PLASMAR

Bases para la planificación sostenible de áreas marinas en la Macaronesia

Identification of areas for Blue Growth

ADVANCES ON THE MCDA METHODOLOGY

UNIVERSIDADE DOS AÇORES – FUNDAÇÃO GASPAR FRUTUOSO

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I. Introduction

1 The PLASMAR project

Aiming the development of methodologies to support Maritime Spatial Planning (MSP) and Blue Growth, the project PLASMAR "Setting the basis for sustainable maritime spatial planning in Macaronesia" has the goal to potentialize the development of marine activities in balance with the biogeographical specific characteristics of Macaronesia region (including in Portugal the Azores and Madeira archipelagos, and in Spain the Canary Islands). It also aims to support the achievement of the Good Environmental Status (GES) launched at the Marine Strategy Framework Directive (MSFD) (Directive 2008/56/EC).

The PLASMAR activity 2.1.2 "Pilot Zoning – identification of areas for Blue Growth development within ecosystem approach" intends to identify potential areas for the "blue growth" in Macaronesia. This task consists on developing a general methodology of zoning activities/sectors over the maritime space and implementing a pilot zoning for Macaronesia, which will be developed on INDIMAR platform.

The elaboration of a zoning proposal demands basis information. Hence, this data will be gathered, organized and produced in the following activities:

i. Activity 2.1.1 "Finding the balance of Blue Growth Sustainable Development within Ecosystem Approach";
ii. Activity 2.2.1 "Analyses of data & information availability, current and potential data holders/providers, in the scope of Maritime Spatial Planning";
iii. Activity 2.3.1. "Marine monitoring methods needed to apply MSP ecosystem approach".

From the results obtained in the project, a zoning methodology will be stablished considering the following marine sectors:

i. Aquaculture;
ii. Fisheries;
iii. Marine transportation;
iv. Offshore renewable energy;
v. Aggregate extraction;
vi. Marine tourism.

The pilot zoning will identify the best suitable areas for specific maritime activities, in line with the maintenance of the GES, according to the information available in the Marine Distributed Data Infrastructure. This is a result of the Activity 2.2.1 of PLASMAR "Analyses of data & information availability, current and potential data holders/providers, in the scope of Maritime Spatial Planning".

In this sense, the different methodologies currently applied for Multi-Criteria Decision Making (MCDM) will be further developed in order to subsidize the methodology currently being developed in this project.

II. Advances on the MCDA draft methodology

2 First-round survey

In order to test the methodology of weight calculation under the PLASMAR project, further detailed at the previous report (Shinoda *et al.*, 2018), a first-round survey was applied within the Regional Directorate for Sea Affairs (DRAM) in the Azores (Portugal). In the first-round survey, the mineral resources sector (focused on sand extraction) was selected due the advances its analysis presented by the time. Experts and/or sector related employees were selected to answer the survey, in a total of four interviewees. The results of this survey will be further developed.

2.1 Mineral resources survey results

As aforementioned, the survey took place at the Azores and was applied in the PLASMAR's partners at DRAM. The aggregation method utilized for this analysis was the arithmetic mean in the final weight of each interviewee, nonetheless, the final aggregation method still needs to be defined on a *post hoc* analysis.

From Figure 1, it is possible to observe that contribution and impact results differed from the different parameters. The parameters that presented the highest weights for contributing to the sector are, in descending order: Depth/Bathymetry, The sea floor integrity, and Distance to the coast. Regarding the parameters that presented the lowest weights for contribution, in the descending order they were: Fisheries/Area effort, Point and lineal coastal pressure, Fish landings.

The mineral resources sector presented the highest impacts in the following parameters, in descending order: The sea floor integrity, Wreck and Depth/bathymetry. The parameters less impacted by this sector are, in descending order: The population of commercial species, Waves and Distance to the coast.

