario with better technical applicability and social acceptability performance.

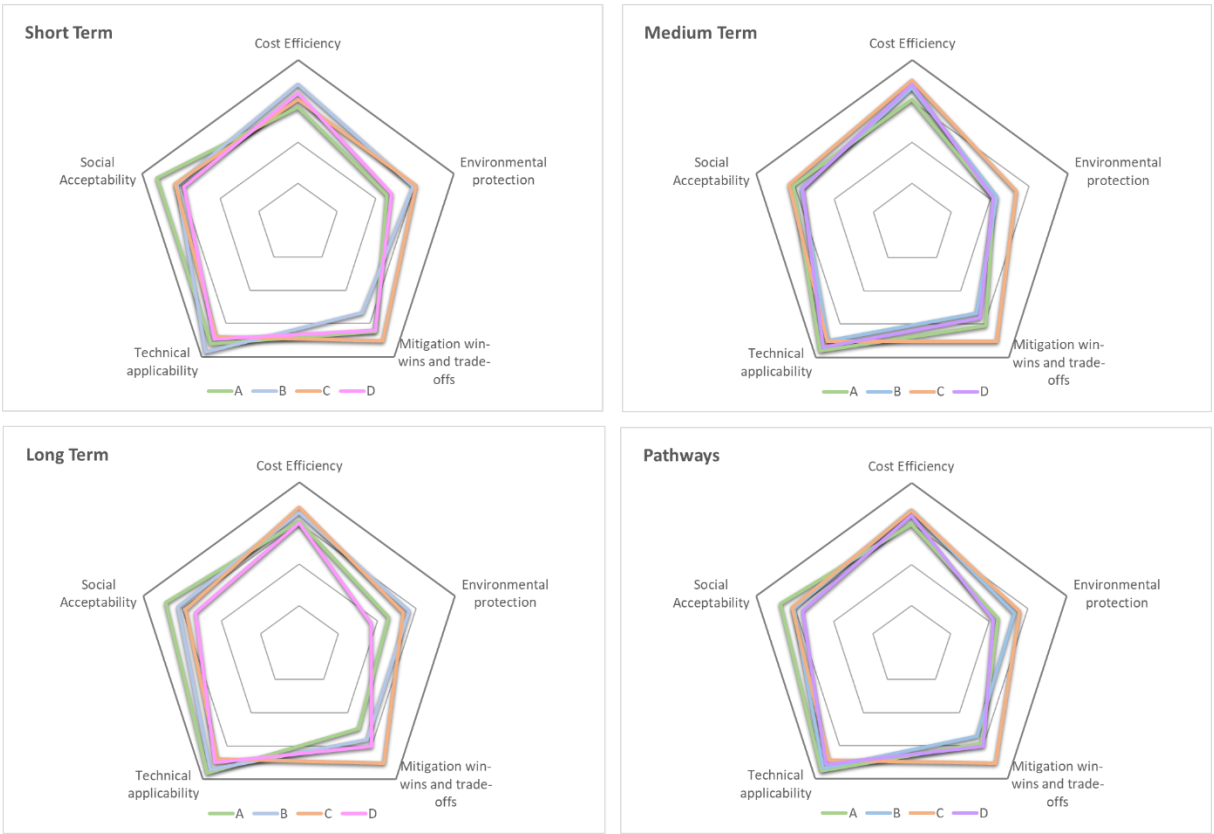


Figure 18. Ranked adaptation pathways for the tourism sector in Madeira considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

8.3.2 Maritime Transport

Figure 19 presents the final package of the ranked adaptation pathways for the maritime transport sector in Madeira. On the short-term frame, the APT A exhibits the best technical applicability and environmental protection performance, the APT B has better mitigation performance, the APT C has better social acceptance performance, while the APT D exhibits a better cost efficiency performance. On the medium-term, the APT A exhibits a better technical applicability, social acceptability, cost efficiency and environmental protection performances, while the APT C has a better mitigation performance. On the long-term, the APT A has a better cost efficiency, environmental protection and technical applicability performance, the APT C exhibits a better mitigation performance, while the APT D has a better social acceptability performance. In particular, at the long-term the technical applicability is low under all four APTs.

Overall, the APT C exhibits the highest contribution to the regional mitigation objectives, while the APT A is the scenario with the best technical applicability, environmental protection, social acceptability and cost efficiency performance.

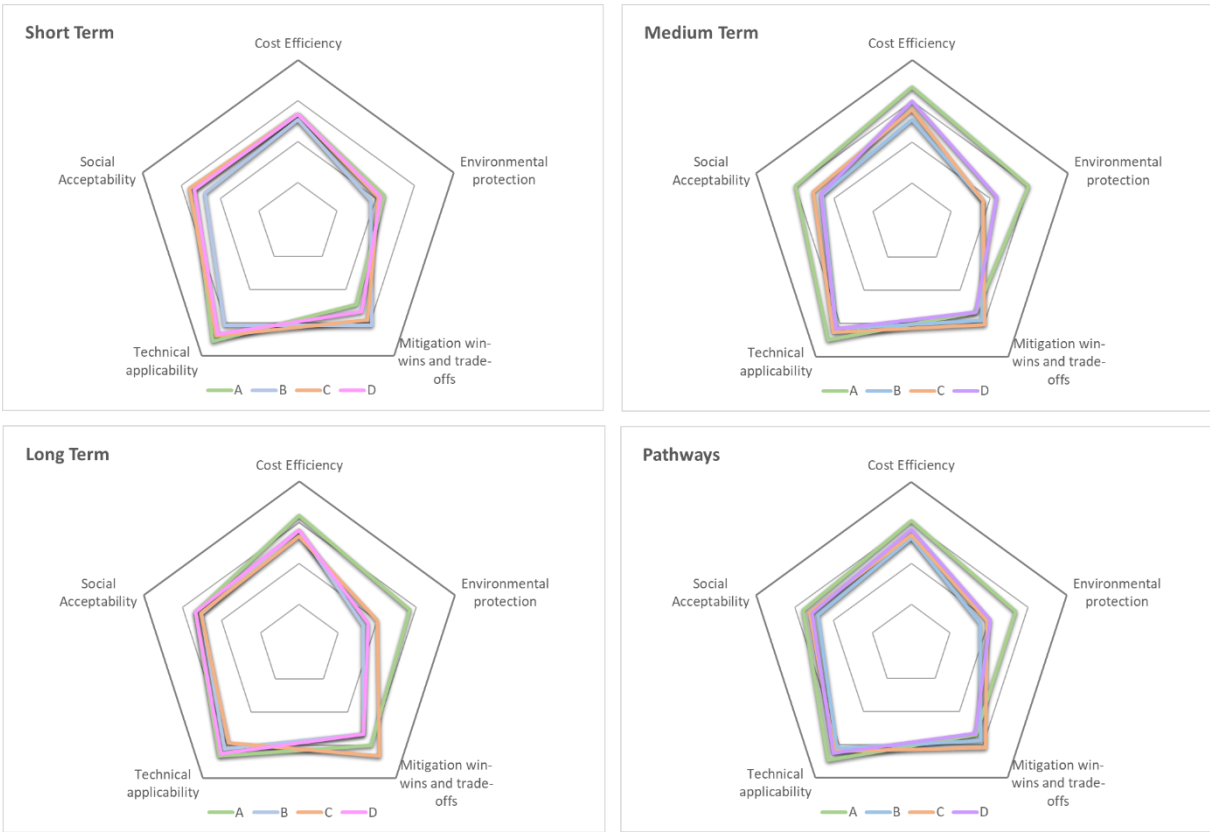


Figure 19. Ranked adaptation pathways for the maritime transport sector in Madeira considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

8.3.3 Energy

Figure 20 presents the final package of the ranked adaptation pathways for the energy sector in Madeira. On the short-term frame, the APT A exhibits a better social acceptability, cost efficiency and mitigation performance, while the APT C has a better technical applicability and environmental protection performance. On the medium-term frame, the APT A has a better cost efficiency performance, the APT B exhibits a better mitigation performance, while the APT C has a better technical applicability, social acceptability and environmental protection performance. On the long-term, the APT A exhibits a better social acceptability and environmental protection performance, the APT B has a better mitigation performance, while the APT C has a better technical applicability performance. In general, the technical applicability is low across all four APTs.

Overall, the APT B is the scenario with the highest contribution to the regional mitigation objectives, the APT A is the scenario with the best social acceptability and cost efficiency performance, the APT C is the scenario with the best technical applicability and environmental protection performance, while the APT D is the scenario with the lowest technical applicability and environmental protection performance.

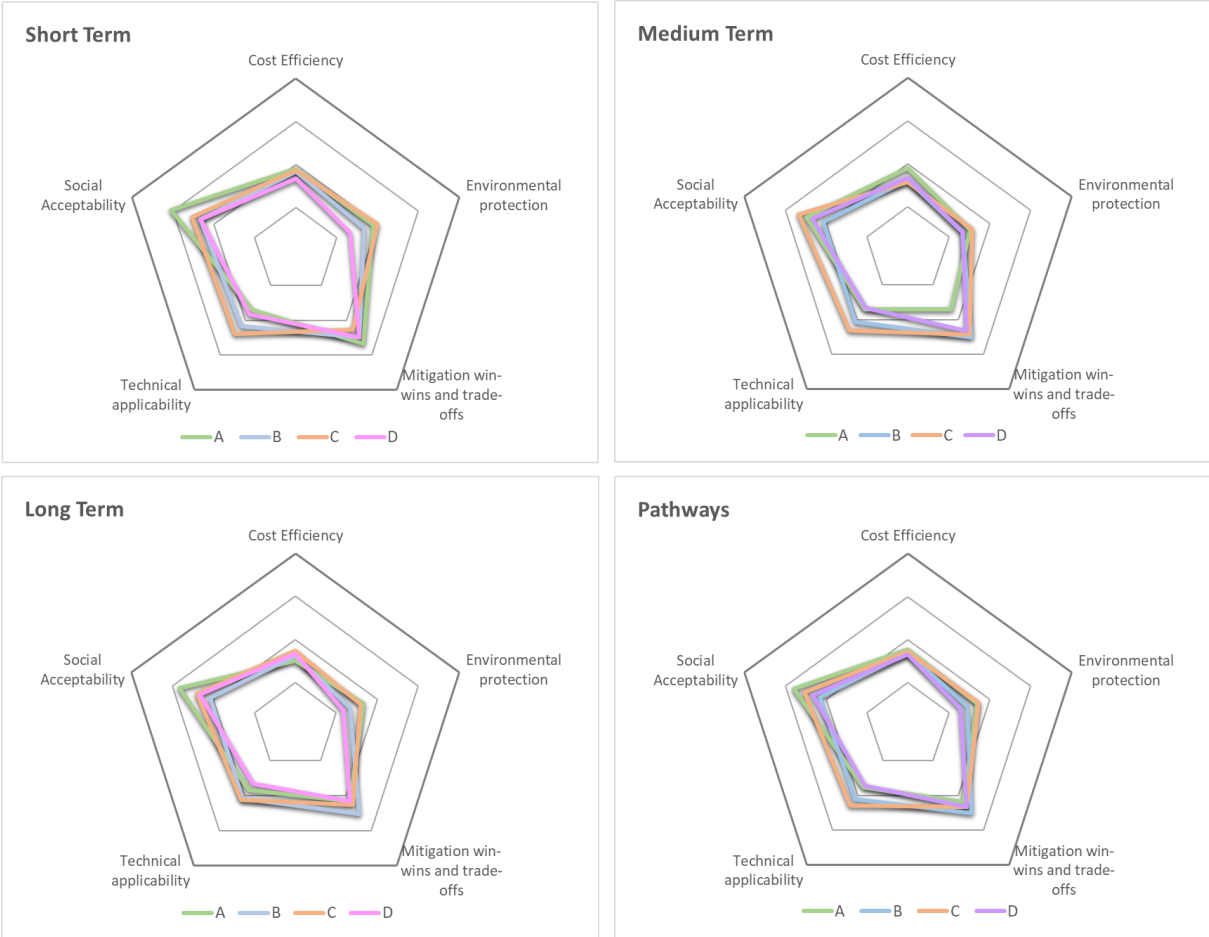


Figure 20. Ranked adaptation pathways for the energy sector in Madeira considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

8.3.4 Aquaculture

Figure 21 presents the final package of the ranked adaptation pathways for the aquaculture in Madeira. On the short-term frame, the APT A exhibits a better technical applicability performance, the APT D has a better social acceptability performance, while the APT C exhibit better cost efficiency, environmental protection and mitigation performances. On the medium-term frame, the APT B has a better technical applicability performance and the APT C has a better cost efficiency, social acceptability, and mitigation performance. On the long term, all APTs exhibit a similar ranking across all evaluation criteria. However, the APT B has a lower mitigation performance, the APT C has a lower environmental protection performance and the APT D exhibits a lower technical performance. Similar to the rest blue economy sectors, the technical applicability is low on the long-term across all APTs.

Overall, the APT C is the scenario with the best contribution to the regional mitigation objectives and exhibits the highest cost efficiency performance. The APT D is the scenario with the best social acceptability performance.

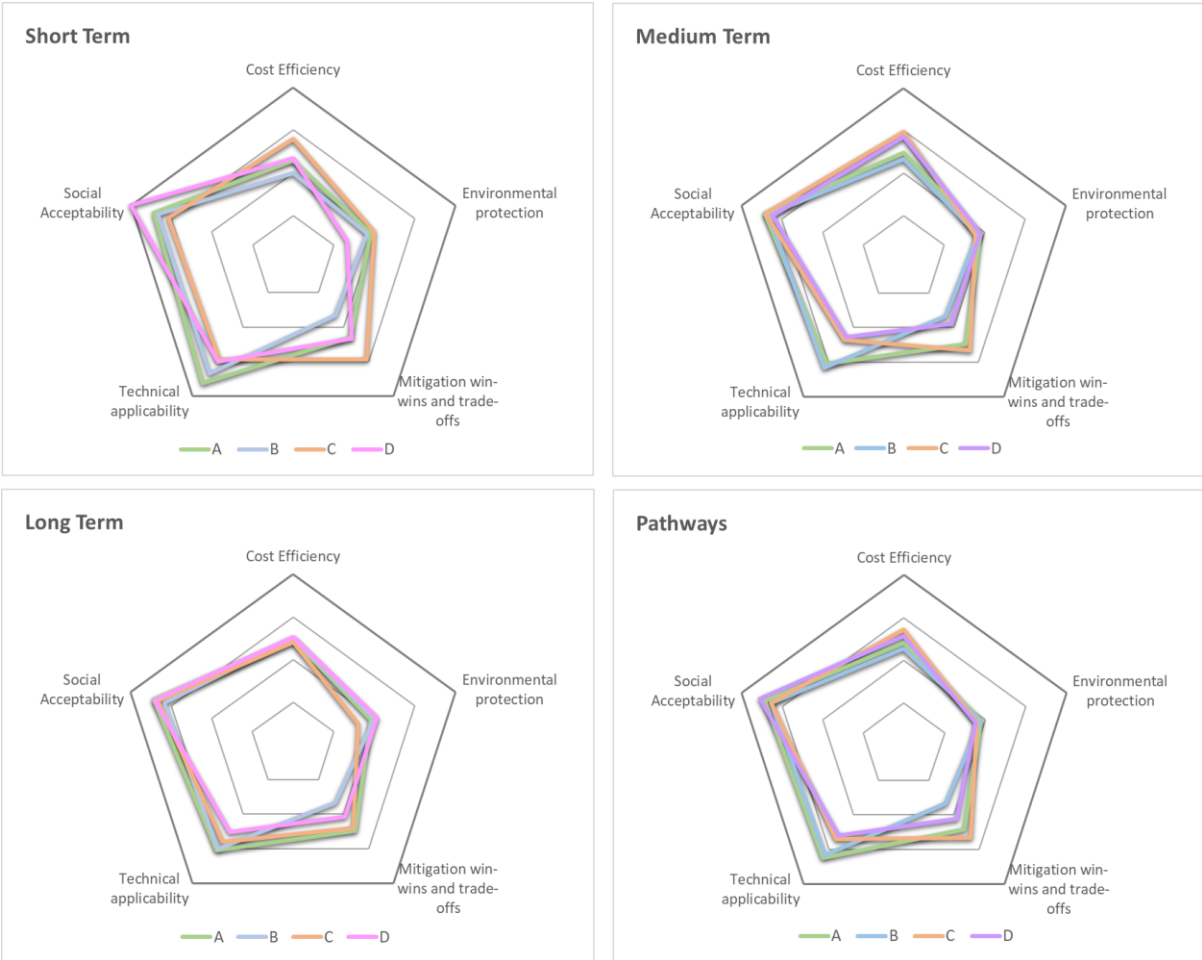


Figure 21. Ranked adaptation pathways for aquaculture in Madeira considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

SOCLIMPACT

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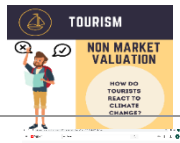
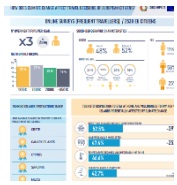
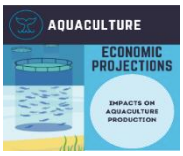
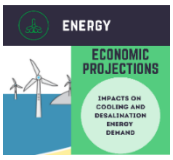
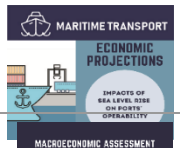
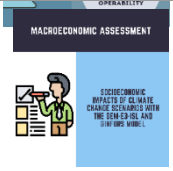
9. Malta

9.1 Introduction

Table 31 presents a summary of the future projections of CC impacts for Malta.

Table 31: Summary of future projections of CC impacts for Malta.

Topic	Presentation	Summary
Climate description		- Climate characteristics - Current climate and related risks - Significant climate events
Climate change outlook:		Hazard indicators are projected for two CC scenarios RCP 2.6 (low emissions scenario) and 8.5 (High emissions scenario) and two periods (2046-2065) and (2081-2100). Hazards were selected according to their relevance for 4 blue economy sectors: Tourism, Aquaculture, Energy and Maritime Transport.
Risk analysis, impact chains and islands 'comparison		Risks analysis was undertaken following the concept of impact chains, by considering the relationships of hazards evolution, exposure and vulnerability. The final objective is to achieve a standardised risk score that allow comparison between islands and decision making on adaptation.. In this island the analysis includes: - Tourism (risk of forest fires, marine habitat degradation y thermal stress) - Energy (risk of increased energy demand for cooling and desalination) - Maritime transport (risk of isolation) - Aquaculture (increased fragility of the activity due to increased temperature and extreme weather)
How do tourists react to climate change? **(Factsheets)** How do tourists react to climate change? **(videos)**	 	Tourists visiting the island were surveyed in order to analyse their rreactions to the impacts of CC and the preferences for adaptation policies that can be implemented. This information can be utilized to measure the potential decrease in tourism arrivals and the economic impact of adaptation policies.
How does CC affect travel decisions of European citizens? (Infographic)		2538 EU citizens (frequent travellers) were interviewed. They were asked about their disposition to stay at home and the willingness to pay to visit islands being exposed to several CC risks. Results alert on how CC would affect tourism expenditure in the EU islands. The results are useful to evaluate the priorities in terms of risks management and responsiveness to meet tourists' expectations.
Big Data Analysis		A specific tool (Google Cloud Vision) is used to scan the content of images posted by tourists on Instagram, while they are on holiday in the islands. Instagram geotagged posts from these islands are scanned according to tourists' publications (identified by a travel-related hashtag, such as #visit #holiday #travel, etc) during summer 2019 (from June to Septem - ber). The map of the island shows the word cloud stemming from the analysis of the pictures' content.

Impact of increased sea surface temperature in aquaculture production (tons)		The effects of increased sea surface temperatures on aquaculture production were calculated using a lethal temperature threshold by specie, and considering the production share of each island, under two RCP scenarios and time horizons, which correspond to four water temperature increases.
Climate change impacts on energy demand for cooling and desalination		The increase in energy demand (GWh/year), needed for cooling buildings and desalinate seawater is estimated for the island under different RCP and time horizons.
Impact of SLR on ports' operation costs		The increased depreciation (amortization) costs caused by Sea Level Rise are estimated for the island's 125 years time horizon under different RCP scenarios of climate change. No discount rate has been applied.
Socio-economic implications of CC for EU islands with cross-sectoral perspective		General Equilibrium models have been used to project socio-economic consequences of CC for the island. Changes in mean temperature, sea level and precipitation rates have been used as input to assess the effects on 14 sectors of economic activity, GDP, consumption, investments and employment

9.2 Final matrix of adaptation and risk management options in Malta

9.2.1 Aquaculture

The scoring and the ranking of adaptation options for the aquaculture is presented in Table 32. The species selection measure (A4) received the highest average score due to its high economic and environmental performance as well as its high social acceptability and technological applicability followed by the best management practices (A6) and the risk-based zoning and site selection (A18). The least performed adaptation measure is the contingency for emergent management, early harvest and relocation (A22) mainly due to its very low ability to meet mitigation objectives and its low social acceptability followed by the recovery post-disaster funds measure (A24).

Table 32: Ranking of adaptation options for aquaculture in Malta

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
A1	Financial schemes, insurance and loans	1.00	3.00	2.00	4.00	3.00	2.60
A2	Tax benefits and subsidies	1.00	3.00	2.00	4.00	2.00	2.40
A3	Feed production	4.00	4.00	3.00	2.00	2.00	3.00
A4	Species selection	4.00	4.00	3.00	4.00	4.00	3.80
A5	Selective breeding	3.00	3.00	3.00	2.00	2.00	2.60
A6	Best Management Practices	4.00	4.00	4.00	3.00	4.00	3.80
A7	Create educational visits	2.00	2.00	1.00	4.00	3.00	2.40
A8	Promote aquaculture cuisine	2.00	2.00	3.00	3.00	2.00	2.40
A9	Awareness campaigns for behavioural change	2.00	3.00	3.00	2.00	4.00	2.80
A10	Efficient feed management	4.00	4.00	4.00	2.00	3.00	3.40

A11	Addressing consumer and environmental concerns at the local level	2.00	4.00	4.00	2.00	3.00	3.00
A12	Promote cooperation to local consumption	4.00	4.00	4.00	2.00	3.00	3.40
A13	Integrated multi-trophic aquaculture (IMTA)	3.00	3.00	3.00	1.00	3.00	2.60
A14	Short-cycle aquaculture	2.00	3.00	1.00	3.00	4.00	2.60
A15	Recirculation Aquaculture Systems (RAS)	2.00	3.00	1.00	4.00	4.00	2.80
A16	Submersible cages	3.00	3.00	3.00	3.00	3.00	3.00
A17	Climate proof aquaculture activities	3.00	3.00	3.00	3.00	3.00	3.00
A18	Risk-based zoning and site selection	4.00	4.00	3.00	4.00	4.00	3.80
A19	Disease prevention methods	4.00	3.00	3.00	2.00	4.00	3.20
A20	Environmental monitoring and Early Warning Systems (EWS)	4.00	4.00	4.00	3.00	4.00	3.80
A21	Mainstreaming Disaster Risk Management (DRM)	4.00	3.00	3.00	3.00	4.00	3.40
A22	Contingency for emergency management, early harvest and/or relocation	3.00	3.00	1.00	2.00	1.00	2.00
A23	Recovery Post-Disaster plans	3.00	4.00	3.00	2.00	4.00	3.20
A24	Recovery Post-Disaster funds	2.00	2.00	2.00	2.00	3.00	2.20

9.3 Final package of ranked adaptation pathways in Malta

9.3.1 Aquaculture

Figure 22 presents the final package of the ranked adaptation pathways for aquaculture in Malta. In general, all four APTs have a similar evaluation across all timeframes. All scenarios exhibit a high level of cost efficiency, environmental protection, mitigation trade-offs, technical applicability and social acceptability. The cost efficiency of APT D for the long term is slightly lower. Environmental protection has an overall high value but with differences between APT D (lower value), APT C (intermediate value) and APT A and B (highest value). Mitigation performance shows a small range of values; APT D (minimal intervention) has the lowest value and APT C (capacity expansion) the highest, while the APTs A and B have average values. The APT A scores highest for all performance indicators with the exception of technical applicability, which takes the highest values in the APT B scenario across all time frames. The APT A exhibits the highest values for social acceptability, while the APT D the lowest. It can be expected that the APT D would have the most challenging options in terms of social acceptability because it is the scenario with the highest commitment to policy change. It is assumed that a higher commitment could better cope with options which have a lower social acceptance. Using the same principal, in APT A (Minimum Intervention) could have had a higher (than D) social acceptability result.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No776661

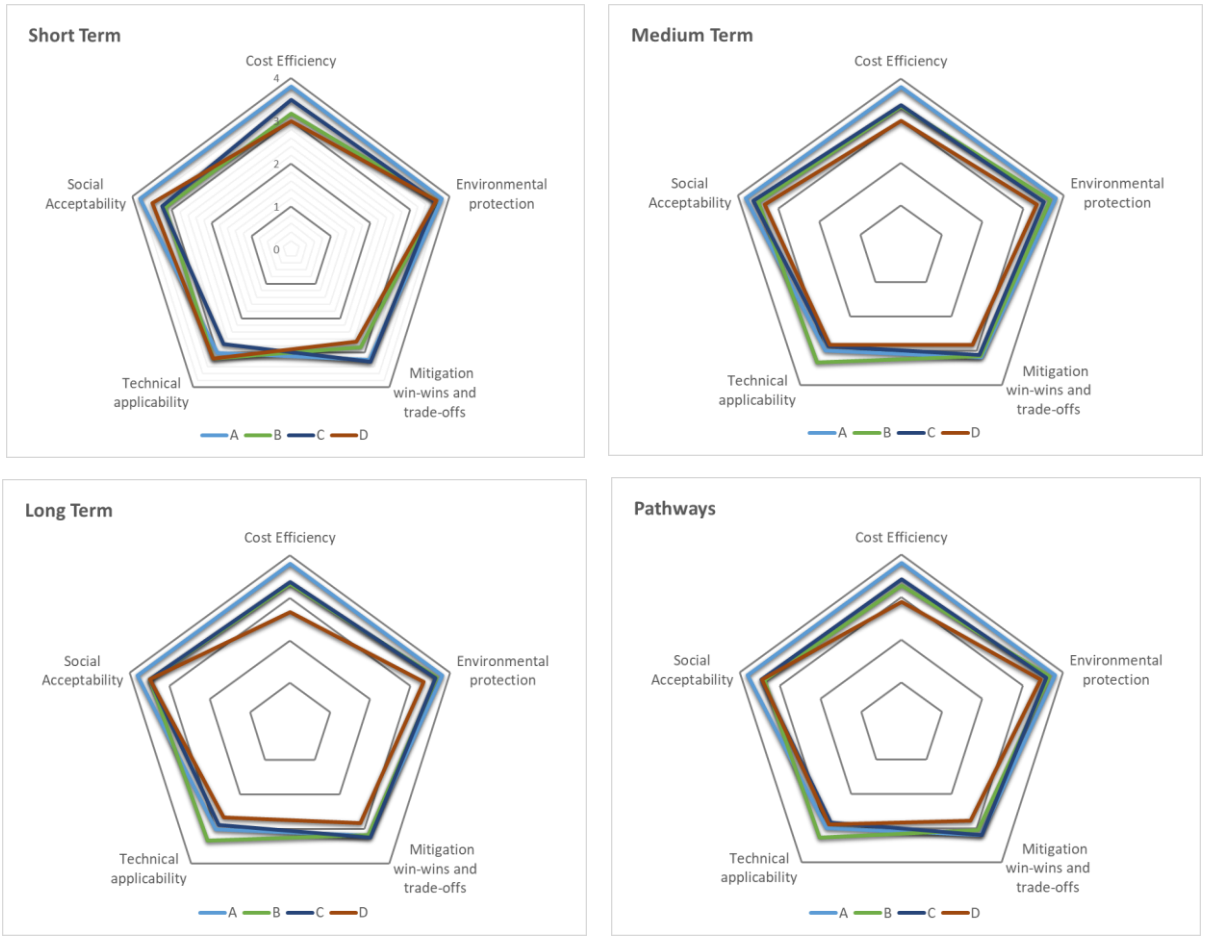


Figure 22. Ranked adaptation pathways for aquaculture in Malta considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

SOCLIMPACT

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No776661

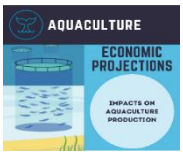
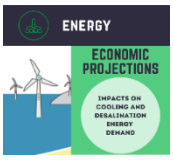
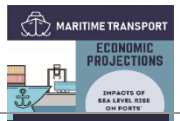
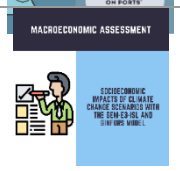
10. Sardinia

10.1 Introduction

Table 33 presents a summary of the future projections of CC impacts for Sardinia.

Table 33: Summary of future projections of CC impacts for Sardinia

Topic	Presentation	Summary
Climate description		- Climate characteristics - Current climate and related risks - Significant climate events
Climate change outlook:		Hazard indicators are projected for two CC scenarios RCP 2.6 (low emissions scenario) and 8.5 (High emissions scenario) and two periods (2046-2065) and (2081-2100). Hazards were selected according to their relevance for 4 blue economy sectors: Tourism, Aquaculture, Energy and Maritime Transport.
Risk analysis, impact chains and islands 'comparison		Risks analysis was undertaken following the concept of impact chains, by considering the relationships of hazards evolution, exposure and vulnerability. The final objective is to achieve a standardised risk score that allow comparison between islands and decision making on adaptation.. In this island the analysis includes: - Tourism (risk of forest fires and thermal stress) - Energy (risk of increased energy demand for cooling and desalination) - Aquaculture (increased fragility of the activity due to increased temperature and extreme weather)
How does CC affect travel decisions of European citizens? (Infographic)		2538 EU citizens (frequent travellers) were interviewed. They were asked about their disposition to stay at home and the willingness to pay to visit islands being exposed to several CC risks. Results alert on how CC would affect tourism expenditure in the EU islands. The results are useful to evaluate the priorities in terms of risks management and responsiveness to meet tourists' expectations.
Impacts of increased temperatures on hotels' prices and revenues		Current weather conditions posted on several weather forecast were analysed, as well as daily prices posted on Booking.com by hotels in the island. The link between daily temperature and daily price was estimated, and then projected for the increase in the number of days with excessive temperature projected for the future in two scenarios (RCP2.6 and RCP8.5) and in two time horizons (near future, about 2050; distant future, about 2100).
Big Data Analysis		A specific tool (Google Cloud Vision) is used to scan the content of images posted by tourists on Instagram, while they are on holiday in the islands. Instagram geotagged posts from these islands are scanned according to tourists' publications (identified by a travel-related hashtag, such as #visit #holiday #travel, etc) during summer 2019 (from June to Septem - ber). The map of the island shows the word cloud stemming from the analysis of the pictures' content.

Impact of increased sea surface temperature in aquaculture production (tons)		The effects of increased sea surface temperatures on aquaculture production were calculated using a lethal temperature threshold by specie, and considering the production share of each island, under two RCP scenarios and time horizons, which correspond to four water temperature increases.
Climate change impacts on energy demand for cooling and desalination		The increase in energy demand (GWh/year), needed for cooling buildings and desalinate seawater is estimated for the island under different RCP and time horizons.
Impact of SLR on ports' operation costs		The increased depreciation (amortization) costs caused by Sea Level Rise are estimated for the island's 125 years time horizon under different RCP scenarios of climate change. No discount rate has been applied.
Socio-economic implications of CC for EU islands with cross-sectoral perspective		General Equilibrium models have been used to project socio-economic consequences of CC for the island. Changes in mean temperature, sea level and precipitation rates have been used as input to assess the effects on 14 sectors of economic activity, GDP, consumption, investments and employment

10.2 Final matrix of adaptation and risk management options in Sardinia

10.2.1 Tourism

The scoring and the ranking of the adaptation measures for the tourism sector is presented in Table 34. The economic policy instruments (T1) is the most highly ranked measure mainly due to its high ability to protect the environment and its high ability to meet the mitigation objectives followed by the mainstreaming disaster risk management (T19) and the use of water to cope with heat waves (T20). On the contrary, the adaptive management of natural habitats (T7) received the lowest ranking due to its low social acceptability and the low ability to protect the environment followed by the beach nourishment (T15).

Table 34: Ranking of adaptation options for the tourism sector in Sardinia

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
T1	Economic Policy Instruments (EPIs)	2.80	3.80	3.60	1.80	3.00	3.00
T2	Financial incentives to retreat from high-risk areas	1.80	2.60	2.40	2.60	3.00	2.48
T3	Adaptation of groundwater management	3.00	3.00	2.60	3.00	2.20	2.76
T4	Monitoring, modelling and forecasting systems	2.60	3.20	1.60	2.40	2.80	2.52
T5	Dune restoration and rehabilitation	2.80	1.40	3.20	4.00	2.00	2.68
T6	River rehabilitation and restoration	2.00	2.40	1.00	2.20	3.00	2.12
T7	Adaptive management of natural habitats	2.20	1.40	2.00	1.80	1.00	1.68
T8	Ocean pools	1.20	3.60	3.00	3.00	1.00	2.36
T9	Activity and product diversification	3.00	1.40	3.00	2.80	3.00	2.64
T10	Public awareness programmes	3.00	2.80	3.00	2.00	2.00	2.56

T11	Local circular economy	2.00	1.60	3.00	1.60	3.00	2.24
T12	Tourist awareness campaigns	1.40	3.20	2.20	1.80	3.00	2.32
T13	Local sustainable fishing	3.60	1.60	2.80	2.40	2.00	2.48
T14	Water restrictions, consumption cuts and grey-water recycling	4.00	1.80	1.60	2.80	3.60	2.76
T15	Beach nourishment	1.40	2.40	1.40	3.20	1.80	2.04
T16	Desalination	1.00	3.00	2.20	3.00	4.00	2.64
T17	Coastal protection structures	2.00	2.60	2.00	2.20	3.00	2.36
T18	Drought and water conservation plans	3.00	1.40	2.20	2.40	2.00	2.20
T19	Mainstreaming Disaster Risk Management (DRM)	1.80	3.20	3.40	3.00	3.00	2.88
T20	Using water to cope with heat waves	2.00	3.60	1.40	3.00	4.00	2.80
T21	Fire management plans	1.00	2.60	3.00	3.80	2.00	2.48
T22	Health care delivery systems	4.00	1.80	2.80	1.20	3.00	2.56
T23	Post-Disaster recovery funds	3.20	3.20	1.00	2.80	3.20	2.68
T24	Pre-disaster early recovery planning	3.60	2.60	2.40	2.00	2.20	2.56

10.2.2 Maritime transport

The scoring and the ranking of the adaptation measures for the maritime transport is presented in Table 35. Across the selected adaptation measures, the restriction of development and settlement in low-lying areas (MT14) had the highest ranking due to its high technical applicability and high ability to protect the environment followed by the diversification of trade using climate resilient commodities (MT11) and the financial incentives to retreat from high-risk areas (MT2). The expansion/retreat of ports in urban planning (MT18) received the lowest ranking mainly due to its low social acceptability and low ability to protect the environment followed by the reinforcement of inspection, repair and maintenance of infrastructures (MT19).

