Journal of *Marine Science and Engineering*

MDPI

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Participatory Approach to Build Up a Municipal Strategy for Coastal Erosion Mitigation and Adaptation to Climate Change

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Abstract: The Ovar coastline is characterized as one of the coastal areas with the highest vulnerability and risk of erosion in the Portuguese coast. The high-energy coast is further threatened by a permanent sediment deficit of anthropic origin, as well as sea level rise due to climate change. It is essential to define modern coastal adaptation strategies to minimize the impacts of these issues on the local communities, while considering social, environmental, and economic factors. It is in this territory that the INCCA project's case study is located, involving stakeholders with technical, scientific, and operational knowledge in the co-management of the coastal stretch. In the scope of the involvement intended for the project's development, five participatory events were held, involving local authorities, civil protection, public entities, academia, and the general community. These events allowed a multidisciplinary and multi-stakeholder analysis of the challenges and possible solutions to mitigate coastal erosion, representing the definition of a shared vision for the coastline's future in this municipality. This work presents the main results of this participatory process as well as reflections on the importance of active citizenship instruments and stakeholder involvement for integrated coastal management in the 21st century.

Keywords: INCCA; participatory action research; participatory workshops; costs and benefits; intervention scenarios; adaptation pathways; tipping points

Citation: Matos, F.A.; Alves, F.; Coelho, C.; Lima, M.; Vizinho, A. Participatory Approach to Build Up a Municipal Strategy for Coastal Erosion Mitigation and Adaptation to Climate Change. *J. Mar. Sci. Eng.* **2022**, *10*, 1718. https://doi.org/10.3390/jmse10111718

Academic Editors: Niki Evelpidou, Anna Karkani and Miltiadis Polidorou

Received: 1 October 2022
Accepted: 8 November 2022
Published: 10 November 2022

1. Introduction

Coastal areas are characterized by the interaction with ocean waters, making them highly dynamic and mutable [1,2]. Due to their complex nature as an interface between land and water, these areas support the provision of several beneficial ecosystem services and functions [3–5], such as storm buffering and nutrient cycling, while also being a choice environment for human recreational and industrial activities [6].

Indeed, coastal areas have been historically characterized by high human occupation, and today they still see higher rates of population growth and urbanization [7]. While these areas constitute only 20% of all land in the world, they are home to 40% of the world's population [3], of which 10% lives specifically in low elevation coastal zones [8], a number that is expected to increase [9].

On a global scale, coastal areas are experiencing significant changes as a result of climate change (e.g., sea level rise, storm frequency and intensity) [10,11], as well as anthropogenic actions (e.g., sediment retention, transformation of natural areas) [11,12] These phenomena result in increased coastal erosion [7] and flooding [13], and consequently, the loss of ecosystem service values [14] and the increased exposure of communities to coastal hazards [15,16].

In the case of Portugal, 75% of the population is located along the coast due to the effect of "coastal compression" [17,18], with significant urban, industrial and touristic activities

being located in these coastal areas, generating 85% of the countries GNP [19]. The rapid population growth and increase in touristic activities places an especially high pressure on coastal systems in Portugal [20]. For this reason, coastal hazards exacerbated by climate change are especially likely to negatively impact a large portion of the population, posing a threat to ecosystems and economic activities [21,22], as well as the cultural and social fabric of communities [23,24].

Managing coastal territories and populations can be achieved through the application of diverse strategies, namely coastal defense structures (e.g., groynes, seawalls), erosion mitigation measures (e.g., artificial sand nourishment), or even relocation plans for population and infrastructure [25]. Portugal has seen a prevalent trend of 'hard interventions' being used to combat coastal erosion since the late 1950s, such as groynes and seawalls, which often failed to solve the problem entirely and produced negative side effects [26,27]. This type of measures comes with high implementation and maintenance costs, and can negatively impact existing ecosystems [28,29]. Furthermore, the present sediment deficit in the Portuguese coast undermines the design principles of hard protection infrastructure, making these measures ineffective at combating coastal erosion [5]. For these reasons, management strategies in the past 20 years have transitioned to focus more on 'soft interventions' of combating coastal erosion, such as artificial nourishment actions or dune preservation and enhancing measures [30,31].

In order to mitigate these issues, it is important to switch to more proactive and anticipatory coastal planning strategies [32,33] involving scientific knowledge [18], community engagement, and public participation [34,35].

Conventional planning models centered on top-down decision making are no longer capable of effectively addressing the issues threatening coastal communities nowadays [36]. Thus, it is necessary to switch to adaptive coastal governance methods [37], centered on trust building, as well as political and managerial flexibility [38]. The need to involve citizens and communities in decision-making processes regarding coastal management has been acknowledged by the scientific community as well as policy makers [39–41], and the popularization of terms such as "stakeholder knowledge" or "bottom-up approach" in risk management studies [42] is proof of this [43–45]. Public participation benefits not only the citizens themselves, but also the overall decision making processes by restoring trust, avoiding potential conflicts, and raising acceptance or even funding [46,47].

Despite the efforts of several countries to involve the public in coastal management, there are still several barriers to be overcome [48,49], mainly pertaining to the citizens' lack of engagement with the process [48,50], which is detrimental to the conception and implementation of adaptation strategies [50]. Thus, the use of innovative tools and participative processes in coastal management can enhance the success of the system and the resulting strategies [51]. The participatory action research (PAR) approach, specifically, can be applied to processes dealing with climate change adaptation [52–54], and by extension, to coastal planning strategies. PAR is an iterative process characterized by cyclical stages of research and action-engagement, involving citizens, academics, and decision makers, who collectively define issues, propose and analyze solutions, and ultimately create strategies that consider social, economic, and environmental factors [52,55,56]. The use of PAR and similar approaches in the field of coastal management and planning is becoming increasingly relevant in Europe, and several studies have been published that demonstrate the potential of these practices [37,57–59].

The INCCA (Integrated Adaptation to Climate Change for Resilient Communities) project uses these innovative PAR methodologies coupled with scientific background research to develop a Municipal Strategy of Mitigation and Adaptation to Coastal Erosion and Climate Change for the study area of Ovar (Portugal), including stakeholders from all sectors to achieve a viable and equitable plan of the future of the coast and its communities.

This paper presents some of the work conducted in the context of the INCCA project, demonstrating how, through participatory methods, it is possible to involve a range of stakeholders from different sectors, in the fundamental processes of coastal management

strategy definition and decision making. In addition, this paper also provides insight into the priorities and concerns of the stakeholders when it comes to the management of their communities, and how the strategies created by integrating their input and opinions differ from those generated through traditional approaches.

INCCA Project

The INCCA (Integrated Adaptation to Climate Change for Resilient Communities) project has the main goal of developing a Municipal Strategy of Mitigation and Adaptation to Coastal Erosion and Climate Change effects for the municipality of Ovar (Portugal), a strategy that integrates the different environmental, social, and economic impacts (positive and negative) in three temporal horizons—2030, 2050, and 2100.