Cluster	Criteira	Subcriteria	Significance	CONTRIBU	IMPACT
Good Environmental Status					
	Biodiversity				
		Marine Habitats	MEDIUM	4.61377	7.17374
		Coastal habitats			
		Sensitive species di	LOW	0	0
		Mammals	LOW	0	0
		Birds	LOW	0	0
		Turtles	LOW	0	0
		Fish /Cephalopod	LOW	0	0
	Non-indigenous species		LOW	0	0
	The population of commercia		MEDIUM	6.17072	3.54337
	Elements of food webs		LOW	0	0
	Eutrophication		LOW	0	0
		Chlorophyll a	-	0	0
		dissolved oxygen	LOW	0	0
		nutrients	LOW	0	0
		water transparency	LOW	0	0
	The sea floor integrity		MEDIUM	16.8653	27.76
	Permanent alteration of hydr		LOW	0	0
	Concentrations of contamina		LOW	0	0
	Contaminants in seafood - as		LOW	0	0
	Marine litter		-	0	0
	Energy, including underwater		LOW	0	0

		Significance	CONTRIBU	IMPACT
MPA			3.8201	7.67952
	Nationally designated areas	INCOMPA	0	0
	Natura 2000	INCOMPA	0	0
	No take zone	INCOMPA	0	0
Land Use & Cover				
	CORINE	-	0	0
	Land use	LOW	0	0
	Distance to the coast	MEDIUM	5.93911	0.90332
	Point and lineal coastal press	MEDIUM	1.95777	4.95605
Oceanography				
	Temperature	-	0	0
	SST	-	0	0
	SSB	-	0	0
	Salinity	-	0	0
	Mixed layer thickness	LOW	9.37206	10.5509
	Currents	LOW	10.4203	4.624
	Waves	LOW	8.48572	2.89004
	Depth/bathymetry	MEDIUM	24.0371	11.6557
	Wind	-	0	0

	Significance	CONTRIBU	IMPACT
Maritime pressures			
Aquaculture facilities	INCOMPA	0	0
Maritime traffic lanes/intesivi	INCOMPA	0	0
Fisheries/Area efforts	LOW	3.05181	4.61377
Fish landings	LOW	1.51065	6.17072
Harbours/ports	INCOMPA	0	0
Cables, Pipelines, transmissio	INCOMPA	0	0
Martime tourism	INCOMPA	0	0
Cables	INCOMPA	0	0
Research area	INCOMPA	0	0
Military area	INCOMPA	0	0
Cruise Tourism	INCOMPA	0	0
Coastal Tourism	INCOMPA	0	0
Artifical reefs	INCOMPA	0	0
Deep sea mining	NA	0	0
Blue biotech	INCOMPA	0	0
Seaweed cultivation	INCOMPA	0	0
Diving	INCOMPA	0	0
Windsurfing/ Sailing	INCOMPA	0	0
Wreck	MEDIUM	3.75566	12.2469
Ship building	INCOMPA	0	0
Fossil fuel extraction	INCOMPA	0	0
Dumping	INCOMPA	0	0
Desalination	INCOMPA	0	0
Offshore supply/bunkuring	INCOMPA	0	0

Figure 1: Results from the mineral resources first-round survey applied within DRAM in the Azores. Contribution results in yellow and impact results in blue.

Some remarks from the first-round survey:

- An introductory explanation of the questionnaire was fundamental in the comprehension of the interviewees about the correct filling of the questionnaire.

- A clarification of the parameters' definition was mentioned as necessary.
- Some interviewees felt uncomfortable in changing the grades in order to achieve a better consistency ratio (CR).

3 PLASMAR face-to-face meeting

In order to test the weight definition methodology, a zoning workshop took place at Madeira (Portugal), in 2019 April 5th. The aim of this workshop was to test the method in order to see the need for further adjustments, as well as to apply the weights at INDIMAR with the purpose of identify the adaptations needed for the combination of both tools.