Table 35: Ranking of adaptation options for the maritime transport in Sardinia

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
MT1	Insurance mechanisms for ports	3.00	4.00	2.00	2.83	1.83	2.73
MT2	Financial incentives to retreat from high-risk areas	4.00	3.17	2.67	1.33	3.00	2.83
MT3	Marine life friendly coastal protection structures	2.83	2.83	1.83	3.83	2.50	2.77
MT4	Combined protection and wave energy infrastructures	1.17	2.83	3.67	2.00	2.17	2.37
MT5	Hybrid and full electric ship propulsion	2.00	1.50	4.00	1.17	3.83	2.50
MT6	Coastal protection structures	2.00	4.00	2.00	1.67	2.67	2.47
MT7	Integrate ports in urban tissue	3.00	1.83	3.00	2.33	1.00	2.23
MT8	Ocean pools	2.83	2.33	3.00	2.00	1.00	2.23
MT9	Awareness campaigns for behavioural change	1.83	2.67	3.50	2.33	1.33	2.33
MT10	Social dialogue for training in the port sector	2.00	3.17	3.17	2.17	2.00	2.50
MT11	Diversification of trade using climate resilient commodities	2.83	2.33	3.67	2.00	3.50	2.87
MT12	Climate resilient economy and jobs	3.33	2.17	2.50	2.00	2.00	2.40

MT13	Refrigeration, cooling and ventilation systems	3.00	3.17	3.17	2.33	1.00	2.53
MT14	Restrict development and settlement in low-lying areas	3.00	3.67	2.17	3.83	2.00	2.93
MT15	Sturdiness improvement of vessels	3.00	3.33	2.17	2.00	3.33	2.77
MT16	Increase operational speed and flexibility in ports	3.00	1.50	3.17	3.67	1.50	2.57
MT17	Climate proof ports and port activities	2.00	2.00	1.83	2.33	2.83	2.20
MT18	Consider expansion/retreat of ports in urban planning	2.33	1.50	2.83	2.00	1.00	1.93
MT19	Reinforcement of inspection, repair and maintenance of infrastructures	1.00	3.67	2.17	3.00	1.00	2.17
MT20	Early Warning Systems (EWS) and climate change monitoring	3.00	1.00	3.67	3.17	2.67	2.70
MT21	Intelligent Transport Systems (ITS)	3.33	1.83	3.33	2.17	2.00	2.53
MT22	Prepare for service delays or cancellations	2.00	3.17	2.83	3.33	1.00	2.47
MT23	Backup routes and infrastructures during extreme weather	3.00	1.83	2.50	2.00	4.00	2.67
MT24	Post-Disaster recovery funds	3.00	4.00	1.83	2.17	3.17	2.83

10.2.3 Energy

The scoring and the ranking of the adaptation measures for the energy sector is presented in Table 36. The green jobs and businesses (E9) measure received the highest ranking due to its high ability to protect the environment and meet the mitigation objectives as well as its high technical applicability followed by the underground tubes and pipping in urban planning (E4) and the financial support for smart control of energy in houses and buildings (E2). The heated pools with waste heat from power plants (E8) has the lowest ranking mainly due to its low technical applicability and low ability to protect the environment followed by the collection and storage of forest fuel loads (E14).

Table 36: Ranking of adaptation options for energy sector in Sardinia

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
E1	Financial support for buildings with low energy needs	2.71	2.29	3.14	1.86	1.14	2.23
E2	Financial support for smart control of energy in houses and buildings	4.00	2.14	2.43	2.57	3.00	2.83
E3	Energy efficiency in urban water management	3.00	2.29	3.29	1.29	1.29	2.23
E4	Underground tubes and piping in urban planning	3.00	2.43	3.43	2.00	3.86	2.94
E5	Biomass power from household waste	2.00	2.00	4.00	3.00	2.00	2.60
E6	Urban green corridors	2.00	3.43	2.86	2.00	3.00	2.66
E7	Educational garden plots	3.00	2.86	1.43	2.57	3.00	2.57
E8	Heated pools with waste heat from power plants	3.00	1.71	2.14	1.29	2.00	2.03
E9	Green jobs and businesses	2.00	3.43	3.29	3.29	3.00	3.00
E10	Public information service on climate action	2.29	2.71	1.43	2.43	1.86	2.14
E11	Small scale production and consumption (prosumers)	2.14	2.29	1.86	4.00	3.00	2.66
E12	Risk reporting platform	2.71	2.43	3.43	4.00	1.00	2.71

E13	Energy storage systems	1.43	2.86	2.00	2.29	3.00	2.31
E14	Collection and storage of forest fuel loads	2.86	1.43	3.00	1.14	2.00	2.09
E15	SeaWater Air Conditioning (SWAC)	3.00	3.00	1.00	2.00	3.00	2.40
E16	Demand Side Management (DSM) of Energy	1.00	2.57	3.43	2.14	3.71	2.57
E17	Review building codes of the energy infrastructure	4.00	2.57	1.29	2.43	3.00	2.66
E18	Upgrade evaporative cooling systems	2.00	4.00	2.57	3.86	1.00	2.69
E19	Early Warning Systems (EWS)	3.00	1.71	2.00	2.71	2.29	2.34
E20	Grid reliability	2.00	2.86	2.57	1.29	2.14	2.17
E21	Study and develop energy grid connections	3.00	2.00	3.86	2.00	1.29	2.43
E22	Energy-independent facilities (generators)	1.86	2.71	2.86	1.43	3.00	2.37
E23	Energy recovery microgrids	3.14	2.43	2.00	2.57	3.43	2.71
E24	Local recovery energy outage capacity	2.00	3.14	2.29	1.71	2.00	2.23

10.2.4 Aquaculture

The scoring and the ranking of the adaptation options for the aquaculture is presented in Table 37. Across the selected adaptation measures, the feed production (A3) has the highest average score due to its high cost-efficiency and high special acceptability followed by the risk-based zoning and site selection (A18) and the selective breeding (A5). The submersible cages (A16) has the lowest ranking mainly due to its low ability to meet mitigation objectives followed by the promotion of cooperation to local consumption (A12).

Table 37: Ranking of adaptation options for aquaculture in Sardinia

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
A1	Financial schemes, insurance and loans	1.17	2.67	3.17	2.17	4.00	2.63
A2	Tax benefits and subsidies	2.00	3.17	2.00	3.83	1.50	2.50
A3	Feed production	4.00	2.17	3.33	2.17	4.00	3.13
A4	Species selection	2.33	3.17	2.67	1.00	2.33	2.30
A5	Selective breeding	2.00	3.00	3.17	2.50	4.00	2.93
A6	Best Management Practices	2.00	3.17	3.00	2.33	3.00	2.70
A7	Create educational visits	2.00	2.67	3.17	2.67	1.00	2.30
A8	Promote aquaculture cuisine	2.00	3.00	3.00	2.17	3.83	2.80
A9	Awareness campaigns for behavioural change	1.33	3.83	2.00	3.00	2.50	2.53
A10	Efficient feed management	2.00	3.00	2.83	2.17	4.00	2.80
A11	Addressing consumer and environmental concerns at the local level	1.00	3.33	3.17	2.83	3.83	2.83
A12	Promote cooperation to local consumption	2.00	1.50	3.00	1.83	2.00	2.07
A13	Integrated multi-trophic aquaculture (IMTA)	1.83	3.33	1.50	2.33	2.00	2.20
A14	Short-cycle aquaculture	2.33	3.00	2.67	2.67	4.00	2.93
A15	Recirculation Aquaculture Systems (RAS)	2.00	3.00	2.67	2.17	3.67	2.70
A16	Submersible cages	2.00	2.00	1.50	2.67	2.17	2.07

A17	Climate proof aquaculture activities	2.00	3.33	3.00	2.33	1.83	2.50
A18	Risk-based zoning and site selection	2.00	2.83	3.00	3.67	4.00	3.10
A19	Disease prevention methods	2.00	3.67	3.00	2.67	2.83	2.83
A20	Environmental monitoring and Early Warning Systems (EWS)	2.00	3.17	1.33	2.00	4.00	2.50
A21	Mainstreaming Disaster Risk Management (DRM)	2.17	2.33	2.00	3.17	3.50	2.63
A22	Contingency for emergency management, early harvest and/or relocation	4.00	3.17	2.17	2.33	3.00	2.93
A23	Recovery Post-Disaster plans	2.00	1.50	2.00	2.67	4.00	2.43
A24	Recovery Post-Disaster funds	3.17	2.00	2.83	2.50	4.00	2.90

10.3 Final package of ranked adaptation pathways in Sardinia

10.3.1 Tourism

Figure 23 presents the final package of the ranked adaptation pathways for the tourism sector in Sardinia.

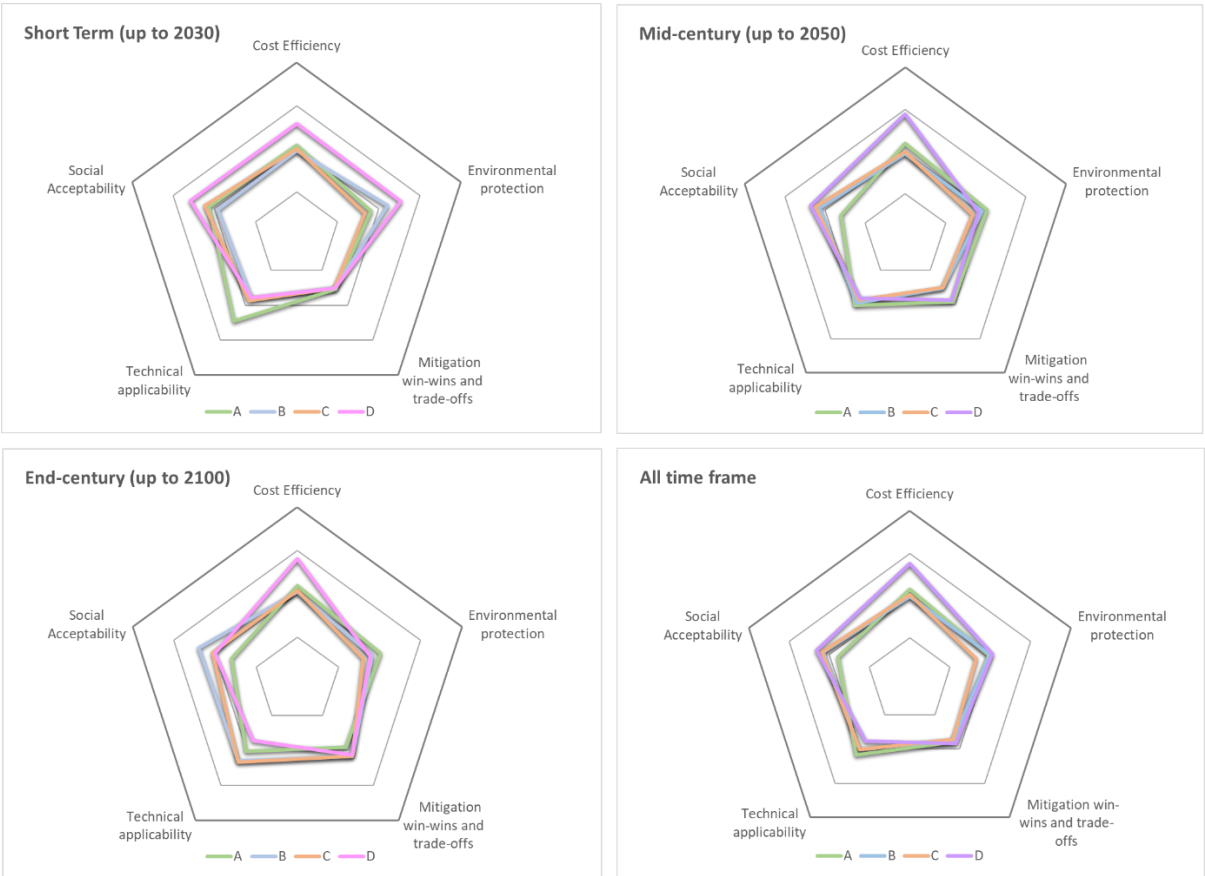


Figure 23. Ranked adaptation pathways for the tourism sector in Sardinia considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion

(ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

10.3.2 Maritime transport

Figure 24 presents the final package of the ranked adaptation pathways for the maritime transport sector in Sardinia.

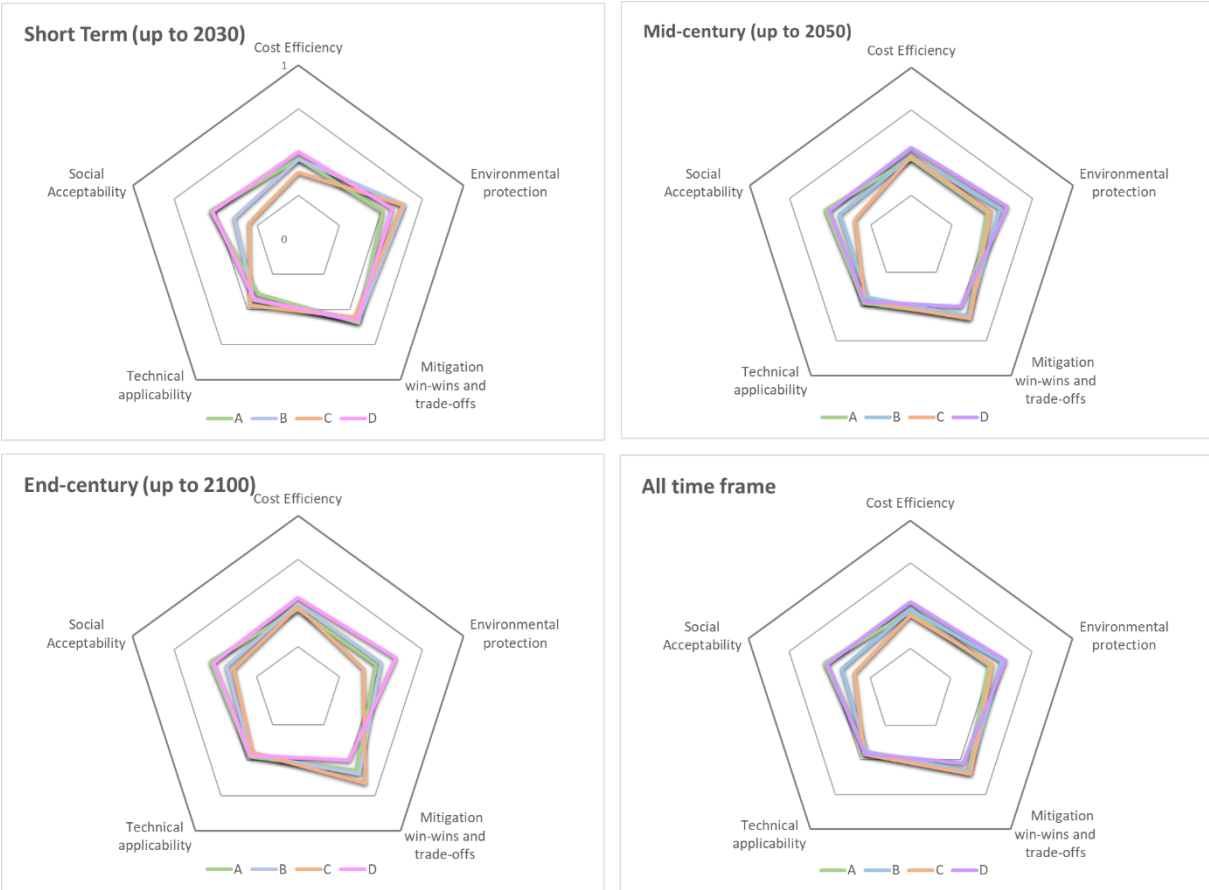


Figure 24. Ranked adaptation pathways for the maritime transport sector in Sardinia considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

10.3.3 Energy

Figure 25 presents the final package of the ranked adaptation pathways for the energy sector in Sardinia.

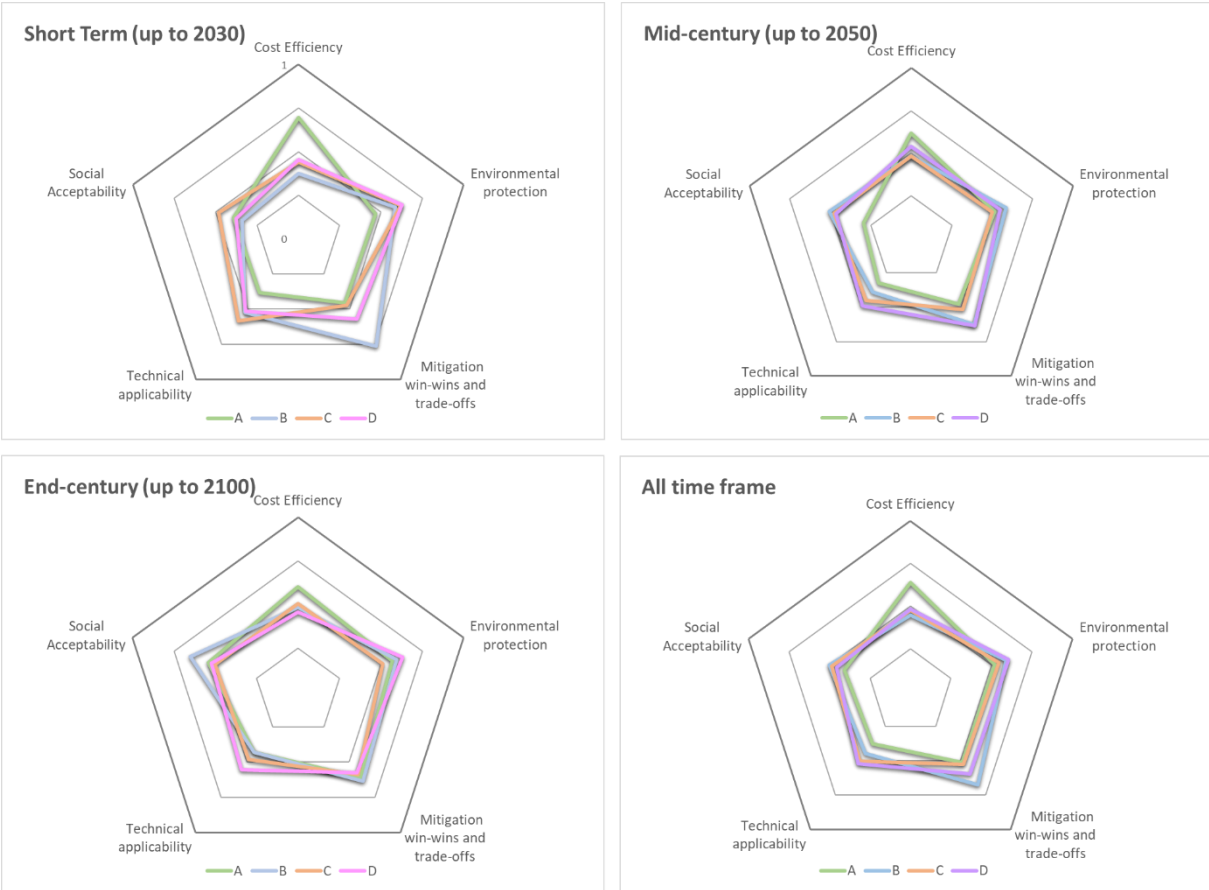


Figure 25. Ranked adaptation pathways for the energy sector in Sardinia considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

10.3.4 Aquaculture

Figure 26 presents the final package of the ranked adaptation pathways for the aquaculture sector in Sardinia.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No776661

Figure 26. Ranked adaptation pathways for the aquaculture sector in Sardinia considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

SOCLIMPACT

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No776661

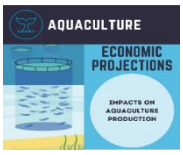
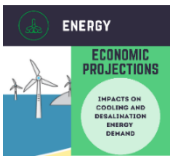
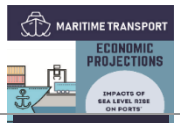
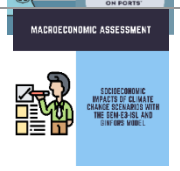
11. Sicily

11.1 Introduction

Table 38 presents a summary of the future projections of CC impacts for Sicily.

Table 38: Summary of future projections of CC impacts for Sicily

Topic	Presentation	Summary
Climate description		- Climate characteristics - Current climate and related risks - Significant climate events
Climate change outlook:		Hazard indicators are projected for two CC scenarios RCP 2.6 (low emissions scenario) and 8.5 (High emissions scenario) and two periods (2046-2065) and (2081-2100). Hazards were selected according to their relevance for 4 blue economy sectors: Tourism, Aquaculture, Energy and Maritime Transport.
Risk analysis, impact chains and islands 'comparison		Risks analysis was undertaken following the concept of impact chains, by considering the relationships of hazards evolution, exposure and vulnerability. The final objective is to achieve a standardised risk score that allow comparison between islands and decision making on adaptation.. In this island the analysis includes: - Tourism (risk of forest fires and marine habitat degradation) - Energy (risk of increased energy demand for cooling and desalination) - Aquaculture (increased fragility of the activity due to increased temperature and extreme weather)
How do tourists react to climate change? **(Factsheets)**		Tourists visiting the island were surveyed in order to analyse their rreactions to the impacts of CC and the preferences for adaptation policies that can be implemented. This information can be utilized to measure the potential decrease in tourism arrivals and the economic impact of adaptation policies.
How do tourists react to climate change? **(videos)**		
How does CC affect travel decisions of European citizens? (Infographic)		2538 EU citizens (frequent travellers) were interviewed. They were asked about their disposition to stay at home and the willingness to pay to visit islands being exposed to several CC risks. Results alert on how CC would affect tourism expenditure in the EU islands. The results are useful to evaluate the priorities in terms of risks management and responsiveness to meet tourists' expectations.
Impacts of increased temperatures on hotels' prices and revenues		Current weather conditions posted on several weather forecast were analysed, as well as daily prices posted on Booking.com by hotels in the island. The link between daily temperature and daily price was estimated, and then projected for the increase in the number of days with excessive temperature projected for the future in two scenarios (RCP2.6 and RCP8.5) and in two time horizons (near future, about 2050; distant future, about 2100).

Big Data Analysis		A specific tool (Google Cloud Vision) is used to scan the content of images posted by tourists on Instagram, while they are on holiday in the islands. Instagram geotagged posts from these islands are scanned according to tourists' publications (identified by a travel-related hashtag, such as #visit #holiday #travel, etc) during summer 2019 (from June to Septem - ber). The map of the island shows the word cloud stemming from the analysis of the pictures' content.
Impact of increased sea surface temperature in aquaculture production (tons)		The effects of increased sea surface temperatures on aquaculture production were calculated using a lethal temperature threshold by specie, and considering the production share of each island, under two RCP scenarios and time horizons, which correspond to four water temperature increases.
Climate change impacts on energy demand for cooling and desalination		The increase in energy demand (GWh/year), needed for cooling buildings and desalinate seawater is estimated for the island under different RCP and time horizons.
Impact of SLR on ports' operation costs		The increased depreciation (amortization) costs caused by Sea Level Rise are estimated for the island's 125 years time horizon under different RCP scenarios of climate change. No discount rate has been applied.
Socio-economic implications of CC for EU islands with cross-sectoral perspective		General Equilibrium models have been used to project socio-economic consequences of CC for the island. Changes in mean temperature, sea level and precipitation rates have been used as input to assess the effects on 14 sectors of economic activity, GDP, consumption, investments and employment

11.2 Final matrix of adaptation and risk management options in Sicily

11.2.1 Tourism

The scoring and the ranking of the adaptation measures for the tourism sector is presented in Table 39. Across the selected adaptation measures, the public awareness programmes (T10) received the highest ranking due to their high technical applicability and social acceptability followed by the dune restoration and rehabilitation (T5) and the activity and product diversification (T9). The health care delivery system (T22) received the lowest ranking due to its low ability to protect the environment and meet mitigation objectives followed by the post-disaster recovery funds (T23).

Table 39: Ranking of adaptation options for the tourism sector in Sicily

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
T1	Economic Policy Instruments (EPIs)	2.00	3.00	3.00	3.00	3.00	2.80
T2	Financial incentives to retreat from high-risk areas	2.00	2.00	2.00	3.00	3.00	2.40
T3	Adaptation of groundwater management	2.00	3.00	3.00	3.00	3.00	2.80
T4	Monitoring, modelling and forecasting systems	3.00	3.00	3.00	3.00	3.00	3.00
T5	Dune restoration and rehabilitation	3.00	3.00	3.00	3.00	4.00	3.20

T6	River rehabilitation and restoration	3.00	3.00	3.00	3.00	3.00	3.00
T7	Adaptive management of natural habitats	3.00	3.00	2.00	3.00	3.00	2.80
T8	Ocean pools	3.00	3.00	3.00	3.00	3.00	3.00
T9	Activity and product diversification	3.00	3.00	3.00	3.00	4.00	3.20
T10	Public awareness programmes	3.00	3.00	3.00	4.00	4.00	3.40
T11	Local circular economy	3.00	3.00	3.00	3.00	4.00	3.20
T12	Tourist awareness campaigns	3.00	3.00	2.00	4.00	4.00	3.20
T13	Local sustainable fishing	3.00	3.00	3.00	3.00	4.00	3.20
T14	Water restrictions, consumption cuts and grey-water recycling	2.00	3.00	3.00	3.00	2.00	2.60
T15	Beach nourishment	2.00	3.00	3.00	3.00	3.00	2.80
T16	Desalination	2.00	3.00	3.00	3.00	3.00	2.80
T17	Coastal protection structures	2.00	3.00	2.00	3.00	3.00	2.60
T18	Drought and water conservation plans	3.00	3.00	3.00	3.00	4.00	3.20
T19	Mainstreaming Disaster Risk Management (DRM)	3.00	3.00	3.00	3.00	4.00	3.20
T20	Using water to cope with heat waves	2.00	2.00	2.00	3.00	4.00	2.60
T21	Fire management plans	3.00	1.00	1.00	3.00	4.00	2.40
T22	Health care delivery systems	3.00	1.00	1.00	3.00	4.00	2.40
T23	Post-Disaster recovery funds	2.00	1.00	2.00	3.00	4.00	2.40
T24	Pre-disaster early recovery planning	3.00	2.00	2.00	3.00	4.00	2.80

11.2.2 Maritime transport

The scoring and the ranking of the adaptation measures for the maritime transport sector is presented in Table 40. The marine life friendly coastal protection structures (MT3) received the highest score mainly due to its high social acceptability followed by the combined protection and wave energy infrastructures (MT4) and the hybrid and full electric ship propulsion (MT5). The least scored adaptation measure is the sturdiness improvement of vessels (MT15) mainly due to its low ability to protect the environment followed by the post-disaster recovery funds (MT24).

Table 40: Ranking of adaptation options for the maritime transport in Sicily

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
MT1	Insurance mechanisms for ports	2.00	1.00	2.00	3.00	4.00	2.40
MT2	Financial incentives to retreat from high-risk areas	3.00	2.00	3.00	3.00	4.00	3.00
MT3	Marine life friendly coastal protection structures	3.00	3.00	3.00	3.00	4.00	3.20
MT4	Combined protection and wave energy infrastructures	3.00	3.00	3.00	3.00	4.00	3.20
MT5	Hybrid and full electric ship propulsion	3.00	3.00	3.00	3.00	4.00	3.20
MT6	Coastal protection structures	3.00	2.00	3.00	3.00	4.00	3.00
MT7	Integrate ports in urban tissue	3.00	1.00	2.00	3.00	4.00	2.60
MT8	Ocean pools	3.00	3.00	3.00	3.00	4.00	3.20
MT9	Awareness campaigns for behavioural change	2.00	2.00	3.00	3.00	4.00	2.80
MT10	Social dialogue for training in the port sector	2.00	2.00	2.00	3.00	3.00	2.40
MT11	Diversification of trade using climate resilient commodities	3.00	2.00	3.00	3.00	3.00	2.80
MT12	Climate resilient economy and jobs	3.00	2.00	3.00	3.00	3.00	2.80

MT13	Refrigeration, cooling and ventilation systems	2.00	2.00	3.00	3.00	3.00	2.60
MT14	Restrict development and settlement in low-lying areas	3.00	3.00	3.00	3.00	3.00	3.00
MT15	Sturdiness improvement of vessels	2.00	1.00	2.00	2.00	3.00	2.00
MT16	Increase operational speed and flexibility in ports	3.00	2.00	3.00	3.00	4.00	3.00
MT17	Climate proof ports and port activities	2.00	2.00	3.00	3.00	3.00	2.60
MT18	Consider expansion/retreat of ports in urban planning	3.00	2.00	3.00	3.00	3.00	2.80
MT19	Reinforcement of inspection, repair and maintenance of infrastructures	3.00	2.00	3.00	3.00	3.00	2.80
MT20	Early Warning Systems (EWS) and climate change monitoring	3.00	2.00	3.00	3.00	3.00	2.80
MT21	Intelligent Transport Systems (ITS)	3.00	1.00	3.00	3.00	3.00	2.60
MT22	Prepare for service delays or cancellations	3.00	1.00	3.00	3.00	4.00	2.80
MT23	Backup routes and infrastructures during extreme weather	3.00	2.00	3.00	3.00	3.00	2.80
MT24	Post-Disaster recovery funds	2.00	1.00	2.00	3.00	4.00	2.40

11.2.3 Energy

The scoring and the ranking of the adaptation options for the energy sectors is presented in Table 41. Urban green corridors (E6) is the most highly ranked measure due to it high cost-efficiency as well as its high technical applicability and social acceptability followed by the educational garden plots (E7) and the energy efficiency in urban water management (E3). The least scored adaptation measures include the local recovery energy outage capacity (E24), mainly due to its very low ability to protect the environment, and the local recovery energy outage capacity (E24).

Table 41: Ranking of adaptation options for energy sector in Sicily

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
E1	Financial support for buildings with low energy needs	2.00	3.00	3.00	3.00	4.00	3.00
E2	Financial support for smart control of energy in houses and buildings	2.00	3.00	3.00	3.00	4.00	3.00
E3	Energy efficiency in urban water management	3.00	3.00	3.00	4.00	4.00	3.40
E4	Underground tubes and piping in urban planning	3.00	3.00	3.00	3.00	3.00	3.00
E5	Biomass power from household waste	3.00	3.00	3.00	3.00	4.00	3.20
E6	Urban green corridors	4.00	3.00	3.00	4.00	4.00	3.60
E7	Educational garden plots	4.00	3.00	3.00	4.00	4.00	3.60
E8	Heated pools with waste heat from power plants	3.00	3.00	3.00	3.00	4.00	3.20
E9	Green jobs and businesses	3.00	3.00	2.00	3.00	4.00	3.00
E10	Public information service on climate action	3.00	2.00	2.00	3.00	3.00	2.60
E11	Small scale production and consumption (prosumers)	3.00	3.00	3.00	4.00	4.00	3.40
E12	Risk reporting platform	3.00	2.00	2.00	3.00	3.00	2.60
E13	Energy storage systems	3.00	3.00	3.00	3.00	4.00	3.20
E14	Collection and storage of forest fuel loads	3.00	3.00	3.00	4.00	4.00	3.40
E15	SeaWater Air Conditioning (SWAC)	3.00	3.00	3.00	3.00	4.00	3.20

E16	Demand Side Management (DSM) of Energy	3.00	3.00	3.00	4.00	4.00	3.40
E17	Review building codes of the energy infrastructure	3.00	2.00	2.00	4.00	4.00	3.00
E18	Upgrade evaporative cooling systems	2.00	2.00	3.00	2.00	3.00	2.40
E19	Early Warning Systems (EWS)	3.00	2.00	3.00	3.00	3.00	2.80
E20	Grid reliability	3.00	2.00	3.00	3.00	4.00	3.00
E21	Study and develop energy grid connections	2.00	2.00	3.00	3.00	3.00	2.60
E22	Energy-independent facilities (generators)	3.00	2.00	3.00	3.00	3.00	2.80
E23	Energy recovery microgrids	3.00	1.00	2.00	3.00	4.00	2.60
E24	Local recovery energy outage capacity	2.00	1.00	2.00	3.00	4.00	2.40

11.2.4 Aquaculture

The scoring and the ranking of the adaptation options for aquaculture is presented in Table 42. Five measures across the selected 24 adaptation measures had the highest average score, namely, the promotion of aquaculture cuisine (A8), the awareness campaigns for behavioural change (A9), the promotion of cooperation to local consumption (A12), the environmental monitoring and Early Warning Systems (A20) and the mainstreaming of disaster risk management (A21), due to their high technical applicability and social acceptability. On the contrary, the financial schemes, insurance and loans (A1) received the lowest ranking due to its low ability to protect the environment and to meet mitigation objectives followed by the Recirculation Aquaculture Systems (A15).