Ovar Municipality (see Figure 1) was chosen as a pilot study because this coastal zone is considered one of the most affected by erosion problems, being protected by coastal defense structures (groynes and seawalls) throughout a large extension of the coast, and hosting three urban areas (Esmoriz, Cortegaça, and Furadouro) with diverse geographical features. Today, the region faces serious social-environmental challenges. Factors that make the region of Ovar especially relevant for this study include the high erosion rates and sediment deficit, the existence of several coastal defense structures, different types of land use (urban and forest), issues related with tourism (relocation of camping park, hotels in flood risk zones), fishing (relocation of the fisherman neighborhood in Esmoriz), and the environment (a sealed landfill, in Maceda, is highly threatened by coastal erosion, leading to concerning ecological consequences such as contamination of the sea water if the ocean reaches the landfill). The participatory methods developed should be replicable and applied to any other Atlantic coast in Portugal or elsewhere.

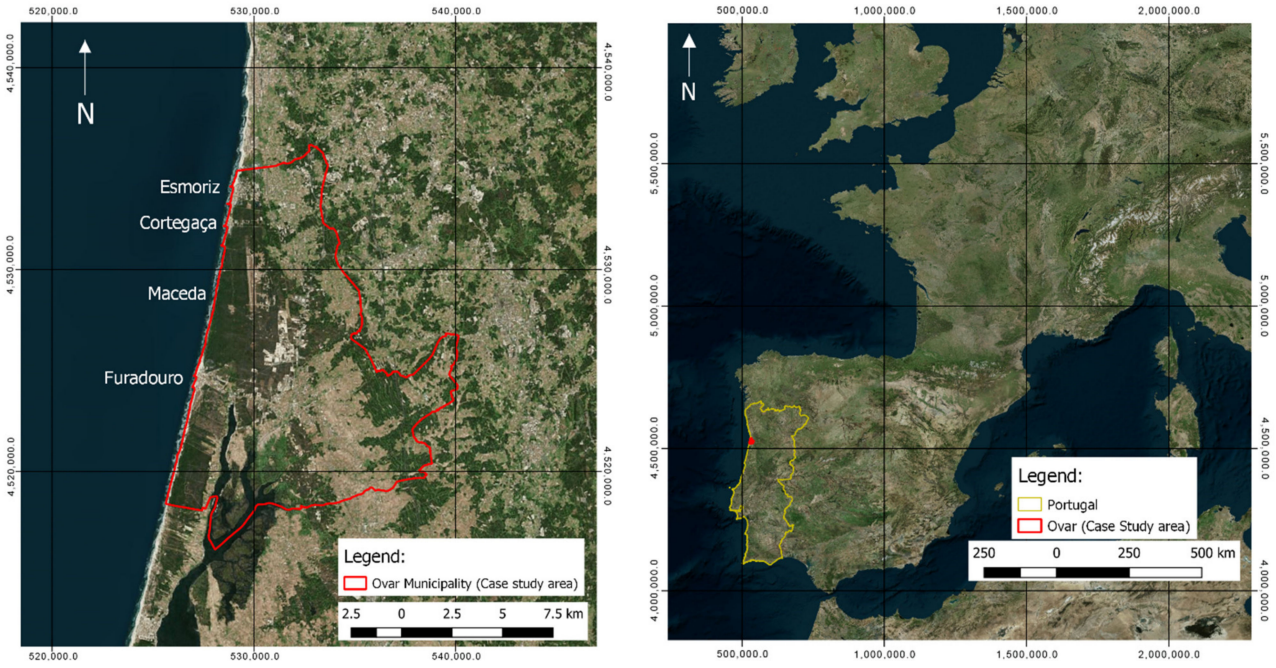

Figure 1. Maps of the study region, the Municipality of Ovar (Portugal, to the **left**) as well as a more global view of the region and the country in the European continent (to the **right**). All coordinates presented are in WGS 84/UTM zone 29N.

The adaptation strategy for the coast of Ovar should include an analysis of the different costs and benefits of mitigation and adaptation measures, clear goals, and pathways to achieve them. This strategy should be supported by results from mathematical numerical models, developed and calibrated specifically for this purpose, but should also include the contribution of the different stakeholders in coastal management. In this way, and in parallel

with the development of the COAST tool (Coastal Optimization Assessment Tool) [60], the project foresees a set of participatory Workshops in order to involve stakeholders in the different stages of the municipal strategy construction process. This promotes multidisciplinary and multisectoral discussion, and, above all, contributes to a new culture of participatory democracy on the future of coastal management in Ovar.

2. Materials and Methods

The methodology employed by the INCCA project revolved around the involvement of a variety of stakeholders in the process of coastal planning. This was achieved by the organization of three workshops:

- 1st Participatory Workshop—"Strategies, Costs and Benefits";
- 2nd Participatory Workshop—"Scenarios for the Territory";
- 3rd Participatory Workshop—"Adaptation Pathways".

2.1. Participatory Workshop: Strategies, Costs, and Benefits

The first participatory workshop, held entirely in online format, was divided in 3 different moments.

The 1st moment, held in November 2020, brought together 21 participants with the objective of analyzing and prioritizing coastal erosion mitigation and adaptation measures (MAM) [61] selected from a list compiled by the project team [62–64]. The participants were asked to choose their top 10 coastal erosion mitigation and adaptation measures (MAM) from an initial list of 28 meta measures. All stakeholders anonymously voted on their preferred MAM in order to generate a top 10 list for the collective group, and then for each of the 3 work groups created for the purpose of the next exercises. After this, each group was also asked to order in priority the 10 MAM resulting from the selection.

The 2nd moment, with the goal of carrying out multi-criteria analyses (MCA) of the set of measures discussed in the first moment, was held in December 2020 and brought together 24 participants. To start the multi-criteria analysis, the project team selected three measures from each group's top 10 list generated in the previous participatory moment. This selection was performed raking into account two factors: (1) a balanced distribution of measure types so that each group could reflect on different intervention rationales; (2) the prioritization of each group. In order to guarantee that different groups would not assess the same measures, and to ensure that varied MAM types were assessed, some measures that scored lower on the priority list were included. After the presentation of the MAMs to be used in the exercise, the groups were asked to elect the 5 criteria that would be most relevant in the analysis. Once the criteria were decided, the groups were invited to assign different weightings to each, when relevant, before starting the MCA.

The 3rd moment, with the goal of validating the impacts of each MAM and carrying out a cost–benefit analysis (CBA), was held in May 2021 and also brought together 24 participants. Based on the results from the MCA in the previous event, the three groups were invited to carry out a cost–benefit analysis of a single measure each. The participants had to identify up to 3 social, environmental and economic impacts, positive and negative, and give them individual or group quantitative scores in order to reach a final Benefit/Cost ratio for their respective measure.

The results obtained in each participatory moment served as a basis for the construction of the participatory events that followed [65].