The proposal of this workshop (Annex 1) was to divide the participants in 3 groups, each group approaching a different sector, in order to attribute weights to the different parameters. The planned dynamic was based on the presentation of each one of the 5 groups of parameters, followed by the application of the questionnaire developed for the Analytical Hierarchy Process (AHP) analysis of each sector. In a second moment, it was planned to test these weights at INDIMAR.

Some remarks from the zoning workshop are:

- It was observed that the importance analysis attributed to the parameters had a different interpretation from the different experts, mainly regarding the logic of analysis (parameter-sector/sector-parameter). Some experts understood that some groups of parameters needed a different logic than other. Furthermore, it was observed that a definition for each parameter would benefit the importance analysis.
- It was observed that the division of contribution and impact for the AHP analysis, even thought more comprehensive, would turn the analysis time-demanding and some parameters would not necessarily make sense for both, contribution and impacts.
- It was observed that many experts had difficulty to adjust the CR lower than 0,1 and the analysis could gain from a higher CR.
- INDIMAR by the time still on development and the test did not worked as planned.

4 Adaptations on the methodology

Due to the different tests taken for the evaluation of the methodology and the reasons exposed, adaptations were necessary in different parts of the methodology. In order to clarify the process of methodology development and the adaptations taken in the methodology, each step will be further approached, and the applicable adaptations developed for each stage.

4.1 Establishing the context: Defining the goal and the objectives

Considering the PLASMAR action 2.2.1 was the basis for the goal definition, the overall goal considered on this analysis remained the "Identification of areas for Blue Growth", as observed in Figure 2. Initially, this goal was subdivided in order to comprehend the relation of the different parameters considered at the project. The subdivision consisted on "Contribution", referring to the parameters contribution to the sector, and the "Impacts", referring to the parameters impacted by the sector.
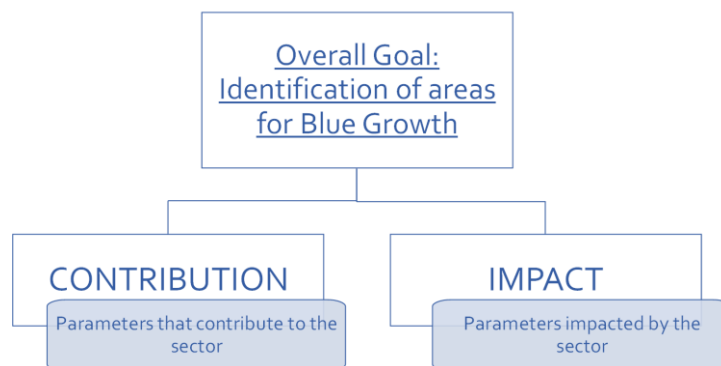

Figure 2: Goal definition in the analysis.

Nonetheless, the goal subdivision leaded to an extra complexity on the analysis, that could be not applicable on INDIMAR and a long questionnaire, that could result in few replies of external experts. As a result, a proposal to avoid the complexity of analysing both, contribution and impact was needed, and this division was removed from the analysis.

Furthermore, in order to comprehend the different maritime sectors addressed during the project as the blue growth sectors, the overall goal was further subdivided into objectives. This subdivision aimed the identification of specific criteria and weights for each sector and the final layout of the analysis can be observed in Figure 3.
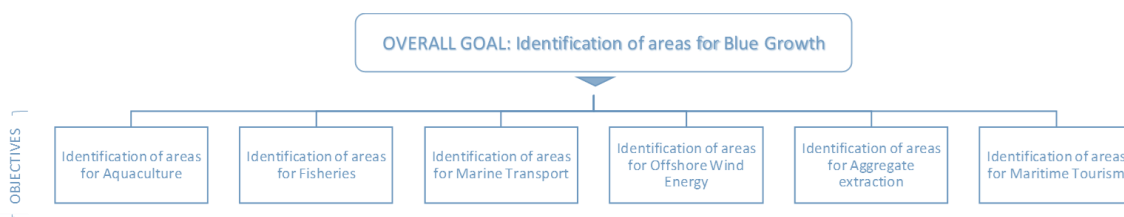
Figure 3: Goal and Objectives definition

4.2 Establishing the context: Defining the criteria

The criteria adopted for the multicriteria analysis in this study were the PLASMAR data framework, in order to associate the aforementioned analysis with the spatial data developed in the scope of the project.