Table 42: Ranking of adaptation options for aquaculture in Sicily

ID	Name	Cost Efficiency	Environmental protection	Mitigation win-wins and trade-offs	Technical applicability	Social Acceptability	Average
A1	Financial schemes, insurance and loans	2.00	1.00	1.00	3.00	4.00	2.20
A2	Tax benefits and subsidies	2.00	3.00	3.00	3.00	4.00	3.00
A3	Feed production	2.00	2.00	3.00	2.00	3.00	2.40
A4	Species selection	3.00	2.00	1.00	3.00	3.00	2.40
A5	Selective breeding	3.00	2.00	1.00	3.00	3.00	2.40
A6	Best Management Practices	3.00	3.00	2.00	3.00	4.00	3.00
A7	Create educational visits	3.00	2.00	2.00	3.00	4.00	2.80
A8	Promote aquaculture cuisine	3.00	3.00	3.00	4.00	4.00	3.40
A9	Awareness campaigns for behavioural change	3.00	3.00	3.00	4.00	4.00	3.40
A10	Efficient feed management	3.00	3.00	3.00	3.00	4.00	3.20
A11	Addressing consumer and environmental concerns at the local level	2.00	2.00	2.00	3.00	3.00	2.40
A12	Promote cooperation to local consumption	3.00	3.00	3.00	4.00	4.00	3.40
A13	Integrated multi-trophic aquaculture (IMTA)	3.00	3.00	3.00	3.00	3.00	3.00
A14	Short-cycle aquaculture	3.00	2.00	2.00	3.00	3.00	2.60
A15	Recirculation Aquaculture Systems (RAS)	2.00	2.00	2.00	3.00	3.00	2.40

A16	Submersible cages	2.00	3.00	3.00	3.00	3.00	2.80
A17	Climate proof aquaculture activities	3.00	2.00	2.00	3.00	4.00	2.80
A18	Risk-based zoning and site selection	3.00	2.00	2.00	4.00	4.00	3.00
A19	Disease prevention methods	3.00	2.00	2.00	3.00	4.00	2.80
A20	Environmental monitoring and Early Warning Systems (EWS)	3.00	3.00	3.00	4.00	4.00	3.40
A21	Mainstreaming Disaster Risk Management (DRM)	3.00	3.00	3.00	4.00	4.00	3.40
A22	Contingency for emergency management, early harvest and/or relocation	2.00	2.00	3.00	3.00	3.00	2.60
A23	Recovery Post-Disaster plans	2.00	3.00	3.00	4.00	4.00	3.20
A24	Recovery Post-Disaster funds	3.00	1.00	2.00	3.00	4.00	2.60

11.3 Final package of ranked adaptation pathways in Sicily

11.3.1 Tourism

Figure 27 presents the final package of the ranked adaptation pathways for the tourism sector in Sicily. The ranking of the four APT scenarios is quite similar for the mid- and long-term timeframes. In general, all APTs exhibit a high level of social acceptability and technical applicability and a medium mitigation, cost-efficiency and environmental protection performance. In particular, in the short-term, the APTC has the best cost efficiency and the APT D exhibits the best environmental protection, mitigation capacity, social acceptability and technical applicability.

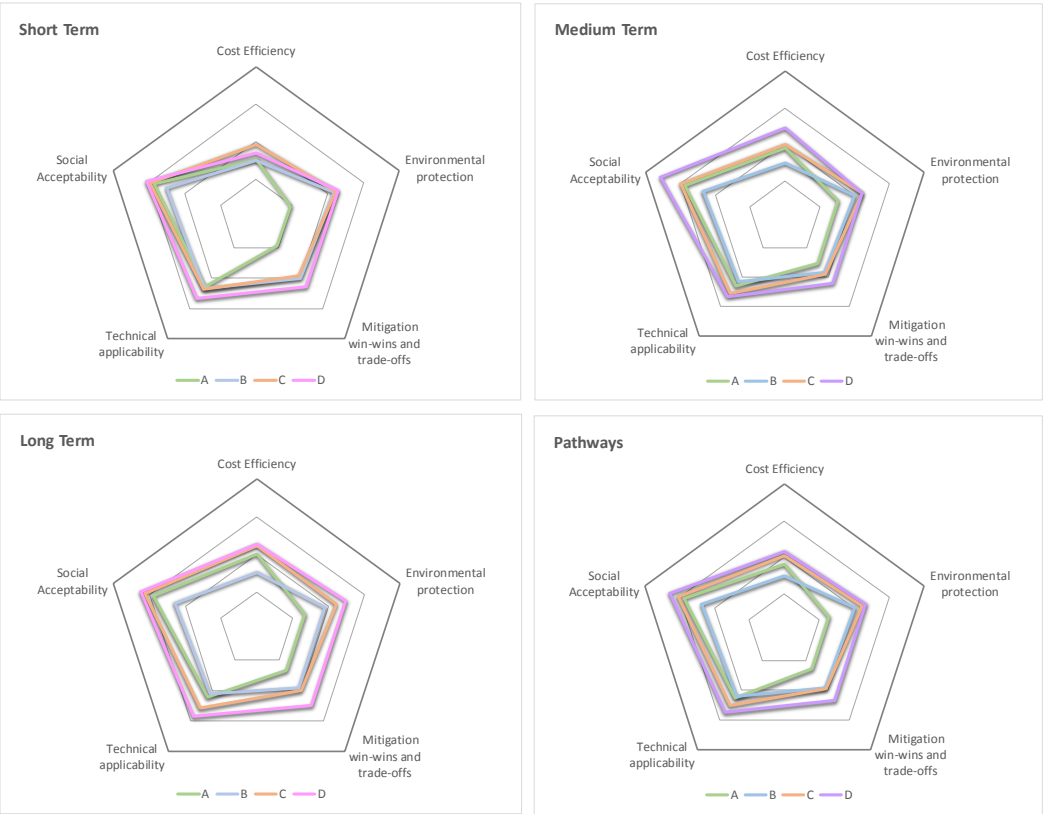


Figure 27. Ranked adaptation pathways for the tourism sector in Sicily considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C-

Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

11.3.2 Maritime transport

Figure 28 presents the final package of the ranked adaptation pathways for the maritime transport sector in Sicily. In general, all four APTs scenarios exhibit a similar ranking, especially from 2050 up to 2100, that is, a relatively high social acceptability and technical applicability, an average mitigation and cost efficiency performance and a low environmental protection. More specifically, the APT C exhibits the best cost efficiency, environmental protection and mitigation performance, while the APT D has the best social acceptability and technical applicability performance. Considering the different timeframes, in the short term, the APT D exhibits the best performance in all criteria except of the cost efficiency. In the medium- and long-time, the APT B exhibits the best performance for all criteria.

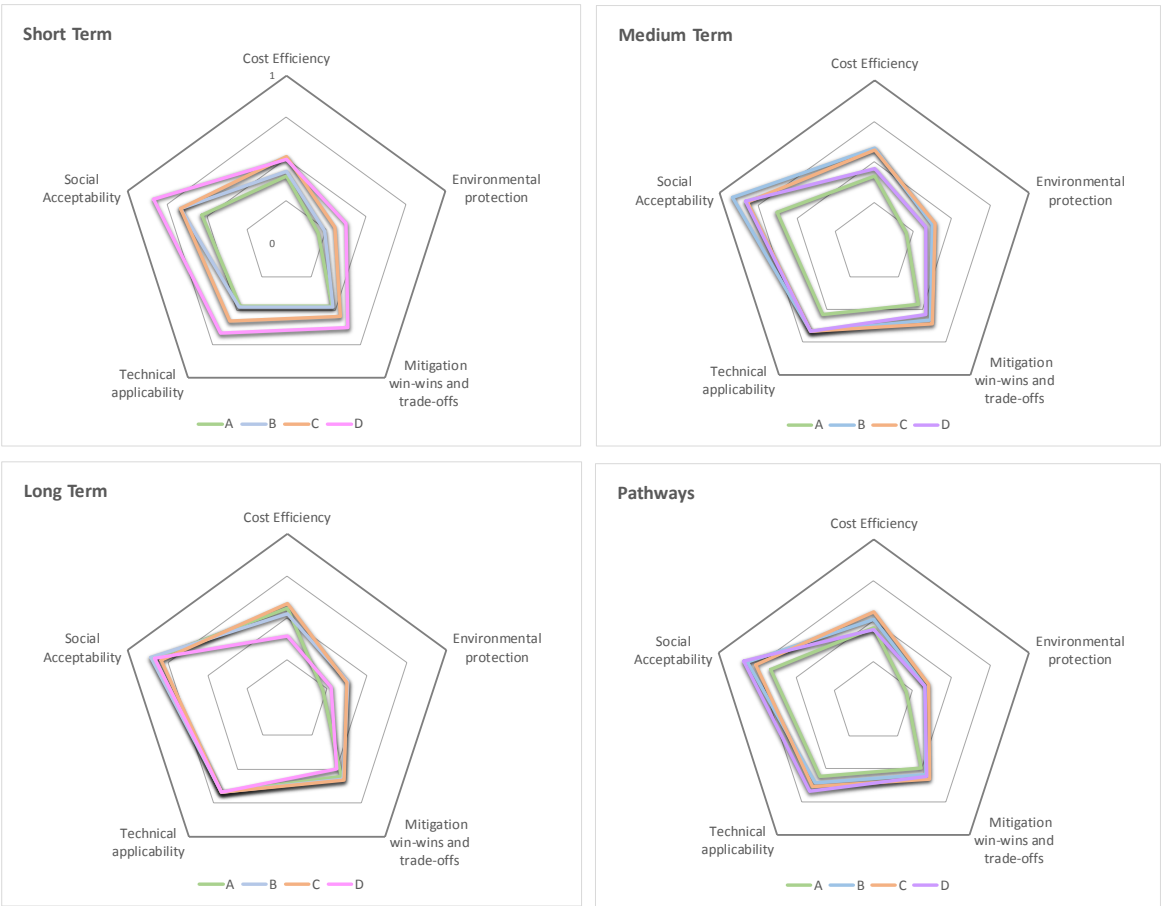


Figure 28. Ranked adaptation pathways for the maritime transport sector in Sicily considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

11.3.3. Energy

Figure 29 presents the final package of the ranked adaptation pathways for the energy sector in Sicily. In general, the APT C exhibits the best cost efficiency, while the APT D has the best performance for the rest four criteria. On the contrary, the APT A exhibits the worst performance across all evaluation criteria, mainly in terms of cost efficiency, mitigation and environmental protection. In the short-term, the APT B provides the best environmental protection, the APT C the best combination of cost efficiency and mitigation, while the APT D exhibits the best performances in terms of technical applicability and social acceptability. In the medium-term, the APT C has the best cost efficiency performance, while the APT D prevails in the rest evaluation criteria. Similarly, in the long-term, the APT C has the performance for cost efficiency and technical applicability, while the APT D exhibits the best environmental protection, mitigation and social acceptability performance. Finally, the social acceptability shows the higher scoring among all evaluation criteria across all APTs and timeframes.

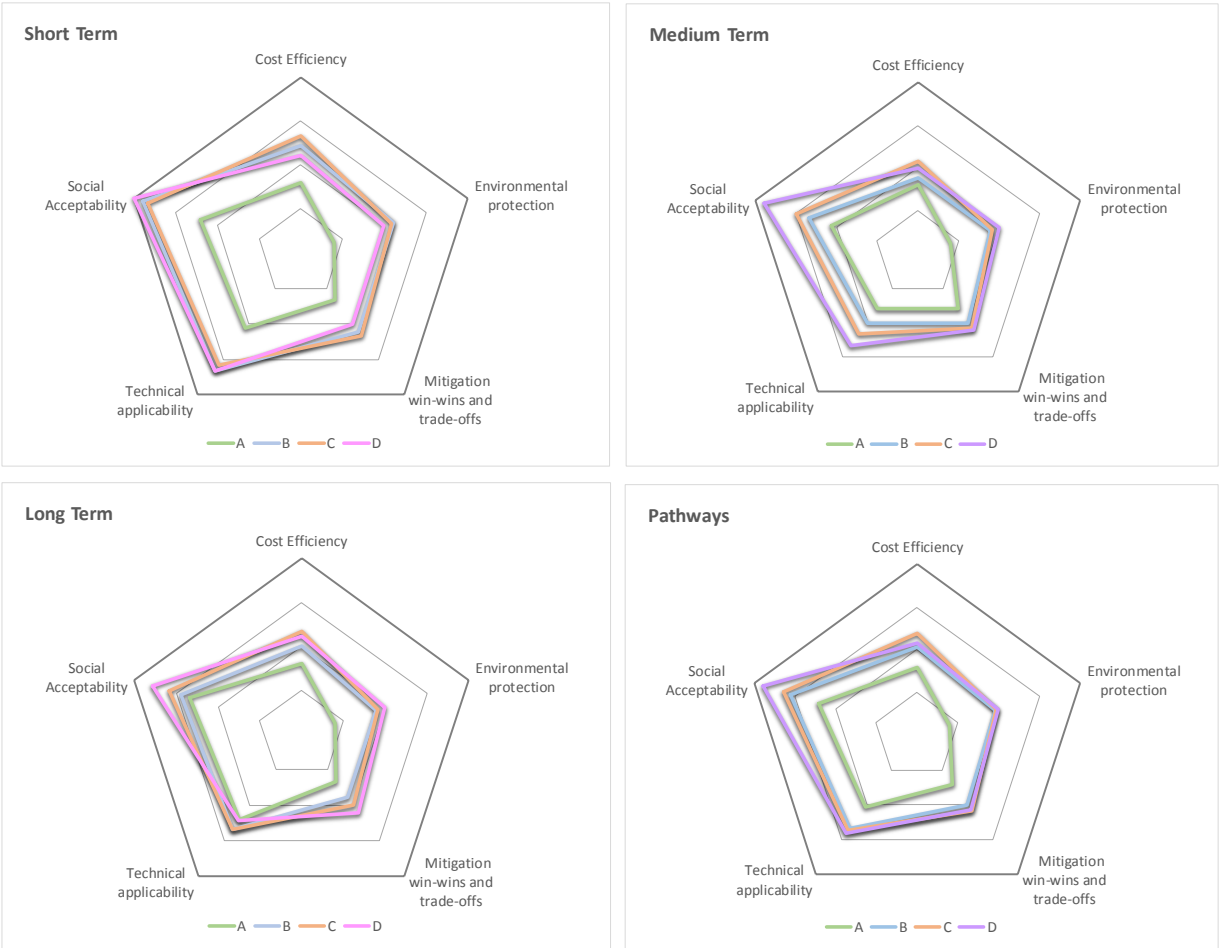


Figure 29. Ranked adaptation pathways for the energy sector in Sicily considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C-

Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

11.3.4 Aquaculture

Figure 30 presents the final package of the ranked adaptation pathways for the aquaculture in Sicily. In general, the APT B exhibits the worst cost efficiency, mitigation and environmental protection performance. On the contrary, the APT D exhibits the best performance in all evaluation criteria except for the environmental protection for which the APT C scenario has the highest ranking. More specifically, the APT D exhibits the best performance in the short-term period, while the APT C exhibits the best ranking in the medium- and long-term timeframe. Finally, it can be said that the social acceptability and technical applicability exhibit the best performance especially in the mid-long term period. On the contrary, the environmental protection and the mitigation exhibits the worst performance in all APTs and under all timeframes.

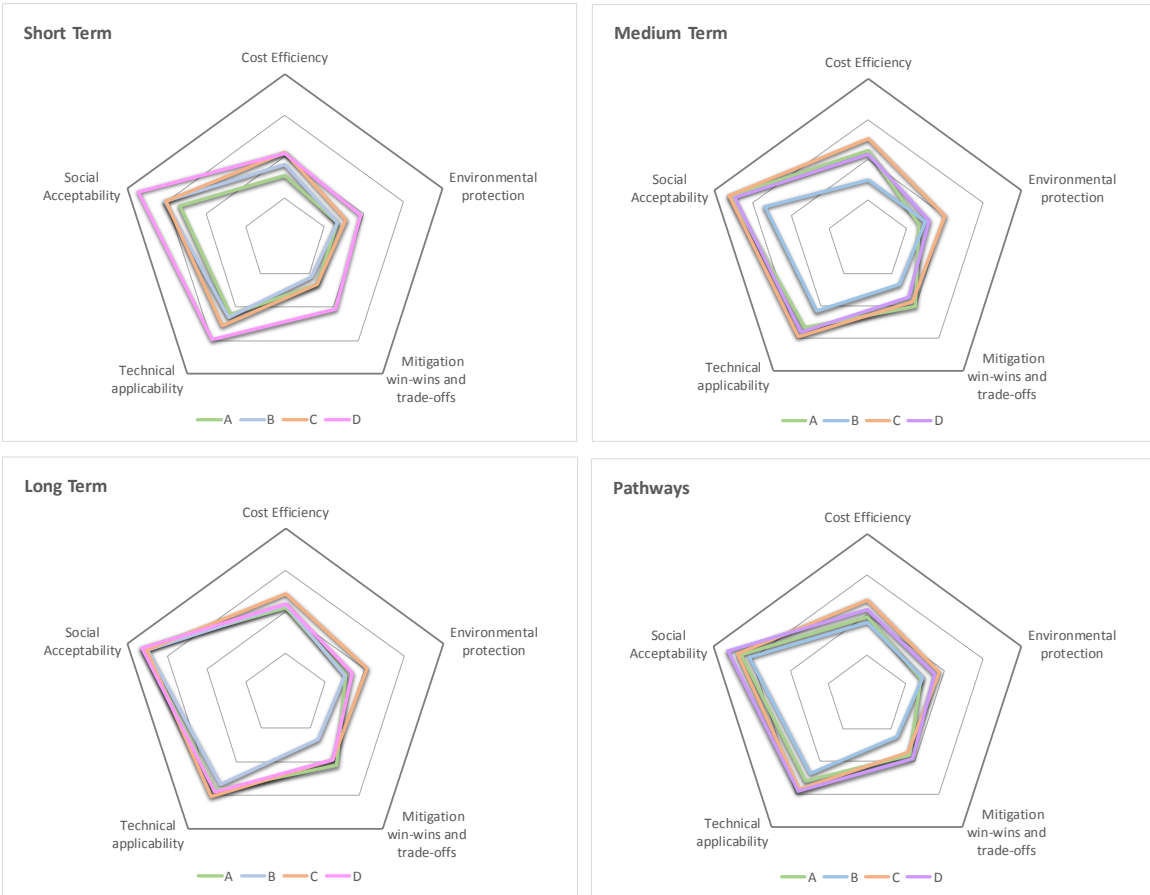


Figure 30. Ranked adaptation pathways for aquaculture in Sicily considering the five criteria: Cost Efficiency; Environmental protection; Mitigation win-wins and trade-offs; Technical applicability; Social acceptability. The policy pathways scenarios: APT A - Minimum Intervention; APT B - Economic Capacity Expansion (ECE); APT C- Efficiency Enhancement (EE); APT D - System Restructuring (SR), for different timeframes: short, medium, and long term

MONITORING PLAN AND BLUE ECONOMY SECTORS INDICATORS

12. Theoretical framework

The next step in Deliverable 7.4, after the ranking of the developed adaptation pathways, is the formulation of a monitoring plan for monitoring the level of implementation of the adaptation pathways and measures. Monitoring is the systematic collection of data, based on pre-defined indicators, to enable competent authorities and stakeholders to check whether adaptation measures or policies are on-track and whether the stated objectives can be achieved (OECD, 2002; Lamhauge et al., 2012; Klostermann et al., 2018).

Monitoring refers to a continuous process of examining progress made in planning and implementing climate adaptation (EEA, 2015). It consists an important component of adaptation process that aims to improve the effectiveness and efficiency of adaptation action by monitoring its outcomes and continuously learning from them (OECD, 2017). Learning aims to enhance stakeholders' understanding on climate change risks and vulnerabilities over time, and whether adaptation interventions are achieving their objectives, thus improving the planning or the implementation of adaptation strategies (OECD, 2015). It examines the drivers which shape resilience and vulnerability (EEA, 2015) and ensures that resources for adaptation are efficiently allocated (OECD, 2017).

A monitoring system forms an iterative process that includes the assessment of impacts, vulnerabilities and risks, planning for adaptation and the implementation of adaptation actions (Figure 31).

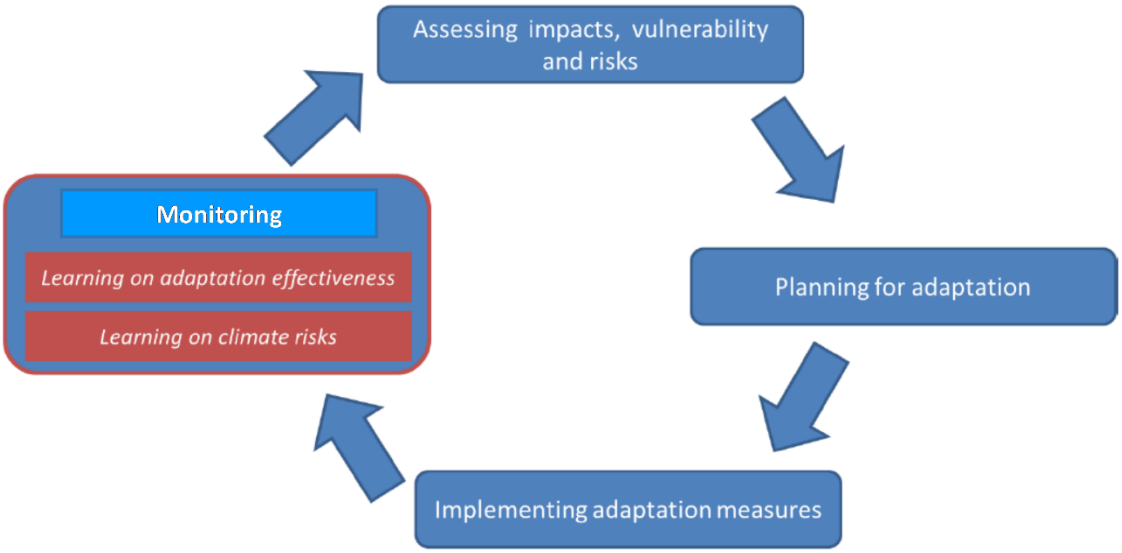


Figure 31. Iterative adaptation cycle

Source: OECD (2017)

SOCLIMPACT adaptation monitoring plan is based on the adaptation framework developed by Klostermann et al. (2018). It consists of four building blocks: (a) definition of the system of interest, (b) selection of indicators, (c) identification of the organizations responsible for monitoring, (d) definition of monitoring procedures. The individual building blocks are described below.

12.1. System of Interest

The interest for the SOCLIMPACT monitoring system is defined in the formulated adaptation pathways[3] and consists of 4 blue economy sectors, namely tourism, aquaculture, marine energy and maritime transport, across 12 EU islands. The adaptation context within this system links the climate system, climate impacts, adaptive capacities, vulnerabilities and adaptation measures and provides information on exposure, sensitivities, impacts, adaptive capacity, vulnerability and adaptation action as described in the formulation of the theoretical and operationalized Impact Chains (IC) developed in Deliverable 4.5.

The monitoring plan of the adaptation pathways across the four SOCLIMPACT blue economy sectors can allow the follow-up progress in the implementation of the suggested adaptation measures and can provide governance information as well as information on good practice.

12.2 Indicators

A critical component of the adaptation monitoring process is the creation of long-term data sets that encompass the expected effects and the final outcomes in terms of changes in the identified risks (OECD, 2017). It is crucial to monitor the climate itself to enable adaptation policies and measures to be normalised against a shifting baseline (Harley et al., 2008; Klostermann et al., 2018). This information combined with data on the trends of the climate drivers can provide a baseline for the analysis and evaluation of the outcomes and the effectiveness of adaptation pathways. Lastly, the monitoring plan has to be produced based on credible indicators (Walker et al., 2013), which should be precise, robust, simple and easy to understand (Harley et al., 2008). Indicators play an essential role in the monitoring of adaptation policy implementation as well as of changing vulnerability and resilience, on an on-going basis (EEA, 2015).

EEA (2015) distinguishes two groups of indicators, namely, indicators from an adaptation perspective and indicators from a policy cycle perspective. Here, we follow the first approach; in particular, the selection of indicators to monitor progress in adaptation is determined by the SOCLIMPACT adaptation context (ICs) as it is expressed in the formulated adaptation pathways (system of interest). Specifically, the SOCLIMPACT monitoring plan relies on a combination of indicators that provide information on (Table 43):

(a) climate hazards
(b) exposure
(c) sensitivity
(d) adaptation outcomes.

[3] See Deliverable 7.3

The specific indicators per blue economy sector and island are presented in the following sections.

Table 43. Illustrative indicator types to monitor SOCLIMPACT adaptation pathways

Indicator type	Definition	Examples of indicator
Climate hazard	A significant climate-related physical process or event (hydro-meteorological or oceanographic variables or phenomena) that is likely to be modified n a way that it can harm human health, livelihoods, or natural resources.	Number of cooling degree days per year
Exposure	The presence of people, livelihoods, species or ecosystems, environmental services and resources, infrastructure, or economic, social, or cultural assets in places that could be adversely affected by a hazard.	Residents population; number of tourists;
Sensitivity*	The degree to which a system may be affected, either adversely or beneficially, when exposed to climate variability or change.	Per capita energy demand
Adaptation outcomes	Adaptation measures that represent: - Alternative adaptation measures proposed by regional stakeholders in the island –Local Knowledge- - Measures that were more frequently chosen by stakeholders as a policy response to the different future scenarios of CC expected for the island, and the priority risks to be face. This is, more than 60% of the interviewees considered necessary the measure, in any of the policy directions analysed –APTs.	Level of production of hydrogen as energy vector/year

Source: Deliverable 3.3; IPCC (2014); World Bank (2020)

*The sensitivity of a sector to changes in climate and its adaptive capacity are the two components of vulnerability, that is defined as the propensity of a sector to suffer the adverse effects of climate change, climate variability and extremes.

12.3 Monitoring processes

Monitoring processes are analytical plans that guide the collection, management, analysis and reporting of data and outline the data collection timeline (Oakley et al. 2003). These procedures can determine the specific quality requirements for the collection of the data.

A clear definition of the responsibilities for data gathering and evaluation is required for an effective and efficient monitoring process (Biesbroek et al. 2010). The responsible organization should be permanent and equipped with appropriate resources (human, technical, financial) to gather data on climate adaptation on an ongoing scale (Swart et al., 2009).

Within the monitoring processes building block, we also include the concept of tipping points when available. In climate change communication, the use of tipping points often illustrates 'points of no return (Kwadijk et al., 2010). In particular, tipping points are defined as the points where the magnitude of change due to climate change is such that the current management strategy will no longer be able to meet the objectives (Kwadijk et al., 2010). However, there has been little empirical or theoretical engagement with tipping points in the climate change adaptation process (Garschagen and Soletzki, 2017). In Soclimpact, tipping points are provided for some specific

climate variables (i.e, a range of water temperature as a threshold for thermal stress-lethal impact on the cultured species).

12.4 Monitoring plan matrices per blue economy sector and island

Individual matrices of the monitoring plan indicators are presented in the following subsections for each island and blue economy sector. Indicators have been selected in each island according to:

1) The climate hazards that mostly alert on future worsened scenarios caused by CC. This is, those hazards with significant changes according to the climate modelling phase of the Soclimpact project. This does not mean that they are the only CC impacts that shall be taken into account in regard adaptation policy design, however, according to our knowledge, they are dominant as contribute to put the island under very high risk. Although policy makers and practitioners cannot change the climate, these indicators inform about physical changes that need to be monitored closely for the island.

2) The different dimensions of exposure and vulnerability analysed in the islands, which were identified as critical factors that intervene (more pressure) in the intensification of the CC risks for the island. These indicators require a periodic measuring of their performance in the islands, and especially for those regions that do not have reliable information systems within the same.

3) The potential adaptation measures that are of mandatory application in the medium-long term in the island, according to the regional stakeholders' views and opinions. These measures are translated into monitoring indicators of actions, that islands may implement and monitor to minimize their exposure and vulnerability to CC. The set of indicators has been validated by external experts, ensuring their appropriateness and viability of the collection of the data needed .

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12.5 Azores

12.5.1 Maritime transport sector

Indicators type	Indicators	Definition	Responsible organisation	Monitoring Processes	Interpretation
Climate hazard	Mean sea level rise	Annual mean sea level (cm)	Direção Regional do Ambiente e Alterações Climáticas	Annual estimations	Status-quo (1995-2020) = +3mm/ yr Business as usual: (up to 2050) + 17 mm/yr (up to 2100) +34.5 mm/yr
Exposure	Passengers	Number of passengers	Direção Regional dos Transportes Aéreos e Marítimos Serviço Regional de Estatística dos Açores	Annual estimations	These are critical factors worsening (more pressure) the risk of isolation due to transport disruption. These indicators require a periodic measuring of their performance.
	Population	Number of island's inhabitants			
	Value of transported goods	Value of goods transported by ships (in freight)			
	Number of port infrastructures	Number of ports			
Sensitivity	Quality of infrastructure and equipment	Number of ports with critical infrastructure not renovated since 1993		Annual updates	
	Island dependence on maritime transport	Number of isolation days from the main land			
	Existence and efficiency of early warning systems	Number of active oceanographic stations			
Adaptation response –	**Strengthen coastal protection, giving priority to the maintenance and adaptation of urban areas and port infrastructures**	➢ Percentage of coastal urban areas with planning including the assessment of their resistance and maintenance work scheduled. ➢ Percentage of maritime transport activity linked to port infrastructures having assessment of their resistance and maintenance work scheduled.		Yearly basis	The climate scenarios point to an increased probability of occurrence of extreme weather events in the RAA. As part of the POOC review, the adequacy of the protection response must be assessed and the degree of resistance of the existing works evaluated, establishing an adequate schedule of needs in terms of maintenance, adaptation or construction of new works.
	Evaluate and plan retreat of buildings /infrastructures from risk areas, through cost-benefit analysis	➢ Percentage of buildings/infrastructures in declared risk coastal areas with cost-benefit analysis on their retreatment from the coast line. ➢ Financial support to retreat buildings and infrastructures from the coast line. Yearly.	Direção Regional do Ordenamento do Território e dos Recursos Hídricos	Yearly basis	Buildings or infrastructures in risk areas relocation in cases of greater sensitivity and vulnerability. Developed within the appropriate territorial management instruments. Cost-benefit analysis should be performed to manage the relocation actions.

	Strengthen coastal monitoring	➢ Percentage of coastal areas covered by a monitoring plan with observation and measuring coastline climate-induced phenomena like erosion, floods, cliffs instability and systematic reporting.	Direção Regional do Ambiente e Alterações Climáticas	Yearly basis	Monitoring the occurrence of coastline phenomena such as erosion, overflow / flood, and instability of the cliffs, which generate risk situations for people and property. It is therefore essential to ensure greater monitoring of coastal risks, considering the scenarios of Climate Change for medium- and long-term time horizons. Including monitoring and systematic analysis of sedimentary dynamics, coastline evolution and coastal protection performance on going.

12.5.2 Energy sector

Indicators type	Indicators	Definition	Responsible Organization	Monitoring Processes	Interpretation
Climate hazard	Number of cooling degree days (CDD) per year	Temperature difference above 18ºC in each year, calculated using average daily temperature values.	Delegação Regional dos Açores do IPMA	Annual estimations	Ref CDD= 28.22 Business as usual (SRES A1B) (up to 2050): 90.84CDD *The indicator is computed by multiplying the number of days exceeding the threshold by the difference in temperatures.*
Exposure	Population	Number of island's inhabitants	Serviço Regional de Estatística dos Açores	Annual estimations	These are critical factors worsening (more pressure) the risk of increased energy demand for cooling buildings and desalinate seawater These indicators require a periodic measuring of their performance.
	Tourists	Number of tourists	Direção Regional do Turismo		
	Tourism seasonality	Annual min-max variation of tourists			
	Cooling penetration rate	Share of households with air-conditioning	Serviço Regional de Estatística dos Açores	Five-year estimations	
	Desalination	Percentage of desalinated water to total water consumption	Entidade Reguladora dos Serviços de Águas e Resíduos dos Açores	Annual estimations	
Sensitivity	Per capital energy demand	Energy demand (MWh) per person	Serviço Regional de Estatística dos Açores	Annual estimations	
	Energy intensity	Energy use (in MWh) per gross domestic product (GDP) (in M€)			
Adaptation response –	**Develop risk maps for the electrical infrastructure**	➢ Existence of a mapped and effective tool for risks identification, per type of infrastructure. ➢ Number of electric infrastructures of energy production, transport and distribution covered by a mapped and	Direção Regional da Energia	Yearly basis	Develop maps to better protect and identify climate risks in the infrastructure (production, transport, and distribution centers) and plan expansion or changes in the infrastructure.

		effective tool for risks identification, per type of infrastructure / TOTAL			
	Assess and map impacts caused in quality and power reserves through changes in climate patterns	➢ Existence of a plan to identify and assess impacts caused in quality and power reserves.	Direção Regional da Energia	0;1	Evaluate and map RES (Renewable Energy Sources) production and the impacts associated with unfavourable climatic patterns to production. It can be also used to identify additional effort or actions to regulate quality and power in the present and for the future.
	Energy storage systems	➢ MWh of renewable storage capacity by different types (batteries, thermal tanks, water height...). ➢ Percentage of renewable storage capacity over the total renewable energy.	Direção Regional da Energia		This allows for a more resilient energy grid while enabling decarbonization and peak levelling at a controlled cost. This includes not only electric batteries (like those in cars and buses), but also other forms of energy storage such as thermal tanks (heat), ice banks (cold) or water height (reversed pumping).
	Energy efficiency in urban water management	➢ Water storage capacity in m3. ➢ Number of days that water demand may be met by stored water. ➢ Percentage of aquifer downloading/overloading. Yearly. ➢ Percentage of water climatization and powered by low enthalpy geothermal and aerothermal energy.	Entidade Reguladora dos Serviços de Águas e Resíduos dos Açores	Yearly basis	The adaptation of urban design and construction for water conservation that avoids energy use under scarcity scenarios. For instance, Water Sensitive Urban Design (WSUD) aims to plan water conservation and storm water storage with integration with elements of urban design.

