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Produced by:	DLO: Marian Stuiver, Katrine Soma, Sander van den Burg, Christine Röckmann, Alwin Gerritsen
Contributors:	UNIBO: Barbara Zanuttigh, Fabio Zagonari, Laura Airoldi Uni Cantabria: Raul Guanche Garcia AUEB: ICREA8: Phoebe Koundouri, Amerissa Giannouli Musholm: Thorbjørn Harkamp, Niels Dalsgaard, Deltares: Jan-Joost Schouten, Saskia Hommes, Enveco: Tore Söderqvist, Chalmers: Lars Rosen, Rita Garção, Jenny Norrman, DHI: Ole Petersen,12 Flemming Møhlenberg12
Work Package Leader Responsible:	DLO: Marian Stuiver
Reviewed by:	Lars Rosen

Article

The governance of Multi-Use Platforms at Sea for energy production and aquaculture; obstacles and challenges for policy makers

Marian Stuiver[1], Phoebe Koundouri[2], Sander van den Burg[3], Alwin Gerritsen[1], Thorbjørn Harkamp[4], Niels Dalsgaard[4], Fabio Zagonari[5], Raul Guanche[6], Jan-Joost Schouten[7], Saskia Hommes[7], Amerissa Giannouli[2], Tore Söderqvist[8], Lars Rosen[9], Rita Garção[9], Jenny Norrman[9], Christine Röckmann[10], Mark de Bel[7], Katrine Soma[3], Barbara Zanuttigh[11], Ole Petersen,[12] Flemming Møhlenberg[12]

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1 Alterra Wageningen UR, PO Box 47, 6700 AA Wageningen, The Netherlands; marian.stuiver@wur.nl; alwin.gerritsen@wur.nl
2 School of Economics, Athens University of Economics and Business, 28is Oktovriou 76, Athens, Greece, amerissa.giannouli@icre8.eu, phoebe.koundouri@icre8.eu
3 LEI Wageningen UR, PO Box 29703, 2502 LS, The Hague, Netherlands ; sander.vandenburg@wur.nl; katrine.soma@wur.nl
4 Musholm A/S ReersøHavn, Strandvejen 101, DK – 4281, Gørlev, Denmark; th@musholm.com; ned@musholm.com
5 Department of Economics, University of Bologna, via Angherà 22, 47921 Rimini, Italy; fabio.zagonari@unibo.it
6 Environmental Hydraulics Institute, IH Cantabria, University of Cantabria, c/ Isabel Torres, 15 Santander, Spain raul.guanche@unican.se,
7 Deltares, P.O. Box 177, 2600 MH, Delft, The Netherlands, janjoost.schouten@deltares.nl, mark.debel@deltares.nl; saskia.hommes@deltares.nl
8 Enveco Environmental Economics Consultancy, Måsholmsgränd 3, SE-127 48 Skärholmen, Sweden tore@enveco.se
9 Chalmers University of Technology, Department of Civil and Environmental Engineering, SE-412 96 Göteborg, Sweden, jenny.norrman@chalmers.se, lars.rosen@chalmers.se; steiger@chalmers.se
10 Institute for Marine Resources & Ecosystem Studies (IMARES) Wageningen UR, PO Box 57, 1780 AB Den Helder, The Netherlands, christine.rockmann@wur.nl
11 Department of Civil, Chemicals, Environmental and Materials Engineering, University of Bologna - Viale Risorgimento 2, 40136 Bologna, Italy, barbara.zanuttigh@unibo.it
12 DHI, Agernalle 5, 2970 Horsholm, Denmark osp@dhigroup.com, fm@dhigroup.com

* Correspondence: marian.stuiver@wur.nl Tel. + 31 317481772

Abstract

The oceans of the world are encountering an upsurge of competing marine activities and infrastructures. Traditional ways of exploitation such as fisheries, tourism, transportation and oil production are added with new sustainable economic activities such as offshore wind farms, aquaculture and tidal and wave energy, also called Blue Growth.

One proposed solution to overcome possible competing claims at sea lies in combining these economic activities as part of Multi-Use Platforms at Sea (from now on called MUPS). MUPS can be understood as areas at sea, designated for a combination of activities, either completely integrated in a platform or in shared marine space. MUPS can potentially benefit from each other in terms of infrastructure, maintenance etc. Developing MUPS in the marine environment asks for adequate governance to enhance the MUPS. In this article, we investigate different models of governance for different European sites. In particular, we investigate different models of governance in a framework that specific policy, economic, social, technical, environmental and legal (PESTEL) considerations relevant to the four different case study sites. The article concludes with policy recommendations on a governance regime towards facilitate the development of MUPs in the future.