Updates were made in the PLASMAR data framework during the methodology application process. The latest version list is presented in Table 1.

Table 1: PLASMAR data framework adopted for the identification of areas for Blue Growth. In red the removed parameters, in green the ones added.

Group of parameters	Parameter	Sub-parameter
MSFD Good Environmental Status criteria elements	Descriptor 1: Biodiversity – Habitats and Species	Marine Habitats
		Coastal habitats
		Sensitive species distribution/migrations
		Mammals
		Birds
		Turtles
		Cephalopod
	Descriptor 2	Non-indigenous species
	Descriptor 3	The population of commercial fish species
	Descriptor 4	Elements of food webs
	Descriptor 5: Human-induced eutrophication	Chlorophyll a
		Dissolved oxygen
		Nutrients
		Water transparency
	Descriptor 6	The sea floor integrity (physical loss & disturbance)
	Descriptor 7	Permanent alteration of hydrographical conditions
	Descriptor 8	Concentrations of contaminants – heavy metals and other contaminates

	Descriptor 9	Contaminants in seafood - assessed data, not time series
	Descriptor 10	Marine litter
	Descriptor 11	Energy, including underwater noise data
MPA	Nationally designated areas (CDDA by EEA)	
	Natura 2000 *	
	No take zone*	
Land use/cover	CORINE data set on land cover	Urban areas**
		Industrial areas**
		Port areas**
		Agriculture**
		Forest**
		Beaches, dunes, sands**
		Airports**
	Distance to the coast **	
	Point and lineal coastal pressures **	
Oceanography	Overall ocean temperature	
	Sea surface/sea bottom temperature	
	Sea salinity	
	Mixed layer thickness	
	Currents	
	Waves	
	Depth/bathymetry	
	Wind	
Maritime activities/pressures	Aquaculture facilities	
	Maritime traffic lanes/intensity maps	
	Fishery areas/efforts	
	Fish landings	
	Harbours/ports	
	Submarine outfalls	
	Mineral extraction	
	Maritime tourism	
	Cables	
	Research area	
	Military area	
	Cruise tourism	
	Coastal tourism	
	Artificial reefs	

Deep sea mining
Blue biotech
Seaweed cultivation
Diving
Windsurfing
Wreck
Ship building
Dredging/sand extraction
Fossil fuel extraction
Dumping
Desalination
Offshore supply/bunkering

* these parameters were considered as excluded areas in the AHP analysis.

** these parameters were considered as Land Use/Cover in the AHP analysis, and not individually

Furthermore, it is important to highlight that the relevant parameters for each maritime sector are currently being re-selected by PLASMAR experts. The re-selection was necessary due to the different interpretations different partners had from the parameters and logics of analysis (parameter-sector/sector-parameter). The importance of each parameter will be classified as "low", "medium" and "high" for each parameter, as observed in Figure 4.

Figure 4: Low, medium and high classification at the experts' parameter selection.

Thus, the critical parameters for the analysis will be considered as the ones defined as "high" and "medium", jointly considered. Moreover, some parameters will be classified as "Need further research", when there is no information available to evaluate the importance of the parameter, and "Incompatible", when the parameters are incompatible