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12.5.3 Tourism sector

Indicators type	Indicators	Definition	Responsible Organization	Monitoring Processes	Interpretation
Climate hazards	Beach reduction	Percentage of reduction of beach area	Direção Regional do Ordenamento do Território e dos Recursos Hídricos		Status-quo (1995-2020) = -4 to 8m of beach area depending on the beach Business as usual: (up to 2050): - 85% (up to 2100): -99%
	Humidity Index	Number of days exceeding 35˚C	Delegação Regional dos Açores do IPMA		Business as usual: SRES A1B (up to 2050): 35.5 days
Exposure	Coast	Size of the coastline (km)	Direção Regional do Ordenamento do Território e dos Recursos Hídricos	Five-year updates	These are critical factors worsening (more pressure) the risk of: loss of attractiveness for tourists due to: - the degradation of marine environments, - decreased thermal comfort These indicators require a periodic measuring of their performance
	Corals	Density of corals and other marine species	Direção Regional dos Assuntos do Mar	Five-year updates	
	Marine ecosystem	Marine ecosystem size (ha)	Direção Regional dos Assuntos do Mar	Five-year updates	
	Tourists	Number of tourists	Direção Regional do Turismo	Annual estimations	
		Tourist characteristics (age, gender etc.)		Annual estimations	
		Type of tourism (sport, pleasure etc.)		Annual estimations	
	Population	Population density (persons/km²)	Serviço Regional de Estatística dos Açores	Annual estimations	
Sensitivity	Pollution	Pollution from human activities	Direção Regional do Ambiente e Alterações Climáticas	Five-year updates	These are critical factors worsening (more pressure) the risk of: loss of attractiveness for tourists due to: - the degradation of marine environments, - decreased thermal comfort These indicators require a periodic review of their performance
	Marine species	Sensitivity of marine species	Direção Regional dos Assuntos do Mar	Five-year updates	
Adaptation response –	**Adapt tourism promotion to Climate Change risks**	➢ Degree of adaptation of tourist promotion to climate change risks, assessed by external experts on a 1-5 Likert scale.	Direção Regional do Turismo	Yearly basis	Adapt the promotion of tourism to Climate Change aims to maximize opportunities for tourism development.
	Improve Natura 2000 habitats - terrestrial, coastal and marine habitats.	➢ Hectares of increase of natural areas under protection. ➢ Percentage of total protected areas interconnected by ecological corridors. ➢ Hectares of restored natural areas.	Direção Regional do Ambiente e Alterações Climáticas	Hectares/year	Create new protected areas or ecological corridors and restore/ protect habitats considering the Climate Change risk.

	Adapt agroforestry systems to drought conditions	➢ Percentage of agroforest areas that have adopted water use rationalization patterns and of landscape rehabilitation, resulting in enhanced tourist attractiveness. ➢ Financial support to agroforestry systems for water use rationalisation and landscape rehabilitation.	Direção Regional da Agricultura	Yearly basis	Increase and improve the water supply systems to farms, considering the installation of water meters and the application of fees / tariffs. This option links up the agroforestry (landscape mosaic and products) with the tourism attractiveness.
	Create water storage reservoirs to ensure water availability without overloading natural resources in times of scarcity.	➢ Water storage capacity in m3. ➢ Number of days that water demand may be met by stored water. ➢ Percentage of aquifer downloading/overloading.	Entidade Reguladora dos Serviços de Águas e Resíduos dos Açores	Yearly basis	Frequency and intensity of periods of water scarcity may occur more often. Maximizing water storage capacity without increasing pressure on resources will allow greater resilience in times of scarcity without affecting water resources
	Create a mosquito detection information system	➢ Existence of an information system on mosquitos capable to act as vector-borne for contagious diseases, to support administrative and collective action.	Direção Regional da Saúde	0;1 An expert assessment of the system appropriateness may be also considered.	The mosquito detection information system (a public access portal where the presence of mosquitoes is reported) is a surveillance and detection process to raise awareness on vector-borne diseases, involving the local community.
	Define protection regime for "Maximum Infiltration Zones", within the scope of the current and climate change risks.	➢ Existence of a protection category for Maximum Infiltration Zones. ➢ Percentage of zones effectively declared and performing as Maximum Infiltration Zones over the total suitable zones.	Direção Regional do Ordenamento do Território e dos Recursos Hídricos	0;1 Yearly basis	Define protection regime for "Maximum Infiltration Zones", within the scope of the current and climate change risks. It is intended to adapt the regime of uses and activities to be applied to strategic areas of protection and recharge of aquifers.

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12.5.4 Aquaculture

Indicators type	Indicators	Definition	Responsible Organization	Monitoring Processes	Interpretation
Climate hazard	Surface water temperature	Changes in surface water temperature	Delegação Regional dos Açores do IPMA	Climate modelling	seam bream: 26ºC - 33 ºC sea bass: 25 ºC – 35.9 ºC tuna: 24 ºC – 26.17 ºC mussels: 20.5 ºC – 27.0 ºC
Exposure	Farm area	Area occupied by sea cages (m^2)	Secretaria Regional do Mar e das Pescas	Annual estimations	There is a lack of reliable statistics related to exposure indicators. This is the first action to be undertaken
	Value of stock	Value of biomass in the cages	Secretaria Regional do Mar e das Pescas		
	Stock size	Annual production of aquaculture products (fish and shellfish) (in tons)	Secretaria Regional do Mar e das Pescas	Annual estimations	
	Employment	Number of employees	Secretaria Regional do Mar e das Pescas	Annual estimations	
	Location of farms	Location of farms related to the prevailing wind direction	Secretaria Regional do Mar e das Pescas	Five-year updates	
		Location of farms related to the average distance to shore	Secretaria Regional do Mar e das Pescas	Five-year updates	
	Sensitivity of species	Vulnerability of species to climate change	Secretaria Regional do Mar e das Pescas	Literature review; aquaculture experts	
	Sensitivity of infrastructure	Vulnerability of infrastructure (type and materials of cages) to extreme weather events	Secretaria Regional do Mar e das Pescas	Literature review; aquaculture experts	
Adaptation response –	The aquaculture sector in the Azores aims to contribute to the creation of business niches associated with aquaculture products, providing opportunities for social development and employment and, at the same time, increasing regional productivity without increasing the extractive pressure on fishery resources. The sector is still developing in the Region, and conditions are still being defined for the exercise of the activity on an experimental or scientific basis. It is proposed the creation of a strategic plan for aquaculture development containing suitable requirements to minimise exposition and maximise resilience against the potential negative impacts of climate change. (*) (*) An expert assessment of the plan suitability may be also considered.				

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12.6 Balearic Islands

12.6.1 Maritime transport sector

Indicators type	Indicators	Definition	Responsible Organization	Monitoring Processes	Interpretation
Climate hazard	Mean sea level rise	Annual mean sea level (cm)	Dirección General de Transporte Marítimo y Aéreo	Annual estimations	Status-quo (1995-2020) = +3mm/yr Business as usual: (up to 2050) +16.5 mm/yr (up to 2100) +33mm/yr
Exposure	Passengers	Number of passengers		Annual estimations	These are critical factors worsening (more pressure) the risk of isolation due to transport disruption
	Population	Number of island's inhabitants			
	Value of transported goods	Value of goods transported by ships (in freight)			
	Number of port infrastructures	Number of ports			
Sensitivity	Quality of infrastructure and equipment	Number of ports with critical infrastructure not renovated since 1993		Annual updates	
	Island dependence on maritime transport	Number of isolation days from the main land			
Adaptation response –	**Development of an adaptation plan to adequate infrastructure to climate threats**	➢ Existence of an integral plan for all ports and funding assignments to adapt them to climate change hazards. Binary. ➢ Percentage of structures heightened to face expected SLR over the 21st century, per type of structure (mooring line, docks areas and dikes).	Dirección General de Transporte Marítimo y Aéreo	1;0It could be complemented by an external expert-based indicator on the plan suitability). Yearly basis	Adapt mooring structures, increase of dikes and the free board in old docks, particularly to the rise in sea level, so as to enable the Balearic Islands to maintain and improve their position in international recreational boating and recreational cruise traffic. Also to the importance of freight traffic.
	Improve and ensure operational safety in ship repair	➢ Existence of a specific plan to guarantee the operational safety of large ship repair activity against climatic events. Binary. ➢ (It could be complemented by an external expert-based indicator on the plan suitability).	Dirección General de Transporte Marítimo y Aéreo	1;0	To improve and guarantee the operational safety of large ship repair activity against climatic events, the Balearic Islands being very specialized in recreational boating and mega-yachts.
	Develop the potential of maritime navigation between the Balearic Islands and the Mediterranean region	➢ Existence of an operative framework for information exchange and collaboration between the Balearic ports and those from the Mediterranean basin to guarantee and enhance connectivity.	Dirección General de Transporte Marítimo y Aéreo	1;0 It could be complemented by an external expert-based indicator on the plan suitability).	To transfer knowledge and capacities for the adaptation to climate change to the Spanish peninsula and the Mediterranean region, which will guarantee their future connectivity with the Balearic Islands and the development of the potential of maritime navigation between the Balearic Islands and the Mediterranean region.

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	Strengthen and prepare the provisioning system to heat waves	➢ Percentage of total perishable goods handled at Balearic ports that use storage areas adapted to face extreme weather conditions (specially heat waves). ➢ Percentage of work-time that port operators work protected against extreme heat.	Dirección General de Transporte Marítimo y Aéreo	Yearly basis Yearly basis	To reinforce and improve, in the face of possible climatic events, in particular to heat waves, the storage areas. Adapt the provisioning system to heat waves.
	Improve monitoring systems	➢ Existence of an early warning and monitoring system of extreme events to assist decisions under those weather conditions. Binary. It could be complemented by an external expert-based indicator on the plan suitability).	Dirección General de Transporte Marítimo y Aéreo	1;0	Monitoring systems can be improved. Identifying operational working windows in case of extreme events.
	Encourage the adaptation of recreational marinas to the main climate change hazards	➢ Percentage of mooring points in recreational marinas covered by effective climate change adaptation plans.	Dirección General de Transporte Marítimo y Aéreo	Yearly basis	To stimulate, accompany and encourage the adaptation of recreational marinas to the main climate change hazards, in order to guarantee the operation and future expansion of recreational sailing. Nautical activities are of special importance for the Balearic Islands tourism, since tourism accounts for about 45% of the GDP.

12.6.2 Energy sector

Indicators type	Indicators	Definition	Responsible Organization	Monitoring Processes	Tipping points?
Climate hazard	Number of cooling degree days (CDD) per year	Temperature difference above 18ºC in each year, calculated using average daily temperature values.	Dirección General de Energía y Cambio climático	Annual estimations	Ref CDD= 194 Business as usual: (up to 2050): 425 CDD (up to 2100: 711.52 CDD *The indicator is computed by multiplying the number of days exceeding the threshold by the difference in temperatures.*
	Standardised precipitation-evaporation index (SPEI)	Transformation of a monthly precipitation time series into a standardized normal distribution		Annual updates	Ref SPEI= 0.8 Alert -1 =<SPEI <= -2 Business as usual: (up to 2050): -1.5 (up to 2100) :-2.3
	Wind and PV productivity	Absolute value (kWh/kW)		Annual updates	Ref WIND prod: 1769/3944 kWh/kW (land/sea) Ref PV prod: 1559/1529 kWh/kW (land/sea) Business as usual: WIND productivity –LAND/SEA (up to 2050): -115/-143 kWh/kW (up to 2100) :-223/-322 kWh/kW

					PV productivity –LAND/SEA (up to 2050): -22/-42 kWh/kW (up to 2100):-36/-78 kWh/kW
	Extreme temperatures	Percentage of days per year when T > 98th percentile - T98p			Ref: 2% of the year with T > 98th percentile - T98p Business as usual: (up to 2100) :23% of the year
Exposure	Population	Number of island's inhabitants	Dirección General de Energía y Cambio climático	Annual estimations	These are critical factors worsening (more pressure) the risk of increased energy demand for cooling and desalinate sea water in the island. The access to this information is limited in the island.
	Tourists	Number of tourists			
	Tourism seasonality	Annual min-max variation of tourists			
	Cooling penetration rate	Share of households with air-conditioning		Five-year estimations	
	Desalination	Percentage of desalinated water to total water consumption		Annual estimations	
Sensitivity	Per capital energy demand	Energy demand (MWh) per person		Annual estimations	These indicators require a periodic measuring of their performance.
	Energy intensity	Energy use (in MWh) per gross domestic product (GDP) (in M€)			
Adaptation response –	**Promotion of domestic and small-scale photovoltaic solar energy**	➢ Euros (public funds) destined to support investment in domestic and small-scale photovoltaic energy systems. ➢ MWh of PV energy covered by micro grids/Total demand of the electric system ➢ Percentage of total energy consumption which is working under small-scale and micro smart grid schemes.	Dirección General de Energía y Cambio climático	Yearly basis Yearly basis Yearly basis	Massive promotion through various instruments: a) Direct subsidy of installations; b) A more favourable legislation than the current one for the net balance; c) Massive development of energy communities in all the public and private buildings to be adapted.
	Financial support for the energy rehabilitation of buildings	➢ Euros/year public fund to support energy rehabilitation of buildings. ➢ Percentage of buildings exhibiting necessities for energy rehabilitation that have undertaken it.	Dirección General de Energía y Cambio climático	Euros/year Yearly basis	Support for investment to rehabilitate old buildings with very low energy efficiency that cannot afford to insulate the house, with the aim of activating the energy rehabilitation of the urban park. In addition, this initiative will also be able to create employment.
	Mass development of the public transport network powered by renewable energies	➢ Percentage of collective transport vehicles powered by electric engines/total ➢ Percentage of collective transport vehicles powered by hydrogen engines/total ➢ Kg of equivalent CO2 per passenger-km	Dirección General de Transporte Marítimo y Aéreo	Yearly basis	Improve the public transport network to make it much more effective and useful for citizens, in order to encourage its use. In particular, to develop the railway network (tramway networks), taking advantage of the existing infrastructure of the old railway network.
	Encourage electric individual transport and car-sharing	➢ Euros/year to subsidise car transition to electric power (should include free-parking and tax cutting measures).	Dirección General de Energía y Cambio climático	Euros/year	As for individual electric mobility, promote the use of hydrogen-powered vehicles. Additionally, encourage the use of vehicle sharing, to avoid the need to acquire a vehicle to move around the

		➢ Percentage of car mobility carried out on car-sharing platforms. ➢ Percentage of urban ways under just-pedestrian & no-engine vehicles regime.		Yearly basis	islands. The concept of sharing includes: cars, motorbikes and bicycles.
	Training development in installation and thermal insulation of buildings	➢ Number of operators/year that have received advanced training in renewables installation and buildings thermal insulation.	Dirección General de Energía y Cambio climático	Yearly basis	Training initiatives in installation and thermal insulation of buildings, in order to enhance the quality of the service of industrial tissue.
	Promoting storage systems for renewable energy installations	➢ MWh of renewable storage capacity. ➢ Percentage of renewable storage capacity over the total renewable energy.	Dirección General de Energía y Cambio climático	Yearly basis Yearly basis	This measure would seek to solve/ diminish surplus problems. The strategic importance of facilitating a proper integration of renewables, particularly photovoltaic energy, with the aim of promoting descarbonization in the islands.
	Low enthalpy geothermal energy	➢ Percentage of water and rooms-climatization and powered by low enthalpy geothermal and aerothermal energy.		Yearly basis	Support for investment in research to determine whether the site is suitable for geothermal energy. The low enthalpy is very appreciated in air conditioning for its stability, and low cost in favourable circumstances.

12.6.3 Tourism sector

Indicators type	Indicators	Definition	Responsible Organization	Monitoring Processes	Interpretation
Climate hazards	Beach reduction	Percentage of reduction of beach area	Inventario Forestal Nacional - INE		Status-quo (1995-2020) = -4 to 8m of beach area depending on the beach Business as usual: (up to 2050): - 51% (up to 2100): -70%
	Seagrass evolution	Coverage (in km2) of the main seagrass species			Ref: Posidonia (1002 km2) Business as usual: (up to 2100): 0 km2 – Posidonia
	Fire weather index (FWI)	Numerical non-dimensional ratings of relative fire potential for a generalized fuel type (mature pine stands) based solely on weather observations. FWI calculation includes temperature, precipitation, relative humidity and wind.		The index only refers to the fire season (defined from May to October)	The index needs to be calculated with new data in order to monitor the evolution Ref . FWI = 0.20 () (coastal areas) 0.40 (other areas) Alert 0.6<FWI<1.0 Business as usual: (up to 2100): 0.40-0.60 (other area)
	Humidity Index	Number of days exceeding 35oC	AEMET		Ref: 53 days /year with HI>= 35°C Business as usual:

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					(up to 2050): 69 days (up to 2100): 115 days
Exposure	Coast	Size of the coastline (km)	Institut d'Estadística de les Illes Balears, IBESTAT Estadísticas del turismo-Anuarios de turismo Inventario Forestal Nacional - INE Agencia de Estrategia Turística de Las Illes Balears (aetib) Banco Español de Algas		These are critical factors worsening (more pressure) the risk of forest fires, thermal stress, and marine habitat degradation in the island. These indicators require a periodic measuring of their performance.
	Corals	Density of corals and other marine species			
	Marine ecosystem	Marine ecosystem size (ha)			
	Tourists	Number of tourists			
		Tourist characteristics (age, gender etc.)			
		Type of tourism (sport, pleasure etc.)			
	Population	Population density (persons/km^2)			
	Agricultural land	Cultivated area (ha)			
	Forests	Forest area (ha)			
	Forests	Density of shrubby forests			
	Forests	Tourist walking paths in the forests (km)			
	Forest species	Number of forest flagship species			
	Protected areas	Percentage of protected areas			
Sensitivity	Pollution	Pollution from human activities			These are critical factors worsening (more pressure) the risk of forest fires, thermal stress, and marine habitat degradation in the island. These indicators require a periodic measuring of their performance.
	Marine species	Sensitivity of marine species			
	Human activities triggering wild fires	Number of recreational areas with barbeque			
Adaptation response –	**Thermal isolation of buildings**	➢ Euros/year public fund to support energy rehabilitation of tourist buildings. ➢ Percentage of tourist buildings exhibiting necessities for energy rehabilitation that have undertaken it. ➢ Percentage of tourism buildings covered by environmental management plans including energy save and efficiency.	Agencia de Estrategia Turística de Las Illes Balears (aetib)	Euros/year Yearly basis Yearly basis	Funding and technical assistance for the adoption of bioclimatic architecture criteria in reformed and newly built tourist buildings; regulation forcing it should be delivered together with economic incentives, socially justified by the positive externality of contributing a more environmental friendly image of the destination. Balearic Islands Architects Association recognises around 45% of buildings at the island exhibit a deficient level of thermal isolation and the potential reduction of energy consumption and emissions would range from 30 to 80% with respect to the current levels.
	Zero sewage discharge to the sea	➢ Percentage of total sewage discharged without treatment (including form treatment plants). ➢ Percentage of treated sewage with tertiary and reuse. ➢ Mg/m3 of pollutants throughout the monitoring network of seawater quality (E. Coli, heavy metals…).	Agencia de Estrategia Turística de Las Illes Balears (aetib)	Yearly basis Mg/m3 /year	This measure means to enhance sewage treatment system throughout the islands with two important, climate related purposes. First, mitigate the impact of seawater heating on the seagrass meadows, in turn crucial to sustain the entire marine ecosystems. Second, contribute to water supply with a lesser energy-demanding water source than desalination.

	Distributed electric grids powered by renewables	➢ Percentage of tourist electricity demand produced in the framework of renewable-based distributed grids.	Agencia de Estrategia Turística de Las Illes Balears (aetib)	Yearly basis	Develop distributed electric grids based on renewable sources (pv, wind) to power desalination plants and tourist firms consortia, to reduce electricity cost and emissions, and increase the stability of the general electric grid while increasing renewables participation in the electric mix.
	Forest fire prevention	➢ Has of forest peripheral agricultural land under scheme of subsidy for farming maintenance, including firewall purposes. ➢ Has of forest under cattle-based uses to diminish flammability index. ➢ Number/year of early extinguished fires thanks to early warning.	Agencia de Estrategia Turística de Las Illes Balears (aetib)	Has/year Yearly basis	Incentive forest traditional cattle-based uses to reduce forest flammability and maintenance of farming activities in the periphery of forest masses, thus performing as firewalls. Social abandon of traditional uses and upper-land agriculture has led to recent 6ª generation, inextinguishable forest fires that destroy endemic terrestrial biodiversity and precious landscapes, and put in risk residents' and tourists' lives.
	Effective plan of water demand management and investment in reducing losses along the water distribution system	➢ Existence of an effective water demand management plan. Binary. ➢ (It could be complemented by an external expert-assessment indicator on the plan suitability). ➢ Percentage of losses along the water distribution system. ➢ Liters of water per overnight stay.	Agencia de Estrategia Turística de Las Illes Balears (aetib)	Yearly basis	Water is one of the chief concerns at Government and societal level in the Balearic Islands when projections on climate chain impacts are made. Experts state that saving water measures have very long run before adopting the contribution of water desalination to the supply-mix. Also sewage treatment and water reusing should be previous to water desalination.
	Residual organic matter composting to reduce methane emissions, restore degraded landscapes and enhance soil fertility	➢ Percentage of residual organic matter composted and used as fertilizer or soil amendment, per type of organic waste (sludge, agricultural and MSW organic matter). ➢ Ha of agricultural land fertilised by composted local residual organic matter. ➢ Ha of rehabilitated landscape using locally composted residual organic matter.	Agencia de Estrategia Turística de Las Illes Balears (aetib)	Yearly basis Ha/year	Sewage sludge, organic waste from agriculture and the organic fraction of the MSW are currently burnt in waste incinerator while agricultural soil shows organic matter scarcity. Composting would contribute to link tourism to decarbonisation, local food options and landscapes rehabilitation.

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12.7 Canary Islands

12.7.1 Maritime transport sector

Indicators type	Indicators	Definition	Responsible organisation	Monitoring Processes	Interpretation
Climate hazard	Mean sea level rise	Annual mean sea level (cm)	AEMET	Annual estimations	Status-quo (1995-2020) = +3mm/ yr Business as usual: (up to 2050) +16.5mm/yr (up to 2100) +33mm/yr
Exposure	Passengers	Number of passengers	World Bank ISTAC Puertos del Estado	Annual estimations	These are critical factors worsening (more pressure) the risk of isolation due to transport disruption. These indicators require a periodic measuring of their performance.
	Population	Number of island's inhabitants			
	Value of transported goods	Value of goods transported by ships (in freight)			
	Number of port infrastructures	Number of ports			
Sensitivity	Quality of infrastructure and equipment	Number of ports with critical infrastructure not renovated since 1993	World Bank ISTAC Puertos del Estado	Annual updates	
	Island dependence on maritime transport	Number of isolation days from the main land			
Adaptation response –	**Adapt infrastructure to climate threats**	➢ Percentage of areas needing heightening regarding to the expected SLR at the end of the 21st century. ➢ Percentage of cold ironing facilities fully adapted to climate change risks.	Consejería de Obras públicas, transporte y viviendas Puertos del Estado	Yearly basis	Adapt mooring structures and related services, especially the electrical connection to ships during the stay in port (cold ironing), to climatic threats, and particularly to the rise in sea level, so as to enable the Canary Islands to maintain and improve their position in international recreational cruise traffic.
	Improve and ensure operational safety in ship repair	➢ Percentage of ship-repairing areas fully adapted to the requirements of climate change (SLR, extreme events), in a 1-5 Likert scale by expert assessment. ➢ Score of ship-repairing facilities safety given by users, in a 1-5 Likert scale.	Consejería de Obras públicas, transporte y viviendas Puertos del Estado	Yearly basis	To improve and guarantee the operational safety of ship repair activity against climatic events, including shipyards and workshops with deep-sea repair capacity.
	Develop the potential of maritime navigation between the Canary Islands and North-West Africa	➢ Number of alive initiatives of knowledge transfer in ports and M.T. adaptation to north-west African ports. ➢ Expenditure initiatives of knowledge transfer in ports and M.T. adaptation to north-west African ports.	Consejería de Obras públicas, transporte y viviendas Puertos del Estado	Yearly basis	To transfer knowledge and capacities for the adaptation to climate change of nearby West African ports, which will guarantee their future connectivity with the Canary Islands and the development of the potential of maritime navigation between the Canary Islands and North West Africa.

		➢ Rate of increase in ports connectivity between the Canary and North-west African ports, in tons and passengers.			
	Strengthen and improve the bunkering facilities	➢ Percentage of bunkering points fully adapted to the requirements of climate change (SLR, extreme events), in a 1-5 Likert scale by expert assessment. ➢ Percentage of bunkering points fully adapted over the total points.	Consejería de Obras públicas, transporte y viviendas Puertos del Estado	Yearly basis	To reinforce and improve, in the face of possible climatic events, the bunkering installations which are of strategic importance for the expansion of the port economy of the islands. This initiative would include cutting edge solutions in the adoption of bunkering facilities to power renewable energy based technologies.
	To plan the expansion of the port linked to the locational rent of the island in areas not exposed to risks	➢ Rate of increase of turnover in activities powered by special regimen ruling in the Canary ports (RUP, ZEC, Registry of ships (REBECA)). ➢ Degree of adequation of current and new port areas devoted to host activities under special regimens to future climate change-associated hazards; by expert assessment	Consejería de Obras públicas, transporte y viviendas Puertos del Estado	Yearly basis 1-5 Likert scale.	To plan with climate security (areas not exposed to risks) the expansion of the port area to accommodate new and more activity related to the opportunities offered by the special regimes of the Canary Islands (RUP, ZEC, Registry of ships (REBECA)); with special attention to mobility and the relationship between the port and the city.
	Encourage the adaptation of recreational marinas to the main climate change hazards	➢ Percentage of mooring points in recreative marines that exhibit a full adaptation to climate change-related hazards; assessed by experts in 1-5 Likert scale	Consejería de Obras públicas, transporte y viviendas Puertos del Estado	Yearly basis	To stimulate, accompany and encourage the adaptation of recreational marinas to the main climate change hazards, in order to guarantee the operation and future expansion of recreational sailing.

12.7.2 Energy sector

Indicators type	Indicators	Definition	Responsible organisation	Monitoring Processes	Interpretation
Climate hazard	Number of cooling degree days (CDD) per year	Temperature difference above 18ºC in each year, calculated using average daily temperature values.	AEMET Dirección General de Energía de Canarias Observatorio Energético de Canarias	Annual estimations	Ref CDD= 186.72 Business as usual: (up to 2050): 395.66 CDD (up to 2100 : 665.24 CDD *The indicator is computed by multiplying the number of days exceeding the threshold by the difference in temperatures.*
	Standardised precipitation-evapotransporation index (SPEI)	Transformation of a monthly precipitation time series into a standardized normal distribution		Annual updates	Ref SPEI= 0.00 Alert -1 =<SPEI <= -2 Business as usual: (up to 2050): -2.1 (up to 2100) :-2.4

	Wind and PV productivity	Absolute value (kWh/kW)		Annual updates	Ref : 1484 kWh/kW Business as usual: PV productivity –SEA (up to 2050): -24 kWh/kW (up to 2100) :-51 kWh/kW
Exposure	Population	Number of island's inhabitants	Dirección General de Energía de Canarias Observatorio Energético de Canarias	Annual estimations	These are critical factors worsening (more pressure) the risk of increased energy demand for cooling and desalinate sea water in the island. These indicators require a periodic measuring of their performance.
	Tourists	Number of tourists			
	Tourism seasonality	Annual min-max variation of tourists			
	Cooling penetration rate	Share of households with air-conditioning		Five-year estimations	
	Desalination	Percentage of desalinated water to total water consumption		Annual estimations	
Sensitivity	Per capital energy demand	Energy demand (MWh) per person	Dirección General de Energía de Canarias Observatorio Energético de Canarias	Annual estimations	
	Energy intensity	Energy use (in MWh) per gross domestic product (GDP) (in M€)			
Adaptation response –	**Hydrogen as energy vector**	Production of storable green hydrogen (tons) Percentage of heavy and collective mobility powered by hydrogen energy.	Dirección General de Energía de Canarias Observatorio Energético de Canarias	tons per year Yearly basis	The promotion for the installation of electrolyzers in areas with the highest renewable potential of unmanageable character. Using the renewable effluents for hydrogen production, the hydrogen could then be used after storage in high-pressure tanks as vehicle fuel, especially for heavy mobility.
	Renewable technology hybridization	Percentage of total installed renewable energy power under hybridization bases.	Dirección General de Energía de Canarias Observatorio Energético de Canarias	Yearly basis	Hybridize more expensive technologies but with greater capacity to manage or provide ancillary services with less expensive but more unstable technologies. Balances the electrical system and guarantees quality supply. For example, if photovoltaic technology means that energy is only available during daylight hours, other technologies such as wind power should be used proportionally to cover what photovoltaic technology cannot.
	Low and high enthalpy geothermal energy	➢ Percentage of water and rooms-climatization and powered by low enthalpy geothermal and aerothermal energy. ➢ Percentage electric energy produced by high enthalpy geothermal energy. ➢ Percentage of heat necessities that are covered by highly efficient co-generation systems.	Dirección General de Energía de Canarias Observatorio Energético de Canarias	Yearly basis Yearly basis Yearly basis	Support for investment in research to determine whether the site is suitable for geothermal energy. The low enthalpy is very appreciated in air conditioning for its stability, and low cost in favourable circumstances. The high enthalpy gives stability to the electrical network. Once the exploration phase is over, the Canary Islands must enter the research phase with soundings that allow the mapping of the resource, and then move on to the commercial phase.

	Shared self-consumption facilities	➢ Percentage of decentralised renewable energy produced in shared facilities. / total production of RES / or RE demand ➢ Percentage of energy produced in shared facilities that is injected into the electricity grid. ➢ Percentage of total electric energy produced by prosumers.	Dirección General de Energía de Canarias Observatorio Energético de Canarias	Yearly basis Yearly basis Yearly basis	Shared use of facilities to share costs and maximize the efficiency and management capacity of this type of facility. Communicate and help implement shared self-consumption actions through technical assistance and financial incentives.
	Promote cogeneration	➢ Percentage of high electricity consumers having highly efficient co-generation systems. ➢ Percentage of heat energy consumed over the total primary energy contented in hydrocarbons. ➢ Euros to fund investment in highly efficient co-generation systems ➢ Percentage of heat necessities covered by highly efficient co-generation systems.	Dirección General de Energía de Canarias Observatorio Energético de Canarias	Yearly basis	Cogeneration aims to cover the deficit in self-consumption by installing conventional back-up groups in tourist establishments, to satisfy peaks in demand for various forms of energy (electricity + heat), through synthetic fuels. To assist technically and financially the companies.
	Micro smart grids	➢ MWh Energy covered by micro grids/total demand of the electric system ➢ Percentage of total energy consumption which is working under micro smart grid schemes.	Dirección General de Energía de Canarias Observatorio Energético de Canarias	Yearly basis	It is an incentive designed with the purpose of providing greater resilience, since in the event of possible power failures in the electrical system, they will always have a guaranteed power supply. They serve to facilitate the penetration of the autogeneration REE in establishments, guaranteeing quality and security in the electrical supply. Technical assistance and financial support.

12.7.3 Tourism sector

Indicators type	Indicators	Definition	Responsible organisation	Monitoring Processes	Interpretation
Climate hazards	Beach reduction	Percentage of reduction of beach area	AEMET		Status-quo (1995-2020) = -4 to 8m of beach area depending on the beach Business as usual: (up to 2050): - 62% (up to 2100): -80%
	Seagrass evolution	Coverage (in km2) of the main seagrass species	Banco Español de Algas		Ref: Cymodocea (83.1 km2) Zostera (4.3 km2) Halophila (4.3 km2) Business as usual:

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					(up to 2050): 0 km2 – all species (up to 2100): 0 km2 – all species
	Fire weather index (FWI)	Numerical non-dimensional ratings of relative fire potential for a generalized fuel type (mature pine stands) based solely on weather observations. FWI calculation includes temperature, precipitation, relative humidity and wind.	Inventario Forestal Nacional - INE	The index only refers to the fire season (defined from May to October)	The index needs to be calculated with new data in order to monitor the evolution Ref . FWI = 0.58 Alert 0.6<FWI<1.0 Business as usual: (up to 2050): 0.63 (up to 2100): 0.66
	Humidity Index	Number of days exceeding 35oC	AEMET		Ref: 15 days /year with HI>= 35°C Business as usual: (up to 2050): 27 days (up to 2100): 75 days
Exposure	Corals	Density of corals and other marine species	Inventario Forestal Nacional - INE	Five-year updates	These are critical factors worsening (more pressure) the risk of forest fires, thermal stress, and marine habitat degradation in the island. These indicators require a periodic measuring of their performance.
	Marine ecosystem	Marine ecosystem size (ha)		Five-year updates	
	Tourists	Number of tourists		Annual estimations	
		Type of tourism (sport, pleasure etc.)		Annual estimations	
	Population	Population density (persons/km²)		Annual estimations	
	Agricultural land	Cultivated area (ha)		Annual estimations	
	Forests	Forest area (ha)		Annual estimations	
	Forests	Density of shrubby forests		Annual estimations	
	Forests	Tourist walking paths in the forests (km)		Five-year updates	
	Forest species	Number of forest flagship species		Five-year updates	
	Protected areas	Percentage of protected areas		Five-year updates	
Sensitivity	Pollution	Pollution from human activities		Five-year updates	These are critical factors worsening (more pressure) the risk of forest fires, thermal stress, and marine habitat degradation in the island. These indicators require a periodic measuring of their performance.
	Marine species	Sensitivity of marine species		Five-year updates	
	Human activities triggering wild fires	Number of recreational areas with barbeque		Five-year updates	
Adaptation response–	**Passive, low carbon adaptation of tourist buildings to longer extreme heat periods**	➢ Percentage of tourist buildings having obtained an energy efficiency certificate of A, B or C degree. ➢ Euros to fund investment in bioclimatic building for tourism purposes (grants). ➢ Existence of tax, fee or promotional incentives to encourage adopting bioclimatic building schemes.	Consejería de Turismo, Industria y Comercio Consejería de Transición Ecológica	Yearly basis Yearly basis Yearly basis	Funding and technical assistance for the adoption of bioclimatic architecture criteria in reformed and newly built tourist buildings; regulation forcing it should be delivered together with economic incentives, socially justified by the positive externality of contributing a more environmentally friendly image of the destination. This option is preferred to encouraging further investment in air conditioning, which implies an increase in GHG emissions.