For purpose of preparing information, a set of interviews were carried out with stakeholders of different sectors of the coast of Ovar, whose knowledge about the past, present, and future of the study area was important to collect. This process took place before the second participatory workshop, and was crucial for the construction of the SWAP participatory methodology. Some of the interviews were conducted in virtual format, while others were conducted in person and accompanied by visits to the territory under study [66].

2.2. Participatory Workshop: Scenarios for the Territory

The 2nd Participatory Workshop was held in October 2021, and made use of the first portion of the Scenario Workshop and Adaptation Pathways (SWAP) [52] participatory method, specifically the Scenario Workshop stage [67], which was applied to issues of adaptation to coastal erosion and climate change [57]. The stakeholders' contributions in the previous events allowed for the creation of the Narratives of Coastal Erosion Adaptation Scenarios for the Ovar coastline in the year of 2100. In this workshop, the participants were divided in four work groups and tasked with analyzing all scenarios, discussing which ones they thought were preferable for the future of Ovar, and providing feedback on how to improve them. The three narratives generated were presented in this 2nd Workshop as follows:

- "From the Silver Coast to the Stone Coast", a scenario focused on heavy engineered hazard mitigation measures, such as groynes, breakwaters. and seawalls, that prioritized the protection of the communities at the cost of negative impacts to landscapes and local beaches;
- "InOvar, accepting the change", a scenario focused on the adaptation of the populations to the changing coast, trying to find new ways to use the land instead of trying to negate or oppose these changes;
- "United we keep the coast and improve the beach", a scenario that envisioned the maintenance of the sandy beaches for recreational use at any cost, placing emphasis on the value of these areas from an economic perspective.

Analyzing the results of this exercise, the project team summarized a list of the perceived 10 main objectives of the stakeholders for the adaptation plan of Ovar. They were then asked, as a collective, to discuss the contents of this list, add or remove topics from it, and help the project team compile a list of the objectives as defined and accepted by stakeholder consensus.

After this, the participants examined a map depicting several scenarios for the evolution of the shoreline for the Ovar region including sea level rise predictions according to greenhouse gas Representative Concentration Pathway (RCP) 8.5 (high emissions) scenario. This map was generated using model simulation results for scenarios such as "business as usual" (maintenance of existing heavy protection measures), abandonment of heavy protection measures, as well as specific scenarios for different MAM implementation, such as beach nourishment. The stakeholders then discussed this new information, speculated where on the map specific MAM could be implemented, and left feedback on what other scenarios they would like to see simulated in a future event.

2.3. Participatory Workshop: Adaptation Pathways

The final, 3rd Participatory Workshop, was held in April 2022 and employed the second portion of the SWAP methodology, dedicated to the creation of Adaptation Pathways [57] for the coastal communities in Ovar. This method consists in the analysis of a set of measures that are expected to be effective for a defined period of time, isolated or combined with other measures, in terms of protection and adaptation to coastal erosion and climate change. Three groups were created by assigning stakeholders of different backgrounds to each in order to make them as equally balanced as possible. Then, in order to allow each of the three groups to analyze a different portion of the territory with minimal overlap, the Ovar coastline was divided in three sections as follows:

- Section 1: Esmoriz-Cortegaça;
- Section 2: Cortegaça-Maceda;
- Section 3: Maceda-Furadouro.

Each group was given an Adaptation Pathways template already including certain MAM which had been discussed in previous workshops. In addition, modeling results for scenarios incorporating some of these MAM were also supplied, including maps of the evolution of the shoreline over time, so as to give the stakeholders as much information as possible. These maps already included modelled scenarios for measures suggested by

the participants at the end of the 2nd Workshop. Then, each group was invited to discuss their specific Section and create Adaptation Pathways using any combination of MAM they found ideal, taking into account their expected efficacy at different points in time, starting with the current time frame and ending in 2100. Afterwards, all groups switched tables to analyze and criticize the pathways proposed by the other groups for their respective sections. Each group then returned to their original table and discussed the feedback left by the other groups, adapting their adaptation pathways when necessary. The project team then compiled the resulting pathways to generate a collective Adaptation Pathways map for the adaptation and management of the entire Ovar coastline. The adaptation pathways will serve as a basis for the creation of the Municipal Strategy of Mitigation and Adaptation to Coastal Erosion and Climate Change effects for the municipality of Ovar, the final goal of the INCCA project.

2.4. Interested Parties—Stakeholders

The Workshops of the project were marked by the presence and involvement of diverse stakeholders representing different sectors of interest in the management of Ovar's coastline. Adding to the project team members that contributed as moderators and facilitators, the participatory events were attended by varying numbers of stakeholders, between 15 and 22 depending on the event, comprising 34 different participants. Their role was to analyze the data provided by the INCCA project, contribute with their own knowledge and understanding of the issues and specificities of the coastal territories of Ovar, and debate which measures and strategies should be applied to the issues of coastal erosion, loss of territory, risks to people and goods, and cost–benefit analyses. The events also had the presence of 1 to 2 moderators, whose function was to lead the session through the various moments, presenting information and contents, launching the themes, and explaining how the debates and discussions in each group would proceed. For the purposes of several exercises during the participatory events, the participants were divided into groups and each group had the presence of a facilitator, whose function was to conduct the discussions within the working groups, clarify questions about the participatory process and record all the contributions made by the participants. A summary of the different stakeholder sectors that had individuals participate in at least one workshop, as well as the moderation and facilitation team, can be seen in Table 1.

Table 1. Stakeholder sectors and groups that participated in the events.

Sector	Organization, Group or Individual
Academia	University of Lisbon University of Aveiro University of Minho University of Porto
National Institutions	National Laboratory for Civil Engineering (LNEC) Portuguese Environment Agency (APA) Polis Litoral Ria de Aveiro
Public Services	Humanitarian Association of Volunteer Firefighters of Ovar
Local Administration	Municipal Council of Ovar Parish Council of Cortegaça Parish Council of Esmoriz Parish Council of Maceda
Private Institutions	Centre for Studies and Urban and Regional Development (CEDRU)
Local Businesses	Barrinha Surf School (BSS)
Local Media	OvarNews
Non-Governmental Organization	Clube de Campismo do Porto (CCP) Youth Association Amigos do Cáster
Others	Interested locals

The sector with the most extensive representation pertained to academia, including participants from four different universities, some of them from different departments and research centers within these institutions. The stakeholders invited from the academic sector were knowledgeable about the topics of coastal erosion, and many of them were also acquainted with the case of Ovar. Another widely represented sector was that of local administration, including council members from the Municipality of Ovar, as well as the individual towns found in the study area, with the exception of Furadouro. Engineers and experts from national and private institutions connected to territory management and related areas were also present, such as Portuguese Environmental Agency (APA), the National Laboratory for Civil Engineering (LNEC), Polis Litoral Ria de Aveiro and the Centre for Studies and Urban and Regional Development (CEDRU). The event also counted with the participation of members from two non-governmental not-for-profit organizations: Amigos do Cáster, which promotes environmental education and awareness-raising, and Clube de Campismo do Porto (CCP), which aims to promote camping and other outdoor activities, and which oversees the Cortegaça camping park. The inclusion of representatives from local businesses (Barrinha Surf School) and local media outlets (OvarNews), as well as interested local citizens with no particular affiliation was also essential to the bottom-up approach of these participatory events.

