Monitoring and Evaluation of Spatially Managed Areas

Deliverable 3.5

Comparison paper: Paper on the comparison of case studies, building on the overlap of human pressures and/or priority habitats.

Due date of deliverable D3.5: month 40
Actual submission date: month 41

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Grant Agreement number:	226661
Project acronym:	MESMA
Project title:	Monitoring and Evaluation of Spatially Managed Areas
Funding Scheme:	Collaborative project
Project coordination:	IMARES, IJmuiden, the Netherlands
Project website:	www.mesma.org

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Contents

Preface

This deliverable presents a first comparison of the overlap between human pressures and priority areas in the different MESMA Case Studies (CS). The annexes to D 3.6 (Zoning Plan – Evaluation of spatial management options for the case studies), based on the application of the generic MESMA Framework provide a case per case list of the different uses of the sea, and a selection of possible conflicts with other uses.
(https://teamsites.wur.nl/sites/mesma/MESMA%20output%20incl%20deliverables/Forms/AllItems.aspx?RootFolder=%2Fsites%2Fmesma%2FMESMA%20output%20incl%20deliverables%2FMESMA%20Deliverables%2FD3%2E6)

Given the very high heterogeneity of the CS, and the resulting heterogeneity in framework results, a comparison of these uses and conflicts was anticipated by the MESMA community to be extremely complicated, with a high risk in (again) reflecting the CS heterogeneity. As such, a discussion during the MESMA General Assembly in Athens (October 2011) concluded that a meaningful way forward was to analyse possibly conflicting uses, that occur in the majority of the CS, or are expected to occur in the near future as a conqequence of developing European legislations.

Such an example is to be found in the possible conflict between nature conservation (designation of MPAs), and the growing demand for the installation of offshore renewable energy installations. While both uses aim to the increase the sustainable use of the Earth's resource, they do compete for space in the already well-exploited marine areas. In addition, this competition is a generally occurig phenomenon, as witnessed by the fact that the majority of the CS were involved in this comparison.

The text below reflects the results of the comparison of the position of nature conservation and offshore renewable energy developers, based on the input of 11 (sub) Case Studies. This input was analysed using game theory. This allows for developing a model reflecting the ideal situation that is compared with the actual situation. Based on this, the underlying reasons for the divergence from an ideal situation can be deduced, and recommendations for futher implementation of both uses in the marine area can be formulated.

The analysis was based on input delivered from 11 (sub)CS, that was analysed by Zacharoula Kyriazi, Frank Maes, Steven Degraer, Jan Vanaverbeke and Magda Vincx. The data needed for this analysis are based on the work performed for MESMA WP2 and WP6. Hence, the data needed to underpin a correct scientific analysis were only available recently. The text below reflects the results of the analysis, and will be the basis for a manuscript that will be submitted to the peer-reviewed literature. Given the procedures of the peer-review process, the accepted paper will be slightly different from the text for this deliverable. As such, the final (published) text will be made available publicly, and uploaded to the MESMA sharepoint as well, and should then be considered as the final result of this analysis.

Offshore renewable energy and nature conservation at sea. Coexistence or exclusivity?

1. Introduction

Marine spatial planning (MSP) should provide an optimal space allocation of the economic and social potential of activities at sea, within the ecological carrying capacity of the marine ecosystem. In terrestrial planning, Forman [1] hypothesised that for any landscape, or major portion of the landscape, there is an optimal spatial combination of ecological values and land uses to maximise ecological integrity. Similarly, marine space being occupied by various users, offer benefits to the society and hence faces problems of overuse that can be managed as a common pool resource [2]. In the already overexploited sea, new needs create new uses, resulting in more pressures to natural systems. These marine uses interact between each other in a socioeconomic system. In turn the processes and systems that represent the natural system react to human interventions, or in other words interact with the aforementioned socioeconomic system. This phenomenon, subject to various lags, produces policy responses and finally a co-evolutionary process characterized by continuous feedback effects [3]. This process results in the creation of complex marine socioecological systems [4][5][2][6]. According to Berkes & Folke [7] the term socioecological system emphasises the idea that humans form part of nature and that the delineation between social and ecological systems is artificial. Hence the existence of these systems and their underlying interactions enhances the need to understand and manage them in an efficient way. Marine spatial planning is so far the most appropriate tool proposed for satisfying this need.

There are two interlinked types of interactions influencing the evolution of marine socio ecological systems. Above all are the interactions at policy level that influence interactions at the ecosystem level. Finally both types of these interactions affect continuously the organizational context of the marine environment in space and time. A recent, though well-known example of these interactions are those between the growing demand for offshore renewable energy (ORE) and the well-established duty to protect the marine environment, by inter alia nature conservation (NC).

ORE (and its related institutions) is a relatively new 'player' appealing for the allocation of space. Directive 2009/28/EC on the promotion of renewable energy from renewable sources aims to achieve the EU target of 20% renewable energy in energy consumption by 2020 [8]. The renewable energy target is distributed among Member States (MS) based on GDP, investment in renewable energy prior to 2005 and standard increase in renewable energy (e.g. target for Belgium is 13%; for Sweden 49%). MS develop National Renewable Energy Action Plans (NREAPs). Today, the North Sea has the highest installed offshore wind energy capacity in the world, in particular in the southern part. It is expected that Belgian, Danish, British, German, Dutch and UK offshore wind farms will produce around 32 GW in 2020, mainly in the North Sea. Denmark and UK expect a production of respectively 4, 6 GW and 33 GW in 2025, and Germany 25 GW in 2030, depending on economic and financial conditions. The WINDSPEED project concludes that a capacity of 135 GW of OWE in the central and southern North Sea is feasible by 2030, assuming that the NREAP projections of around 32 GW for the six North Sea countries involved are achieved in 2020 [9].