	Zero sewage discharge to the sea	➢ Percentage of non-treated sewage discharges. ➢ Percentage of sewage with tertiary treatment and reuse.	Consejería de Turismo, Industria y Comercio	Yearly basis Yearly basis Yearly basis	This measure means to enhance sewage treatment system throughout the islands with two important, climate related purposes. First, mitigate the impact of seawater heating on the seagrass meadows, in turn crucial to sustain the entire marine ecosystems. Second, contribute to water supply with a lesser energy-demanding water source than desalination. Additionally, it meets the tourist's demand for non-polluted, clean bathing seawater.
	Distributed electric grids powered by renewables	➢ Installed capacity in tourism-based distributed grids (MWh). ➢ Percentage of electricity consumed by tourist sector produced with renewables under individual or shared schemes.		Yearly basis Yearly basis	Develop distributed electric grids based on renewable sources (pv, wind) to power desalination plants and tourist firms consortia, to reduce electricity cost and emissions, and increase the stability of the general electric grid while increasing renewables participation in the electric mix.
	Forest fire prevention	➢ Flammability index. ➢ Surface of abandoned agricultural land surrounding forested areas. ➢ Surface of burned endemic flora, ➢ Total surface of burned forested areas ➢ Surface covered by land safekeeping agreements.	Consejería de Transición Ecológica	Yearly basis Hectares per year Hectares per year Hectares per year Hectares per year	Incentive forest traditional cattle-based uses to reduce forest flammability and maintenance of farming activities in the periphery of forest masses, thus performing as firewalls. Social abandonment of traditional uses and upper-land agriculture has led to recent 6ª generation, inextinguishable forest fires that destroy endemic terrestrial biodiversity and precious landscapes, and put in risk residents' and tourists' lives.
	Bottom-up managed marine protected micro-areas	➢ Number/surface marine micro-areas hosting ecotourism activities. ➢ Number of tourists visiting marine micro-areas ➢ Index of biomass/biodiversity within the ecotourist micro-area (using Shanon index or similar).	Consejería de Turismo, Industria y Comercio	Yearly basis Yearly basis Yearly basis	Stakeholders-led deals to improve the management of marine areas affected by overfishing and habitat degradation to favour habitat rehabilitation and create synergies amongst sustainable fishing, eco-friendly tourist activities (diving, snorkelling, bottom-glass boating…) and land-based activities (local product-based gastronomy, ichthyo-ethnology interpretation paths, etc.).
	Residual organic matter composting to reduce methane emissions, restore degraded landscapes and enhance soil fertility	➢ Tons of organic residual matter composted. ➢ Tons of avoided CO2 equivalent emissions. ➢ Tons of tourism-based compost in tourism-local agriculture exchange agreements.	Consejería de Turismo, Industria y Comercio	Yearly basis Yearly basis Yearly basis	Sewage sludge, organic waste from agriculture and the organic fraction of the MSW are currently disposed in poorly managed landfills, releasing methane to the atmosphere while agricultural soil shows extreme organic poorness and exhausted quarries degrade landscapes. Composting would contribute to link tourism to decarbonization, local food options and landscapes rehabilitation.
	Sand nourishment of natural beaches against SLR	➢ M3 of sand used in natural beaches nourishment actions. ➢ Beach surface restored by sand nourishment actions. ➢ Percentage of natural sand beach total surface under a sand nourishment program.		Yearly basis Yearly basis Yearly basis	The Canary Islands are coastal destinations that mostly rely on their sand beach endowment. Misguided human interventions and climate change (SLR) pose a threat on long term beaches surface maintenance justifying sand nourishment actions. Yet, eco-friendly sand nourishment practices are crucial in order to achieve its environmental compatibility and social acceptance.

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	Heat waves alleviating measures	➢ Percentage of tourist facilities that provide air conditioner. ➢ Percentage of tourist beds covered by air conditioner. ➢ Percentage of tourist business that adapt their routine to heat waves (pool opening time, outdoor fresh-air devices, etc.). ➢ Has (absolute value and annual rate of increase) of urban green areas specifically equipped to deal with extreme heat periods (shadow, water and air streams,…).	Consejería de Transición Ecológica	Yearly basis Yearly basis Yearly basis Yearly basis	Abnormal heat mismatches the expectation of pleasant warmness thus having a negative impact on the recreative experience. Take actions to alleviate extreme heat effects through water-based activities, air-conditioning and non-conventional measures to provide thermal comfort helps keeping destination attractiveness on.

12.7.4 Aquaculture

Indicators type	Indicators	Definition	Responsible organisation	Monitoring Processes	Interpretation
Climate hazard	Surface water temperature	Changes in surface water temperature	AEMET	Climate modelling	sea bream: 26ºC - 33 ºC sea bass: 25 ºC – 35.9 ºC tuna: 24 ºC – 26.17 ºC mussels: 20.5 ºC – 27.0 ºC
Exposure	Farm area	Area occupied by sea cages (m²)	Dirección General de Pesca	Annual estimations	These are critical factors worsening (more pressure) the risk of increased fragility of aquaculture activity for the island. These indicators require a periodic measuring of their performance However, information systems in the island provide incomplete data related to exposure indicators. This is the first action to be undertaken in the monitoring process.
	Value of stock	Value of biomass in the cages		Annual estimations	
	Stock size	Annual production of aquaculture products (fish and shellfish) (in tons)		Annual estimations	
	Employment	Number of employees	AEMET	Annual estimations	
	Location of farms	Location of farms related to the prevailing wind direction		Five-year updates	
		Location of farms related to the average distance to shore		Five-year updates	
Sensitivity	Sensitivity of species	Vulnerability of species to climate change	Dirección General de Pesca	Literature review; aquaculture experts	
	Sensitivity of infrastructure	Vulnerability of infrastructure (type and materials of cages) to extreme weather events	AEMET	Literature review; aquaculture experts	
Adaptation response–	**Increase POSEI and REF incentives**	➢ Rate of increase of funds for POSEI and REF schemes. ➢ Percentage of POSEI and REF over total revenue of the sector/ kg	Dirección General de Pesca	Yearly basis Yearly basis	Increase incentives that compensate for the distance and insularity in the POSEI and the REF. Also guarantee viable commercial margins, which will be affected by climate change.

	Knowledge transfer and financial support of emerging industries	➢ Public and private investment in R&D&I in not-fish-based and locally sustainably produced feed and to support local production of juveniles. ➢ Percentage of total feed coming from not fish-based, locally produced food. ➢ Percentage of total juveniles that are locally produced.	Dirección General de Pesca	Yearly basis Yearly basis Yearly basis	Optimize the transfer of knowledge from research groups to the industry, aimed at enabling local production of raw materials and juveniles, and the introduction of new species more resilient to CC and its effects; also, financial support scheme to this industry until it reaches the optimal scale.
	Review and streamline administrative processes	➢ Percentage of time over the best reference in administrative processes to initiate aquaculture activity. ➢ Extra cost per produced ton due to comparatively inefficient administrative process to initiate aquaculture activity.	Dirección General de Pesca	Yearly basis Yearly basis	Improving governance is key to addressing the impact of climate change. Reviewing and streamlining administrative procedures will help minimize the impact on production volumes.
	Promote tourist and non-tourist consumption	➢ Rate of increase of local consumption (by residents and tourists, separately) ➢ Percentage of local aquaculture in local fish consumption	Dirección General de Pesca	Yearly basis Yearly basis	The increase in consumption on the islands helps to reduce emissions, enhances the km 0 concept, contributes to the development of food sovereignty with high quality protein, and strengthens social cohesion.
	Promote the development of off-shore aquaculture	➢ Annual investment (euros) in offshore, climate change resilient aquaculture. ➢ Percentage of production in offshore located cages over total production.	Dirección General de Pesca	Yearly basis Yearly basis	It means an increase in the area of innovation, technological change. To introduce a cultivation system that does not exist on the islands. It improves the resistance to catastrophic weather episodes as a result of climate change and consequently contributes to reducing the environmental impact, favouring an increase in production.
	Reformulate the POEM (Zoning)	➢ Degree of adequacy of the zoning plan to encourage sustainable aquaculture. ➢ Industry assessment of the adequacy of the zoning plan to the industry necessities.	Dirección General de Pesca	through external experts' assessment on a 1-5 Likert scale. on 1-5 Likert scale.	To address the impact of climate change, the criteria for determining areas to be used in the future need to be improved and expanded: planning. Increasing depth reduces impact, improves habitats, and increases production.

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12.8 Corsica

12.8.1 Tourism sector

Indicators type	Indicators	Definition	Responsible Organization	Monitoring Processes	Interpreation
Climate hazards	Beach reduction	Percentage of reduction of beach area	BRGM https://www.brgm.fr/fr/implantation-regionale/corse	Irregular assessment of beach erosion	Status-quo (1995-2020) = -4 to 8m of beach area depending on the beach Business as usual: (up to 2050): - 32% (up to 2100): -54%
	Fire weather index (FWI)	Numerical non-dimensional ratings of relative fire potential for a generalized fuel type (mature pine stands) based solely on weather observations. FWI calculation includes temperature, precipitation, relative humidity and wind.	Meteo France-http://www.drias-climat.fr/	Updated at each IPCC report	Ref. FWI = 0.2-0.6 depending on the area Alert 0.6<FWI<1.0 Business as usual: (up to 2100): 0.40-0.80 depending on the area
	Vector Suitability Index for Aedes Albopictus (Asian Tiger Mosquito)	Increases of ambient air temperature and changes in the hydrological cycle.	Meteo France-http://www.drias-climat.fr/	Updated at each IPCC report	Ref: VBSI = 84.9 Alert VBSI>80 Business as usual: (up to 2100): 83.8
	Humidity Index	Number of days exceeding 35oC	Meteo France-http://www.drias-climat.fr/	Updated at each IPCC report	Ref: 14 days /year with HI>= 35°C Business as usual: (up to 2050): 29 days (up to 2100): 72 days
Exposure	Coast	Size of the coastline (km)	https://www.insee.fr/fr/information/2017051	Five-year updates	These are critical factors worsening (more pressure) the risk of forest fires, thermal stress, and marine habitat degradation in the island. These indicators require a periodic measuring of their performance. However, information systems in the island provide incomplete data related to exposure indicators. This is the first action to be undertaken in the monitoring process.
	Corals	Density of corals and other marine species		Five-year updates	
	Marine ecosystem	Marine ecosystem size (ha)		Five-year updates	
	Tourists	Number of tourists		Annual estimations	
		Tourist characteristics (age, gender etc.)		Annual estimations	
		Type of tourism (sport, pleasure etc.)		Annual estimations	
	Population	Population density (persons/km²)		Annual estimations	
	Agricultural land	Cultivated area (ha)		Annual estimations	
	Forests	Forest area (ha)	Office national des forêts Corse www.onf.fr/corse	Annual estimations	
	Forests	Density of shrubby forests	https://www.insee.fr/fr/information/2017051	Annual estimations	

	Forests	Tourist walking paths in the forests (km)	Local survey	Five-year updates	
	Forest species	Number of forest flagship species	Office national des forêts Corse www.onf.fr/corse	Five-year updates	
	Protected areas	Percentage of protected areas	Office national des forêts Corse www.onf.fr/corse	Five-year updates	
Sensitivity	Pollution	Pollution from human activities		Five-year updates	Lack of reliable statistics. This is the first action to be undertaken
	Marine species	Sensitivity of marine species		Five-year updates	
	Human activities triggering wild fires	Number of recreational areas with barbeque		Five-year updates	
Adaptation response	**Water restrictions, consumption cuts and grey-water**	➢ Percentage of grey-water over total sewage. ➢ Days a year with water restrictions. ➢ Percentage of water losses along the water distribution system ➢ Existence of an effective efficiency water use plan.	Agence de l'eau Rhône Méditerranée Corse https://www.eaurmc.fr/	Yearly basis This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale.	Restriction (or rationing) of certain uses of water such as irrigation of lawns, car washing, filling swimming pools or hosing down pavement areas may be necessary during these times. Grey-water recycling (or reclamation) is the reuse of non-drinkable water (usually treated wastewater) to cover water use needs that don't demand such a high-quality standard.
	Local circular economy	➢ >Existence of a socially consensual plan to adopt circular economy principles to tourism related activities. ➢ Percentage of MSW that are locally recycled or sent to be recycled abroad, by types of material. ➢ Percentage of sewage receiving tertiary treatment and being reused. ➢ Percentage renewable sources in electricity production. ➢ Percentage of mobility powered by electric/hybrid/green hydrogen/ engines.	Collectivité territoriale de la Corse https://www.isula.corsica/	0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale. Yearly basis	An economic system aimed at eliminating waste and the continual use of resources that offers a valuable framework for reduced carbon emissions from materials (decarbonization) and increased resilience to climate change and its impacts.
	Health care delivery systems	➢ Number of hospital beds per 1000 tourists in tourist areas. ➢ Number of health personnel working in tourist areas per 1000 tourist. ➢ Existence of an effective plan to cover climate change related diseases (heatstroke, traumatology, infectious diseases…) medical attention demand.	Agence regionale de santé https://www.corse.ars.sante.fr/	Yearly basis Yearly basis 0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale.	Pre-emptive actions and adjustments that need to be made to health care systems, namely reinforcing less prepared aspects of its operation and/or logistics, in order to guarantee effectiveness and efficiency during, for example, high temperature and heat-wave situations.

	Economic Policy Instruments (EPIs)	➢ Existence of a set of economic policy instruments to support firms and local government to increase resilience against climate change.	Collectivité territoriale de la Corse https://www.isula.corsica/	0;1 This indicator can be complemented by an expert assessment of the set of instruments' suitability in a 1-5 Likert scale.	Incentives designed and implemented with the purpose of adapting individual decisions to collectively agreed goals. Pricing (e.g. water tariffs), environmental taxes and charges, subsidies; trading (e.g tradable permit for pollution or water abstraction, compensation mechanisms, payments for environmental services); and voluntary agreements and risk management schemes such as insurances.
	Monitoring, modelling and forecasting systems	➢ >Existence of a set of economic policy instruments to support firms and local government to increase resilience against climate change.	Collectivité territoriale de la Corse https://www.isula.corsica/	0;1 This indicator can be complemented by an expert assessment of the set of instruments' suitability in a 1-5 Likert scale.	Monitoring, modelling and forecasting systems are information system that provide timely and reliable climate information. Drought-related, water quality monitoring, water resources management and predicting and managing flood risks.
	Adaptive management of natural habitats	➢ Percentage of tourism-relevant natural habitats with exhibiting effective adaptive management including an explicit visitors' management plan.	Collectivité territoriale de la Corse https://www.isula.corsica/	Yearly basis This indicator can be complemented by an expert assessment of the adaptive management suitability in a 1-5 Likert scale.	The preservation of ecosystem services which are essential for human well-being. It include sunderstanding species response; make space for the development of rivers and coasts; aid gene flow; species translocation; targets and conservation mechanisms/plans.

12.8.2 Aquaculture

Indicators type	Indicators	Definition	Responsible Organization	Monitoring Processes	Interpretation
Climate hazard	Surface water temperature	Changes in surface water temperature	Meteo France-http://www.drias-climat.fr/	Climate modelling	seam bream: 24°C - 33 °C sea bass: 25 °C – 35.9 °C tuna: 24 °C – 26.17 °C mussels: 20.5 °C – 27.0 °C
Exposure	Farm area	Area occupied by sea cages (m²)	https://www.poisson-aquaculture.fr/	Annual estimations	These are critical factors worsening (more pressure) the risk of increased fragility of aquaculture activity.
	Value of stock	Value of biomass in the cages	https://www.poisson-aquaculture.fr/	Annual estimations	

	Stock size	Annual production of aquaculture products (fish and shellfish) (in tons)	https://www.poisson-aquaculture.fr/	Annual estimations	These indicators require a periodic measuring of their performance.
	Employment	Number of employees	https://www.poisson-aquaculture.fr/	Annual estimations	
	Location of farms	Location of farms related to the prevailing wind direction	https://www.poisson-aquaculture.fr/	Five-year updates	
		Location of farms related to the average distance to shore	https://www.poisson-aquaculture.fr/	Five-year updates	
	Sensitivity of species	Vulnerability of species to climate change	https://www.poisson-aquaculture.fr/	Literature review; aquaculture experts	
	Sensitivity of infrastructure	Vulnerability of infrastructure (type and materials of cages) to extreme weather events	https://www.poisson-aquaculture.fr/	Literature review; aquaculture experts	
Adaptation response	**Integrated multi-trophic aquaculture (IMTA)**	➢ >Percentage of multi-trophic aquaculture over the total aquaculture production. ➢ Existence of a plan to support through funding and technical assistance the aquaculture sector transition to IMTA schemes. ➢ Annual public expenditure to support aquaculture sector transition to IMTA schemes.	Local survey	Yearly basis 0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale. Yearly basis	Culture species from different trophic levels (fish, shellfish, seaweeds) in an integrated farm to create balanced systems for environmental sustainability. IMTA can increase resilience due to its tolerance to wider ranges of climatic factors such as temperature and salinity.
	Promote cooperation to local consumption	➢ Annual rate of local consumption increase. ➢ Percentage of aquaculture production locally consumed. ➢ Number of stakeholders involved in agreements to promote local consumption of local aquaculture, including tourism agents.	Local survey	Yearly basis Yearly basis	Cooperation to promote local consumption of aquaculture produced fish specially in tourist sector will reduce the cost of distribution and will improve the creation of add value in local products or by-products in innovative industries.
	Species selection	➢ >Existence of a plan to promote species selection to increase resilience against climate change impacts (mainly seawater heating and diseases).	Local survey	0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale. Yearly basis	Species selection consists of selecting species that are less sensitive to changes in the environment, less prone to diseases and less dependent on fish meal and oil. For example, choosing non-carnivorous species reduces food dependence and stocking larger hatchery

		➢ Annual public expenditure to support species selection programs to enhance aquaculture resilience against climate change.			fingerlings reduces the culture cycle and exposure to diseases.
	Disease prevention methods	➢ Existence of a plan with proper methods to prevent disease spreading. ➢ Annual public expenditure to fund diseases prevention in aquaculture.	Local survey	0;1 -This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale.	Disease prevention methods are preventive health measures such as vaccines, stronger fingerlings, probiotics, ensuring optimal water quality and implementing stricter hygiene procedures with the aim of reducing the risk of diseases now and in the future.
	Submersible cages	➢ Percentage of aquaculture production in submersible cages over the total production. ➢ Annual public expenditure to support substitution of conventional for submersible cages.	Local survey	Yearly basis Yearly basis	Oceanic depth-adjustable and can be moved up and down in the sea to escape the worst effects of storms, parasite outbreaks, surface algal blooms and to keep species at an optimal temperature.
	Awareness campaigns for behavioural change	➢ Existence of a plan to increase awareness on the long-term benefits of aquaculture development, for local and global socio-environments and promote behavioural change towards aquaculture development.	Local survey	0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale..	Awareness campaigns aim to increase the knowledge of individuals and organisations, it could also be relevant in a region affected by a particular climate threat, groups of stakeholders, and the general public.

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12.9 Crete

12.9.1 Maritime transport sector

Indicators type	Indicators	Definition	Responsible Organization	Monitoring Processes	Interpretation
Climate hazard	Wind Extremity Index (NWIX98)	Number of days per year exceeding the 98th percentile of mean daily wind speed.	NOA & HNMS		Ref: 7 days/year Up to 2050 (business as usual): 8 days
	Mean sea level rise	Annual mean sea level (cm)	NOA & HNMS	Annual estimations	Status-quo (1995-2020) = +3mm/ yr Business as usual: (up to 2050) +16 mm/yr (up to 2100) +31mm/yr
Exposure	Passengers	Number of passengers	Hellenic statistical authorities	Annual estimations	These are critical factors worsening (more pressure) the risk of isolation due to transport disruption. These indicators require a periodic measuring of their performance.
	Population	Number of island's inhabitants			
	Value of transported goods	Value of goods transported by ships (in freight)			
	Number of port infrastructures	Number of ports	Island's Port Authorities & Harbour Management Organisations		
Sensitivity	Quality of infrastructure and equipment	Number of ports with critical infrastructure not renovated since 1993	Island's Port Authorities & Harbour Management Organisations	Annual updates	
	Island dependence on maritime transport	Number of isolation days from the main land			
Adaptation response	**Prepare for service delays or cancellations**	➢ Existence of a plan de minimise service delays or cancellations due to climate change-related extreme weather events, including new transport channels and procedures. ➢ Percentage of ship-repairing areas fully adapted to the requirements of climate change (SLR, extreme events), in a 1-5 Likert scale by expert assessment	Island's Port Authorities & Harbour Management Organisations	0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale. Yearly basis	Prepare for service delays or cancellations aims to promote the creation of new procedures, alternative options and channels to sell goods and transport passengers, as well as better communication to deal with delays or cancellations. Dealing with more frequency and/or intensity of storms (which will happen in some regions) improves port reputation and customer preferences.
	Integrate ports in urban tissue	➢ Existence of a ports-urban areas integrated planning system, to activate port potential as factor for urban protection against climate change and cities taking advantage of secure port areas for leisure and cultural activities.	Harbour Management Organisations	0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale.	Integrate ports into the urban tissue opening port areas to other activities, namely cultural, while gaining room in the urban landscape. This allows some port activities to be pooled from low-laying

					areas while leisure and cultural activities can access more waterfront space.
	Climate proof ports and port activities	➢ Existence of a plan to achieve climate proof ports and port activities by progressive adaptation of port structures and operations. ➢ Annual public expenditure in adapting port and port activities to climate change related requirements.	Island's Port Authorities & Harbour Management Organisations	0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale.	These can include retrofitting or reconfiguring breakwaters and other port structures to avoid overtops and flooding due to storm surges, heavy precipitation, extreme heat, strong winds events and extreme swell conditions. The Copernicus Emergency Management Services (EMS) services can provide regarding climate change and disaster risk reduction.
	Backup routes and infrastructures during extreme weather	➢ Existence of backup routes and infrastructures to be used during extreme weather, if necessary. ➢ Percentage of annual maritime traffic using backup routes and infrastructures.	Island's Port Authorities & Harbour Management Organisations	0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale.	Backup routes and infrastructures during extreme weather aims to creates a post disaster response that ensures available alternatives when the main ports are damaged or inaccessible due to extreme weather events. It considers alternative ports and access roads. Alternative ports can be smaller in size, simpler and be used for other purposes, but should have a different location and orientation from the main ones.
	Social dialogue for training in the port sector	➢ Percentage of workers and employees that have received proper training about potential climate change impacts and how to deal with them. ➢ Annual expenditure in training on climate change and port operations to new workers and to update training about new knowledge related to climate change and ports.	Ministery of maritime affairs	Yearly basis Yearly basis	Social dialogue for training in the port sector refers to social and educational issues related with the gender equality and attracting the young to the sector, while tackling climate change. It relies on social dialogue between workers and employees to define common guidelines for training. It considers key challenges that ports are facing and how the industry is adapting to change and preparing for the future.
	Coastal protection structures	➢ Percentage of total port front which are defended by coastal protection structures.	Island's Port Authorities & Harbour Management Organisations	Yearly basis	

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12.9.2 Tourism sector

Indicators type	Indicators	Definition	Responsible Organization	Monitoring Processes	Interpretation
Climate hazards	Seagrass evolution	Coverage (in km2) of the main seagrass species	HCMR & Ministery of enviroment		Ref: Posidonia (17.4 km2) Business as usual: (up to 2050): 0 km2
	Beach reduction	Percentage of reduction of beach area	Ministery of environment & region of Crete		Status-quo (1995-2020) = -4 to 8m of beach area depending on the beach Business as usual: (up to 2050): - 53% (up to 2100): -68%
	Fire weather index (FWI)	Numerical non-dimensional ratings of relative fire potential for a generalized fuel type (mature pine stands) based solely on weather observations. FWI calculation includes temperature, precipitation, relative humidity and wind.	NOA & Civil protection	The index only refers to the fire season (defined from May to October)	Ref . FWI = 0.2-0.6 depending on the area Alert 0.6<FWI<1.0 Business as usual: (up to 2050): More areas under 0.4-0.6 range
	Vector Suitability Index for Aedes Albopictus (Asian Tiger Mosquito)	Increases of ambient air temperature and changes in the hydrological cycle.	NOA & Civil protection	The index needs to be calculated with new data in order to monitor the evolution. Although the indicator is expected to decrease it needs to be monitored, as still remain around 0.6 – Medium suitability	Ref: VBSI = 74.8 Alert VBSI>80 Business as usual: VBSI=62.8
	Humidity Index	Number of days exceeding 35oC	NOA & Civil protection		Ref: 31 days /year with HI>= 35°C Business as usual: (up to 2050): 56 days (up to 2100): 103 days
Exposure	Coast	Size of the coastline (km)	HCMR & Ministry of enviroment	Five-year updates	Information systems in the island provide incomplete data related to these exposure indicators. This is the first action to be undertaken in the monitoring process.
	Corals	Density of corals and other marine species		Five-year updates	
	Marine ecosystem	Marine ecosystem size (ha)		Five-year updates	
	Tourists	Number of tourists	Hellenic statistical Authority	Annual estimations	These are critical factors worsening (more pressure) the risk of forest fires, thermal stress, and marine habitat degradation in the island. These indicators require a periodic measuring of their performance.
		Tourist characteristics (age, gender etc.)		Annual estimations	
		Type of tourism (sport, pleasure etc.)		Annual estimations	
	Population	Population density (persons/km²)		Annual estimations	
	Agricultural land	Cultivated area (ha)		Annual estimations	
	Forests	Forest area (ha)	Decentrilized administrationof Crete	Annual estimations	
	Forests	Density of shrubby forests		Annual estimations	
	Forests	Tourist walking paths in the forests (km)		Five-year updates	
	Forest species	Number of forest flagship species		Five-year updates	

	Protected areas	Percentage of protected areas		Five-year updates	
Sensitivity	Pollution	Pollution from human activities	Ministry of environment & Region of Crete	Five-year updates	Information systems in the island provide incomplete data related to these sensitivity indicators. This is the first action to be undertaken in the monitoring process.
	Marine species	Sensitivity of marine species	HCMR & Ministry of enviroment	Five-year updates	
	Human activities triggering wild fires	Number of recreational areas with barbeque	CIVIL PROTECTION	Five-year updates	
Adaptation response	**Water restrictions, consumption cuts and grey-water recycling**	➢ Percentage of grey-water over total sewage. ➢ Days a year with water restrictions. ➢ Percentage of water losses along the water distribution system ➢ Existence of an effective efficiency water use plan.	Decentrilized administrationof Crete & Region of Crete	Yearly basis Yearly basis 0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale	Restrictions can be applied to allow water administration services to cope with water crises. Restriction (or rationing) of certain uses of water such as irrigation of lawns, car washing, filling swimming pools or hosing down pavement areas may be necessary during these times. Grey-water recycling (or reclamation) is the reuse of non-drinkable water (usually treated waste water) to cover water use needs that don't demand such a high-quality standard.
	Mainstreaming Disaster Risk Management (DRM)	➢ >Existence of a Mainstreaming Disaster Risk Management (DRM) plan, including decision making structure and procedures, and trained operators. ➢ Existence of a proper zoning of climate change exposed areas guiding decisions on the location of tourist activities, infrastructures and facilities at the destination	Decentrilized administrationof Crete & Region of Crete	0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale. 0;1 Can be complemented by an expert assessment of the zoning suitability in a 1-5 Likert scale.	Mainstreaming Disaster Risk Management (DRM) aims to plan and organize DRM along five stages including prevention, protection, preparedness, and response, recovery and review. Examples include interventions to limit urban development in flood prone areas; identify natural hazard prone areas; develop strategies, arrangements, and procedures to address crises; and post-emergency recovery activities.
	Activity and product diversification	➢ Number of tourism-oriented activities at the destination, according to the International Standard Industrial Classification of All Economic Activities (ISIC). ➢ Average tourist expenditure per overnight stay. ➢ Existence of an integrated plan to promote activity and product diversification including training, start-up firms and feasible funding.	Ministery of Tourism & Region of Crete	Yearly basis Yearly basis 0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale	Activity and product diversification include actions to diversify the tourism activities and products and aim to reduce seasonality and overload in infrastructures and ecosystems. Shifting the dependency from 'sun, sea and sand' products to alternative leisure activities can reduce the impacts of heat waves, coastal erosion or ecosystem degradation, and thus help to maintain destination attractiveness.
	Local circular economy	➢ Existence of a socially consensual plan to adopt circular economy principles to tourism related activities.		0;1 This indicator can be complemented by an expert	Local circular economy is an economic system aimed at eliminating waste and the continual use of resources that offers a valuable framework for reduced carbon emissions

		➢ Percentage of MSW that are locally recycled or sent to be recycled abroad, by types of material. ➢ Percentage of sewage receiving tertiary treatment and being reused. ➢ Percentage renewable sources in electricity production. ➢ Percentage of mobility powered by electric/hybrid/green hydrogen/ engines.	Region of Crete	assessment of the plan suitability in a 1-5 Likert scale. Yearly basis Yearly basis Yearly basis Yearly basis	from materials (decarbonization) and increased resilience to climate change and its impacts.
	Pre-disaster early recovery planning	➢ Existence of a Pre-disaster early recovery plan containing critical ecosystems, best recovery practices, guidelines to prevent future disasters and funding sufficiency.	Region of Crete & Ministry of enviroment	0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale.	Pre-disaster early recovery planning processes include the development of knowledge, good practices and objectives that aim to improve the living conditions of the affected communities, while facilitating the adjustments necessary to reduce the risk of future disasters. Examples of good practices are may include identifying critical ecosystems (goods and services) that require immediate restoration after a disaster or particularly vulnerable communities
	Economic Policy Instruments (EPIs)	➢ Existence of a set of economic policy instruments to support firms and local government to increase resilience against climate change.	Ministry of Environment & Region of Crete	0;1 This indicator can be complemented by an expert assessment of the set of instruments' suitability in a 1-5 Likert scale.	Incentives designed and implemented with the purpose of adapting individual decisions to collectively agreed goals. pricing (e.g. water tariffs), environmental taxes and charges, subsidies; trading (e.g tradable permit for pollution or water abstraction, compensation mechanisms, payments for environmental services); and voluntary agreements and risk management schemes such as insurances.

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12.10 Cyprus

12.10.1 Tourism sector

Indicators type	Indicators	Definition	Responsible Organization	Monitoring Processes	Interpretation
Climate hazard	Beach reduction	Percentage of reduction of beach area	Department of Environment		Status-quo (1995-2020) = -4 to 8m of beach area depending on the beach Business as usual: (up to 2050): - 38% (up to 2100): -54%
	Fire weather index (FWI)	Numerical non-dimensional ratings of relative fire potential for a generalized fuel type (mature pine stands) based solely on weather observations. FWI calculation includes temperature, precipitation, relative humidity and wind.	Department of Meteorology	The index only refers to the fire season (defined from May to October)	The index needs to be calculated with new data in order to monitor the evolution Alert 0.6<FWI<1.0 Ref: some areas are between 0.6 and 1.0 Business as usual: around 50% of total area between 0.6 and 1.0
	Humidity Index	Number of days exceeding 35°C	Department of Meteorology		Ref: 92 days /year with HI>= 35°C Business as usual: (up to 2050): 118 days (up to 2100): 162 days
	Seagrass evolution	Changes in relative terms (in %) of the coverage of the main seagrass species	Department of Fisheries; CYMEPA		Present coverage: 84km2 Business as usual: (up to 2050): 0km2
Exposure	Coast	Size of the coastline (km)	Department of Fisheries	Five-year updates	These are critical factors worsening (more pressure) the risk of forest fires, thermal stress, and marine habitat degradation in the island. These indicators require a periodic measuring of their performance.
	Corals	Density of corals and other marine species	Oceanography Centre	Five-year updates	
	Marine ecosystem	Marine ecosystem size (ha)	Oceanography Centre	Five-year updates	
	Tourists	Number of tourists	National Statistical Service; Regional Accounts	Annual estimations	
		Tourist characteristics (age, gender etc.)	National Statistical Service; Regional Accounts	Annual estimations	
		Type of tourism (sport, pleasure etc.)	National Statistical Service; Regional Accounts	Annual estimations	
	Population	Population density (persons/km²)	National Statistical Service; Regional Accounts	Annual estimations	
	Agricultural land	Cultivated area (ha)	National Statistical Service; Regional Accounts	Annual estimations	
	Forests	Forest area (ha)	National Statistical Service; Regional Accounts	Annual estimations	
	Forests	Density of shrubby forests	Forestry Department	Annual estimations	

	Forests	Tourist walking paths in the forests (km)	Forestry Department	Five-year updates	
	Forest species	Number of forest flagship species	Forestry Department	Five-year updates	
	Protected areas	Percentage of protected areas	Forestry Department	Five-year updates	
Sensitivity	Pollution	Pollution from human activities	Department of Environment	Five-year updates	These indicators require a periodic measuring of their performance.
	Marine species	Sensitivity of marine species	Oceanography Centre	Five-year updates	
	Human activities triggering wild fires	Number of recreational areas with barbeque	Forestry Department	Five-year updates	
Adaptation response	**Economic Policy Instruments (EPIs)**	➢ Existence of a set of economic policy instruments to support firms and local government to increase resilience against climate change.	Department of Environment	0;1 This indicator can be complemented by an expert assessment of the set of instruments' suitability in a 1-5 Likert scale.	Incentives designed and implemented with the purpose of adapting individual decisions to collectively agreed goals. Different type of instruments can be applied, like: pricing (e.g. water tariffs), environmental taxes and charges, subsidies; trading (e.g tradable permit for pollution or water abstraction, compensation mechanisms, payments for environmental services); and voluntary agreements and risk management schemes such as insurances.
	Pre-disaster early recovery planning	➢ Existence of a Pre-disaster early recovery plan containing critical ecosystems, best recovery practices, guidelines to prevent future disasters and funding sufficiency.	Department of Environment	0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale	Development of knowledge, good practices and objectives that aim to improve the living conditions of the affected communities, while facilitating the adjustments necessary to reduce the risk of future disasters. Examples of good practices are may include identifying critical ecosystems (goods and services) that require immediate restoration after a disaster or particularly vulnerable communities.
	Adaptive management of natural habitats	➢ Percentage of natural habitats relevant for tourism that exhibit effective adaptive management including an explicit visitors' management plan.	Department of Environment	Yearly basis This indicator can be complemented by an expert assessment of the adaptive management suitability in a 1-5 Likert scale.	Preservation of ecosystem services which are essential for human well-being. Human activities induce pressure and impacts on biodiversity and ecosystems that tend to be aggravated by climate change. Adaptive management measures include understanding species response; make space for the development of rivers and coasts; aid gene flow; species translocation; targets and conservation mechanisms/plans.
	Drought and water conservation plans	➢ Existence of a drought and water conservation plan containing measures to reduces water losses in distribution and encourage efficiency in water uses and, when necessary, the access to extraordinary sources of drinking water during critical periods.	Regional Water Boards; Water Development Department; Energy, Environment and Water Research Center (CYI)	0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale.	Tourism-lead adaptation and/or involvement in drought management plans with the aim to reduce the economic, social, and environmental consequences of drought and water scarcity, and to reduce the loss of water and improve efficiency in the sector.