Each of the stakeholders present at the event, in representation of the above-mentioned entities, shared their particular and unique vision, opinion, and experience in relation to the topics discussed. Some of the participants contributed with a more operational and technical view of the problems associated with coastal erosion of the Ovar coastline and its impact on people and property. Other participants contributed with a more legislative and bureaucratic view of coastal management, while others provided scientific information and studies on the spatial and temporal evolution of coastal erosion, shoreline retreat and loss of territory. Finally, environmental groups take a more holistic, sustainable, and integrated approach in their management strategies. The contributions made by each participant have been registered and processed in order to be considered in the construction of the following participatory moments and to become part of the Municipal Strategy for Coastal Erosion Mitigation and Adaptation to Climate Change effects for the municipality of Ovar.

3. Results

3.1. Participatory Workshop: Strategies, Costs and Benefits

The collective voting for the top 10 mitigation and adaptation measures (MAM) produced the results shown in Figure 2. These results revealed a preference for measures that aim to act directly on the effects of coastal erosion, through the addition of sediments to the coastal system (nourishing the beach, the coastal drift, and the dune systems). On the other hand, there was also a very significant vote for adaptation measures, expressed as education, awareness-raising and monitoring, relocation, and building adaptation. Heavy engineered protection measures were also considered, but only one, the detached breakwater, made it into the top 10 list.

After the stakeholders were divided in three groups, the exercise was repeated, and the top 10 list of MAMs for each group was ordered according to priority of implementation, as seen in Table 2.

It remains clear that all three groups find the measures of nourishment to be crucial, as each group picked at least two measures related to this topic in their respective top 10 lists. Equally significant is the constant occurrence of at least one heavy engineering protection measure in each group. Additionally, each group picked exactly two measures related to the preservation and management of the dunes. Group 1 ended up having a diverse and balanced list, being the only one to have considered renaturalization and water course restoration measures. Group 2, on the other hand, placed a heavier focus on more discrete measures, such as governance, financing, and awareness-raising/education actions, as well as the adaptation of urban areas. Both Groups 2 and 3 additionally considered measures to relocate people and/or buildings as part of their preferred measures.

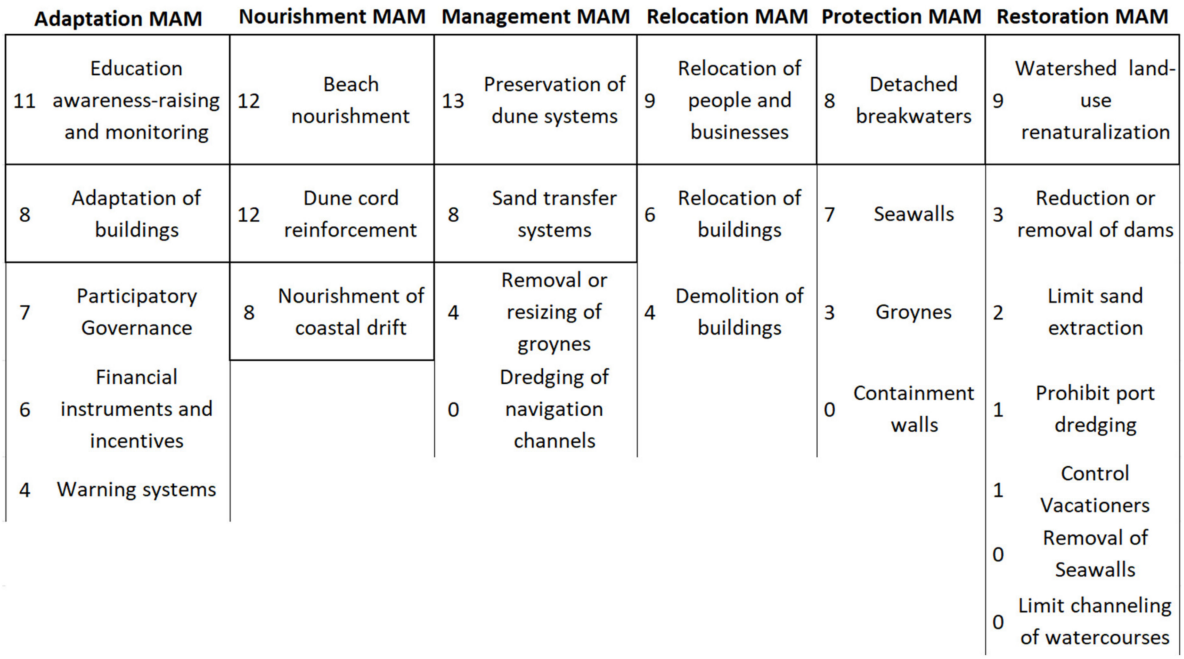

Figure 2. List of major MAM used for this exercise, each with the number of total votes it received from the stakeholders. The 10 most voted measures are highlighted with thicker outlines.

Table 2. Prioritization of the previously picked top 10 MAMs from highest (1) to lowest (10) priority, as decided by groups 1, 2, and 3 for a short-term period (2030). The colored cells represent specific types of measures: adaptation (blue), nourishment (yellow), management (orange), protection (purple), restoration (green), and relocation (red).

	Group 1	Group 2	Group 3	
1	Financial instruments and incentives	Participatory Governance	Financial instruments and incentives	**Legend:**
2	Nourishment of coastal drift	Adaptation of buildings	Nourishment of coastal drift	Adaptation MAM
3	Beach nourishment	Beach nourishment	Beach nourishment	Nourishment MAM
4	Reduction or removal of dams	Seawalls	Preservation of dune systems	Management MAM
5	Preservation of dune systems	Education awareness-raising and monitoring	Dune cord reinforcement	Protection MAM
6	Dune cord reinforcement	Relocation of people and businesses	Education awareness-raising and monitoring	Restoration MAM
7	Detached breakwaters	Financial instruments and incentives	Detached breakwaters	Relocation MAM
8	Groynes	Preservation of dune systems	Removal or resizing of groynes	
9	Education awareness-raising and monitoring	Dune cord reinforcement	Adaptation of buildings	
10	Watershed land-use renaturalization	Sand transfer systems	Relocation of buildings	

Some patterns are visible from this prioritization exercise's results, which suggest that, while each group has their own individual ideas and plans for coastal management, their priorities are similar. The top three measures of all groups include both soft measures focused on adaptation and measures aimed at artificially delivering sand to the local beaches, with no other MAM types present. It is also important to point out that Groups 1 and 3 are in perfect agreement as to the top three priority measures. The majority of MAM involving addition of sand (six out of eight picked across the three groups) appear in the top half of the priority lists, five of which being in the global top three. While some of the discrete adaptation measures (e.g., governance and financial instruments) placed very high

on the priority lists (four out of nine occur in the global top three), several can also be found scattered throughout most positions of the list, with the bottom half having almost as many of these measures as the top half (five in the global top five, four in the global bottom five). The dune management and preservation measures are either placed in the upper middle of the lists or at the bottom three spots. Relocation measures (e.g., relocation of people and buildings), as well as "heavy/hard" protection measures (e.g., groynes, breakwaters and seawalls) can all be found in the bottom half of the priority list, with the exception of one seawall measure placed fourth on Group 2′s list. Lastly, the renaturalization measures proposed by Group 1 follow no clear distribution, with one in the upper half of the list, and the other one at the very bottom.