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Keywords: Multi- Use Platforms, governance, PESTEL, energy production, aquaculture

1. Introduction

European oceans will undergo massive development of marine infrastructure and face an increase in competing claims in the marine environment in near future. This is because of, for instance, the development of energy facilities like offshore wind farms, exploitation of wave energy, expansion of electricity connections but also further development and the implementation of marine aquaculture. One possible solution for these competing claims lies in the development of Multi Use Platforms at Sea (MUPS) that combine energy production with aquaculture. MUPS can be understood as areas at sea, designated for a combination of activities, either completely integrated or next to each other, that benefit from each other in terms of infrastructure, maintenance etc.

The European Commission has initiated a program called Blue Growth, which is the EU's long term strategy to support sustainable growth in the marine and maritime sectors. Marine space will become a delicate issue to future Blue Growth plans in European seas, challenging creative and innovative contributions which at the same time can ensure environmental sustainability. One such creative and innovative possibility is multi-use, i.e. making use of marine space in a more efficient effective way when two or more sectors join activities in same area. Whereas this is not fully new, as we used to combine, for instance, shipping and fishing, the approach is now expanded to cover typical Blue Growth sectors, such as wind and aquaculture combinations. While the multi-use arrangement increasingly is accepted as a valuable contribution to Blue Growth, it is not clear how to practically implement it in European seas.

Within this context, a European FP7 project called MERMAID has examined offshore platforms for multi-use of ocean space for energy extraction, aquaculture and platform related transport. New combinations of structures or complete new structures on representative sites under different conditions in four offshore case study sites were designed by means of a participatory design process [1]:

1. The Baltic Sea - a typical estuarine area with fresh water from rivers and salt water. The design is a combination of wind turbines and off-shore aquaculture by floating fish-cages with trout/salmon production [1].
2. The trans-boundary area of the North Sea-Wadden Sea - a typical active morphology site. The proposed MUPS design is offshore wind including an offshore hotel and support centre, combined with seaweed and mussel farming [1].
3. The Atlantic Ocean - a typical deep water site. The final design included a combination of floating offshore wind turbines and wave energy generators [1].

4. The Mediterranean Sea - a typical sheltered deep water site. The final design included grid connected wind turbines combined with fish farming [1].

This paper aims at contributing to the discussion on the development of MUPS for energy production and aquaculture from a governance perspective. It therefore analyses the present governance conditions. It unravels the underlying logic behind the policies and interventions at this moment or in the words of Lascoumes & Le Gall [2] 'the sociology of policy instrumentation', and use this to explore the contours of an 'optimal' governance for MUPS development. Therefore in this article, the different modes of governance that are present in the different sites are analysed. Second, specific policy, economic, social, technical, environmental and legal (PESTEL) obstacles that stakeholders faced in the study sites are analysed. The article concludes with policy recommendations. First, governments need to develop clear policy frameworks and mechanisms for financial support at all levels to make developers more willing to invest in MUPS. Second, special consideration is needed for the protection of the marine environment through careful monitoring. Third, knowledge developed over the past years in diverse projects can contribute to a careful integral implementation of MUPS in Europe, including all relevant stakeholders. All these steps are needed in order to build on more apt governance regimes, which can overcome obstacles to enhance MUPS for energy production and aquaculture in the future.

2. Methodological approach

2.1. Modes of governance framework

Governance concerns all processes of governing, whether undertaken by a government, market or network, whether over a family, tribe, formal or informal organisation or territory and whether through laws, norms, power or language [3]. A 'mode of governance' refers to the underlying logic and coordinative principles which can be recognized in governance processes. In this paper we distinguish between five modes of governance: *hierarchy, network, market* [4,5,6], *self-governance* [7] and *knowledge* [8,9]. These modes of governance are ideal-types, for analytical purposes only, whereas real life is a lot fuzzier. The understanding of the coordinative principles can clarify why governance processes stagnate or how they can be strengthened.

Over the years, new forms of governance emerged in addition to the classical hierarchical notion of governance. The hierarchical notion of governance, belonged to the nation state which uses authority, a clear division of tasks, rules, rationality and objectivity [6] to intervene in society and markets. Regulations, spatial planning and national policy plans are examples of this hierarchic governance. In other modes of governance, government was not solely responsible any more for the provision of collective goods [10,11]. In market governance, societal change is realized by the powers of the market, where competition and pricing decide what path is selected and where financial incentives are an important instrument [4,12]. Network governance, makes use of the potentials of actor networks, and their ability to combine multiple agenda's and responsibilities and to distribute gains in order to arrive at policy outcomes. Reciprocity, collaboration, interdependency, trust and empathy are coordinative principles in network governance [13,14,15]. Self-governance relies on 'the capacity of societal entities to govern themselves autonomously'[7]. Self-governance is based on a shared identity and a common interest, for instance in the usage of natural resources by local communities [16,17,18].