with the sector being evaluated. Consequently, both classifications will be excluded from the MCDA. The selection of PLASMAR data framework for the AHP analysis can be observed in *Figure 5*.
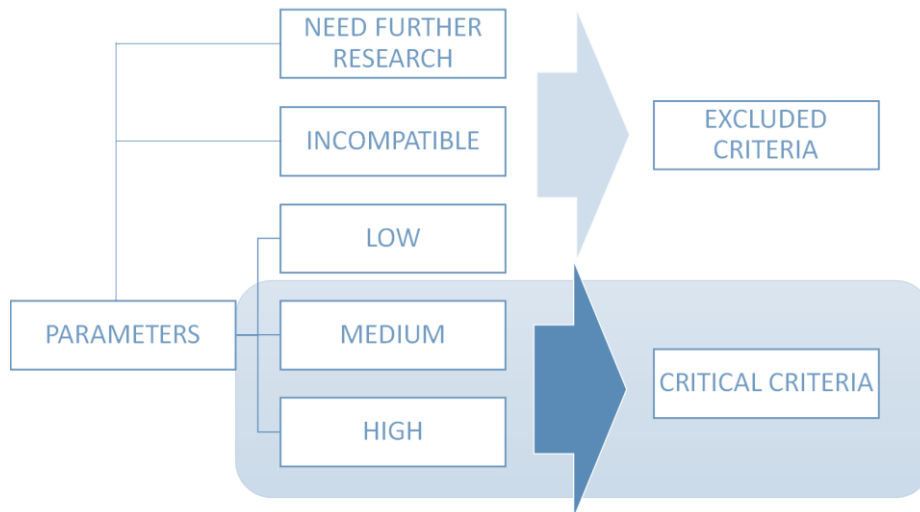

Figure 5: Parameters selection for the multicriteria analysis.

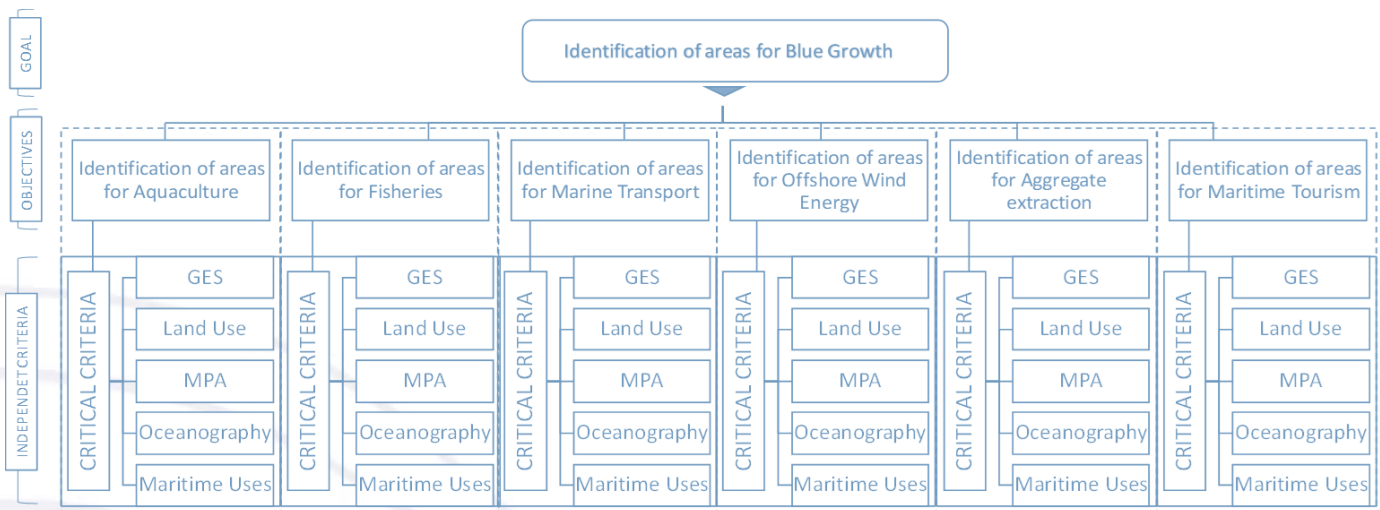The final hierarchical structure proposed for this analysis can be observed in Figure 6.

Figure 6: Final proposition of hierarchical structure for the PLASMAR analysis.