For the multi-criteria analysis (MCA), stakeholders were asked which criteria should be assessed. The three groups unanimously chose "Effectiveness", "Cost/Investment", and "Environmental impact" as the most relevant criteria for the exercise. The remaining ones were chosen differently among each group: Group 1—"Acceptance of the local population" and "Urgency"; Group 2—"Acceptance of the local population" and "Temporality of the measure"; Group 3—"Level of certainty and confidence" and "Urgency". The criterion "Effectiveness" was selected as the one with the highest weight, followed by the criteria "Cost/Investment" and "Environmental Impact". The results of the MCA performed by each of the three groups can be seen in Tables 3–5, respectively.

Table 3. Multi-criteria analysis performed by group 1 for each MAM using their 5 elected criteria and respective importance for the weighted calculation. The colored cells represent adaptation (blue) and nourishment (yellow) measures respectively.

MAM	Environmental Impact (20%)	Efficacy (20%)	Level of Certainty (20%)	Cost/Investment (20%)	Urgency (20%)	Average Total	Weighted Total
Financial instruments and incentives	5	7	4	9	8	6.6	6.6
Beach nourishment	7	6	5	6	8	6.0	6.0

Table 4. Multi-criteria analysis performed by Group 2 for each MAM using their 5 elected criteria and respective importance for the weighted calculation. The colored cells represent adaptation (blue) and nourishment (yellow) measures respectively.

MAM	Efficacy (40%)	Cost/Investment (20%)	Popular Acceptance (10%)	Environmental Impact (20%)	Temporality (10%)	Average Total	Weighted Total
Participatory Governance	7	8	8	5	8	7.2	7.0
Adaptation of buildings	7	2	6	3	7	5.0	5.1
Dune cord reinforcement	6	3	7	8	1	5.0	5.4

Table 5. Multi-criteria analysis performed by Group 1 for each MAM using their 5 elected criteria and respective importance for the weighted calculation. The colored cells represent nourishment (yellow), management (orange), and adaptation (blue) measures respectively.

MAM	Efficacy (30%)	Cost/Investment (25%)	Environmental Impact (20%)	Urgency (15%)	Popular Acceptance (10%)	Average Total	Weighted Total
Nourishment of coastal drift	8	4	7	9	7	7.0	6.9
Preservation of dune systems	6	7	8	9	7	7.4	7.2
Education awareness-raising and monitoring	6	5	8	8	6	6.6	6.5

Group 1 (Table 3) was only able to analyze two out of the three measures in the time given for the exercise. The measures "Financial instruments and incentives" and "Beach nourishment" both scored very high in urgency. They were also given similar scores in the efficacy and level of confidence criteria, although the financial instruments measure was deemed slightly more effective, albeit with slightly less confidence. The beach nourishment measure scored higher where environmental impacts were concerned, but significantly lower in the cost/investment criterion. For this reason, the measure with the best performance in the latter criterion was the one to obtain the bigger score in the MCA. In this case, all different criteria had the same weights in the final calculation.

In Group 2 (Table 4), the "Participatory Governance" measure was the one with the highest score in the MCA, with the "Reinforcement of the dune cord" and "Adaptation of buildings" both obtainting similar, lower scores. All three measures scored similarly for effectiveness, with moderately positive performance. Participatory governance was deemed inexpensive, unlike the remaining two measures which the group expected to require significant investment to implement. The winning measure also scored highest on the temporality criterion. All measures were expected to have a positive response from the population, with the participatory planning, once again, obtaining the highest score. On the other hand, the group expected the population to offer some resistance to the building adaptation. Reinforcing the dune cord was expected to have good environmental impacts, while the construction activities required for the building adaptation earned the measure a low score on this criterion. Once again, the measure with the highest overall score ended up being the one with the best score in the cost/investment criterion, but also in the criteria of population acceptance and temporality. The efficacy criterion had a higher weight, but since all measures scored similar results on this one, the variation of scores in the other criteria decided the result.

In Group 3 (Table 5), the measure "Preservation of the dune systems" was the one that gathered the highest weighting by the participants: the group considered the coastal drift measure to have a higher efficacy than the other two; however, they also estimated it would have significantly higher costs, which severely impact the measure's final score. All three measures scored similarly high values in urgency, they were all expected to have similar positive environmental impacts and decent acceptance by the population. The uniformity of the results across these three criteria, once again, favored the measure with the lower implementation cost, where the scores were more uneven, over the measure with the higher expected effectiveness, even though the latter criteria had a higher weight.

This exercise made it possible to define a list of priority measures to be analyzed at the third moment of the first Workshop. However, to increase the type of MAM to be evaluated, the final election for the third moment of the first workshop was slightly changed by the project team. The results of the cost–benefit analyses (CBA) performed by the groups on their appointed measure, as well as their respective impacts and results, are shown in Figure 3.

All measures were deemed beneficial in different degrees as a result of this exercise. The measure with the best Benefit/Cost ratio was the "Adaptation of Buildings", studied by Group 2, with the other two measures being tied for second place.

Group 2 theorized their measure would have few environmental impacts, but that the benefits of preserving the coastal features were more significant than the waste generated by the modification of the existing buildings. On the other hand, the group recognizes the high costs of implementation for this measure, in addition to the compensation that must be paid to relocated citizens, which they say outweighs the money saved by reducing protection costs. Lastly, the group voiced concerns regarding the modification of built heritage and touristic activities, yet they expect a more significant improvement of adaptation and quality of life for the population, as well as the preservation of cultural values.