The Convention on Biological Diversity (1992) [10] and regional sea conventions (Barcelona Convention on the Protection of the Mediterranean Sea (1976) as amended [11]; Helsinki Convention of the Protection of the Baltic Sea (1992) [12]: Convention on the Protection of the North East Atlantic (OSPAR, 1992) [13] do not contain explicit provisions or restrictive elements for ORE installations regarding NC. The EU Habitats and Birds Directives do not necessary prohibit ORE; hence a system of assessment needs to apply. When a planned project, either individually or in combination with other plans, is likely to have a significant effect on Special Areas of Conservation (SAC) under the Habitats Directive (92/43/EEC) [14] or Special Protection Areas (SPA) under the Birds Directive (79/409/EEC) [15] an appropriate assessment of its implications is necessary in the light of the site's conservation objectives [16].

Both ORE and NC promote the achievement of environmental objectives, although from a different perspective. ORE contributes to the reduction of green house gases and is a mitigation measure under climate change, while NC contributes to halting the loss of biodiversity. However, it is not obvious that these two sectors are spatially compatible, although they may present a high compatibility in relation to other sectors. In making decisions about compatibility and exclusivity, it is critical to quantify trade-offs. Importantly, the economic concept of "resource rent," representing the value of marine space as a scarce resource, should be utilised in analysing such trade-offs [17]. This is not always feasible for a number of reasons. Firstly, the calculation of costs and benefits of allocating areas for specific uses or for specific combinations of uses is complicated. ORE supports a profitable industry with monetary gains and losses, while NC is not explicitly an economic activity although it also produces gains and opportunity costs [18] [19]. Additionally, when a renewable energy facility is sited in an MPA, there is uncertainty about the non-market values of potential effects of that activity to the main objectives of the MPA. The lack of property rights for alternative uses of marine space as a public resource adds to the complexity. Furthermore, ORE can benefit by expanding spatially in MPAs, but not from NC per se. On the contrary NC can lose assets in the short term by coexisting with ORE, but it can benefit in the long term since there are possibilities that more NC values will result both in ORE restricted access areas and in areas around them [20][21][22][23]. In other words the interdependence between ORE and NC is not equally divided and is difficult to calculate.

2. Research strategy

A variety of policy options and tools exist regarding the management of spatial overlaps between ORE and NC, along with their relevant interactions and interdependences. The latter can be summarised in three options or tools that are mostly combined, although they can be used independently:

- ORE constructions can be based on the location selection under MSP[24][25][26][27][2][28][29][30][31] [16].
- Conducting Strategic Environmental Assessments (SEAs, Environmental Impact Assessments (EIAs) and Appropriate Assessments, for the ORE construction and license approval. [32][33][34][2]
- Coexistence of ORE and NC and parallel monitoring of NC features [34][35][36][37]

Departing from the above policy options and tools, our analysis is focused on: a) the theoretic ideal ORE-NC interactions; b) the trends for managing coexistence between ORE and NC at European level; c) balancing both ORE and NC interests to contribute to sustainability; d) a mechanism supporting the optimal use of marine space, when NC interests are involved. The study departs from game theoretic modelling to predict the ideal combination of policy options for the optimal use of a certain area where ORE and NC, as two players, are involved. Starting from a theoretical perspective, the model is tested in case studies reflecting current practice regarding ORE and NC. Practice is described through empirical analysis of 11 locations identified in the FP7 European project MESMA. Details regarding each location can be found in the project's official website www.mesma.org under WP3 "Case studies description". The empirical analysis is taking into account: a) the options chosen by each case study to deal with interactions between ORE and NC; b) the factors that influence the strategies for each player per location; and consequently c) how the game changes in practice. Section 3 describes the tools and methods used, followed by section 4 where theoretical and empirical results are presented. Section 5 discusses the implications of the modelling exercise for the design of a mechanism for an optimal management of ORE and NC in case of interactions. Finally, in section 6 conclusions are drawn.

3. Game theoretic modelling: tools and methods

3.1 Model development

3.1.1 Game theory contribution to marine spatial planning

When more than one entity or agent (here ORE and NC) claims part of the marine space as a resource, game theory offers an appropriate method to analyze such type of management problems. Interdependency among the agents leads to collective action in which the contributions or efforts of one agent influence the actions of other agent, thus implying a strategic interaction. Game theory can contribute to an improved understanding of the decision making process in case of strategic interdependences, allowing policy makers to formulate better policy. The game-theoretic conceptualization of strategic interactions has a very high degree of prima facie plausibility for the study of policy interactions. At the same time, these interactive conditions are most likely to be ignored by disciplines such as welfare economics or systems analysis that are primarily involved in substantive policy research. They tend to ascribe policy choices to a unitary "policymaker" or "legislator" rather than to strategic interactions among independent agents [38]. It is therefore important to assess social acceptability of alternative sets of management actions or strategies against a range of criteria such as environmental effectiveness, economic efficiency and fairness across different stakeholder interests [2]. We depart from the assumption that game theory can be a more appropriate approach for evaluating above types of spatial decision making, instead of a monetary oriented analysis ((i.e; cost benefit analysis). Game theory is a tool for analyzing strategic interactions between a finite number of agents. Many models have been developed, particularly in the field of resource sharing. Reference papers on the management of Common Pool Resources (CPR) are based on a game theoretical approach [39][40][41][42]. Others deal with the optimal sharing of fisheries [43] [44], the optimal allocation of water resources [45] and cooperative or competitive behavior between NC organizations [46] [47]. The fundamentals of game theory thinking can be summarized in two concepts: strategic interaction and equilibrium outcomes. The first implies that agents are aware of their interdependence. Hence, in arriving at their own choices each agent will try to anticipate the choices of the others, knowing that the other will act the same. Equilibrium outcomes e.g. Nash Equillibrium are those in which no player can improve his or her own payoff by unilaterally changing to another strategy [48].