Knowledge governance is understood as: '... purposefully organizing the development of knowledge in order to deal with societal problems. Knowledge governance is aimed at creating new insights, and innovative solutions which tempt actors to leave traditional insights and practices and get away from inert

interaction patterns, stalemate negotiations, and interest conflicts'[9]. It involves a transdisciplinary approach to knowledge, a reliance on social learning, a reflexive attitude, is set up by self-organization and boundary arrangements to communicate the results to outside stakeholders [8].

2.2. PESTEL framework

Economic activities such as the development of MUPS are subject to different obstacles for development that need to be overcome. Combining activities in the marine space needs to fit in different regimes and practices that at present apply to different sectors and to different national jurisdictions. The challenge is to identify the real and perceived obstacles for the development. One way can be done within the so-called PESTEL framework.

The PESTEL framework of political, economic, social, technological, environmental and legal factors is typically used to analyse changing conditions for businesses by looking for sources of general opportunity and risks. The PESTEL framework is an analytical tool used to identify key drivers of change in the strategic environment. Other variants of PESTEL include ETPS (including economic, technical, political and social factors), STEPE (adding the ecological factors to the four in ETPS), PEST, PESTLE (including international and demographic factors) and STEEPLE (including ethical factors) [19].

The focus of the PESTEL framework is on the external business environment to understand the 'big picture' in which businesses need to operate, as opposed to the internal business focus which often is used [20]. The intention is thus to assist businesses in taking advantages of the opportunities, while minimizing the threats [20]. In this way the PESTEL framework assists firms towards more long term sustainable business innovation and investment strategies [21, 22]

2.3. Methods

The selected data has been based mainly on information gathered by the so-called site managers during the participatory design process within the MERMAID project. Each site had a site manager: a key expert and process facilitator for that particular site. The participatory design process aimed to co-develop MUPS by a group of relevant stakeholders for each site. It was organized through three steps:

1. Collection of the views and needs of selected stakeholders in the first round [23]
2. Reviewing the preliminary MUPS design in the second round [1]
3. Evaluating the final design in the third round [24]

Within the different sites, the site managers invited different stakeholder groups: such as policy makers, businesses, sector representatives, NGO's, local citizens and research institutes[24].

Modes of governance.

The site managers explored the 5 modes of governance with the following questions.

1. Hierarchy:

- Is there a public stakeholder that has decided that MUPS will be realised?
- Are there plans or rules or visions by a particular government that are given to others to realise a MUPS?

2. Market:

- Are companies investing in MUPS (in cash or in kind?)
- Is there a competition in developing MUPS and among whom?

3. Network:

- Is there cooperation between stakeholders in the area that aim to develop a MUPS?
- Is there a collective effort that makes decisions on developing MUPS in the area?

4. Self-governance:
- Are there spontaneous initiatives to develop MUPS by stakeholders?
- Does the government give space to develop these initiatives?

5. Knowledge governance:
- Is there knowledge development on MUPS in the area?
- Is there reflexive- social learning among the stakeholders involved?

Obstacles.

In order to examine the obstacles, the site managers analysed the main political, economic, social, technical, environmental and legal obstacles that were raised by the participants during the three rounds of participatory design of the MUPS [1,23,24]. Whereas PESTEL mostly is applied at firm level, in this study it is applied at different levels, and for different stakeholders. The logical levels for these case studies include national and regional levels. In this adapted version of PESTEL the focus is on the obstacles, which cover issues of risks, lack of social acceptance and legal barriers among others.

2.5. Case study areas

The Mediterranean Sea

The analysis was focusing on Greece and Italy, more explicitly the Adriatic Ionian Macro region and the area located in Crete, Greece. References to Cyprus, Spain, France Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, occupied Palestinian territory, Syria and Tunisia were also included in order to capture issues from the rest of the Mediterranean region.

Stakeholders involved in the analysis were governing bodies and policy makers from different authority levels (regional, national and European), end users and suppliers of the MUPs (e.g. energy, aquaculture, cable and construction industries and SMEs), representatives of offshore maritime activities, locals and NGOs, universities and research institutes. The analysis of the PESTEL framework was based on information gathered during the MERMAID project for the particular Mediterranean case study located in the northern Adriatic Sea, Venice coast.

The Atlantic Sea

The analysis was carried out in the Cantabrian offshore area, in the Spanish area of Bay of Biscay. The ocean conditions in this site are typical for an exposed area: harsh conditions leading to high technical demands. Offshore wind development is not foreseen in the area but there is experimentation on wave energy generation. The invited stakeholders included offshore energy sector, aquaculture, suppliers to the offshore industry, as well as NGO's and scientists. [1].