		Environmental Impacts	Score	Mean	Economic Impacts	Score	Mean	Social Impacts	Score	Mean	Mean Total	Benefit/ Cost Ratio
Group 1 - Preservation of dune systems	Positive Impacts	Enhanced sand retention capacity	9	8.67	Valorisation of territory	7	7.5	Landscape attractivity	7	7.33	23.5	1.04
		First line of defence	9		Low initial investment	8		Creation of new businesses	7			
		Valorization of ecosystems	8					Better beach management	8			
	Negative Impacts	Conflict with other measures	8	8	Maintenance costs	8	8.33	Hinderance of beach accessibility	7	6.33	22.7	
					Complementary restoration costs	9		Restriction of land use for by fishermen	7			
					Path creation costs	8		Restriction of land use for vacationers	5			
Group 2 - Adaptation of buildings	Positive Impacts	Coastal conservation	7	7	Valorisation of businesses	7	7	Adaptation of the population	8	8	22.0	1.10
					Reduced protection costs	7		Improved management and quality of life	8			
								Preservation of cultural values	8			
	Negative Impacts	Waste and emissions from construction activities	5	5	High cost of implementation	8	8	Tampering with built heritage	7	7	20.0	
					Compensation costs	8		Tampering with touristic activities	7			
					Difficulty associated with relocations	8			7			
Group 3 - Detached breakwaters	Positive Impacts	Increased beach width	8	6.33	Reduced costs associated with flooding	8	6.67	Improved beach quality due to added safety	8	5	18.0	1.04
		Flooding prevention	9		Increase in tourists and related business profits	7		Hipothetical improvement of sports conditions (e.g. surfing)	4			
		Habitat creation	2		Profit for the company hired to implement the measure	5		Improvement of recreational fishing conditions	3			
	Negative Impacts	Negative visual impact on the landscape	6	6.33	Implementation and maintenance costs	8	6	Hypothetical loss of attractivity due to negative visual impact	4	5	17.3	
		Increased erosion after the protected area	8		Wear and tear of local roads during implementation	4		Hindrance of fishing communities' way of life	6			
		Noise and pollution generated by construction	5									

Figure 3. Results of the cost–benefit analysis performed by the three work groups.

Group 1 performed the analysis for the measure "Preservation of dune systems". The group identified several positive environmental aspects of the measure, mainly focusing on the ecosystem benefits and sand retention, although there were concerns regarding the feasibility of other potential measures if this one was to be implemented. On the economic side, the measure was deemed less attractive, with the potential costs for maintenance and restoration being expected to outweigh the benefits from a territory value increase. On the social parameter, the measure fared better, positively affecting the landscape and beach management, which could generate new touristic activities, at the cost of reducing their direct access to the beach and force fishermen to find new preferred spots.

Group 3 analyzed the possible impacts of detached breakwaters and found them slightly positive overall. The group expects the environmental impacts to be neutral, as the gains from increasing habitats, beach width, and flood prevention are thought to have the same significance as the pollution and noise generated by the construction of the measure, as well as the degraded landscape and increase in erosion to the south. In economic terms, the measure is expected to be beneficial, with gains being expressed in savings from reduced flooding related damage costs, but also for local companies, such as the one building the breakwater and the touristic businesses profiting from the safe environment it creates. While relevant, the implementation and maintenance costs of the measure, as well as the maintenance of infrastructure associated with the activities, is considered less significant. In social terms, the group finds the measure neutral, with positive points entailing improvements to the safety of the beach for recreational activities, while negative aspects foresee a loss of visual attractiveness and a possible negative effect of the local fishing communities.

3.2. Participatory Workshop: Scenarios for the Territory

The second participatory workshop was held around the narratives of the scenarios for the coast of Ovar in a long-term future (2100). The results of the discussion and analysis of the narratives by the four working groups created for this session are presented in Table 6.

Taking into account the scenarios presented for 2100 in each narrative, conditioned by the mitigation and adaptation measures that were supposedly taken in the present, the groups of most tables expressed a preference for an integration of several scenarios, notably scenarios 1 and 3. The Group 3 preferred Scenario 3 and were the only group to reject scenario 1 entirely, while Group 4 expressed that the integration of the three scenarios presented would be ideal for the future of Ovar. Scenario 2 ("InOvar—accept change") was found to be the least likely to earn approval from the stakeholders, as it was rejected by Groups 1, 2, and 3, although Group 3 gave it some consideration before reaching the decision. Scenario 3 ("United we keep the coast and improve the beach")

proved to be the most appealing, with every group accepting it in some way. These results show the stakeholders hold a strong inclination towards the preservation and maintenance of the sandy beaches in the region, which is in accordance with the findings of previous participatory moments, and are unwilling to lose the territory to erosion or the climate change effects. Additionally, the acceptance of Scenario 1 ("From the Silver Coast to the Stone Coast") by three out of four groups also shows the protection of people and buildings from coastal hazards is a priority for the stakeholders.

Table 6. Results of the analysis of all narratives by each of the four groups.

Narrative	Group 1	Group 2	Group 3	Group 4
Scenario 1 "From the Silver Coast to the Stone Coast"	Accepted in combination with Scenario 3	Accepted in combination with Scenario 3	Rejected scenario	Integration of the three scenarios
Scenario 2 "InOvar, accept change"	Rejected scenario	Rejected scenario	Rejected Scenario	
Scenario 3 "United we keep the coast and improve the beach"	Accepted in combination with Scenario 1	Accepted in combination with Scenario 1	Preferred scenario	

Based on the perceived priorities of the stakeholders regarding the region's coastal management, a list of 10 objectives for the Adaptation Plan of Ovar was created. From this list, participants elected the objectives they believed to be most relevant for the Ovar coastline. They also had the opportunity to add new elements that were not initially in the list. Ultimately, the four groups agreed on the following objectives:

1. Avoid the loss of beach areas and urban territory by adding sediment via artificial nourishment as opposed to heavy protection measures;
2. Gradual relocation of communities (housing, commerce and leisure) that are currently in danger and that will remain so in the coming years, as expressed by modelling simulations;
3. Maintain the existing coastal defense works and consider the possibility of adding a detached breakwater to the Furadouro area;
4. Combine engineering protection measures with artificial sand nourishment in key areas, namely the urban fronts of Esmoriz, Cortegaça and Furadouro;
5. Renaturalize the areas left vacant by the relocation of the communities.

The ideas shared by the four working groups reveal that there is a common vision for the coastline of the municipality of Ovar and that consists in: protecting the coastline with strong anthropic occupation, either in terms of housing or in terms of economic activities, and which is not susceptible to suffer relocations of people and goods (ex: Furadouro); relocate communities that are at coastal risk; and naturalize the areas that are to be targeted for relocation, making them more resilient to coastal erosion (ex: Cortegaça Camping Park area).

3.3. Participatory Workshop: Adaptation Pathways

In the third Workshop, the stakeholders, divided into three groups, created adaptation pathway maps for their respective sections of the Ovar coast and evaluated the strategies of the groups assessing the remaining sections. The collective adaptation pathways map compiled from the plans of all groups is shown in Figure 4.