3.1.2 Conceptual model

The assumption is that the area at stake has a high ecological value and is claimed for an economic activity such as ORE. Essentially the ORE developer is the one who would start the game for a number of reasons, either a) he does not own the area; or b) would claim the area only if ORE has no alternative areas to choose from. Another assumption is that there is uncertainty whether ORE will harm the environment of the area or not. In a search to the most appropriate spatial decision that ensures sustainability, there are two main options: either coexistence (cooperation) of ORE and NC or the exclusive use of a certain marine zone by one of them (competition). The spatial allocation of ORE facilities and NC measures does not always require an exclusive use of their relevant marine space. On the contrary, coexistence might be not only feasible but also- under some conditions- desirable. The fact that there is strategic interaction between the two agents creates the basis for a non-cooperative, or a cooperative game and hence considerations of cooperative management are largely the point. What is important here is that players will be willing to cooperate if, and only if, by doing so they can achieve an outcome at least as good as by acting alone - a condition referred to as collective rationality [49].

3.1.3 Game theoretical modelling

The game is a two person static game where decisions or moves of each player are taken once and simultaneously, while each player has full knowledge about possible strategies of the other (complete information). After the players simultaneously choose strategies, they receive payoffs that depend on the combination of the chosen strategies. Here the payoffs of the strategies are presented in a matrix (strategic form or normal form) and represented in ordinal numbers. Although it is stated that the players choose their strategies simultaneously in a normal-form game, it does not imply that they necessarily act simultaneously: it suffices that each choose his or her strategy without knowledge of the others' choices [48]. Moreover the game is a non-zero sum game. In non-zero sum games, aggregate payoffs are different from zero. Furthermore, non-zero sum games are not strictly competitive games. The solution of the game should be a Nash equilibrium. A Nash equilibrium means “no one has incentives to deviate from it”. In a two-player game, the solution is found as follows: for each player, and for each feasible strategy for that player, the other player's best response to that strategy and vice versa is determined.

3.2 Model comparison

The model is tested in case studies reflecting current practice regarding ORE and NC. Practice is described through empirical analysis of 11 locations identified in the FP7 European project MESMA. Details regarding each location can be found in the project's official website www.mesma.org under WP3 "Case studies description".

4. Results

4.1 The ORE-NC game

NC and ORE claim the same space at sea. ORE is represented by the developer who applies for an ORE project in an MPA. NC is represented by the relevant authority, responsible for the conservation and management of this MPA. Each player aspires to realize its own objectives: a) maximization of the used space; b) minimization of costs.

The sets of strategies for each player are as follows:

NC authority has two strategies.

- NC1 (NC-allow): the authority has the intention to allow for ORE developments in designated MPAs.
- NC2 (NC-not allow): the authority does not have the intention to allow for ORE developments in designated MPAs.

ORE developer has two strategies

- ORE1 (ORE-apply): ORE developer chooses to apply for ORE developments inside designated MPAs.
- ORE2 (ORE not-apply): ORE developer chooses not to apply for ORE developments inside designated MPAs.

Ordinal numbers for payoffs are set as follows: 2=gain without compromise, 1=gain with compromise, 0=indifference, -1=cost balanced with some gain, -2=absolute cost.

In this game it is not sure whether ORE will harm the environment or not. Even if studies (through EIAs) prove that ORE will not harm the environment, this is not absolutely sure (uncertainty). Hence, it is assumed that there is a possibility that ORE may harm the environment in this game, although the precise qualification of harm is not incorporated in the present analysis.

Table 1.The theorethical outcome of the ORE-NC game

Uncertainty of harming	NC1	NC2
ORE1	2,-2	1,2
ORE2	-2,-1	-1,1

The following combinations of strategies shown in table 1 are analysed:

ORE1, NC1= (2,-2): The developer is allowed to build ORE in the MPA so ORE1 gets the highest payoff i.e. 2. However the authority is uncertain whether ORE will harm or not, so engaging NC1 is the worst strategy as response to ORE1 and it gets -2

ORE1, NC2= (1,2): ORE1 remains the best strategy for the developer, but since the authority does not allow ORE in the area the payoff of ORE1 is reduced to 1. On the other hand NC2 is the best strategy which is an application of the precautionary principle when the developer applies to build ORE in the certain area. So NC2 gets 2.

ORE2, NC1= (-2,-1): ORE2 is the worst strategy for the developer to choose when ORE is allowed in the area so it gets -2. On the other hand NC1 is still the worst for the authority but now the developer does not apply for a project. So NC1 gets a lighter negative payoff i.e. -1

ORE2, NC2=(-1,1): The payoff of ORE2 becomes better than before since now the authority does not allow for projects in the area. The payoff of NC2 becomes less than before since the developer is not interested to apply.

The equilibrium of this game is (ORE1, NC2) that means that the ORE developer chooses to apply for a project in the MPA but the NC authority doesn't allow. This combination of strategies supports exclusivity among uses i.e. the zone is used only for NC purposes. However according to the rest of the analysis this is in contrast to the optimal use of marine space which supports coexistence whenever possible.

4.2 The empirical analysis

The above theoretical model provides a representation of the reality if decisions were taken under rational behaviour of the ORE developer and the NC authority, both having only above mentioned moves available. In this section a comparison between the theoretical model and the real world is made using 11 locations of the MESMA project. Table 2 includes a brief description of each location's NC considerations such as environmental prerequisites for licensing, whether coexistence between ORE and NC is followed as a practice and some numbers justifying the latter.

Except for the Barents Sea, environmental impact assessment is a prerequisite in all the locations for granting permission to ORE developers. In the Baltic Sea (Sweden and Poland) and the Celtic Sea a separate permit is required for Natura 2000 sites. For the BPNS, the Celtic Sea and the PFOW, the existence of spatial plans works as a guide to which areas should be avoided from the beginning for permit applications.

In five out of eleven locations, ORE is not prohibited in MPAs but until now MPAs have been avoided by ORE. In four locations ORE is allowed and actually built (or planned to be built) in MPAs. In one location ORE is not prohibited in MPAs, but there are no (plans to construct) ORE installations anywhere yet. In one case (the BPNS) ORE is not allowed to be built in MPAs.

In the game above, the equilibrium is when the ORE developer applies for a project in an MPA, while this is not allowed by the NC authority. According to the data in table 2, ORE is not prohibited in MPAs for all cases except for the BPNS. This is happening for the BPNS because civil engineering in NC areas is prohibited by the legislation on MPAs [50]. Furthermore the granting of concessions for renewable energy are restricted to special ORE zones in the "Master plan" [51]. So according to the game above, in the BPNS the equilibrium ORE2, NC2 i.e. neither the developer nor the NC authority is interested to coexist.