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	Water restrictions, consumption cuts and grey-water recycling	➢ Percentage of grey-water over total sewage. ➢ Days a year with water restrictions. ➢ Percentage of water losses along the water distribution system ➢ Existence of an effective efficiency water use plan.	Regional Water Boards; Water Development Department; Energy, Environment and Water Research Center (CYI)	Yearly basis The last indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale.	Grey-water recycling (or reclamation) is the reuse of non-drinkable water (usually treated wastewater) to cover water use needs that don't demand such a high-quality standard. It concerns irrigation of lawns, car washing, filling swimming pools or hosing down pavement areas may be necessary during these times.

12.10.2 Energy sector

Indicators type	Indicators	Definition	Responsible organisation	Monitoring Processes	Interpretation
Climate hazard	Number of cooling degree days (CDD) per year	Temperature difference above 18ºC in each year, calculated using average daily temperature values.	Department of Meteorology	Annual estimations	Ref CDD= 460 Business as usual: (up to 2050): 841 CDD (up to 2100 : 1183CDD *The indicator is computed by multiplying the number of days exceeding the threshold by the difference in temperatures.*
	Standardised precipitation-evapotransporation index (SPEI)	Transformation of a monthly precipitation time series into a standardized normal distribution	Department of Meteorology	Annual updates	Ref SPEI= 0.00 Alert -1 =<SPEI <= -2 Business as usual: (up to 2050): -1.9 (up to 2100) :-2.4
	Wind productivity	Absolute value (kWh/kW)	Electricity Authority Cyprus; Cyprus Energy Regulatory Authority; Cyprus Energy Agency; Energy, Environment and Water Research Center (CYI)	Annual updates	Ref : 1435 kWh/kW –land 3245 kWh/kW - sea Business as usual: (up to 2100): -24 kWh/kW (land) (up to 2100) :-283 kWh/kW (sea)
Exposure	Population	Number of island's inhabitants	National Statistical Service; Regional Accounts	Annual estimations	These are critical factors worsening (more pressure) the risk of increased energy demand for cooling and desalinate sea water in the island. These indicators require a periodic measuring of their performance.
	Tourists	Number of tourists			
	Tourism seasonality	Annual min-max variation of tourists			
	Cooling penetration rate	Share of households with air-conditioning		Five-year estimations	

	Desalination	Percentage of desalinated water to total water consumption		Annual estimations	
Sensitivity	Per capital energy demand	Energy demand (MWh) per person	Electricity Authority Cyprus; Cyprus Energy Regulatory Authority; Cyprus Energy Agency; Energy, Environment and Water Research Center (CYI)	Annual estimations	
	Energy intensity	Energy use (in MWh) per gross domestic product (GDP) (in M€)			
Adaptation response –	**Green Energy Jobs and businesses**	➢ Percentage of green energy jobs over the total jobs. ➢ Number of persons involved in training processes related to encouraging green jobs and businesses. ➢ Public and private funding of R+D+I projects aiming at encouraging green innovation.	National Statistical Service; Regional Accounts;	Yearly basis Yearly basis Yearly basis	Training people and supporting green businesses to implement energy solutions across the economy, both in mitigation and adaptation. One example can be the support of research projects to help businesses deal with new technologies relevant to climate action.
	Demand Side Management (DSM) of Energy	➢ Number of self-consumptions systems that includes DSM strategies in their facilities. This question can be included in the facility registration form	Electricity Authority Cyprus; Cyprus Energy Regulatory Authority; Cyprus Energy Agency; Energy, Environment and Water Research Center (CYI)	Yearly basis	Operational strategy that better coordinates producers and consumers of energy. More renewable energy (like solar and wind) use is possible while ensuring the energy service reliability and controlled costs. DMS balances off-peak and peak demand using peek shaving, which is important, for example, during heat waves.
	Energy recovery micro-grids	➢ Capacity in MW of energy recovery micro-grids to restore systems from power outages. ➢ Average time in hours required to restore systems from power outages.	Electricity Authority Cyprus; Cyprus Energy Regulatory Authority; Cyprus Energy Agency; Energy, Environment and Water Research Center (CYI)	Yearly basis Yearly basis	Operational elements of the energy grids that rely on distributed generation to restore systems from power outages and to stabilize the grid. This allows for a flexible and swifter recovery from power outages caused by knock-out events (e.g. tree falls on energy lines), excess demand (e.g. during heat waves) or other causes.
	Energy storage systems	➢ Energy storage systems capacity in MWh, by different types (batteries, thermal tanks, water height...). ➢ Percentage of energy storage systems capacity over the total renewable energy production capacity.	Electricity Authority Cyprus; Cyprus Energy Regulatory Authority; Cyprus Energy Agency; Energy, Environment and Water Research Center (CYI)	Yearly basis	This allows for a more resilient energy grid while enabling decarbonization and peak levelling at a controlled cost. This includes not only electric batteries (like those in cars and buses), but also other forms of energy storage such as thermal tanks (heat), ice banks (cold) or water height (reversed pumping).
	Harnessing low enthalpy energy	➢ Percentage of water and rooms-climatization and powered by low enthalpy geothermal and aerothermal energy.	Electricity Authority Cyprus; Cyprus Energy Regulatory Authority; Cyprus Energy Agency;	Yearly basis	These systems can be Earth Air Heat Exchanger (EAHE) and Ground Source Heat Pump (GSHP) types. Both systems use tubes or pipes that usually need to be buried beyond the footprint of the building or house.

		➢ Percentage electric energy produced by high enthalpy geothermal energy. ➢ Percentage of heat necessities that are covered by highly efficient co-generation systems.	Energy, Environment and Water Research Center (CYI)		The measure considers this need, and both allows and encourages the use of such space in urban planning.
	Small scale production and consumption (prosumers)	➢ Number of prosumers (individuals and communities). ➢ Percentage of renewable energy produced under prosumers regime. ➢ Percentage of decentralised renewable energy produced in shared facilities./ total production of RES / or RE demand	Electricity Authority Cyprus; Cyprus Energy Regulatory Authority; Cyprus Energy Agency; Energy, Environment and Water Research Center (CYI)	Yearly basis	This allows for a greater use of local renewable resources and waste energy recovery which allow for a better resilience when dealing with climate change events such as heat waves.

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12.11 Fehmarn

12.11.1 Tourism sector

Indicators type	Indicators	Definition	Responsible Organization	Monitoring Processes	Interpretation
Hazard	Vector Suitability Index for Aedes Albopictus (Asian Tiger Mosquito)	Increases of ambient air temperature and changes in the hydrological cycle.	Deutscher Wetterdienst (DWD) www.dwd.de	The index needs to be calculated with new data in order to monitor the evolution.	Ref: VBSI = 77.7 Alert VBSI>80 Business as usual (up to 2050): 96.2 (up to 2100): 99.4
Exposure	Coast	Size of the coastline (km)	Landesamt für Küstenschutz, Nationalpark und Meeresschutz https://www.schleswig-holstein.de/DE/Landesregierung/LKN/_documents/lkn.html	Five-year updates	These are critical factors worsening (more pressure) the risk the risk of forest fires, thermal stress, and marine habitat degradation in the island. These indicators require a periodic measuring of their performance However, information systems in the island provide incomplete data related to exposure indicators. This is the first action to be undertaken
	Corals	Density of corals and other marine species	GEOMAR, Institute für Ozeanforschung www.geomar.de	Five-year updates	
	Marine ecosystem	Marine ecosystem size (ha)	GEOMAR, Institute für Ozeanforschung www.geomar.de	Five-year updates	
	Tourists	Number of tourists	Tourismus Service Fehmarn, www.fehmarn.de	Annual estimations	
		Tourist characteristics (age, gender etc.)	Tourismus Service Fehmarn, www.fehmarn.de	Annual estimations	
		Type of tourism (sport, pleasure etc.)	Tourismus Service Fehmarn, www.fehmarn.de	Annual estimations	
	Population	Population density (persons/km²)	Fehmarn Municipality, www.stadtfehmarn.de	Annual estimations	
	Agricultural land	Cultivated area (ha)	Bauernverband Schleswig-Holstein, Bezirksvorsitzender Fehmarn, https://www.bauern.sh/verband/kreisbauernverbaende/ostholstein-luebeck/bezirke.html	Annual estimations	
	Protected areas	Percentage of protected areas	NABU Wallnau www.wallnau.nabu.de	Five-year updates	

Sensitivity	Pollution	Pollution from human activities	Environmental Council Fehmarn, Beate Burow, b.burow@stadtfehmarn.de	Five-year updates	
	Marine species	Sensitivity of marine species	GEOMAR, Institute für Ozeanforschung www.geomar.de	Five-year updates	
	Human activities triggering wild fires	Number of recreational areas with barbeque	Camping-Paradies Fehmarn, www.campingparadies-fehmarn.de	Five-year updates	
Adaptation response	**Activity and product diversification**	➢ Number of tourism-oriented activities at the destination, according to the International Standard Industrial Classification of All Economic Activities (ISIC). ➢ Average tourist expenditure by overnight stay ➢ Existence of an integrated plan to promote activity and product diversification including training, start-up firms and feasible funding.	Tourismus Service Fehmarn, www.fehmarn.de	Yearly basis Yearly basis 0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale	Actions to diversify the tourism activities and products and aim to reduce seasonality and overload in infrastructures and ecosystems. Shifting the dependency from 'sun, sea and sand' products to alternative leisure activities can reduce the impacts of heat waves, coastal erosion or ecosystem degradation, and thus help to maintain destination attractiveness.
	Local circular economy	➢ Existence of a socially consensual plan to adopt circular economy principles to tourism related activities. ➢ Percentage of MSW that are locally recycled or sent to be recycled abroad, by types of material. ➢ Percentage of sewage receiving tertiary treatment and being reused. ➢ Percentage renewable sources in electricity production. ➢ Percentage of mobility powered by electric/hybrid/green hydrogen/ engines.	Environmental Council Fehmarn, Beate Burow, b.burow@stadtfehmarn.de, https://www.stadtfehmarn.de/Stadt/Stadtverwaltung/Umweltrat/Initiative-im-meer-weniger-Plastik-	0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale. Yearly basis	Measures to eliminate waste and the continual use of resources that offers a valuable framework for reduced carbon emissions from materials (decarbonization) and increased resilience to climate change and its impacts.
	Mainstreaming Disaster Risk Management (DRM)	➢ Existence of a Mainstreaming Disaster Risk Management (DRM) plan, including decision making structure and procedures, and trained operators.	Technisches Hilfwerk Burg, https://ov-burg.thw.de/ Freiwillige Feuerwehr Burg, http://www.ff-burg.de/	0;1 Both indicators can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale.	To plan and organize DRM along five stages including prevention, protection, preparedness, and response, recovery and review. Examples include interventions to limit urban development in flood

		➢ Existence of a proper zoning of climate change exposed areas guiding decisions on the location of tourist activities, infrastructures and facilities at the destination.			prone areas; identify natural hazard prone areas; develop strategies, arrangements, and procedures to address crises; and post-emergency recovery activities.
	Beach nourishment	➢ M3 of sand used in natural beaches nourishment actions. ➢ Beach surface restored by sand nourishment actions. ➢ Percentage of natural sand beach total surface under a sand nourishment program.	Landesamt für Küstenschutz, Nationalpark und Meeresschutz https://www.schleswig-holstein.de/DE/Landesregierung/LKN/_documents/lkn.html	Yearly basis Yearly basis Yearly basis	. Misguided human interventions and climate change (SLR) pose a threat on long term beaches surface maintenance justifying sand nourishment actions. Yet, eco-friendly sand nourishment practices are crucial in order to achieve its environmental compatibility and social acceptance.
	Health care delivery systems	➢ Number of hospital beds per 1000 tourists in tourist areas. ➢ Number of health personnel working in tourist areas per 1000 tourist. ➢ Existence of an effective plan to cover climate change related diseases (heatstroke, traumatology, infectious diseases…) medical attention demand.	Krankenhaus Oldenburg Ostholstein, info.oh@sana.de https://www.sana-oh.de/oldenburg/,	Yearly basis Yearly basis 0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale.	Pre-emptive actions and adjustments that need to be made to health care systems, namely reinforcing less prepared aspects of its operation and/or logistics, in order to guarantee effectiveness and efficiency during, for example, high temperature and heat-wave situations.

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12.12 Madeira

12.12.1 Maritime transport sector

Indicators type	Indicators	Definition	Proposal for the Responsible Organization	Monitoring Processes	Interpretation
Climate hazard	Mean sea level rise	Annual mean sea level (cm)	Instituto Hidrográfico https://www.hidrografico.pt/ APRAM http://www.apram.pt/site/index.php/pt/ IPMA https://www.ipma.pt/pt/index.html	Annual estimations	Status-quo (1995-2020) = +3mm/ yr Business as usual: (up to 2050) +18.5mm/yr (up to 2100) +37.5mm/yr
Exposure	Passengers	Number of passengers	DREM https://estatistica.madeira.gov.pt/dre-2.html	Annual estimations	These are critical factors worsening (more pressure) the risk of isolation due to transport disruption. These indicators require a periodic measuring of their performance. However, information systems in the island provide incomplete data related to exposure indicators. This is the first action to be undertaken in the monitoring process.
	Population	Number of island's inhabitants	DREM https://estatistica.madeira.gov.pt/dre-2.html INE https://www.ine.pt/xportal/xmain?xpgid=ine_main&xpid=INE&xlang=pt	Annual estimations	
	Value of transported goods	Value of goods transported by ships (in freight)	DREM https://estatistica.madeira.gov.pt/dre-2.html APRAM http://www.apram.pt/site/index.php/pt/ INE https://www.ine.pt/xportal/xmain?xpgid=ine_main&xpid=INE&xlang=pt	Annual estimations	
	Number of port infrastructures	Number of ports	Vice-presidency https://www.madeira.gov.pt/vp (APRAM: http://www.apram.pt/site/index.php/pt/)	Annual estimations	
Sensitivity	Quality of infrastructure and equipment	Number of ports with critical infrastructure not renovated since 1993	Vice-presidency https://www.madeira.gov.pt/vp (APRAM: http://www.apram.pt/site/index.php/pt/)	Annual updates	
	Island dependence on maritime transport	Number of isolation days from the main land		Annual updates	
Adaptation response	**Specific requirements to**	➢ Existence of an effective plan to operate backup routes and		0;1	It must be underlined, that small and fragmented territories are disadvantages of islands and archipelagos

	increase climate change resilience of maritime transports services in islands	infrastructures to ensure maritime transport and island provisioning in case of extreme weather events. ➢ Percentage of areas needing heightening regarding to the expected SLR at the end of the 21st century ➢ Percentage of cold ironing facilities fully adapted to climate change risks.	DRAAC https://www.madeira.gov.pt/draac	A complementary indicator could be defined for the plan suitability, based on expert opinion in 1-5 Likert scale. Yearly basis Yearly basis	regarding climate change assessment that must be considered, as adaptation measures and allocated resources, namely for maritime transports, should deal with higher uncertainty. The maritime transport of passengers and goods is crucial for archipelagos, especially for smaller islands that are depend on main islands, aggravating their vulnerability to climate change. Additionally, to the consideration of backup routes and infrastructures, it is important to define specific requirements for this service, in order to ensure the operation of vessels with characteristics to deal with higher climate change uncertainty, and promote the use of natural gas, biogas, hydrogen and electricity, in order to decrease dependence from fossil fuels and increase manoeuvrability of vessels.
	Prepare islands ports to supply alternative fuels and electricity	➢ Percentage of total energy supplied to docked vessels that is produced by renewable and reduced emissions sources, per type of energy use.	Currently Not applied. If applied: Vice-presidency https://www.madeira.gov.pt/vp (APRAM: http://www.apram.pt/site/index.php/pt/	Yearly basis	Islands ports must be prepared to supply natural gas, biogas, hydrogen and electricity, in order to be prepared to alternative propulsion technologies and supply docked vessels with electricity from renewable sources, reducing the dependence from fossil fuels, and thus increasing the resilience of the islands energy systems to climate change, measures with high synergies with mitigation objectives.
	Increase knowledge and modelling tools on climate change for islands	➢ Existence of an operative modelling tool providing updated information on the risk faced by port infrastructures and useful simulations on the results of alternative adaptation options.	DRAAC https://www.madeira.gov.pt/draac	0;1 A complementary indicator could be defined for the integrated plan suitability, based on expert opinion in 1-5 Likert scale	Given the high dependence from air transports, specific climate forecast models and climate data collection systems to ensure islands airports real-time operation must be specially promoted in other to decrease islands vulnerability to climate change.
	City ports as coastal protection infrastructures against extreme climate events (sea level rise combined with sea storm)	➢ Existence of an integrated urban-port plan with ports forming part of the protection of urban areas against extreme weather events.	Vice-presidency https://www.madeira.gov.pt/vp (APRAM: http://www.apram.pt/site/index.php/pt/) Municipalities https://www.amram.pt/ DROTe	0;1 A complementary indicator could be defined for the integrated plan suitability, based	Future interventions in ports, specially urban and city ports, should take into consideration their potential to protect turban coastal areas from sea storms combined with sea level rise. The intervention in marinas and boatyards should also guarantee the security of the infrastructures in case of extreme weather events and

		➢ Percentage of total mooring points in recreative marinas with an effective adaptation plan against extreme weather.	https://www.madeira.gov.pt/sraac/GovernoRegional/OGoverno/Secretarias/Structure/SRAAC/ctl/Read/mid/6801/InformacaoId/54473/UnidadeOrganicaId/8 Vice-presidency https://www.madeira.gov.pt/vp (APRAM: http://www.apram.pt/site/index.php/pt/)	on expert opinion in 1-5 Likert scale. Yearly basis	consider the need of increase the dry dock areas, to ensure the boats security.
	Restrict development and settlement in low-lying areas	➢ Existence of a specific regulation restricting ports development with the identification of areas and risks involved	DROTe https://www.madeira.gov.pt/sraac/GovernoRegional/OGoverno/Secretarias/Structure/SRAAC/ctl/Read/mid/6801/InformacaoId/54473/UnidadeOrganicaId/8	0;1	Restrict development and settlement in low-lying areas means to assure that ports are not further developed in low-laying areas exposed to SLR. Planning must consider the long-term potential risks.
	Climate resilient economy and jobs	➢ Percentage of perishable goods that preserved in perfect temperature conditions while stored at ports. ➢ Percentage of workers operating with proper protection against climate change events (security, thermal comfort…). ➢ Capacity in accumulated days of perishable goods storage.	Vice-presidency https://www.madeira.gov.pt/vp (APRAM: http://www.apram.pt/site/index.php/pt/) DREM https://estatistica.madeira.gov.pt/dre-2.html Survey to the imports, export, logistics and distribution companies.	Yearly basis	As part of newly products and services that depend less on Just In Time (JIT) operations, using for instance larger stocks.
	Backup routes and infrastructures during extreme weather	➢ Degree of adequacy of current and new port areas devoted to host activities under special regimens to future extreme events; by expert assessment ➢ Existence of backup routes and infrastructures to be used during extreme weather, if necessary. ➢ Percentage of annual maritime traffic using backup routes and infrastructures.	Vice-presidency https://www.madeira.gov.pt/vp (APRAM: http://www.apram.pt/site/index.php/pt/)	1-5 Likert scale.	It considers alternative ports and access roads. Alternative ports can be smaller in size, simpler and be used for other purposes, but should have a different location and orientation from the main ones.

	Integrate ports in urban tissue	➢ Existence of a ports-urban areas integrated planning system, to activate port potential as factor for urban protection against climate change and cities taking advantage of secure port areas for leisure and cultural activities. ➢ Number of new licenses of commercial activities in port areas	Vice-presidency https://www.madeira.gov.pt/vp (APRAM: http://www.apram.pt/site/index.php/pt/) Municipalities, https://www.amram.pt/ DROTe https://www.madeira.gov.pt/sraac/GovernoRegional/OGoverno/Secretarias/Structure/SRAAC/ctl/Read/mid/6801/InformacaoId/54473/UnidadeOrganicaId/8	0;1 Yearly basis	Opening port areas to other activities, namely cultural, while gaining room in the urban landscape. This allows some port activities to be pooled from low-laying areas while leisure and cultural activities can access more waterfront space.
	Increase operational speed and flexibility in ports	➢ Existence of a plan to increase operational speed and flexibility aimed at increasing ports attractiveness ➢ Percentage of CO2 equivalent emissions avoided thanks to the increase of operational speed and flexibility in ports, with respect to a baseline-year. ➢ Average reduction in hours of vessels stay in ports due to the increase of the operational speed, with respect to a baseline-year.	Vice-presidency https://www.madeira.gov.pt/vp (APRAM: http://www.apram.pt/site/index.php/pt/)	0:1 Yearly basis	Faster operations also reduce the effects of heat waves on goods and people as well as decarbonise the economy.
	Intelligent transport systems	➢ Existence of an Intelligent Transport Systems (ITS) to assist navigation through standardised safety-related messages.	Vice-presidency https://www.madeira.gov.pt/vp (APRAM: http://www.apram.pt/site/index.php/pt/)	0;1 This indicator can be complemented by an expert assessment of the (ITS) suitability in a 1-5 Likert scale.	Technologies that relay automated and tailored data and safety-related messages to ships, regarding climate hazards and other relevant information. ITS use communication and information standards that are uniform and widely accepted by other ports that the island is linked to.
	Early Warning Systems (EWS) and climate change monitoring	➢ Existence of an Early Warning System and mechanisms to provide suitable information to support decision making for authorities and companies.	IPMA https://www.ipma.pt/pt/index.html SRPC,IP-RAM https://www.procivmadeira.pt/pt/ LREC Website not available	0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale.	The collected data can also be used to study the evolution of climate impacts as time progresses, for instance the impact of heat waves and storms in operations.

			CPF-AMN https://www.amn.pt/DGAM/Capitanias/Funchal/Paginas/Capitania-do-porto-do-Funchal.aspx		
	Integrate ports in urban tissue	➢ Existence of a ports-urban areas integrated planning system, to activate port potential as factor for urban protection against climate change and cities taking advantage of secure port areas for leisure and cultural activities.	Vice-presidency https://www.madeira.gov.pt/vp (APRAM: http://www.apram.pt/site/index.php/pt/)	0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale.	Integrate ports into the urban tissue opening port areas to other activities, namely cultural, while gaining room in the urban landscape. This allows some port activities to be pooled from low-laying areas while leisure and cultural activities can access more waterfront space.
	Combined protection and wave energy infrastructures	➢ Percentage of protection structures endowed with wave energy devices. ➢ Percentage of wave energy produced in protection structures over total consumed energy at the port.	DRETT https://www.madeira.gov.pt/drett/ Vice-presidency https://www.madeira.gov.pt/vp (APRAM: http://www.apram.pt/site/index.php/pt/)		
	Coastal protection structures	➢ Percentage of coastal urban areas with planning including the assessment of their resistance and maintenance work scheduled. ➢ Percentage of maritime transport activity linked to port infrastructures having assessment of their resistance and maintenance work scheduled.	Vice-presidency https://www.madeira.gov.pt/vp (APRAM: http://www.apram.pt/site/index.php/pt/) DROTe https://www.madeira.gov.pt/sraac/GovernoRegional/OGoverno/Secretarias/Structure/SRAAC/ctl/Read/mid/6801/InformacaoId/54473/UnidadeOrganicaId/8 Municipalities https://www.amram.pt/	Yearly basis	The climate scenarios point to an increased probability of occurrence of extreme weather events in the RAA. As part of the POOC review, the adequacy of the protection response must be assessed and the degree of resistance of the existing works evaluated, establishing an adequate schedule of needs in terms of maintenance, adaptation or construction of new works.

12.12.2 Energy sector

Indicators type	Indicators	Definition	Responsible Organization	Monitoring Processes	Tipping points?
Climate hazard	Number of cooling degree days (CDD) per year	Temperature difference above 18ºC in each year, calculated using average daily temperature values.		Annual estimations	Ref CDD= 74.22 Business as usual: (up to 2050): 207.71 CDD (up to 2100 : 410.93CDD *The indicator is computed by multiplying the number of days exceeding the threshold by the difference in temperatures.*

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	Standardised precipitation-evapotransporation index (SPEI)	Transformation of a monthly precipitation time series into a standardized normal distribution	IPMA https://www.ipma.pt/pt/index.html	Annual updates	Ref SPEI= 0.00 Alert -1 =<SPEI <= -2 Business as usual: (up to 2050): -1.5 (up to 2100) :-2.4
	Extreme temperatures	Percentage of days per year when T > 98th percentile - T98p			Ref: 2% of the year with T > 98th percentile - T98p Business as usual: 2100- 25.7% of the year
Exposure	Population	Number of island's inhabitants	INE https://www.ine.pt/xportal/xmain?xpgid=ine_main&xpid=INE&xlang=pt	Annual estimations	These are critical factors worsening (more pressure) the risk of increased energy demand for cooling and desalinate sea water in the island. These indicators require a periodic measuring of their performance.
	Tourists	Number of tourists	SRTC https://www.madeira.gov.pt/srtc	Annual estimations	
	Tourism seasonality	Annual min-max variation of tourists	SRTC https://www.madeira.gov.pt/srtc	Annual estimations	
	Cooling penetration rate	Share of households with air-conditioning	DREM https://estatistica.madeira.gov.pt/dre-2.html	Five-year estimations	
	Desalination	Percentage of desalinated water to total water consumption	SRAAC https://www.madeira.gov.pt/sraac (ARM: http://www.aguasdamadeira.pt/In%C3%ADcio.aspx)	Annual estimations	
Sensitivity	Per capital energy demand	Energy demand (MWh) per person	DRETT https://www.madeira.gov.pt/drett/	Annual estimations	
	Energy intensity	Energy use (in MWh) per gross domestic product (GDP) (in M€)		Annual estimations	
Adaptation response	**Minimize islands energy dependence from imported fossil fuels to increase resilience to climate change**	➢ Percentage of final energy production coming from renewable sources. RES production/Total production ➢ RES production/Load consumption. Load demand coverage through renewable energy sources. ➢ Primary Energy/PIB (high efficiency-tend to decrease)	DRETT https://www.madeira.gov.pt/drett/	Yearly basis	Energy efficiency and renewable resources potential are key assets in islands to increase resilience to climate change and to reduce dependence from fossil fuels, integrated with storage technologies, namely hydrogen, batteries and water storage. In islands territories, savings associated to sustainable energy measures are important for companies' recovery and competitiveness and to tackle and prevent energy poverty among families, particularly in tourism dependent islands, highly affected by the COVID-19 pandemic.

	Diversification on energy supply and electricity generation	➢ Index of energy supply security by expert assessment of energy mix and the weighted vulnerability of the involved energy sources. ➢ RES production with each specific source / load demand. This index should be used for each type of renewable energy source estimating the contribution of each source in the load demand coverage.	DRETT https://www.madeira.gov.pt/drett/	1-5 Likert scale. Yearly basis	To reduce the vulnerability of energy supply and electricity generation is important to have a balanced diversification of energy sources, namely renewable energy sources that may be affected by climate change events (wind, solar, hydro, biomass, etc.) and fossil fuels needed to ensure the security of supply, promoting the transition to cleaner fuels like natural gas in the electricity generation and vessels supply.
	Implement electricity prices for renewable energy generation on islands based on actual local costs to stimulate the RES generation	➢ Existence of price incentives to the electricity produced with renewable energy sources. ➢ Percentage of Funding of total cost of electricity production (%).	DRETT https://www.madeira.gov.pt/drett/ (EEM: https://www.eem.pt/pt/inicio/)	➢ 0;1 A complementary indicator could be defined for the incentives plan suitability, based on expert opinion in 1-5 Likert scale. Yearly basis	Taking into consideration European Commission specific derogations on the electricity market directives, Member States should Implement differentiated electricity tariffs for renewable energy production on islands with non-interconnected energy systems that take into consideration the additional costs of investments in islands territories, the lack of competitiveness in these isolated markets and the marginal costs of local thermal electricity generation.
	Modelling and forecasting of supply and demand	➢ Forecasting error using as reference the determination coefficient (R2), the Mean Absolute Error (MAE) and the Mean Absolute Percentage Error (MAPE).	DRETT https://www.madeira.gov.pt/drett/ (EEM: https://www.eem.pt/pt/inicio/) These metrics compare an estimation with the observed data to know if the forecasting model is accurate or not.	R2 value These metrics compare an estimation with the observed data to know if the forecasting model is accurate or not correlation analysis	The safety of supply of energy can be reinforced through more detailed modelling of the complexity of the insular energy systems combined with a forecasting of the demand and supply based on weather aspects.
	Promote electric mobility integrated in smart grids with smart-charging and vehicle-to-grid infrastructure	➢ Percentage of motor vehicles which are electric vehicles, by type. ➢ Percentage of EV performing under Vehicles-to-Grid schemes. ➢ Percentage of households' electricity consumption coming from Vehicles-to-Grid source.	DRETT https://www.madeira.gov.pt/drett/ (EEM: https://www.eem.pt/pt/inicio/	Yearly basis	The transition from Internal Combustion Engine (ICE) to electric powertrains followed with a capable charging infrastructure with smart-charging, and V2G (Vehicle-to-Grid) functionalities not only speeds up the transition, as softens the impact of electric vehicles on electric grid. This measure with the increase of RES power contributes to the decarbonization of the insular energy systems.
	Electrification of energy demand	➢ Percentage of electricity demand over the total households' energy demand.	DRETT https://www.madeira.gov.pt/drett/	Yearly basis	Electrification of residential and services consumptions regarding heating, cooling and cooking, contributes to the decarbonization of the territory and removes the dependence

			(EEM: https://www.eem.pt/pt/inicio/		on fossil fuels transport and distribution and also increase of RES contribution.
	Energy storage systems	➢ MWh of renewable storage capacity by different types (batteries, thermal tanks, water height...). ➢ Percentage of renewable storage capacity over the total renewable energy.	DRETT https://www.madeira.gov.pt/drett/ (EEM: https://www.eem.pt/pt/inicio/		This allows for a more resilient energy grid while enabling decarbonization and peak levelling at a controlled cost. This includes not only electric batteries (like those in cars and buses), but also other forms of energy storage such as thermal tanks (heat), ice banks (cold) or water height (reversed pumping).
	Educational garden plots	➢ Number of new garden plots	Municipalities https://www.madeira.gov.pt/sra	Yearly basis	sites where people, especially children, can garden with volunteers one afternoon a week after school. The harvest can be taken home.
	Energy efficiency in urban water management	➢ Water storage capacity in m3. ➢ Number of days that water demand may be met by stored water. ➢ Percentage of aquifer downloading/overloading. Yearly. ➢ Percentage of water climatization and powered by low enthalpy geothermal and aerothermal energy.	SRAAC https://www.madeira.gov.pt/sraac (ARM: http://www.aguasdamadeira.pt/In%C3%ADcio.aspx) Municipalities https://www.madeira.gov.pt/sra	Yearly basis	The adaptation of urban design and construction for water conservation that avoids energy use under scarcity scenarios. For instance, Water Sensitive Urban Design (WSUD) aims to plan water conservation and storm water storage with integration with elements of urban design.
	Green Energy Jobs and businesses	➢ Percentage of green jobs over the total jobs. ➢ Number of persons involved in training processes related to encouraging green jobs and businesses. ➢ Public and private funding of R+D+I projects aiming at encouraging green innovation.	IEM https://www.iem.madeira.gov.pt/	Yearly basis Yearly basis Yearly basis	Training people and supporting green businesses to implement energy solutions across the economy, both in mitigation and adaptation. One example can be the support of research projects to help businesses deal with new technologies relevant to climate action.
	Small scale production and consumption (prosumers)	➢ Number of prosumers (individuals and communities). ➢ Percentage of renewable energy produced under prosumers regime. ➢ Percentage of decentralised renewable energy produced in shared facilities./ total production of RES / or RE demand	DRETT https://www.madeira.gov.pt/drett/ (EEM: https://www.eem.pt/pt/inicio/	Yearly basis	This allows for a greater use of local renewable resources and waste energy recovery which allow for a better resilience when dealing with climate change events such as heat waves.

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	Energy microgrids	➢ MWh Energy covered by micro grids/total demand of the electric system ➢ ➢ Percentage of total energy consumption which is working under micro smart grid schemes.	DRETT https://www.madeira.gov.pt/drett/ (EEM: https://www.eem.pt/pt/inicio/	Yearly basis	This allows for a flexible and swifter recovery from power outages caused by knock-out events (e.g. tree falls on energy lines), excess demand (e.g. during heat waves) or other causes.