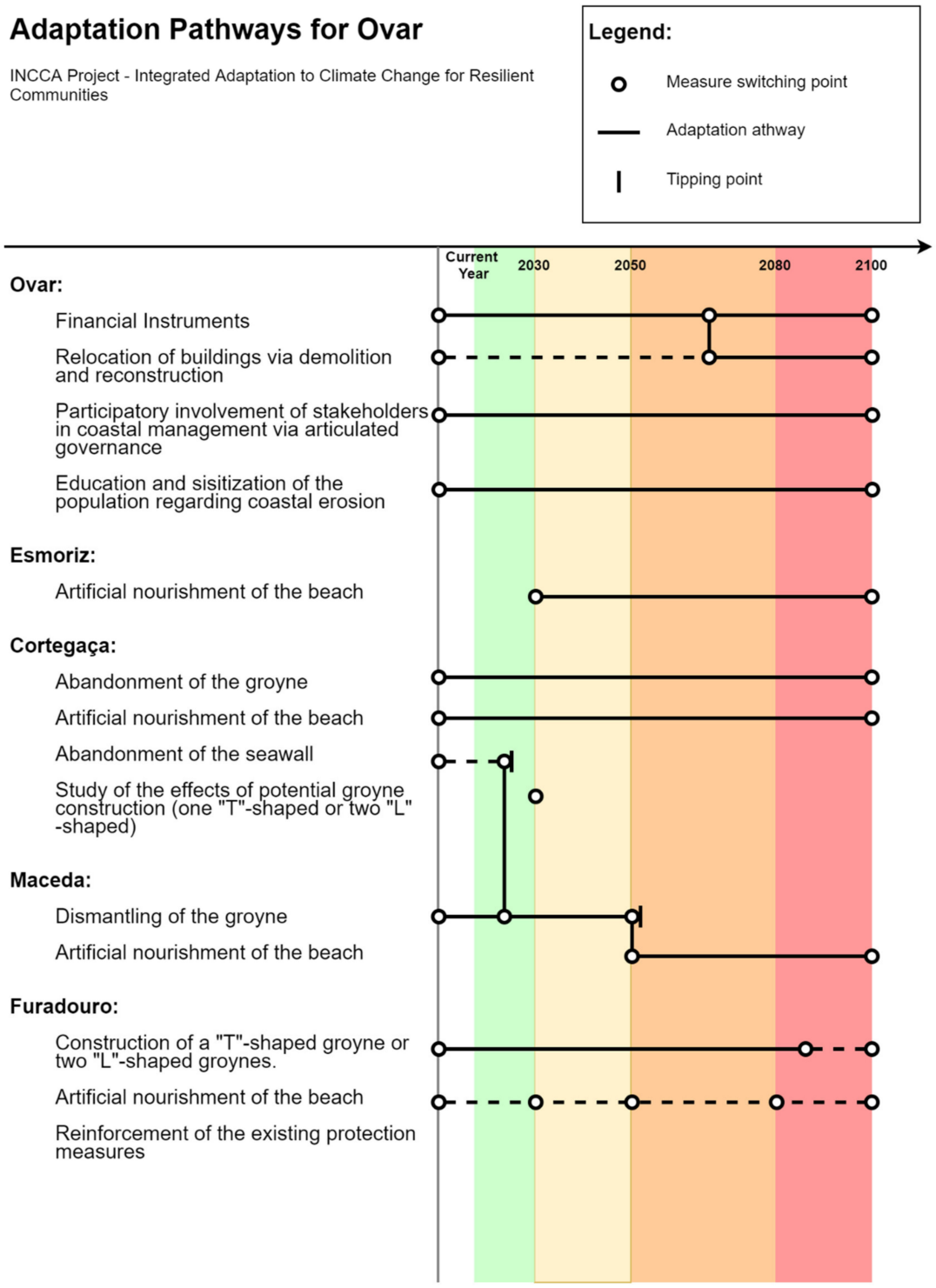

Figure 4. Final adaptation pathways map for the coast of Ovar. Full lines indicate planned measures, while dotted lines represent considered actions that may be taken if possible/necessary.

Some of the measures were suggested for multiple communities, and can, due to their nature, be applied to Ovar as a whole. This is the case of the participatory involvement of stakeholders in in coastal management using articulated governance, as well as the awareness-raising and education of the community regarding the issues of coastal erosion and possible solutions to them. Additionally, the consensus called for the immediate implementation of financial instruments to discourage the use of buildings in the zones

within the urban areas where flooding risk is higher. The participants explained that this measure should prepare the community for the relocation of these buildings, which should take place starting in 2050 and continuing until completion in 2080.

The consensus regarding Esmoriz was that it was necessary to keep at least 90% of the current beach area and not allow the advance of the sea. Thus, the stakeholders would like to begin artificially nourishing the beach with sand starting in 2030, when the tipping point that is the loss of 10% of the beach area is expected to be reached. This measure would continue indefinitely for as long as it is necessary.

The stakeholders suggest stopping the maintenance of the Cortegaça groynes, defending that its gradual deterioration should be accompanied by strict monitoring of the evolution of the shore, and that the process can be reverted if deemed necessary. The same strategy was proposed for the seawall to the south of the town, which currently only protects a camping park that is scheduled to be relocated, but this measure should come only after assessing the impacts of the abandonment of the groyne. The plan to perform artificial nourishment in the Cortegaça beach was also proposed in the same manner as described for Esmoriz. Additionally, stakeholders expressed interest in studying the potential effects of "T" or "L" shaped groynes in this locale.

In Maceda, the decision to remove the northern groynes was unanimous, as the simulations results for this scenario showed visible benefits to combat coastal erosion. The stakeholders would like to see the removal of the structure completed by 2050. If by that year the sea has advanced 25 m inland, the tipping point established by the stakeholders in order to protect a nearby road, then artificial nourishment should be applied to keep the shoreline from receding further.

In the case of Furadouro, the consensus was that a "T" shaped groyne or two "L" shaped groynes should be constructed, after performing a comparative study to assess the best option, in order to protect the urban front. If deemed necessary, the existing protection structures can also be raised to provide further protection. As for the beaches in the Furadouro area, the stakeholders defend that they should only be nourished sporadically as required to maintain 50% of their area for touristic activities.

4. Discussion

The results from the participatory events are enlightening as to the way stakeholders see the issues of coastal erosion and shoreline recession, as well as what measures they believe to be promising to solve them.

Since the very first participatory moment, the focus placed by the participants was on "soft" or discrete adaptation and management measures, such as financial instruments, education and awareness raising, participatory governance, and others. These types of MAM, occurred four times in the global top 10 measures elected, and the top priority measure for each individual group was consistently an adaptation type MAM. This is a stark departure from the approach taken in the past where top-down decision-making processes heavily favored "hard" engineered protection measures, such as groynes and seawalls. Out of the three multi-criteria analyses performed, two of them scored an adaptation MAM higher than the other measures assessed, while the remaining MCA scored a management MAM highest. The stakeholders believe these measures to be easy to implement from an investment standpoint, and to have acceptable efficacy while providing benefits in the long term, showing they are not just concerned with mitigating the issues in the immediate future. The cost–benefit analysis also favored an adaptation measure over management and a protection MAM. The adaptation pathways map generated by the stakeholders also shows the expectations they place on these measures, as they unanimously agreed that the different measures considered should be applied in the whole Ovar region and not just in select communities.