Table 2NC implications in ORE licensing in European areas

Location	NC considerations of ORE projects	ORE projects applications	ORE projects licensed	ORE projects rejected in MPAs	ORE projects approved in MPAs
Sweden	SEA, EIA, Special permit for Natura 2000 sites, Coexistence applied	15	4	1	1 (NC designation after ORE approval)
Poland	SEA, EIA, Special permit for Natura 2000 sites, Coexistence avoided	14 areas proposed (no aprovals yet)	0	0	0
Barents Sea	SEA, Coexistence but no plans	15 areas proposed (no applications yet)	0	0	0
Basque Country	SEA, EIA, Coexistence avoided	1	1	0	0
Belgian part of the north sea (BPNS)	SEA, EIA, Special permit for Natura 2000 sites, MSP guidance, Coexistence prohibited	25	4	1	0
Greece	SEA, EIA, Coexistence avoided	35	2	0	0
Pentland Firth and Orkney Waters (PFOW)	SEA, EIA, MSP guidance, coexistence applied	6 wave and 5 tidal energy sites (2 coincide with MPAs)	0	0	0
Southern North Sea (SNS)-Doggerbank	SEA, EIA, Coexistence applied	182	31	0	1 (NC designation after ORE approval in Doggerbank)
Strait of Sicily (SoS)	SEA, EIA, Coexistence avoided	2 (no aprovals yet)	0	0	0
Celtic Sea	SEA, EIA, Special permit for Natura 2000, MSP guidance, Coexistence avoided	Data yet to be given	1 local/ 2 national	Data yet to be given	Data yet to be given
Malta	SEA, EIA, Coexistence applied	3 (1 coincides with MPA, designation of MPA came later)	0	0	0

For the rest of the cases, although coxistence is allowed, only in the PFOW, Sweden, Malta and Doggerbank it is applied. Hence for these four cases the equilibrium is ORE1, NC1.

What is happening with the rest of the cases where coexistence is allowed but not applied? In the previous section the simplified game was described without considering parameters that in reality affect ORE and NC policy making and implementation, and may influence the equilibrium of the game. In each location, the solution depends not only on the strategies chosen from each player and their relative payoffs, but also on the players' power.

Since NC1 seems to be a strategy at least as good as NC2 for the NC authorities in all cases, the focus should be given to the strategies chosen from the ORE developer. Therefore, factors that may affect whether the developer will choose ORE1 or ORE2, common to all locations, must be considered, These factors are (1) conservation targets achievement; (2) application of the precautionary principle; (3) application of the polluter pays principle; (4) energy targets achievement (from renewables in general); (5) energy independence achievement; (6) new ORE technologies testing; (7) investments in fossil fuels extraction enhancement; (8) fisheries sector promotion. The first three factors influence ORE1 negatively and the rest five factors influence ORE1 positively (and vice versa for ORE2). Other factors that could affect renewable energy development, independently of its interaction to NC, are: price distortions, failure of the market to value the public benefits of renewables, and the social cost of fossil fuel technologies, inadequate information, institutional barriers to grid interconnection, high transaction costs due to small project size, high financing costs because of lender unfamiliarity, and perceived risk [52]. But here the focus is given to those that influence the coexistence of ORE and NC.

For comparison purposes among locations, an assessment matrix (Table 3) is used. Each factor gets a score in terms of its priority for spatial decision making. The ranking scale is: 2=high priority, 1=medium priority, 0=no priority. The scores of the factors were given by experts i.e. researchers conducting case study research in MESMA. In order to calculate how either ORE1 or ORE2 is influenced for each location, the sign of the scores of either the first three or the last five factors should be changed respectively. The analysis from now is focused on ORE1, so factors 1, 2 and 3 will get a minus (-) which indicates the negative effect of these factors to ORE1.

Table 3 Average aggregated score of factors that affect strategy ORE1/ location

Location	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Average score
Sweden	-2	-2	-2	1	0	0	0	1	-0,5
Poland	-2	-2	-2	1	1	0	0	1	-0,375
Barents Sea	-2	-2	-2	1	0	2	2	1	0
Basque country	-2	-1	0	2	2	2	0	2	0,625
BPNS	-2	-2	-1	2	0	2	0	1	0
Greece	-1	-1	-1	1	1	0	1	0	-0,25
PFOW	-1	-1	-2	2	2	2	0	1	0,6
SNS (Dogger bank)	-1	-1	-1	2	0	0	0	0	-0,125
SoS	-2	-2	0	0	0	0	1	1	-0,3
Celtic Sea	Data to be delivered								
Malta	Data to be delivered								

Then, the scores of all factors per location are averaged (shown in the last right column of table 3). The average score is an indicator of whether ORE should choose ORE1 or ORE2. The highest average score would be 1,25 and the lowest would be -0,75. The highest score for ORE1 is calculated if the first three factors get 0 and the last five factors get 2. The opposite is followed in order to calculate the lowest average score. The closer to 1,25 the more preferable ORE1 is. The closer to -0,75 the more preferable ORE2 should be. The average scores for ORE1 per location are visualized in the form of a spider graph which compares the scores of ORE1 among locations.

The spider graph in Figure 1 clearly shows to which extent ORE1 is preferable for each location. With 0,6 for PFOW and 0.625 for the Basque country (case study) ORE1 seems more possible than ORE2. However, the ORE developer actually follows this strategy only in the PFOW. For the Basque country the choice of ORE1 cannot be reflected in practice as only one ORE project exists for the moment. This project does not overlap with NC.

It is remarkable that in Sweden and Dogger bank) there is already one approved ORE project in a MPA while according to the graph Swedish and Dogger Bank ORE developers would not chose ORE1. This can be explained due to the reason that the areas where ORE and NC coexist were declared as MPAs after the relevant ORE projects were licensed.