12.12.3 Tourism sector

Indicators type	**Indicators**	**Definition**	**Responsible Organization**	**Monitoring Processes**	**Interpretation**
Climate hazard	Beach reduction	Percentage of reduction of beach area	DROTe https://www.madeira.gov.pt/sraac/GovernoRegional/OGoverno/Secretarias/Structure/SRAAC/ctl/Read/mid/6801/InformacaoId/54473/UnidadeOrganicaId/8		Status-quo (1995-2020) = -4 to 8m of beach area depending on the beach Business as usual: (up to 2050): - 78% (up to 2100): -95%
Exposure	Coast	Size of the coastline (km)		Five-year updates	These are critical factors worsening (more pressure) the risk of forest fires danger, loss of attractiveness of Madeira as tourist destination due to thermal stress, and the marine habitat degradation. These indicators require a periodic measuring of their performance. However, information systems in the island provide incomplete data related to exposure indicators. This is the first action to be undertaken in the monitoring process
	Corals	Density of corals and other marine species	SRMar https://www.madeira.gov.pt/srmar	Five-year updates	
	Marine ecosystem	Marine ecosystem size (ha)		Five-year updates	
	Tourists	Type of tourism (sport, pleasure etc.)	SRTC https://www.madeira.gov.pt/srtc	Annual estimations	
	Forests	Forest area (ha)	IFCN https://ifcn.madeira.gov.pt/	Annual estimations	
	Forests	Density of shrubby forests		Annual estimations	
	Forests	Tourist walking paths in the forests (km)		Five-year updates	
	Forest species	Number of forest flagship species	IFCN https://ifcn.madeira.gov.pt/	Five-year updates	
	Population	Population density (persons/km²)		Annual estimations	
	Protected areas	Percentage of protected areas		Five-year updates	
Sensitivity	Pollution	Pollution from human activities	DRAAC https://www.madeira.gov.pt/draac SRMar	Five-year updates	

			https://www.madeira.gov.pt/srmar		
	Marine species	Sensitivity of marine species	SRMar https://www.madeira.gov.pt/srmar	Five-year updates	
Adaptation outcome	**Rehabilitation and conservation of islands natural habitats key assets for Islands tourism agriculture, fisheries, and food security.**	➢ Percentage of total of land and marine areas under EU Natura 2000 or UNESCO World Heritage protection. ➢ Percentage of total protected areas exhibiting a favourable conservation status. ➢ Percentage of protected and marine areas under rehabilitation over the total areas exhibiting non-favourable conservation status.	IFCN https://ifcn.madeira.gov.pt/	Yearly basis Yearly basis Yearly basis	In islands, habitats rehabilitation, conservation and monitoring actions, including control of non-indigenes species, are important measures to increase ecosystems resilience to climate change, in order to preserve habitats, biodiversity, landscape and key assets for tourism, agriculture, fisheries and food security. In this context, the EU Natura 2000 protected areas, and UNESCO World heritage Sites and Biosphere reserves, are important tools for conservation and management that help islands to preserve their natural, cultural, or mixed heritage.
	Diversification of economic activities to reduce the dependence from tourism activities	➢ Percentage of tourism' Gross Value Added overt total Gross Value Added of the island¡ economy. ➢ Existence of a suitable plan to encourage non-tourism related economy diversification. ➢ Existence of a suitable plan to encourage tourist products and experiences diversification.	DREM https://estatistica.madeira.gov.pt/dre-2.html SREM https://www.madeira.gov.pt/srem (IDE: http://www.ideram.pt/ SRTC https://www.madeira.gov.pt/srtc	Yearly basis 0;1 A complementary indicator could be defined for the plan suitability, based on expert opinion in 1-5 Likert scale.	Promote the development of primary sector activities taking into consideration innovative and sustainable approaches are important to increase self-sufficiency in food products and reduce its carbon footprint, contribution to increase economy diversification in islands. Fair trade, quality, certification and differentiation can increase competitiveness of islands cash crops (and subproducts) and traditional handcrafts contributing to economy diversification from tourism. Digital innovative products and services can also be explored in islands as an economy diversification vector.
	Promote islands as telework tourism destinations	➢ Percentage of digital nomads' overnight stays over total of tourist overnight stays. ➢ Percentage of tourism accommodation which exhibits excellence services for teleworking.	Vice presidency https://www.madeira.gov.pt/vp (Start up: https://startupmadeira.eu/) SREM https://www.madeira.gov.pt/srem	Yearly basis Yearly basis	The pandemic COVID-19 accelerated the adoption of video conferencing, cloud collaboration and teleworking, opening new possibilities for remote working lifestyles. Telework tourism opens new perspectives for individuals, couples, families, and groups, who are interested to combine a possibility of a new format of remote office work, and leisure in a foreign country. The territorial expansion and strength of digital infrastructures, the adaptation of traditional lodging products, and the provision of family support services are important to the promotion of islands as teleworking destinations and should be explored to ensure lodgement occupation and reduce tourism seasonality.

	Increase knowledge and modelling tools on climate change for islands	➢ Existence of suitable modelling and forecast tools for tourists' responses prediction to climate change impacts and adaptation policies.	DRAAC https://www.madeira.gov.pt/draac SRTC https://www.madeira.gov.pt/srtc	0;1 A complementary indicator could be defined for the plan suitability, based on expert opinion in 1-5 Likert scale.	Given the high dependence from air transports, specific climate forecast models and climate data collection systems to ensure islands airports real-time operation must be specially promoted in other to decrease islands vulnerability to climate change.
	Control measures for terrestrial and maritime tourist activities	➢ Degree of adaptation of measures to control de environmental impact of tourist activities on island ecosystems to the context of higher pressures on ecosystems due to climate change impacts, obtained from expert assessment	SRAAC https://www.madeira.gov.pt/sraac	1-5 Likert scale.	Climate change can originate higher pressures on natural ecosystems. For that reason, additional measures could be necessary to protect those ecosystems from some touristic activities, including regulations and normative instructions in order to ensure sustainable development of terrestrial and maritime tourism activities, such as limitations of volume visitors in fragile and restricted areas, and promote the practice of respectful wildlife watching, such as birds, marine turtles, cetaceans, and others.
	Implement waste reduction and management procedures to reduce dependence from exterior and pressures in natural ecosystems	➢ Percentage of recycling of total waste, by type of by-product (organic, plastic, glass, metals, paper). ➢ Kg of MSW per touristic overnight stay. ➢ Kg of MSW per 1000 euros of tourist gross value added. ➢ Percentage of waste treatment fees paid for tourism businesses over the total cost of tourist MSW treatment.	DREM https://estatistica.madeira.gov.pt/dre-2.html SRAAC https://www.madeira.gov.pt/sraac (ARM: http://www.aguasdamadeira.pt/) Municipalities https://www.amram.pt/	Yearly basis	Organic waste valorisation (composting or bioenergy production) should be considered as there is lack of space in islands for final disposal. Incineration with energy recovery should also be studied as a solution to reduce final disposal. Specific policies to reduce overpackaging and plastic use, particularly disposable plastics, should be implemented in islands. Real-time Monitoring systems to detect and characterize marine litter, high seas pollution focus (namely by fossil fuels), coastal discharges and algae blooms should be implemented with support of innovative technologies and procedures. Dedicated awareness raising campaigns for economic actors, residents, and tourists, should be implemented to reduce waste production, increase reutilization and promote adequate waste selective collection for recycling.
	Local circular economy	➢ Existence of a socially consensual plan to adopt circular economy principles to tourism related activities. ➢ Percentage of MSW that are locally recycled or sent to be recycled abroad, by types of material. ➢ Percentage of sewage receiving tertiary treatment and being reused. ➢ Percentage renewable sources in electricity production.	SRAAC https://www.madeira.gov.pt/sraac ARM: http://www.aguasdamadeira.pt/) Municipalities https://www.amram.pt/ DRETT	0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale. Yearly basis	An economic system aimed at eliminating waste and the continual use of resources that offers a valuable framework for reduced carbon emissions from materials (decarbonization) and increased resilience to climate change and its impacts.

		➢ Percentage of mobility powered by electric/hybrid/green hydrogen/ engines.	https://www.madeira.gov.pt/drett/ (EEM: https://www.eem.pt/pt/inicio/)		
	Mainstreaming Disaster Risk Management (DRM)	➢ Existence of a Mainstreaming Disaster Risk Management (DRM) plan, including decision making structure and procedures, and trained operators. ➢ Existence of a proper zoning of climate change exposed areas guiding decisions on the location of tourist activities, infrastructures and facilities at the destination.	SRPC,IP-RAM https://www.procivmadeira.pt/pt/ DROTe https://www.madeira.gov.pt/sraac/GovernoRegional/OGoverno/Secretarias/Structure/SRAAC/ctl/Read/mid/6801/InformacaoId/54473/UnidadeOrganicaId/8 Municipalities https://www.amram.pt/	0;1 0;1 These indicators can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale.	Mainstreaming Disaster Risk Management (DRM) aims to plan and organize DRM along five stages including prevention, protection, preparedness, and response, recovery and review. Examples include interventions to limit urban development in flood prone areas; identify natural hazard prone areas; develop strategies, arrangements, and procedures to address crises; and post-emergency recovery activities.
	Adaptive management of natural habitats	➢ Percentage of tourism-relevant natural habitats with exhibiting effective adaptive management including an explicit visitors' management plan.	IFCN https://ifcn.madeira.gov.pt/	Yearly basis	The preservation of ecosystem services which are essential for human well-being. It include sunderstanding species response; make space for the development of rivers and coasts; aid gene flow; species translocation; targets and conservation mechanisms/plans.
	Water restrictions, consumption cuts and grey-water	➢ Percentage of grey-water over total sewage. ➢ Days a year with water restrictions. ➢ Percentage of water losses along the water distribution system ➢ Existence of an effective efficiency water use plan.	SRAAC https://www.madeira.gov.pt/sraac (ARM: http://www.aguasdamadeira.pt/) Municipalities https://www.amram.pt/	Yearly basis This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale.	Restriction (or rationing) of certain uses of water such as irrigation of lawns, car washing, filling swimming pools or hosing down pavement areas may be necessary during these times. Grey-water recycling (or reclamation) is the reuse of non-drinkable water (usually treated wastewater) to cover water use needs that don't demand such a high-quality standard.

	Activity and product diversification	➢ Number of tourism-oriented activities at the destination, according to the International Standard Industrial Classification of All Economic Activities (ISIC). ➢ Average tourist expenditure by overnight stay. ➢ Existence of an integrated plan to promote activity and product diversification including training, start-up firms and feasible funding.	SRTC https://www.madeira.gov.pt/srtc DREM https://estatistica.madeira.gov.pt/dre-2.html SRTC https://www.madeira.gov.pt/srtc	Yearly basis Yearly basis 0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale.	Activity and product diversification include actions to diversify the tourism activities and products and aim to reduce seasonality and overload in infrastructures and ecosystems. Shifting the dependency from 'sun, sea and sand' products to alternative leisure activities can reduce the impacts of heat waves, coastal erosion or ecosystem degradation, and thus help to maintain destination attractiveness.

12.12.4 Aquaculture

Indicators type	Indicators	Definition	Responsible Organization	Monitoring Processes	Interpretation
Climate hazard	Surface water temperature	Changes in surface water temperature (thermal stress- lethal temperature)	SRMar https://www.madeira.gov.pt/srmar	Climate modelling	seam bream: 26ºC - 33 ºC sea bass: 25 ºC – 35.9 ºC tuna: 24 ºC – 26.17 ºC mussels: 20.5 ºC – 27.0 ºC
Exposure	Farm area	Area occupied by sea cages (m²)	SRMar https://www.madeira.gov.pt/srmar	Annual estimations	These are critical factors worsening (more pressure) the risk of increased fragility of aquaculture activity for the island. These indicators require a periodic measuring of their performance
	Value of stock	Value of biomass in the cages	SRMar https://www.madeira.gov.pt/srmar	Annual estimations	
	Stock size	Annual production of aquaculture products (fish and shellfish) (in tons)	SRMar https://www.madeira.gov.pt/srmar	Annual estimations	
	Employment	Number of employees	SRMar https://www.madeira.gov.pt/srmar	Annual estimations	
	Location of farms	Location of farms related to the prevailing wind direction	SRMar https://www.madeira.gov.pt/srmar	Five-year updates	
		Location of farms related to the average distance to shore	SRMar https://www.madeira.gov.pt/srmar	Five-year updates	
	Sensitivity of species	Vulnerability of species to climate change	SRMar https://www.madeira.gov.pt/srmar (CMC – Calheta Mariniculture Center: website not available)	Literature review; aquaculture experts	

	Sensitivity of infrastructure	Vulnerability of infrastructure (type and materials of cages) to extreme weather events	SRMar https://www.madeira.gov.pt/srmar (CMC – Calheta Mariniculture Center: website not available)	Literature review; aquaculture experts	
Adaptation response	**Long-term environmental data collection and management at regional**	➢ Existence of an indicators-based dashboard to integrated manage of marine habitats, including aquaculture zoning.	SRMar https://www.madeira.gov.pt/srmar (CMC – Calheta Mariniculture Center: website not available) IFCN https://ifcn.madeira.gov.pt/	0;1 A complementary indicator could be defined for the defined dashboard suitability, based on expert opinion in 1-5 Likert scale.	Long-term consistent environment data collection and management, and planning - establishment of long-term standard monitoring systems for the different regions, integrating climate, oceanography and environmental data...and Marine Strategy Framework Directive descriptors. Adaptation at planning level by using environmental updated data in planning instruments such as programme INDIMAR, model developed under project PLAsMAR (Interreg MAC) to select the most appropriate areas for maritime activities , including aquaculture, in Macaronesia Islands (https://www.msp-platform.eu/practices/indimar).
	Implementation of local sanitary programs at regional scale	➢ Existence of a sanitary program to control and eradicate related to aquafarming.	SRMar https://www.madeira.gov.pt/srmar (CMC – Calheta Mariniculture Center: website not available	0;1 A complementary indicator could be defined for the defined dashboard suitability, based on expert opinion in 1-5 Likert scale.	Long-term stock health surveys, disease control and eradication;
	Aquaculture and circular economy	➢ Existence of a plan to adopt circular economy principles and recommendations to aquaculture exploitations, particularly multitrophic aquaculture. ➢ Percentage of aquaculture production which produced under circular economy principles.	SRMar https://www.madeira.gov.pt/srmar (CMC – Calheta Mariniculture Center: website not available	0;1 A complementary indicator could be defined for the defined dashboard suitability, based on expert opinion in 1-5 Likert scale. Yearly basis	Integrate aquaculture in circular economy to take advantage of potential local wastes regarding energy, fish industry discards and wastes, distribution and marketing systems, etc. in order to strengthen, diversify and increase resilience of the local economies. Diminishing the ecological footprint of aquaculture;
	Implement measures for increasing local industry self-sufficiency	➢ Existence of a effective plan to increase local production of alevins and food, reducing cost and external dependence and reinforcing local marine ecosystem.	SRMar https://www.madeira.gov.pt/srmar (CMC – Calheta Mariniculture Center: website not available	0;1 A complementary indicator could be defined for the defined dashboard suitability, based on expert opinion in 1-5 Likert scale.	viding higher autonomy and selfcare of the industry with production of local "seed" (lower risk of introduction of new species; lower number of pathogens) with strains of higher adaptability to local climate changes. Cooperative links between companies to increase purchase scale and lower

		➢ Percentage of alevins used in local aquaculture that are locally produced. ➢ Percentage of feed locally produced.		Yearly basis Yearly basis	costs, for better the stock management as well as decrease the costs of production, to improve response to market demand and improve first sale price.
	Aquaculture as an alternative to fishing	➢ Percentage of local fish production coming from aquaculture. ➢ Percentage of fishing local industry jobs (extracting plus farming) in aquaculture ➢ Number of fishing boats adapted to operate in aquaculture.	DREM https://estatistica.madeira.gov.pt/dre-2.html SRMar https://www.madeira.gov.pt/srmar	Yearly basis	Jobs offer and training programmes for fishermen who left decommissioned fishing boats; adaptation of fishing boats into aquaculture service boats.
	Submersible cages	➢ Percentage of aquaculture production in submersible cages over the total production. ➢ Annual public expenditure to support substitution of conventional for submersible cages.	SRMar https://www.madeira.gov.pt/srmar	Yearly basis Yearly basis	Oceanic depth-adjustable and can be moved up and down in the sea to escape the worst effects of storms, parasite outbreaks, surface algal blooms and to keep species at an optimal temperature.
	Disease prevention methods	➢ Existence of a plan with proper methods to prevent disease spreading. ➢ Annual public expenditure to fund diseases prevention in aquaculture.	SRMar https://www.madeira.gov.pt/srmar (CMC – Calheta Mariniculture Center: website not available)	0;1 -This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale. Yearly basis	Disease prevention methods are preventive health measures such as vaccines, stronger fingerlings, probiotics, ensuring optimal water quality and implementing stricter hygiene procedures with the aim of reducing the risk of diseases now and in the future.
	Recovery Post-Disaster plans	➢ Existence of a Post-Disaster Plan for the maritime transport sector.	SRMar https://www.madeira.gov.pt/srmar	0;1 This indicator can be complemented by an expert assessment of the funds sufficiency and proper use when disasters occur suitability, in a 1-5 Likert scale.	Funds and plans for Post-Disaster in Aquaculture with Initiatives to get the economy running quickly, e.g. rebuild damaged critical infrastructures such boats, docks, and farm infrastructure. This option minimizes the economic and social impacts that can occur in a post-disaster context.

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12.13 Malta

12.13.1 Aquaculture

Indicators type	Indicators	Definition	Responsible Organization	Monitoring Processes	Interpretation
Climate hazard	Surface water temperature	Changes in surface water temperature	Academia, National Statistics Office	Climate modelling	seam bream: 24°C - 33 °C sea bass: 25 °C – 35.9 °C tuna: 24 °C – 26.17 °C mussels:20.5 °C – 27.0 °C
	Wave height	Average annual height of waves (in m)	Academia, National Statistics Office	Climate modelling	These are critical factors worsening (more pressure) the risk of increased fragility of aquaculture activity for the island. These indicators require a periodic measuring of their performance
	Return time	Number of years between extreme wave heights (above threshold of 7 m)	Academia, National Statistics Office	Climate modelling	
Exposure	Farm area	Area occupied by sea cages (m^2)	Department of Fisheries and Aquaculture	Annual estimations	
	Value of stock	Value of biomass in the cages	Department of Fisheries and Aquaculture	Annual estimations	
	Stock size	Annual production of aquaculture products (fish and shellfish) (in tons)	Department of Fisheries and Aquaculture	Annual estimations	
	Employment	Number of employees	Department of Fisheries and Aquaculture	Annual estimations	
	Location of farms	Location of farms related to the prevailing wind direction	Department of Fisheries and Aquaculture	Five-year updates	
		Location of farms related to the average distance to shore	Department of Fisheries and Aquaculture	Five-year updates	
	Sensitivity of species	Vulnerability of species to climate change	Academia	Literature review; aquaculture experts	
	Sensitivity of infrastructure	Vulnerability of infrastructure (type and materials of cages) to extreme weather events	Academia, Department of Fisheries and Aquaculture	Literature review; aquaculture experts	
Adaptation outcome	**Best Management Practices**	➢ Existence of a Best Management Practices consensual chart for Aquaculture at the island focusing on food safety, fish health, environmental and climate change impact, and social responsibility. ➢ Percentage of time over the best reference in administrative processes to initiate aquaculture activity.	Department of Fisheries and Aquaculture, Environment, Climate Change and Planning Ministry, Academia	0;1 Yealy basis 1-5 Likert scale-based expert assessment.	Practices at farms which focus on food safety, fish health, environmental impact (including climate change) and social responsibility. These practices improve the farms capacity to participate in value chains with the aim of improving the overall resilience of the farm. For example, increasing hygiene will improve resilience of species to diseases.

		➢ Markets' perception of food safety, fish health, environmental and climate change impact, and social responsibility			
	Efficient feed management	➢ Average of Food Conversion Ratio of island aquaculture. ➢ Percentage of food (nutrients) released into the marine environment.	Department of Fisheries and Aquaculture, Academia	Yearly basis	Efficient feed management practices that reduce the Food Conversion Ratio by using technology or practices to feed more efficient helps to reduce the cost of production and increase environmental standards.
	Species selection	➢ Existence of a plan to promote species selection to increase resilience against climate change impacts (mainly seawater heating and diseases). ➢ Annual public expenditure to support species selection programs to enhance aquaculture resilience against climate change.	Environment, Climate Change and Planning Ministry, Academia	0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale. Yearly basis	Selecting species that are less sensitive to changes in the environment, less prone to diseases and less dependent on fish meal and oil. For example, choosing non-carnivorous species reduces food dependence and stocking larger hatchery fingerlings reduces the culture cycle and exposure to diseases.
	Environmental monitoring and Early Warning Systems (EWS)	➢ Existence of an environmental monitoring plan and early warning system to support firms' adaptation decision, preferably fed by remote sensing and GIS	Environment, Climate Change and Planning Ministry, Environmental and Resources Authority	0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale	Environmental monitoring and Early Warning Systems (EWS) systematically collects and provides information to fish farmers with the aim of supporting climate risk management decision-making
	Mainstreaming Disaster Risk Management (DRM)	➢ Existence of a Disaster Risk Management plan including declaration of hazards-exposed areas, engineering standards for cages, procedures to address crises and post-emergency recovery activities, at least.	Environment, Climate Change and Planning Ministry	0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale.	Examples include interventions to limit farm development in natural hazard areas; review safety engineering standards for farms; study the interactions of climate change in local ecosystems and appropriately develop strategies, arrangements, and procedures to address crises; and post-emergency recovery activities.
	Risk-based zoning and site selection	➢ Existence of a risk-based zoning considering climate change scenarios and potential impacts, and also facilitate effective sharing of space and resources with other users.	Environment, Climate Change and Planning Ministry, Department of Fisheries and Aquaculture, Planning Authority, Environmental and Resources Authority	0;1 This indicator can be complemented by an expert assessment of the zoning suitability in a 1-5 Likert scale.	zoning and site selection consists of taking into consideration climate change scenarios when planning and selecting a site for a farm. For example, marine cage operations should not select a site that is (or is expected to be) exposed to high waves or strong currents, and pond

					farming operations should select sites with low risk of flooding.
	Financial schemes, insurance, and Loans	➢ Financial schemes, insurance and loans are public or private risk-sharing mechanisms that aim to support farmers to respond to loss of production and infrastructures damages due to extreme weather, such as strong winds, heavy rains, floods, or tidal surges.	Environment, Climate Change and Planning Ministry, Department of Fisheries and Aquaculture	Yearly basis	Financial schemes, insurance and loans can provide capital to farm relocation, infrastructure and equipment upgrade, repair or replacement required.
	Integrated multi-Trophic aquaculture (IMTA)	➢ Percentage of multi-trophic aquaculture over the total aquaculture production. ➢ Existence of a plan to support through funding and technical assistance the aquaculture sector transition to IMTA schemes. ➢ Annual public expenditure to support aquaculture sector transition to IMTA schemes.	Department of Fisheries and Aquaculture, Environment, Climate Change and Planning Ministry, Academia	Yearly basis 0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale. Yearly basis	Culture species from different trophic levels (fish, shellfish, seaweeds) in an integrated farm to create balanced systems for environmental sustainability. IMTA can increase resilience due to its tolerance to wider ranges of climatic factors such as temperature and salinity.
	Submersible cages	➢ Percentage of aquaculture production in submersible cages over the total production. ➢ Annual public expenditure to support substitution of conventional for submersible cages.	Department of Fisheries and Aquaculture	Yearly basis Yearly basis	Oceanic depth-adjustable and can be moved up and down in the sea to escape the worst effects of storms, parasite outbreaks, surface algal blooms and to keep species at an optimal temperature.
	Create educational visits	➢ Number of educational programmes that include visits and fieldwork in fish farms	Department of Fisheries and Aquaculture, The Ministry for Education	Yearly basis	These visits can increase knowledge on different impacts on aquaculture including man-made and climate impacts. Biosecurity should be strictly observed.

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12.14 Sardinia

12.14.1 Maritime transport sector

Indicators type	Indicators	Definition	Responsible Organization	Monitoring Processes	Interpretation
Climate hazard	Mean sea level rise	Annual mean sea level (cm)	Department of Meteorology - of Sardinia-Arpas (http://www.sar.sardegna.it/),	Annual estimations	Status-quo (1995-2020) = +3mm/ yr Business as usual: (up to 2050) +15mm/yr (up to 2100) +30 mm/yr
Exposure	Passengers	Number of passengers	Island Port Authority, National Institute of Statistics (https://www.istat.it/en/)	Annual estimations	These are critical factors worsening (more pressure) the risk of isolation due to transport disruption. These indicators require a periodic measuring of their performance. However, information systems in the island provide incomplete data related to exposure indicators. This is the first action to be undertaken in the monitoring process.
	Population	Number of island's inhabitants	Island Port Authority, National Institute of Statistics (https://www.istat.it/en/)	Annual estimations	
	Value of transported goods	Value of goods transported by ships (in freight)	Island Port Authority	Annual estimations	
	Number of port infrastructures	Number of ports	Island Port Authority	Annual estimations	
Sensitivity	Quality of infrastructure and equipment	Number of ports with critical infrastructure not renovated since 1993	Island Port Authority	Annual updates	
	Island dependence on maritime transport	Number of isolation days from the main land	Island Port Authority	Annual updates	
Adaptation outcome	**Intelligent Transport Systems (ITS)**	➢ Existence of an Intelligent Transport Systems (ITS) to assist navigation through standardised safety-related messages.	Island Port Authority	0;1 This indicator can be complemented by an expert assessment of the (ITS) suitability in a 1-5 Likert scale.	Technologies that relay automated and tailored data and safety-related messages to ships, regarding climate hazards and other relevant information. ITS use communication and information standards that are uniform and widely accepted by other ports that the island is linked to.
	Increase operational speed and flexibility in ports	➢ Existence of a plan to increase operational speed and flexibility aimed at increasing ports attractiveness ➢ CO2 equivalent emissions avoided thanks to the increase of operational speed and flexibility in ports, with respect to a baseline-year.	Island Port Authority	0:1 Yearly basis	Faster operations also reduce the effects of heat waves on goods and people as well as decarbonise the economy.

		➢ Average reduction in hours of vessels stay in ports due to the increase of the operational speed, with respect to a baseline-year.			
	Climate resilient economy and Jobs	➢ Percentage of perishable goods that preserved in perfect temperature conditions while stored at ports. ➢ Capacity in accumulated days of perishable goods storage. ➢ Percentage of workers operating with proper protection against climate change events (security, thermal comfort…).	Island Port Authority	Yearly basis	As part of newly products and services that depend less on Just In Time (JIT) operations, using for instance larger stocks.
	Integrate ports in urban tissue	➢ Existence of a ports-urban areas integrated planning system, to activate port potential as factor for urban protection against climate change and cities taking advantage of secure port areas for leisure and cultural activities.	Island Port Authority, Regional and local administrations	0;1 This indicator can be complemented by an expert assessment of the integrated planning system suitability in a 1-5 Likert scale.	Integrate ports into the urban tissue opening port areas to other activities, namely cultural, while gaining room in the urban landscape. This allows some port activities to be pooled from low-laying areas while leisure and cultural activities can access more waterfront space.
	Backup routes and infrastructures during extreme weather	➢ Existence of backup routes and infrastructures to be used during extreme weather, if necessary. ➢ Percentage of annual maritime traffic using backup routes and infrastructures.	Island and National Port Authority	0;1 This indicator can be complemented by an expert assessment of the set of backup routes and infrastructures suitability in a 1-5 Likert scale.	Backup routes and infrastructures during extreme weather aims to creates a post disaster response that ensures available alternatives when the main ports are damaged or inaccessible due to extreme weather events. It considers alternative ports and access roads. Alternative ports can be smaller in size, simpler and be used for other purposes, but should have a different location and orientation from the main ones.
	Restrict development and settlement in low-lying areas	➢ Existence of a specific regulation restricting ports development with the identification of areas and risks involved	Island and National Port Authority	0;1	Restrict development and settlement in low-lying areas means to assure that ports are not further developed in low-laying areas exposed to SLR. Planning must consider the long-term potential risks.

12.14.2 Energy sector

Indicators type	Indicators	Definition	Responsible Organization	Monitoring Processes	Interpretation
Climate hazard	Number of cooling degree days (CDD) per year	Temperature difference above 18ºC in each year, calculated using average daily temperature values.	Department of Meteorology -of Sardinia-Arpas (http://www.sar.sardegna.it/	Annual estimations	Ref CDD= 169.53 Business as usual: (up to 2050): 379.16 CDD

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			), Autonomous region of Sardinia, Academia		(up to 2100 : 656.71 CDD *The indicator is computed by multiplying the number of days exceeding the threshold by the difference in temperatures.*
	Standardised precipitation-evaporation index (SPEI)	Transformation of a monthly precipitation time series into a standardized normal distribution	Department of Meteorology -of Sardinia-Arpas (http://www.sar.sardegna.it/), Autonomous region of Sardinia, Academia	Annual updates	Ref SPEI= 0.00 Alert -1 =<SPEI <= -2 Business as usual: (up to 2050): -1.2 (up to 2100) :-2.1
	Wind and PV productivity	Decrease of [kWh/kW]per year	Terna (Home - Terna spa) and Autonomous region of Sardinia		
Exposure	Population	Number of island's inhabitants	National Institute of Statistics (https://www.istat.it/en/), Sardinia Water Authority ENAS (http://www.enas.sardegna.it/), regional Accounts	Annual estimations	These are critical factors worsening (more pressure) the risk of increased energy demand for cooling and desalinate sea water in the island. These indicators require a periodic measuring of their performance. However, information systems in the island provide incomplete data related to exposure and vulnerability indicators. This is the first action to be undertaken in the monitoring process.
	Tourists	Number of tourists		Annual estimations	
	Tourism seasonality	Annual min-max variation of tourists		Annual estimations	
	Cooling penetration rate	Share of households with air-conditioning		Five-year estimations	
	Desalination	Percentage of desalinated water to total water consumption		Annual estimations	
Sensitivity	Per capital energy demand	Energy demand (MWh) per person	Ministry of Energy & National Statistical Service; Regional Accounts	Annual estimations	
	Energy intensity	Energy use (in MWh) per gross domestic product (GDP) (in M€)		Annual estimations	
Adaptation response	**Study and develop energy grid connections**	➢ Existence of studies on the feasibility of all potential grid connections. ➢ Index of openness of the island grid system with respect to the mainland ((X+M)/TOTAL). X=export; M= import; TOTAL energy consumption	Terna S.p.a. (Home - Terna spa) and Autonomous region of Sardinia, Academia	Yearly basis	Energy grid connections aims to develop interconnections between islands and/or with the mainland allowing for the creation of economies of scale, energy system reliability improvements and more Renewable Energy Sources (RES) penetration.
	Financial support for buildings with low energy needs	➢ Total loans to support the reduction of energy needs of new or existing buildings, per year. ➢ Total subsidies to support the reduction of energy needs of new or existing buildings, per year. ➢ Average of tax reliefs in loans to support the reduction of energy needs of new or existing buildings, per year.	Ministry of Energy; Regional Accounts	Yearly basis	Such a system could coordinate the automated opening vents with the air conditioning operation, avoiding energy consumption when possible. This will allow for the adaptation of buildings at a controlled cost, while complying with mitigation goals.

		➢ Percentage of buildings that have adopt energy needs reduction schemes. ➢ KWh/m2 per year in heating and cooling.			
	Green energy Jobs and businesses	➢ Percentage of green energy jobs over the total jobs. ➢ Number of persons involved in training processes related to encouraging green jobs and businesses. ➢ Public and private funding of R+D+I projects aiming at encouraging green innovation.	Ministry of Energy & National Statistical Service; National Institute of Statistics (https://www.istat.it/en/), Regional Accounts	Yearly basis Yearly basis Yearly basis	Training people and supporting green businesses to implement energy solutions across the economy, both in mitigation and adaptation. One example can be the support of research projects to help businesses deal with new technologies relevant to climate action.
	Grid reliability	➢ Existence of a proper grid reliability plan. ➢ LOLE index. This index defines the mean interruption time (due to problems in the electrical system) per year.> Coverage factor. Total generation power of the electrical system/Annual peak load demand.	Terna S.p.a. (Home - Terna spa) , Ministry of Energy, Autonomous region of Sardinia, Academia	0;1	This may include redundant circuitry or components that provide alternative dispatch of energy, equipment upgrades (e.g. better cooling to cope with heat waves) or power downrating (e.g. decrease power output of energy transformers so that they do not overheat during heat waves).
	Demand Side Management (DSM) of Energy	➢ Number of self-consumptions systems that includes DSM strategies in their facilities. This question can be included in the facility registration form.	Terna S.p.a. (Home - Terna spa) , Ministry of Energy, Autonomous region of Sardinia, Academia	Yearly basis	Operational strategy that better coordinates producers and consumers of energy. More renewable energy (like solar and wind) use is possible while ensuring the energy service reliability and controlled costs. DMS balances off-peak and peak demand using peek shaving, which is important, for example, during heat waves.
	Energy storage systems	➢ Energy storage systems capacity in MWh, by different types (batteries, thermal tanks, water height...). ➢ Percentage of energy storage systems capacity over the total renewable energy production capacity.	Terna S.p.a. (Home - Terna spa), Ministry of Energy, Autonomous region of Sardinia, Academia		This includes not only electric batteries (like those in cars and buses), but also other forms of energy storage such as thermal tanks (heat), ice banks (cold) or water height (reversed pumping).