If adaptation and management are the stakeholders' goals for the future, the maintenance of the existing beaches is the present concern. Nourishment measures to add sediment to the coastal system occurred thrice in the global top 10 MAM list, and place

second and/or third in the individual group top 3 priority MAM. These measures scored lower than others on MCA, but they remain a high priority in order to protect the urban fronts in the short term in a fluid and adaptable way, as described by the participants, with the option to add more or less sand as required or even stop altogether if it proves to no longer be profitable. The general rejection of Scenario 2 (accept change) in the second workshop, and the preference for Scenario 3 (keep the beaches) is in line with this thinking; the beaches are a valuable source of revenue for the communities, and allowing the sea to reduce their available area is not acceptable for them. The pathways map shows that consensus agreed that all four regions in the coast of Ovar should make use of nourishment MAM starting at different points in time, further showing how important the beaches are to the stakeholders.

The stakeholders recognize the importance of "hard" protection measures for the protection of urban fronts, one of their primary concerns; however, they do not always agree as to their efficacy. These measures occurred only once in the global top 10, generally place lower in the individual group priority lists. The mixed reception of the first scenario (stone coast) in the second Workshop, as well as the antithetical calls in the pathways map to maintain some existing structures, abandon some others, and build a few new ones further suggests the conflict between the acceptance that communities need to be protected and the idea that heavy constructions may not be the ideal way to reach that goal. The fact that stakeholders agreed to build the "T"-shaped groyne in Furadouro, yet still want artificial nourishment and even consider the possibility of reinforcing existing structures further points to the uncertainty they feel about these measures.

In general, this project has showed that stakeholders want to be actively involved in the coastal management processes, contributing to the decision making with knowledge and constructive criticism. The choices made in certain stages of the workshops also prove that stakeholders pay attention to the simulation data provided by the INCCA team, and consider them when making decisions. This is especially visible by the choices to abandon some groynes yet build others, especially given the low popularity of these MAM in the most recent years.

5. Conclusions and Final Thoughts

As a result of the participatory events organized by the INCCA project, several insights could be obtained regarding the use of participatory action research (PAR) methodologies for a better and more equitable coastal management:

1. Stakeholders residing or acting in areas affected by issues such as coastal erosion are passionate about their region and are willing to engage in participatory events designed to discuss future management plans and alternatives to help tackle these issues.
2. Despite the belief that the public mistrusts the decision-making organs, all groups including administration, private and public sectors, as well as general citizens, can work together in these events if managed correctly. Not only that, but they also place trust in the experts and academics providing transparent information and mediating the process.
3. Stakeholders prefer "soft" measures to mitigate and/or adapt to coastal erosion and related issues, placing emphasis on beach nourishment actions to combat the sediment deficit and on alternative governance and financing measures which they believe are simple and inexpensive to adopt, with benefits that can be visible in the long term. The tendency is, thus, to avoid using the "hard" engineered protection measures (e.g., groynes, seawalls) that were prevalent in the traditional approach used in decades past.
4. The stakeholders hold the firm belief that their coast is valuable and must be maintained. They are willing to invest in arguably expensive continuous nourishment solutions in order to keep the beaches attractive and generating revenue, but also accept that some concessions must be made and that some level of shoreline change

is inevitable. Above all, they unanimously agree that the communities must be protected, opting to keep most defensive structures where they prove effective but also proposing adaptation strategies to reduce exposure and risk to the rising sea level.

The coastal management of the future will necessarily be very different from what was the management of these territories throughout the 20th century. Whether at the level of actors and institutions involved, whether in the decision-making processes, the funding model, and the complexity of solutions and their implementation.

The growing human, economic and environmental pressure in these territories, as well as the urgency of measures to combat and prevent increasingly frequent and damaging events forces the need to plan and act better, and in a more integrated way. If the coastal management "1.0" was marked by heavy engineering works, of which the numerous groynes are the major mark, and centralized decision-making processes and assumedly with public investments, the coastal management "2.0" has seen a gradual movement from heavy works to measures of sand nourishment, dune cord management and the renaturalization of some areas, often already involving local authorities and other stakeholders of local scope. Finally, coastal management "3.0" has been achieved. On the one hand, with more actors and stakeholders having a role and an active voice in decision-making processes. On the other hand, there are increasingly complex and complementary funding models between European, national, regional, and even municipal funding for the implementation of an increasingly vast and diverse set of measures, which no longer act at the level of the consequences, but also at the level of the causes of the sedimentary deficit. This increasingly complex, participative, and integrated management invites the use of new management instruments and new ways of listening to and involving populations, companies, organizations, the civil society, and academia. It is no longer a question of involving all these stakeholders—yes or no—but more of knowing who to involve, how, and when. It is here that projects such as INCCA may contribute significantly to this new culture of coastal management, either by experimenting with participatory methodologies, or by the new inter and intra-stakeholders dynamics that it promotes and facilitates. First of all, who to involve? It is certainly not feasible nor sustainable to involve all stakeholders, let alone in all phases of the process and in all decisions. Experience has shown the importance of having representativeness, diversity and, at the same time, ensuring the presence of key people and institutions in order to guarantee the validity, autonomy and legitimacy of the process. Cross-referencing these criteria with the available timeframe, the project resources and the objectives resulted in a cohesive group of 25–30 people. The same multi-criteria logic could be used in other projects and other coastal realities, arriving at these circles of sharing, reflection, discussion, and decision.

The question always arises of when, or at what stage of the management and decision process, stakeholders are involved. In the coastal management 1.0 this question did not even arise, in the management 2.0 technical teams from various institutions and even moments of public consultation begin to appear, usually in the final stages and with little or no effective constructive contribution. In management 3.0 the involvement should be constant, iterative, and using different mechanisms. It is not about eliminating steps, but rather adding stages, investing more time and resources throughout the decision-making process, to save later on in terms of acceptance, support, and mobilization of resources for action. The question is, how? In addition, here there is still a long way to go, either in the experimentation of different methodologies, or in the construction of a truly participative, active and democratic culture, which is an essentially societal and generational design. This work and the INCCA project propose some methodologies that are useful, have potential, and can serve the future of coastal management in Portugal. The future will tell if it is necessary to continue innovating, learning, and improving.

Author Contributions: Conceptualization, F.A. and F.A.M.; methodology, A.V. and F.A.; software, C.C. and M.L.; validation, F.A., C.C. and M.L.; formal analysis, F.A.M.; investigation, F.A.M.; resources, F.A.; data curation, F.A.M.; writing—original draft preparation, F.A.M. and F.A.; writing—review and editing, C.C., A.V. and M.L.; visualization, F.A.; supervision, C.C.; project administration, F.A.; funding acquisition, M.L. All authors have read and agreed to the published version of the manuscript.

Funding: This work was financially supported by the project "Integrated Coastal Climate Change Adaptation for Resilient Communities", INCCA—POCI-01-0145-FEDER-030842, funded by FEDER, through "Competividade e Internacionalização" in its FEDER/FNR component and by national funds (OE), through FCT/MCTES. It was also supported by the Foundation for Science and Technology (FCT)—Aveiro Research Centre for Risks and Sustainability in Construction (RISCO), Universidade de Aveiro, Portugal [FCT/UIDB/ECI/04450/2020].

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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