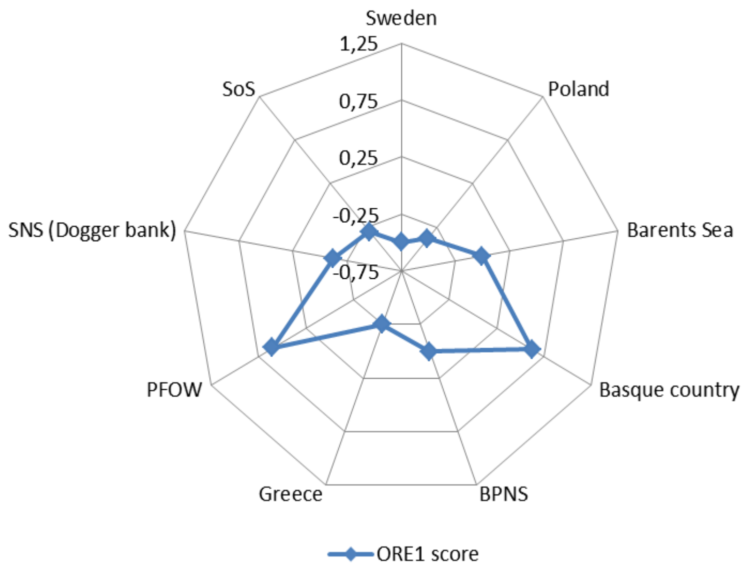

Figure 1 ORE1 score for each location

This phenomenon gives the impression that an approach of "first comes first served" engaged from a government could fundamentally affect the designation of ORE and MPAs. Therefore, it becomes obvious that above factors are not enough to reflect in detail the reason why coexistence is not actually followed in some cases. Hence, in order to facilitate the interpretation of above results, a number of additional, national factors or causes (provided by MESMA researchers) are examined. Of these causes, again, some influence ORE1 positively and some others negatively. In Table 4 the existence of these additional factors in each location is given with X. From this table BPNS is excluded (coexistence is prohibited by law). The analysis refers only to the national level. In the results presented in table 4, the major cause preventing coexistence in practice is the uncertainty on the actual NC value of the area. If the total NC value of an area could be calculated then the actual losses from coexistence could be assessed as well. On the other hand, if the possible harm of ORE could be absolutely assessed then actual pros and cons of coexisentenc could be calculated. To date, the lack of optimal space for ORE seems to be important only for one case (PFOW – Scotland). However, this can become important in the future for other countries as well, as the exploitation of marine space is not a static situation.

Two other factors emerging at all locations, but without explicitnegative or positive influence on coexistence are: a) the fact that not all MPAs are officially designated yet, and b) the free interpretation of the term "national priority" when characterising national objectives. These two issues can be used either in favour or against coexistence. Some countries may take advantage of the fact that a candidate MPA is not officially designated and prevent ORE in this area, while some others may use this excuse to allow ORE development in a candidate MPA because there is no legal protection going on there. The same applies for the later issue. For some countries national priority might be ORE and thus this would be allowed anywhere and for some others national priority might be the protection of NC values for the common good and use the need for NC whenever possible.

Table 4 Existing causes that prevent coexistence of ORE and NC in the national level for each case

Negative causes	Basque Country	Sweden	Poland	Barents Sea	Celtic Sea	SNS Dogger bank	SoS	Malta	Greece	PFOW	Yes	No
Uncertainty of the actual NC value of the areas	X	X	X	X	X	X	X	X	X		9	1
Uncertainty of the actual harm of ORE to NC	X	X	X	X	X	X	X	X	X		9	1
Conflict between national and local priorities and power	X						X		X		3	7
Public opposition/ lobbying of coastal municipalities	X		X				X		X		4	6
Higher cost for developers (compensation measures in case of damage)		X	X		X	X			X		5	5
Long administrative procedures	X						X	X	X		4	6
Scale differences				X	X	X					3	7
Positive causes												
Need for optimised use	X				X		X	X		X	5	5
MPAs designation came after ORE licensing		X					X	X		X	4	6
Lack of available space for ORE										X	1	9

5. Discussion: A mechanism to facilitate coexistence

The uncertainty regarding the risk of damage and the real NC value of an area seem to be the most important reasons for avoiding coexistence of ORE and NC. In the case where ORE installations in alternative sites are able to support the fulfilment of renewable energy objectives, coexistence is not an issue. But what is happening where there is still a long way to go for renewable energy objectives and the space is limited? In the latter case, where there is a risk of damage to a designated MPA, planning authorities should consider the use of conditions or planning obligations in the interest of NC. If MPAs have already been defined through MSP, then negotiations for coexistence between the NC authorities and ORE developers should take place. Here NC authorities can set some rules for the game and influence the final solution and lead the result. Game theory helps policy makers to focus on incentives faced by individuals who make a decision and those faced by others who react to the initial decision. These incentives are explored in the present section as a mechanism to facilitate coexistence. The goal is to design rules of the game in such a way that a desired set of outcomes is an equilibrium of the game [53]. The equilibrium is the optimisation of the use of marine space through coexistence. A benefit should be set for both ORE developers and NC authorities that they would lose in case they do not play the game. Following types of gains for NC are considered:

ORE facilities can provide effective protection for surrounding areas of seabed which require a high level of protection for conservation (including fisheries) purposes along with potential creation of Reef effects and No-take zones [20][25]. Here ORE as an economic activity yields habitat protection as a byproduct. It is not conservation per se that delivers the benefit, but conservation may indirectly result from the pursuit of the benefit. However this type of benefit is only ensured after installations have taken place at the area.

Donations or actions made by ORE for NC, even though the ORE activity has no direct negative impact on nature. This approach is well suited to the assumption that is presented in [18] that more investments should be engaged from the economic domain in order to favor NC [20][25].

Biodiversity offsetting and developer contributions [54] in order to achieve benefits for nature conservation over and above those required for mitigation (S106 agreements, PGS) [55][56][57]. Biodiversity offsets are conservation activities, funded typically by project developers, that are designed to compensate for the residual adverse biodiversity impacts arising from project development and persisting after appropriate prevention and mitigation measures have been implemented. The goal of biodiversity offsets is to achieve no net loss, or preferably a net gain, of biodiversity on the ground with respect to species composition, habitat structure and ecosystem services, including livelihood aspects. Offsets should only be considered at the end of the mitigation hierarchy where unavoidable residual impacts remain [58]. For more information on how developers can contribute to the enhancement of marine nature conservation the reader can refer to [59][60][61].