12.14.3 Tourism sector

Indicators type	Indicators	Definition	Responsible Organization	Monitoring Processes	Interpretation
Climate hazard	Humidity Index	Number of days exceeding 35oC	Department of Meteorology -of Sardinia-Arpas (http://www.sar.sardegna.it/), Autonomous region of Sardinia – Arpas (http://www.sardegnaambiente.it/arpas/), Academia		Ref: 49.7 days /year with HI>= 35°C Business as usual: (up to 2050): 68.6 days (up to 2100): 112.2 days

	Fire weather index (FWI)	Numerical non-dimensional ratings of relative fire potential for a generalized fuel type (mature pine stands) based solely on weather observations. FWI calculation includes temperature, precipitation, relative humidity and wind.	Department of Meteorology -of Sardinia-Arpas (http://www.sar.sardegna.it/), Autonomous region of Sardinia – Arpas (http://www.sardegnaambiente.it/arpas/)	The index only refers to the fire season (defined from May to October)	Ref . FWI = 0.0-0.5 (depending on the area) Alert 0.6<FWI<1.0 Business as usual: (up to 2050): 0.2-0.8 (depending on the area) (up to 2100): 0.2-0.8 (depending on the area)
	Vector Suitability Index for Aedes Albopictus (Asian Tiger Mosquito)	Increases of ambient air temperature and changes in the hydrological cycle.	Department of Meteorology -of Sardinia-Arpas (http://www.sar.sardegna.it/), Sardinia Water Authority ENAS (http://www.enas.sardegna.it/), Autonomous region of Sardinia – Arpas (http://www.sardegnaambiente.it/arpas/), Academia	The index needs to be calculated with new data in order to monitor the evolution.	Ref: VBSI = 87.1 Alert VBSI>80 Business as usual: VBSI ranges from 83 to 74. The index is expected to decrease but it remains higher than 60 indicating Medium Suitability
	Seagrass evolution	Coverage (in km2) of the main seagrass species	Autonomous region of Sardinia – Arpas (http://www.sardegnaambiente.it/arpas/), Academia		Ref: Posidonia (1963 km2) Business as usual: (up to 2100): 14 km2
	Beach reduction	Percentage of reduction of beach area	Autonomous region of Sardinia – Arpas (http://www.sardegnaambiente.it/arpas/), Academia		Status-quo (1995-2020) = -4 to 8m of beach area depending on the beach Business as usual: (up to 2050): - 42% (up to 2100): -77%
Exposure	Coast	Size of the coastline (km)	Autonomous region of Sardinia – Arpas (http://www.sardegnaambiente.it/arpas/), Academia National Institute of Statistics (https://www.istat.it/en/),; Regional Accounts National Institute of Statistics (https://www.istat.it/en/), Regional Accounts Autonomous region of Sardinia – Arpas (http://www.sardegnaambiente.it/arpas/), Academia Autonomous region of Sardinia – Arpas (http://www.sardegnaambiente.it/arp	Five-year updates	These are critical factors worsening (more pressure) the risk of forest fires, thermal stress, and marine habitat degradation in the island. These indicators require a periodic measuring of their performance. However, information systems in the island provide incomplete data related to vulnerability/exposure indicators related to marine ecosystems. This is the first action to be undertaken in the monitoring process.
	Corals	Density of corals and other marine species		Five-year updates	
	Marine ecosystem	Marine ecosystem size (ha)		Five-year updates	
	Tourists	Number of tourists		Annual estimations	
		Tourist characteristics (age, gender etc.)		Annual estimations	
		Type of tourism (sport, pleasure etc.)		Annual estimations	
	Population	Population density (persons/km²)		Annual estimations	
	Agricultural land	Cultivated area (ha)		Annual estimations	
	Forests	Forest area (ha)		Annual estimations	
	Forests	Density of shrubby forests		Annual estimations	
	Forests	Tourist walking paths in the forests (km)		Five-year updates	

	Forest species	Number of forest flagship species	as/), Forestry Department of the Anthonomus region of Sardinia FO.RE.S.T.A.S. (https://www.sardegnaforeste.it/), Academia.	Five-year updates	
	Protected areas	Percentage of protected areas		Five-year updates	
Sensitivity	Pollution	Pollution from human activities		Five-year updates	
	Marine species	Sensitivity of marine species		Five-year updates	
	Human activities triggering wild fires	Number of recreational areas with barbeque		Five-year updates	
Adaptation response	**Economic Policy Instruments (EPIs)**	➢ Existence of a set of economic policy instruments to support firms and local government to increase resilience against climate change.	Autonomous region of Sardinia – Arpas (http://www.sardegnaambiente.it/arpas/), Academia	➢ 0;1 This indicator can be complemented by an expert assessment of the set of instruments' suitability in a 1-5 Likert scale.	Incentives designed and implemented with the purpose of adapting individual decisions to collectively agreed goals. Pricing (e.g. water tariffs), environmental taxes and charges, subsidies; trading (e.g tradable permit for pollution or water abstraction, compensation mechanisms, payments for environmental services); and voluntary agreements and risk management schemes such as insurances.
	Mainstreaming Disaster Risk Management (DRM)	➢ > Existence of a Mainstreaming Disaster Risk Management (DRM) plan, including decision making structure and procedures, and trained operators. ➢ Existence of a proper zoning of climate change exposed areas guiding decisions on the location of tourist activities, infrastructures and facilities at the destination.	Autonomous region of Sardinia – Arpas (http://www.sardegnaambiente.it/arpas/), Academia	0;1 Both indicators can be complemented by an expert assessment of the plan and zoning suitability in a 1-5 Likert scale.	Mainstreaming Disaster Risk Management (DRM) aims to plan and organize DRM along five stages including prevention, protection, preparedness, and response, recovery and review. Examples include interventions to limit urban development in flood prone areas; identify natural hazard prone areas; develop strategies, arrangements, and procedures to address crises; and post-emergency recovery activities.
	Drought and water conservation plans	➢ Existence of a drought and water conservation plan containing measures to reduces water losses in distribution and encourage efficiency in water uses and, when necessary, the access to extraordinary sources of drinking water during critical periods.	Autonomous region of Sardinia – Arpas (http://www.sardegnaambiente.it/arpas/), Academia	0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale.	Tourism-lead adaptation and/or involvement in drought management plans with the aim to reduce the economic, social, and environmental consequences of drought and water scarcity, and to reduce the loss of water and improve efficiency in the sector.
	Fire management plans	➢ Existence of a fire management plan containing an early warning system, escape routes, citizens advise and forest fuel management, at least.	Autonomous region of Sardinia – Arpas (http://www.sardegnaambiente.it/arpas/), Academia	0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale.	Fire management plans are management actions have wide range of application such as early warning detection, with escape routes and advice to local citizens and tourists, mobilization and suppression of unwanted and damaging fires, or use of fire to

		➢ Number of Firefighters per 1000 km2 of forest. ➢ Annual forest surface burnt. ➢ Annual budget for fire management per km2 of forest.		Yearly basis	manage fuel. Additionally, these plans help to increase the understanding of the interactions of climate change with vegetation cover and fire regimes.
	Monitoring, modelling and forecasting systems	➢ Existence of monitoring, modelling and forecasting systems. ➢ Existence of a tourism satellite account system with detailed extension to environmental and climate change issues	Autonomous region of Sardinia – Arpas (http://www.sardegnaambiente.it/arpas/), Academia	0;1 This indicator can be complemented by an expert assessment of the set of instruments' suitability in a 1-5 Likert scale.	Information system that provide timely and reliable climate information, as well as up-to-date data on the occurrence and severity of extreme events, possible impacts and their duration. Different systems can be implemented to respond to different climate hazards, such as drought-related, water quality monitoring, water resources management and predicting and managing flood risks.
	Pre-disaster early recovery planning	➢ Existence of a Pre-disaster early recovery plan containing critical ecosystems, best recovery practices, guidelines to prevent future disasters and funding sufficiency.	Autonomous region of Sardinia – Arpas (http://www.sardegnaambiente.it/arpas/), Academia	0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale.	It includes the development of knowledge, good practices and objectives that aim to improve the living conditions of the affected communities, while facilitating the adjustments necessary to reduce the risk of future disasters. Examples of good practices are may include identifying critical ecosystems (goods and services) that require immediate restoration after a disaster or particularly vulnerable communities.

12.14.4 Aquaculture

Indicators type	Indicators	Definition	Responsible Organization	Monitoring Processes	Interpretation
Climate hazard	Surface water temperature	Changes in surface water temperature	Department of Meteorology -of Sardinia-Arpas (http://www.sar.sardegna.it/), Academia	Climate modelling	seam bream: 24°C - 33 °C sea bass: 25 °C – 35.9 °C tuna: 24 °C – 26.17 °C mussels:20.5 °C – 27.0 °C
Exposure	Farm area	Area occupied by sea cages (m²)	Department of Fisheries	Annual estimations	These are critical factors worsening (more pressure) the risk of increased fragility of aquaculture activity for the island. These
	Value of stock	Value of biomass in the cages	Department of Fisheries	Annual estimations	
	Stock size	Annual production of aquaculture products (fish and shellfish) (in tons)	Department of Fisheries	Annual estimations	
	Employment	Number of employees	Department of Fisheries	Annual estimations	

	Location of farms	Location of farms related to the prevailing wind direction	Department of Fisheries	Five-year updates	indicators require a periodic measuring of their performance process.
		Location of farms related to the average distance to shore	Department of Fisheries	Five-year updates	
	Sensitivity of species	Vulnerability of species to climate change	Academia	Literature review; aquaculture experts	
	Sensitivity of infrastructure	Vulnerability of infrastructure (type and materials of cages) to extreme weather events	Academia	Literature review; aquaculture experts	
Adaptation response	Environmental monitoring and Early Warning Systems (EWS)	➢ Existence of an environmental monitoring plan and early warning system to support firms' adaptation decision, preferably fed by remote sensing and GIS.	Department of Fisheries	0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale.	The collected data can also be used to study the evolution of climate impacts as time progresses, for instance the impact of heat waves and storms in operations.
	Integrated multi-trophic aquaculture (IMTA)	➢ Percentage of multi-trophic aquaculture over the total aquaculture production. ➢ Annual public expenditure to support aquaculture sector transition to IMTA schemes. ➢ Existence of a plan to support through funding and technical assistance the aquaculture sector transition to IMTA schemes	Department of Fisheries	Yearly basis 0;1 this indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale.	Culture species from different trophic levels (fish, shellfish, seaweeds) in an integrated farm to create balanced systems for environmental sustainability. IMTA can increase resilience due to its tolerance to wider ranges of climatic factors such as temperature and salinity.
	Best Management Practices	➢ Existence of a Best Management Practices consensual chart for Aquaculture at the island focusing on food safety, fish health, environmental and climate change impact, and social responsibility. ➢ Percentage of top-5 Best Management Practices being accomplished across the industry in the island. ➢ Markets' perception of food safety, fish health, environmental and climate change impact, and social responsibility,	Department of Fisheries	0;1 Yearly basis by Likert scale-based expert assessment.	Practices at farms which focus on food safety, fish health, environmental impact (including climate change) and social responsibility. These practices improve the farms capacity to participate in value chains with the aim of improving the overall resilience of the farm. For example, increasing hygiene will improve resilience of species to diseases
	Addressing consumer and environmental concerns at the local	➢ Percentage of aquaculture production under eco-labelling schemes. ➢ Changes in ocean floor pollution on better-equal-worse basis.	Department of Fisheries	Yearly basis	This option aims to promote economy and jobs to address the future challenges of climate change. The major challenges need to

					be underlined and linked to the key concerns and impacts on the aquaculture sector.
	Recirculation Aquaculture Systems (RAS)	➢ Percentage of land-based aquaculture production managed using Recirculation Systems.	Department of Fisheries	Yearly basis	Recirculation Aquaculture Systems (RAS) are land-based indoor fish farms with closed containment rearing systems where filtration is applied to purify and regulate water parameters and remove toxic metabolic wastes of fish. Since RAS is land-based and indoor it limits the risk of infrastructure destruction due to extreme events in the ocean.
	Tax benefits and subsidies	➢ Average percentage of tax rate relief. ➢ Percentage of subsidies over the total aquaculture investments.	Department of Fisheries	Yearly basis	Tax benefits and subsidies consists in financial public policy instruments to promote or benefit economic or aquaculture sustainable practices and operator's overall resilience to climate change.

12.15 Sicily

12.15.1 Maritime transport sector

Indicators type	Indicators	Definition	Responsible Organization	Monitoring Processes	Interpretation
Climate hazard	Mean sea level rise	Annual mean sea level (cm)	Oceanography Center	Annual estimations	Status-quo (1995-2020) = +3mm/ yr Business as usual: (up to 2050) +15.5mm/yr (up to 2100) +31.5 mm/yr
Exposure	Passengers	Number of passengers	National Statistical Service; Regional Accounts	Annual estimations	These are critical factors worsening (more pressure) the risk of isolation due to transport disruption. These indicators require a periodic measuring of their performance. However, information systems in the island provide incomplete data related to exposure/vulnerability indicators. This is the first action to be undertaken in the monitoring process
	Population	Number of island's inhabitants		Annual estimations	
	Value of transported goods	Value of goods transported by ships (in freight)		Annual estimations	
	Number of port infrastructures	Number of ports	Island Port Authority	Annual estimations	
Sensitivity	Quality of infrastructure and equipment	Number of ports with critical infrastructure not renovated since 1993	Island Port Authority	Annual updates	
	Island dependence on maritime transport	Number of isolation days from the main land	Island Port Authority	Annual updates	
Adaptation response	**Integrate ports in urban tissue**	➢ Existence of a ports-urban areas integrated planning system, to activate port potential as factor for urban protection against climate change and cities taking advantage of secure port areas for leisure and cultural activities.	Island Port Authority	0;1 This indicator can be complemented by an expert assessment of the integrated planning system suitability in a 1-5 Likert scale.	Integrate ports into the urban tissue opening port areas to other activities, namely cultural, while gaining room in the urban landscape. This allows some port activities to be pooled from low-laying areas while leisure and cultural activities can access more waterfront space.
	Intelligent Transport Systems (ITS)	➢ Existence of an Intelligent Transport Systems (ITS) to assist navigation through standardised safety-related messages.	Island Port Authority	0;1 This indicator can be complemented by an expert assessment of the (ITS) suitability in a 1-5 Likert scale.	Technologies that relay automated and tailored data and safety-related messages to ships, regarding climate hazards and other relevant information. ITS use communication and information standards that are uniform and widely accepted by other ports that the island is linked to.
	Refrigeration, cooling and ventilation systems	➢ Percentage of perishable goods needing low temperatures that have been preserved under proper temperatures while staying at port.	Island Port Authority	Yearly basis	Improve the efficiency of refrigeration, cooling and ventilation systems in order to reduce costs in warmer weather and maintain operations during heat waves. Human thermal comfort provided by efficient

		➢ Percentage of port workers working in proper thermal conditions (temperature, ventilation, etc.) during heat waves. ➢ Existence of a protocol to protect outdoor workers during heatwaves.		0;1 This indicator can be complemented by workers' assessment of the protocol suitability in a 1-5 Likert scale.	ventilation and cooling is relevant to ensure the health and safety of passengers and port workers. Refrigeration is relevant for managing goods that need low temperatures.
	Diversification of trade using climate resilient commodities	➢ Existence of a plan for the diversification of trade towards reducing dependence on perishable goods and increasing the share of resilient commodities.	Island Port Authority	0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale	Diversification of trade using climate resilient commodities aims to reduce dependency on trade of perishable goods and critical services, create larger stocks of goods that are climate resilient and consider were changing trading systems to endure changes in climate is economically feasible, strategically justifiable and equitable.
	Social dialogue for training in the port sector	➢ Percentage of workers and employees that have received proper training about potential climate change impacts and how to deal with them. ➢ Annual expenditure in training on climate change and port operations to new workers and to update training about new knowledge related to climate change and ports.	Island Port Authority	Yearly basis	Social dialogue for training in the port sector refers to social and educational issues related with the gender equality and attracting the young to the sector, while tackling climate change. It relies on social dialogue between workers and employees to define common guidelines for training. It considers key challenges that ports are facing and how the industry is adapting to change and preparing for the future.
	Post-Disaster recovery funds	➢ Existence of a Post-Disaster Fund for the maritime transport sector.	Island Port Authority	0;1 This indicator can be complemented by an expert assessment of the funds sufficiency and proper use when disasters occur suitability, in a 1-5 Likert scale.	Funds and plans for Post-Disaster in Aquaculture with Initiatives to get the economy running quickly, e.g. rebuild damaged critical infrastructures such boats, docks, and farm infrastructure. This option minimizes the economic and social impacts that can occur in a post-disaster context.

12.15.2 Energy sector

Indicators type	Indicators	Definition	Responsible Organization	Monitoring Processes	Interpretation
Climate hazard	Number of cooling degree days (CDD) per year	Temperature difference above 18ºC in each year, calculated using average daily temperature values.	Academia Sistema Informativo agrometeorologico siciliano SIAS - Dati meteorologici (regione.sicilia.it)	Annual estimations	Ref CDD= 210.40 Business as usual: (up to 2050): 454 CDD (up to 2100 : 746 CDD *The indicator is computed by multiplying the number of days exceeding the threshold by the difference in temperatures.*

	Standardised precipitation-evapotransporation index (SPEI)	Transformation of a monthly precipitation time series into a standardized normal distribution	Academia	Annual updates	Ref SPEI= 0.00 Alert -1 =<SPEI <= -2 Business as usual: (up to 2050): -1.4 (up to 2100) :-2.3
	Wind and PV productivity	Decrease of [kWh/kW]per year	Terna (Home - Terna spa) and Regional accounts		WIND productivity Ref: 1567 [kWh/kW]per year (land) 3836 [kWh/kW]per year (sea) Business as usual: Up to 2050: -143 kWh/kW]per year (land) Up to 2100: -264 kWh/kW]per year (sea)
Exposure	Population	Number of island's inhabitants	National Statistical Service; Regional Accounts	Annual estimations	These are critical factors worsening (more pressure) the risk of increased energy demand for cooling and desalinate sea water in the island. These indicators require a periodic measuring of their performance. However, information systems in the island provide incomplete data related to exposure indicators. This is the first action to be undertaken in the monitoring process.
	Tourists	Number of tourists	National Statistical Service; Regional Accounts	Annual estimations	
	Tourism seasonality	Annual min-max variation of tourists	National Statistical Service; Regional Accounts	Annual estimations	
	Cooling penetration rate	Share of households with air-conditioning	National Statistical Service; Regional Accounts	Five-year estimations	
	Desalination	Percentage of desalinated water to total water consumption	Water Resources Authority	Annual estimations	
Sensitivity	Per capital energy demand	Energy demand (MWh) per person	Ministry of Energy & National Statistical Service; Regional Accounts	Annual estimations	
	Energy intensity	Energy use (in MWh) per gross domestic product (GDP) (in M€)		Annual estimations	
Adaptation outcome	**Energy storage systems**	➢ Energy storage systems capacity in MW, by different types (batteries, thermal tanks, water height...). ➢ Percentage of energy storage systems capacity over the total renewable energy production capacity.	Ministry of Energy & National Statistical Service; Regional Accounts	Yearly basis	This allows for a more resilient energy grid while enabling decarbonization and peak levelling at a controlled cost. This includes not only electric batteries (like those in cars and buses), but also other forms of energy storage such as thermal tanks (heat), ice banks (cold) or water height (reversed pumping).
	Green energy Jobs and businesses	➢ Percentage of green jobs over the total jobs. ➢ Number of initiatives and number of persons involved in training processes related to encouraging green jobs and businesses.	Ministry of Energy & National Statistical Service; Regional Accounts	Yearly basis	Training people and supporting green businesses to implement energy solutions across the economy, both in mitigation and adaptation. One example can be the support of research projects to help businesses deal with new technologies relevant to climate action.

		➢ Public and private funding of R+D+I projects aiming at encouraging green innovation.			
	Heated pools with waste heat from power plants	➢ Percentage of pools using waste heat from power plants. ➢ KW equivalent of waste heat from power plants used to heat pools. ➢ CO2 equivalent tons saved with respect to the best alternative option.	Ministry of Energy & National Statistical Service; Regional Accounts	Yearly basis	This type of heat recovery design is called Combined Heat and Power (CHP). Pools provide a heat sink for the power plants which increases efficiency and is useful during heat waves.
	Grid reliability	➢ Existence of a proper grid reliability plan. ➢ LOLE index. This index define the mean interruption time (due to problems in the electrical system) per year.> Coverage factor. Total generation power of the electrical system/Annual peak load demand.	Ministry of Energy & National Statistical Service; Regional Accounts	0;1	This may include redundant circuitry or components that provide alternative dispatch of energy, equipment upgrades (e.g. better cooling to cope with heat waves) or power downrating (e.g. decrease power output of energy transformers so that they do not overheat during heat waves).
	Small scale production and consumption (prosumers)	➢ Number of prosumers (individuals and communities). ➢ Percentage of renewable energy produced under prosumers regime. ➢ Percentage of decentralised renewable energy produced in shared facilities./ total production of RES / or RE demand	Ministry of Energy & National Statistical Service; Regional Accounts	Yearly basis	This allows for a greater use of local renewable resources and waste energy recovery which allow for a better resilience when dealing with climate change events such as heat waves.
	Harnessing low enthalpy energy -	➢ Percentage of water and rooms-climatization and powered by low enthalpy geothermal and aerothermal energy. ➢ Percentage electric energy produced by high enthalpy geothermal energy. ➢ Percentage of heat necessities that are covered by highly efficient co-generation systems.	Ministry of Energy & National Statistical Service; Regional Accounts	Yearly basis	These systems can be Earth Air Heat Exchanger (EAHE) and Ground Source Heat Pump (GSHP) types. Both systems use tubes or pipes that usually need to be buried beyond the footprint of the building or house. The measure considers this need, and both allows and encourages the use of such space in urban planning.

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12.15.3 Tourism sector

Indicators type	Indicators	Definition	Responsible Organization	Monitoring Processes	Interpretation
Climate hazard	Humidity Index	Number of days exceeding 35oC	Sistema Informativo agrometeorologico siciliano SIAS - Dati meteorologici (regione.sicilia.it)		Ref: 52 days /year with HI>= 35°C Business as usual: (up to 2050): 74 days (up to 2100): 119days
	Fire weather index (FWI)	Numerical non-dimensional ratings of relative fire potential for a generalized fuel type (mature pine stands) based solely on weather observations. FWI calculation includes temperature, precipitation, relative humidity and wind.		The index only refers to the fire season (defined from May to October)	Ref . FWI = 0.0-0.4 Alert 0.6<FWI<1.0 Business as usual: (up to 2050): 0.0-0.60 (depending on the area) (up to 2100): 0.20-0.60 (depending on the area)
	Vector Suitability Index for Aedes Albopictus (Asian Tiger Mosquito)	Increases of ambient air temperature and changes in the hydrological cycle.	National institute of health Malattie infettive (iss.it)		Ref: VBSI = 83.7 Alert VBSI>80 Business as usual: VBSI ranges from 79 to 67 The index is expected to decrease but it remains higher than 60 indicating Medium Suitability
	Seagrass evolution	Coverage (in km2) of the main seagrass species	Academia, Regional fishing department, CNR		Ref: Posidonia (966.3 km2) Business as usual: (up to 2100): 28.3 km2
	Beach reduction	Percentage of reduction of beach area	CNR, Academia, ARPA		Status-quo (1995-2020) = -4 to 8m of beach area depending on the beach Business as usual: (up to 2050): - 62%
Exposure	Coast	Size of the coastline (km)	Department of Fisheries	Five-year updates	These are critical factors worsening (more pressure) the risk of forest fires, thermal stress, and marine habitat degradation in the island. These indicators require a periodic measuring of their performance.
	Corals	Density of corals and other marine species	Oceanography center	Five-year updates	
	Marine ecosystem	Marine ecosystem size (ha)	Oceanography center	Five-year updates	
	Tourists	Number of tourists	National Statistical Service; Regional Accounts	Annual estimations	
		Tourist characteristics (age, gender etc.)	National Statistical Service; Regional Accounts	Annual estimations	
		Type of tourism (sport, pleasure etc.)	National Statistical Service; Regional Accounts	Annual estimations	
	Population	Population density (persons/km²)	National Statistical Service; Regional Accounts	Annual estimations	

	Agricultural land	Cultivated area (ha)	National Statistical Service; Regional Accounts	Annual estimations	However, information systems in the island provide incomplete data related to exposure indicators of thermal comfort and heat waves. This is the first action to be undertaken in the monitoring process.
	Forests	Forest area (ha)	National Statistical Service; Regional Accounts	Annual estimations	
	Forests	Density of shrubby forests	Forestry Department	Annual estimations	
	Forests	Tourist walking paths in the forests (km)	Forestry Department	Five-year updates	
	Forest species	Number of forest flagship species	Forestry Department	Five-year updates	
	Protected areas	Percentage of protected areas	Forestry Department	Five-year updates	
Sensitivity	Pollution	Pollution from human activities	Department of Environment	Five-year updates	
	Marine species	Sensitivity of marine species	Oceanography center	Five-year updates	
	Human activities triggering wild fires	Number of recreational areas with barbeque	Forestry Department	Five-year updates	
Adaptation response	**Adaptive management of natural habitats**	➢ Percentage of tourism-relevant natural habitats with exhibiting effective adaptive management including an explicit visitors' management plan.	Regional Tourism Department	0;1 This indicator can be complemented by an expert assessment of the adaptive management suitability in a 1-5 Likert scale.	Preservation of ecosystem services which are essential for human well-being. Human activities induce pressure and impacts on biodiversity and ecosystems that tend to be aggravated by climate change. Adaptive management measures include understanding species response; make space for the development of rivers and coasts; aid gene flow; species translocation; targets and conservation mechanisms/plans.
	Pre-disaster early recovery planning	➢ Existence of a Pre-disaster early recovery plan containing critical ecosystems, best recovery practices, guidelines to prevent future disasters and funding sufficiency.	Protezione civile Attività sui rischi (protezionecivile.gov.it)	0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale.	It includes the development of knowledge, good practices and objectives that aim to improve the living conditions of the affected communities, while facilitating the adjustments necessary to reduce the risk of future disasters. Examples of good practices are may include identifying critical ecosystems (goods and services) that require immediate restoration after a disaster or particularly vulnerable communities.
	Health care delivery systems	➢ Number of hospital beds per 1000 tourists in tourist areas. ➢ Number of health personnel working in tourist areas per 1000 tourist. ➢ Existence of an effective plan to cover climate change related diseases (heatstroke, traumatology, infectious diseases…) medical attention demand.	Regional department	0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale.	Pre-emptive actions and adjustments that need to be made to health care systems, namely reinforcing less prepared aspects of its operation and/or logistics, in order to guarantee effectiveness and efficiency during, for example, high temperature and heat-wave situations.
	River rehabilitation and restoration	➢ Percentage of watercourses needing rehabilitation and restoration that are under rehabilitation works.	Regional Departments, protezione civile, ARPA	Yearly basis	River and valley rehabilitation and restoration are measures that emphasise the natural functions of rivers/valleys and create vegetated buffer zones alongside watercourses. This contributes to the improvement of micro-climatic conditions, reduces run-off

		➢ Percentage of areas alongside watercourses being used as tourist and leisure areas.			and erosion, and increases groundwater recharge. For Tourism, this option also increases available leisure areas, increases thermal comfort areas and the availability of water.
	Monitoring, modelling and forecasting systems	➢ Existence of a set of economic policy instruments to support firms and local government to increase resilience against climate change. ➢ Existence of a tourism satellite account system with detailed extension to environmental and climate change issues	Regional Departments, protezione civile, ARPA	0;1This indicator can be complemented by an expert assessment of the set of instruments' suitability in a 1-5 Likert scale.	Information system that provide timely and reliable climate information, as well as up-to-date data on the occurrence and severity of extreme events, possible impacts and their duration. Different systems can be implemented to respond to different climate hazards, such as drought-related, water quality monitoring, water resources management and predicting and managing flood risks.
	Beach nourishment	➢ Percentage of beaches surface diminishing over the average of reference period (1985-2005). ➢ Percentage of total beaches surface requiring sand nourishment. ➢ Percentage of beach surface under sand nourishment during the year.	CNR, Academia, ARPA	Yearly basis	Beach nourishment (or replenishment) is the artificial placement of sand to compensate for erosion. Beach nourishment also often aims at maintaining beach width (for tourism and recreational purposes). Several beach nourishment techniques can be used including beach, backshore and shoreface nourishment, and large-scale coastal nourishment (e.g. using sand motors).

12.15.4 Aquaculture

Indicators type	Indicators	Definition	Responsible Organization	Monitoring Processes	Interpreation
Climate hazard	Surface water temperature	Changes in surface water temperature	Academia, CNR, zoological station Anton Dohrn Home - Stazione Zoologica Anton Dohrn (szn.it)	Climate modelling	seam bream: 24°C - 33 °C sea bass: 25 °C – 35.9 °C tuna: 24 °C – 26.17 °C mussels: 20.5 °C – 27.0 °C
Exposure	Farm area	Area occupied by sea cages (m^2)	Department of Fisheries	Annual estimations	These are critical factors worsening (more pressure) the risk of increased fragility of aquaculture production due to extreme weather events and higher water temperatures. These indicators require a periodic measuring of their performance.
	Value of stock	Value of biomass in the cages	Department of Fisheries	Annual estimations	
	Stock size	Annual production of aquaculture products (fish and shellfish) (in tons)	Department of Fisheries	Annual estimations	
	Employment	Number of employees	Department of Fisheries	Annual estimations	
	Location of farms	Location of farms related to the prevailing wind direction	Department of Fisheries	Five-year updates	
		Location of farms related to the average distance to shore	Department of Fisheries	Five-year updates	
	Sensitivity of species	Vulnerability of species to climate change	Department of Fisheries	Literature review; aquaculture experts	

	Sensitivity of infrastructure	Vulnerability of infrastructure (type and materials of cages) to extreme weather events	Department of Fisheries	Literature review; aquaculture experts	
Adaptation outcome	**Recirculation Aquaculture Systems (RAS)**	➢ Percentage of land-based aquaculture production managed using Recirculation Systems. ➢ Percentage of land-based aquaculture production over total aquaculture production in the island.	Regional fishing department, Academia	Yearly basis	Recirculation Aquaculture Systems (RAS) are land-based indoor fish farms with closed containment rearing systems where filtration is applied to purify and regulate water parameters and remove toxic metabolic wastes of fish. Since RAS is land-based and indoor it limits the risk of infrastructure destruction due to extreme events in the ocean.
	Integrated multi-trophic aquaculture (IMTA)	➢ Percentage of multi-trophic aquaculture over the total aquaculture production. ➢ Existence of a plan to support through funding and technical assistance the aquaculture sector transition to IMTA schemes. ➢ Annual public expenditure to support aquaculture sector transition to IMTA schemes.	Regional fishing department, Academia	Yearly basis 0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale. Yearly basis	Culture species from different trophic levels (fish, shellfish, seaweeds) in an integrated farm to create balanced systems for environmental sustainability. IMTA can increase resilience due to its tolerance to wider ranges of climatic factors such as temperature and salinity.
	Promote aquaculture cuisine	➢ Annual rate of local consumption increase. ➢ Percentage of aquaculture production locally consumed. ➢ Number of stakeholders involved in agreements to promote local consumption of local aquaculture, including tourism agents.	Regional fishing department, Academia	Yearly basis	Promoting aquaculture species in restaurants or setting up specific 'aquaculture' restaurants will provide both a cultural experience and promote farmed products. The online tool highlights the initiative, provides recipes and aggregates information.
	Best Management Practices	➢ Existence of a Best Management Practices consensual chart for Aquaculture at the island focusing on food safety, fish health, environmental and climate change impact, and social responsibility. ➢ Percentage of top-5 Best Management Practices being accomplished across the industry in the island. ➢ Markets' perception of food safety, fish health, environmental and climate change impact, and social responsibility	Regional fishing department, Academia	0;1 Yearly basis Likert scale-based expert assessment	Implementing Best Management Practices at farms which focus on food safety, fish health, environmental impact (including climate change) and social responsibility. These practices improve the farms capacity to participate in value chains with the aim of improving the overall resilience of the farm. For example, increasing hygiene will improve resilience of species to diseases.
	Feed production	➢ Percentage of total food used in local aquaculture coming from local sustainable non-fish based sources.	Regional fishing department, Academia		This already a current problem with many fisheries overexploited and will only intensify in the future. Therefore, alternative feed ingredients may be developed such as insect meal and algae.

		➢ Public and private investment in R+D+I to encourage local sustainable food sources, per year.			
	Environmental monitoring and Early Warning Systems (EWS)	➢ Existence of an environmental monitoring plan and early warning system to support firms' adaptation decision, preferably fed by remote sensing and GIS.	Regional fishing department, Academia	0;1 This indicator can be complemented by an expert assessment of the plan suitability in a 1-5 Likert scale.	Environmental monitoring and Early Warning Systems (EWS) systematically collects and provides information to fish farmers with the aim of supporting climate risk management decision-making. Monitoring and early warning can facilitate adaptation actions, such as early harvesting or relocation of fish net pens from sites of intense harmful algae blooms. Dynamic vulnerability maps, remote sensing and GIS are typically applied in the development of this type of measures.

Conclusions

This deliverable presents the final island reports, including: (a) a background material of future projections of CC on the selected islands, (b) a final matrix of adaptation measures per blue economy sector and island, (c) a final package of alternatives adaptation pathways per sector and island, ranked by intervention levels and time horizons, (d) a monitoring plan with blue economy sectors' indicators per island.

The evaluation of the individual adaptation measures for the four blue economy sectors (tourism, maritime transport, energy and aquaculture), on the basis of the five selected criteria, namely, cost efficiency, environmental protection, mitigation win-wins and trade-offs, technical applicability, social acceptability, revealed similarities and differences across the islands. In particular, for the tourism sector, the economic policy instruments, e.g., pricing, subsidies and environmental taxes, were highly ranked in six islands followed by the adaptation of groundwater management, e.g., through artificial recharge or efficient use of freshwater, modification of pumping practices (across 5 islands) and local circular economy (across 4 islands). On the contrary the financial incentives to retreat from high risk areas, i.e., due to flood, sea level rise and storm surges was the least ranked adaptation measure across five islands followed by the beach nourishment to combat erosion (across 3 islands).

For the maritime transport sector, the marine life friendly coastal protection structures that aim to reduce climate change impacts on local ecosystems is the most highly ranked adaptation measure across seven islands followed by the Early Warning Systems (across 3 islands) and the financial incentives to retreat from high-risk areas (across 3 islands). On the contrary, the expansion/retreat of ports in urban planning due to climate change risks is the least scored measure across four islands followed by the financial incentives to retreat from high-risk areas (across 3 islands).

For the energy sector, the energy efficiency in urban water management, e.g., the water sensitive urban design that aims to minimise hydrological impacts on the environment and the associated energy use of water supply is a highly ranked adaptation measure across five islands followed by the urban green corridors (across 3 islands), the educational garden plots (across 3 islands) and the public information service on climate action (across 3 islands). On the contrary, the energy recovery microgrids that allow for a flexible and a swifter recovery from power outages caused by knock-out events and/or excess demand, is the least ranked adaptation measure across three islands followed by the energy demand side management (across 2 islands) and the energy-independent facilities (across 2 islands).

For the aquaculture sector, the risk-based zoning and site selection considering climate change scenarios and the feed production consist the two most highly ranked measures across three islands. On the contrary, the tax benefits and subsidies instruments and the creation of recovery funds and plans for post-disaster are the least ranked measures at least across two islands.

The ranking of the adaptation pathways revealed great similarities across the four APT scenarios among the selected islands. For the tourism sector, the four APT scenarios are considerably similar along the three timeframes considered. In most of the islands, the four APT scenarios exhibit a high level of social acceptability and technical applicability. The APT A (minimal intervention) scenario exhibits a higher social acceptability, since little action is taken, in most of the islands,

while the APTD (system restructuring) contributes more to environmental protection, which is also expected, since this is a very voluntarist scenario. Similar to the tourism sector, all four APTs for the maritime transport sector exhibit a similar ranking across the different timeframes. The social acceptability and the technical applicability received the highest score across the four APTs in the majority of the islands, while the environmental protection and the mitigation win-wins and trade-offs received lower scores. For the energy sector, the four APTs exhibit also a similar ranking across the different time frames. In particular, all APTs exhibit the same cost efficiency in most of the islands, while the environmental protection received an overall low value. Similarly, there are not many differences across the four APTs for the aquaculture sector. In general, the cost efficiency and the social acceptability received the highest score across the four APTs in most of the islands, while the environmental protection and the mitigation exhibit the worst performance, respectively.

Finally, a monitoring plan for the implementation of the adaptation measures and adaptation pathways was developed. The SOCLIMPACT adaptation monitoring plan consists of four building blocks: (a) definition of the system of interest, (b) selection of indicators, (c) identification of the organizations responsible for monitoring, (d) definition of monitoring procedures. Specifically, the SOCLIMPACT monitoring plan relies on a combination of indicators to monitor progress in adaptation, including (a) climate hazards, (b) exposure, (c) sensitivity, (d) adaptive capacity and (e) adaptation response indicators. Specific indicators for each blue economy sector and island were developed.

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