4.3 Establishing the context: Defining the stakeholders

The approach for expert's consultation will remain, initially, the same. Bearing in mind the actions developed under the PLASMAR project, the consultation will be applied on the project's partner researchers, once they are currently developing a dense research over the Macaronesia area and, as a result, they also hold the structured framework of PLASMAR project within their research. Furthermore, this consultation aims to be

complemented by experts external to PLASMAR project, at the main Universities in Macaronesia or key sectoral experts. This selection can be based on three methods:

- If available, governmental experts' database;
- Snowball sampling, through the indication of experts by the previously consulted PLASMAR experts;
- Internet surveys on scientific platforms for authors of publications related to the sector in the region.

It is important to observe that different sectors might apply different strategies for expert's identification.

Furthermore, the aggregation will be based on a *post hoc* analysis.

4.4 Specifying preferences

The steps to obtain the weight will remain the same as proposed on the previous report.

Annex 1

3rd PLASMAR face to face meeting
Funchal, 3 - 5 April 2019

Zoning workshop proposal

3rd day – 05/04/2019 Friday

Agenda proposal*
Introduction
Cluster comparison/GES/MPA
Land use
Oceanography
Maritime pressures
Presentation of weights and INDIMAR

* It is important to observe that different sectors might take different time to evaluate each group of parameters, once the parameters might vary in each sector.

Guideline

Introduction and GES/MPA exercise ~ 1 hour 40 minutes

- Explanation of the MPA's table. **20 Minutes**
- Group division per expertise (2 groups, one for energy and other for tourism).
- In each group, facilitator briefly introduce him/herself and ask each person to present themselves and talk about the experience with the respective sector.
- In each group, facilitator explain the exercise to the group.
- Each participant must fill an individual excel table and send it to deborah.c.shinoda@uac.pt at the end of the exercise. 4 worksheets should be filled in this exercise, 2 for the cluster comparison (Impact and Contribution) and 2 others for the GES comparison (Impact and Contribution). **~30 minutes**
- Facilitator ask the group to reach a consensus grade for all the 4 worksheets, starting with the cluster comparison. In case no consensus is reached, majority defines the grade. Facilitator should notice the consistency correction. **~40 minutes**

Land use exercise ~ 1 hour

- Explanation of the Land Use's table. **20 Minutes**

- In each group, facilitator re-explain the exercise to the group.
- Each participant must fill an individual excel table and send it to deborah.c.shinoda@uac.pt at the end of the exercise. 2 worksheets should be filled in this exercise, one for Impacts and other for Contributions for the land use & cover parameters. **~10 to 15 minutes**
- Facilitator ask the group to reach a consensus grade for all the 2 worksheets, starting with the cluster comparison. In case no consensus is reached, majority defines the grade. Facilitator should notice the consistency correction. **~25 minutes**

Oceanography ~ 1 hour

- Explanation of the Oceanography's table. **20 Minutes**
- In each group, facilitator re-explain the exercise to the group.
- Each participant must fill an individual excel table and send it to deborah.c.shinoda@uac.pt at the end of the exercise. 2 worksheets should be filled in this exercise, one for Impacts and other for Contributions for the oceanographic parameters. **~10 to 15 minutes**
- Facilitator ask the group to reach a consensus grade for all the 2 worksheets, starting with the cluster comparison. In case no consensus is reached, majority defines the grade. Facilitator should notice the consistency correction. **~25 minutes**

Maritime pressures ~ 1 hour

- Explanation of the Land Use's table. **20 Minutes**
- In each group, facilitator re-explain the exercise to the group.
- Each participant must fill an individual excel table and send it to deborah.c.shinoda@uac.pt at the end of the exercise. 2 worksheets should be filled in this exercise, one for Impacts and other for Contributions for the maritime pressures' parameters. **~15 to 20 minutes**
- Facilitator ask the group to reach a consensus grade for all the 4 worksheets, starting with the cluster comparison. In case no consensus is reached, majority defines the grade. Facilitator should notice the consistency correction. **~25 minutes**

Logistic needs: 2 facilitators and excel sheets for calculations.