Integration of the cost for environmental damage in ORE insurance cost that covers the full net present value of the ecosystem in case of loss.

The renting (leasing) cost of an area should increase proportionally to that areas NC value.

For ORE developers the incentives could be:

Breaks on governmental levies such as taxes, fees or tariffs that grant advantages or exemptions for activities that are beneficial for conservation and/or sustainable use.

Subsidies should be provided to activities considered conducive to conservation. This is a way of rewarding ORE for benefiting NC.

However the developers can only make use of these incentives after they have proved that ORE is beneficial for NC or at least it does not harm the environment.

Provided above incentives, the game changes as in table 5. Three scenarios are possible, according to the following analysis.

Table 5 Modified ORE-NC game

Harm	NC1	NC2
ORE1	1,1	0,0
ORE2	-1,0	0,1
Not harm	NC1	NC2
ORE1	2,0	1,0
ORE2	-2,0	-1,0
NC enhancement	NC1	NC2
ORE1	2,2	1,-2
ORE2	-2,1	-1,-1

In the first scenario i.e. ORE harms the ecosystem. In this case both the developer and the NC authority need to be given incentives as above in order to participate in the game. The equilibrium is ORE1, NC1 (1,1). Although the developer is allowed access in the MPA he does not get the highest payoff (i.e. 2) because he bares the cost of providing promised benefits for NC. So ORE1 gets 1. NC1 could get 2 since the authority has an extra gain from the benefits provided by the developer, but only gets 1 because the gain is reduced by the harm caused by ORE. In the second scenario i.e. ORE does not harm the ecosystem. The equilibrium is again ORE1, NC1 (2, 0). Here the developer is allowed to use the area and he gets the highest payoff (i.e. 2). NC1 gets 0 since there is nothing for the authority to gain or lose when the developer cause no harm. Finally, in the third scenario when ORE enhances NC, the equilibrium is once again the ORE1, NC1 (2,2). Here both the developer and the authority have only benefits by following these strategies. The developer proves that he does not harm and even enhance NC and the authority gains in terms of conservation value.

As the above theoretical models show, in all scenarios ORE1, NC1 is the equilibrium (best combination of payoffs). This combination of payoffs means coexistence. The equilibrium solution is ensured when the site owner's (NC) willingness-to-accept a given payment level and the developer's (ORE) willingness-to-pay is equal. In the present study the NC authority is perceived as the supplier of the site and the ORE developer is the one who demands the area. The goal is to have market transactions either reflecting the value of biodiversity benefits, or the cost of biodiversity loss. Hence, a first step would be to create the underlying institutional framework that enables a well-managed exchange between those who supply and those who demand the area at stake. Where there are multiple users with unrestricted access to a marine area as a resource, they will compete away the value of the resource and overexploit it in the process. Government policies that aim to use markets must restrict access via either property rights mechanisms or other restrictions on use. These restrictions serve the same purpose as well-defined property rights: they generate incentives to invest in the resource [62]. An ideal solution would be property rights for NC in the area and resources ensured for conservation, which are in essence held in common (so-called "common pool" or "open-access" resources), and the concomitant leasing of marine resources (submerged land, the water column, and the airspace above) to prospective developers [63]. The restricted access in MPAs reflects the idea of a restricted property. For the allocation of limited resources or goods, especially of public goods, various choice mechanisms can be selected by the relevant authority e.g the public authority may select some specific auction mechanism. Different types of auctions are then compared along several criteria: high reservation value for the buyer, high profit for the seller, low possibility of manipulation [64].

6. Conclusions

The findings of this study are the following:

- In 10 out of 11 European marine areas NC authorities don't prohibit ORE in MPAs, although theoretically the "right" strategy to choose would be to prohibit ORE in MPAs
- However in practice coexistence doesn't occur so often
- Apparently, the strategy that the ORE developer will choose, is the one that affects coexistence
- The choice of the developer's strategy is explicitly or implicitly affected from a number of factors as presented previously

Therefore, according to the equilibrium solution presented in section 5 that supports coexistence of ORE and NC, a government could introduce measures to force the multiple use of space and only grant a permit if co-use is possible. This could encourage the co-use by having parties with an interest to negotiate the terms e.g. ORE developers and other users of the marine space. Therefore, at a strategic level there would be a preference in both planning and permitting towards multiple uses as opposed to single use. This would encourage innovation and the use of modern technique(s). In an investment level a new use should be willing to invest in technologies to be compatible with other uses. This would minimize exclusion zones and promote the co-use of marine space. In general, innovation is the key to promoting multiple use of marine space in MSP processes [65]. Recognizing that sea space is finite, MSP should guarantee a sparingly use of space and actively encourage co-use. Rather than breaking fresh ground, planners do their best to promote the use of "used" sea space. This means making good use of synergies and considering options for multiple uses of sea space wherever this is possible [66]. Maximizing spatial efficiency and minimizing conflicts of use is not a one-off, but a dynamic process that needs to respond to actual developments in sea use. As stated above, patterns of use can shift as a result of changing dynamics within individual sectors and in response to external forces; this can alter the balance of uses and the relative significance of certain uses over others. It follows that monitoring of external driving forces is particularly important in the marine context [67]. As a planning system, MSP should contribute to minimization of the impacts that developments have on the marine environment through the avoidance, reduction or compensation of cumulative effects; and to the delivery of wider nature conservation gains [18]. Although much uncertainty remains on environmental effects of ORE, this is not a reason in itself to block ORE. Many of the questions will only be answered once ORE installations are in place. The best way to address uncertainty is to use an adaptive environmental management (or a step- by step learning) approach.

References

[1] Forman RTT. 1995. Land Mosaics: The Ecology of Landscapes, and Regions. University Press, Cambridge

[2] Harte, Michael, J., Campbell, Holly V., Webster, Janet. 2010. Looking for Safe Harbor in a Crowded Sea: Coastal Space Use Conflict and Marine Renewable Energy Development. The Coastal Society's 22nd International Conference titled "Shifting Shorelines: Adapting to the Future". June 13-16 2010. Wilmington. North Carolina. http://hdl.handle.net/1957/17332

[3] Andrews, J., Beaumont, N., Brouwer, R., Cave, R., Jickells, T. 2005. Integrated assessment for catchment and coastal zone management. In: Vermaat, J.E.; Bouwer, L.; Turner, K. & Salomons, W. (Eds.), Managing European Coasts. Springer, 322-350.

[4] Rice, J. (ed). 2010. Science dimensions of an Ecosystem Approach to Management of Biotic Ocean Resources (SEAMBOR). Marine Board-ESF Position Paper 14

[5] R. Ian Perry, Manuel Barange, Rosemary E. Ommer. Global changes in marine systems: A social-ecological approach. Progress In Oceanography, Vol. 87, No. 1-4. (2010), pp. 331-337

[6] Levin, S. A., and J. Lubchenco. 2008. Resilience, robustness, and marine ecosystem-based management. BioScience 58(1):27-32.

[7] Berkes, F., Folke, C. (Eds.), 1998. Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience. Cambridge University Press, Cambridge, UK.

[8] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources, OJ L 140, 05.06.2009, 16.

[9] Veum, K., Cameron, L., Huertas Hernando, D. and Korpäs, M., Roadmap to the deployment of offshore wind energy in the Central and Southern Part of the North Sea, 08.08.2011, at http://www.windspeed.eu/media/publications/WINDSPEED_Roadmap_110719_final.pdf.

[10] The Convention on Biological Diversity (1992)

[11] Barcelona Convention on the Protection of the Mediterranean Sea (1976) as amended

[12] Helsinki Convention of the Protection of the Baltic Sea (1992):

[13] Convention on the Protection of the North East Atlantic (OSPAR, 1992)

[14] Habitats Directive

[15] Birds Directive

[16] OSPAR. 2008. Guidance on Environmental Considerations for Offshore Wind Farm Development. (Reference number: 2008-3)

[17] Porter Hoagland. 2007. Renewable Energy Opportunities and Issues on the Outer Continental Shelf. Written testimony presented to the Joint Hearing of the Subcommittee on Fisheries, Wildlife and Oceans and the Subcommittee on Energy and Mineral Resources Committee on Natural Resources U.S. House of Representatives. Marine Policy Center. Woods Hole Oceanographic Institution

[18] Kyriazi et. al

[19] Gjertsen, H., T. Groves, D.A. Miller, E. Niesten, D. Squires, and J. Watson. 2010. A contract-theoretic model of conservation agreements. Department of Economics, University of California San Diego.

[20] BirdLife Europe (2011) Meeting Europe's Renewable Energy Targets in Harmony

with Nature (eds Scrase I. and Gove B). The RSPB, Sandy, UK.

[21] European Commission (2010) Wind Energy developments and Natura 2000.,

[22] Lumb, C M, Fowler, S L, Atkins, S, Gilliland, P M and Vincent, M A (2004). The Irish Sea Pilot: Developing marine nature conservation objectives for the Irish Sea. Report to Defra by the Joint Nature Conservation Committee, Peterborough.,

[23] ABPMer, 2005. Irish sea pilot regional plan. MSPP Consortium. ABPMer, Southampton, pp. 1–109 <http://www.abpmer.co.uk/mspp>.

[24] Wolfhart Dürrschmidt, Gisela Zimmermann, Dieter Böhme (ed). 2006. RENEWABLE ENERGIES

Innovations for the future. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). Germany

[25] ABPmer. 2009. Wet Renewable Energy and Marine Nature Conservation: Developing Strategies for Management. A Report for the Npower Juice Fund.

[26] Draft marine bill vol.2,

[27] Carolyn Elefant. 2009. Overview of Global Regulatory Processes for Permits Consents and Authorization of Marine Renewables. Law Offices of Carolyn Elefant. Ocean Renewable Energy Coalition (OREC),

[28] Scottish and Southern Energy Response: Consultation on Marine Licensing for Scotland under the Marine (Scotland) Act 2010 and the Marine and Coastal Access Act 2009

[29] Dukes, E. Franklin (2004). What We Know About Environmental Conflict Resolution: An Analysis Based on Research. Conflict Resolution Quarterly, 22(1-2), 191-220

[30] EWEA (coordinator), ECN, 3E, SOW. 2012. Delivering offshore electricity to the EU. Spatial planning of offshore renewable energies and electricity grid infrastructures in an integrated EU maritime policy. SEANERGY 2020. Final project report

[31] White, C., B.S. Halpern, and C.V. Kappel. 2012. Ecosystem service tradeoff analysis reveals the value of marine spatial planning for multiple ocean uses. Proceedings of the National Academy of Sciences of the USA, 109: 4696-4701.

[32] Julia Köller, Johann Köppel, Wolfgang Peters (Editors). 2006. Offshore Wind Energy. Research on Environmental Impacts. Springer-Verlag Berlin Heidelberg

[33] DEFRA (2005) Nature conservation guidance on offshore windfarm development. A guidance note on the applications of the EC Wild Birds and Habitats Directives for developers undertaking offshore windfarm developments. Version R1.9, March 2005.

[34] Glaeser, B.; Gee, K.; Kannen, A. & Sterr, H. (2005): Vorschläge für eine nationale IKZM-Strategie aus Sicht der Raumordnung. In: Bundesministerium für Verkehr, Bau- und Wohnungswesen und Bundesamt für Bauwesen und Raumordnung (eds.): Nationale IKZM-Strategien - Europäische Perspektiven und Entwicklungstrends. Konferenzbericht zur Nationalen Konferenz 28.02-01.03.2005 in Berlin, Bonn 2005, pp. 47-52.

[35] Regional Locational Guidance (RLG) for Offshore Renewable Energy Developments in NI Waters http://www.detini.gov.uk/regional_locational_guidance__rlg__for_offshore_renewable_energy_developments_in_ni_waters

[36] Michler-Cieluch, T.; Krause, G. & Buck, B. (2009): Marine Aquaculture within Offshore Wind Farms: Social Aspects of Multiple Use Planning. GAIA 18(2): 158-162.

[37] Gee, K.; Kannen, A.; Glaeser, B. & Sterr, H. (2004): National ICZM strategies in Germany: A spatial planning approach. In: Schernewski, G. & Loeser, N. (eds.) Managing the Baltic coast. Coastline Reports 2 (2004), pp. 23-34.

[38] Fritz W. Scharpf 1997. Games Real Actors Play: Actor-Centered Institutionalism in Policy Research Theoretical Lenses on Public Policy. Westview Press.

[39] Hardin, G., 1968. The tragedy of the commons. Science 162, 1243–1248.

[40] Ostrom, E., 1990. Governing the Commons. Cambridge University Press, Cambridge, MA.

[41] Stevenson, G. G. (1991). Common Property Economics: A General Theory and Land Use Applications, Cambridge University Press.

[42] Ostrom, E., Gardner, R., Walker, J., 1994. Rules, Games, and Common-Pool Resources. University of Michigan Press, Ann Arbor.

[43] U ssif Rashid Surnaila. 1997. A review of game theoretic models of fishing Working Paper. Chr. Michelsen Institute. Development Studies and Human Rights. Bergen Norway

[44] Veijo Kaitala and Marko Lindroos. 2007. GAME THEORETIC APPLICATIONS TO FISHERIES. In: Handbook Of Operations Research In Natural Resources. International Series In Operations Research amp; Mana Volume 99, 2007, pp 201-215

[45] Kaveh Madani. 2010. Game theory and water resources. Journal of Hydrology 381/225–238

[46] Bode, M., Probert, W., Turner, W. R., Wilson, K. A., Venter, O., 2011. Conservation Planning with multiple organizations and objectives. Conservation Biology 25(2), 295-304.

[47] Tisdell C (2007) Behaviours of conservation organisations and their environmental implications: analysis based on new (and not so new) Institutional Economics. Institutional Change in Agriculture and Natural Resources (ICAR) Discussion Paper 19/2007. Division of Resource Economics, Humboldt University, Berlin

[48] Robert Gibbons. 1992. Game Theory for Applied Economists. Princeton University Press. Princeton, New Jersey

[49]Davos Klimis. 1999. Sustainable cooperation as the challenge for a new coastal management paradigm. Journal of Coastal Conservation 5: 171-180.

[50] Art. 5 and 10 Royal Decree of 14 October 2005 on the establishing of MPAS.

[51] Master plan in 2005

[52] Florida's Energy and Climate Change Action Plan

[53] Borgers, T. (2010): "An Introduction to the Theory of Mechanism Design," Teaching Notes, University of Michigan (author's personal website).

[54] Lawton, J.H., Brotherton, P.N.M., Brown, V.K., Elphick, C., Fitter, A.H., Forshaw, J., Haddow, R.W., Hilborne, S., Leafe, R.N., Mace, G.M., Southgate, M.P., Sutherland, W.J., Tew, T.E., Varley, J., & Wynne, G.R. (2010) Making Space for Nature: a review of England's wildlife sites and ecological network. Report to Defra.

[55] ENTEC UK LIMITED. 2006 Using a planning gain supplement for nature conservation purposes. English Nature and the Royal Society for the Protection of Birds. English Nature Research Reports, No 672

[56] Curry, Nigel. 1993. Negotiating gains for nature conservation in planning practice. Planning Practice & Research, Vol. 8 Issue 2, p10, 6p.

[57] Sarah Whatmore and Susan Boucher. 1993. Bargaining with Nature: The Discourse and Practice of 'Environmental Planning. Transactions of the Institute of British Geographers, New Series, Vol. 18, No. 2. pp. 166-178

[58] Emma Comerford, Dominic Molloy and Paul Morling. 2010. Financing nature in an age of austerity. RSPB report.

[59] Niesten, E. and H. Gjertsen. 2010. Economic Incentives for Marine Conservation. Science and Knowledge Division, Conservation International, Arlington, Virginia, USA.

[60] Squires, D, K Carden, A Khan, M Smith, and N Vestergaard. 2010. "Rethinking Marine Conservation: From Solving the Commons Problem to Conservation and Management of Impure Public Goods." Working Paper.

[61] Organisation for Economic Cooperation and Development. 1998. Individual Transferable Quotas as an Incentive Measure for the Conservation and the Sustainable Use of Marine Biodiversity. ENV/EPOC/GEEI/BIO(97)14/FINAL. Paris, France.

[62] Organisation for Economic Co-operation and Development (OECD) 2004. Handbook of market creation for biodiversity: issues in implementation, Paris, France.

[63] Amardeep Dhanju and Jeremy Firestone. 2008. A Framework for Regulation of Offshore Wind Power in Delaware State Waters. University of Delaware College of Earth, Ocean, and Environment.

[64] Walliser, B. (2005) : Game theory and emergence of institutions, mimeo

[65] ICES. 06 May 2013. Report of the Joint HELCOM/VASAB, OSPAR and ICES Workshop on Multi-Disciplinary Case Studies of MSP (WKMCMSP), 2-4 November 2011, Lisbon, Portugal. Administrator. 20 pp.

[66] Bernhard Heinrichs, Kira Gee. 2011. Necessary common minimum requirements for Maritime Spatial Planning (MSP) in the Baltic Sea Contribution to the PLAN BOTHNIA work package "Region-wide recommendations on minimum requirements for MSP systems" (component 5.2.4.)

[67] Lange, M., Burkhard, B., Garthe, S., Gee, K., Kannen, A., Lenhart, H. & Windhorst, W. (2010): Analyzing Coastal and Marine Changes: Offshore Wind Farming as a Case Study. Zukunft Küste - Coastal Futures Synthesis Report. LOICZ Research & Studies No. 36. GKSS Research Center, Geesthacht, 212 pp.