The North Sea

The analysis focused on the Dutch part of the North Sea, 55 km north of the Wadden Sea Island called Schiermonnikoog, in an already licensed site to develop offshore wind farm, named Gemini. At this location, an offshore wind energy farm is being built, which is planned to be fully operational by 2017 onwards with a total capacity of 600 MW [25]. Stakeholders from all the relevant sectors were contacted and invited to participate in the MERMAID participatory design process. Participants were selected on the basis of interest in discussions about multi-use activities in the North Sea: offshore wind, offshore aquaculture, fisheries, and tourism. Next to these stakeholders, MERMAID also approached the following three stakeholder groups: Governing bodies/regulators/policy makers such as regional, national and European officers; Stakeholders

from other offshore activities from for example shipping, and mining sectors; NGO's and local citizens. All stakeholders responded and participated, except for representatives from the mussel sector. The North Sea case study specifics and stakeholder involvement in the various participatory rounds are described in detail in [24].

The Baltic Sea

The findings are based on the case study site Kriegers Flak in the MERMAID project in the Baltic Sea that is situated on Danish territory. Offshore wind energy is already an established business in this area and further development of the Kriegers Flak area is foreseen. The design is a combination of wind turbines and off-shore aquaculture by floating fish-cages with trout/salmon production [1]. This combination is interesting given the large-scale development of offshore wind – with subsequent spatial claims and the critical attitude towards nearshore aquaculture. Stakeholders involved are businesses that expressed interest in the development of a MUPS, policy makers and shipping authorities. Furthermore, NGO's and scientists participated.

3. The Mediterranean Sea

3.1. Modes of governance

In the Mediterranean Sea no public stakeholders, at national or regional level, have decided to realize MUPs to date. Even so, in a series of research projects (including ADRIPLAN [26], TROPOS [27], IMP-MED [28], SEANERGY2020 [29], ADRICOSM [30], RITMARE [31]) it is documented that multiple use appears in national plans for ocean space and Marine Spatial Planning (MSP).

Still, the main initiatives are mainly European driven, involving funding opportunities for MUPS development and efficient multi-use of ocean space. EU intends to improve coordination and increase common understanding between different stakeholders. For instance, in support of Integrated Maritime Policy in the Mediterranean, they seek to provide opportunities for nine southern neighbourhood states in the Mediterranean to engage in and to obtain assistance for developing integrated approaches to maritime affairs [28]. In this way they aim at improved maritime governance in the Mediterranean by raising awareness across countries about potential sustainable maritime growth and jobs, environmental sustainability and safer maritime space use.

MUPS could solve some of the competing claims for space that exist among companies in the Mediterranean Sea. The core competing economic activities include aquaculture and petroleum tankers, as well as aquaculture and tourism in the Region of Ionian islands and Igoumenitsa [26]. The aquaculture sector in particular has limited availability of space, due to near-shore competition from other uses essential to the local economy and deep waters with harsh conditions [27]. Still, companies invest in MUPs mainly by participating in research projects (such as TROPOS, MERMAID, H2OCEAN, MARIBE, ORECCA, MARINA [32], IONAS [33])with a vision to develop or participate in future developments of MUPS and other multi-use solutions of ocean space. For instance, an existing partnership between European ports and cities from neighbouring countries in the Adriatic and Ionian area involved companies that could be interested in the future development of multi-use activities in the ocean [33]. Still, no companies have obtained permissions and licences to proceed with multi-use, mainly due to environmental and social concerns [27].

While it is too early to judge on cooperation between stakeholders in the area that aim to develop a MUP, networks are emerging within MSP initiatives. These networks include working groups in all the countries

bordering to the Mediterranean. Potential support to development of a MUPS exist, such as the Mediterranean Sea Innovation & Business Cluster [34], who supports investment in research and development of innovative future technologies. Furthermore, energy networks are emerging that consider the establishment of a hub between Europe and other countries, such as between Cyprus and Israel. The networks for offshore energy production are located in Greece (CRES - centre for renewable energy sources), Italy (associazione produttori energie rinnouabily), Spain and Portugal (LNEG-laboratorio nacional de energia e geologia) and there is also an international team for renewable energy (3E) [35].

Related to self-regulation and knowledge governance, a potential benefit from closer interaction and learning with other activities/sectors is according to stakeholders observed in a series of occasions [1, 26].

3.2. Obstacles perceived by the stakeholders

In the Mediterranean Sea, bureaucratic barriers (authorizations, licenses, infrastructural development, etc.) have been identified by stakeholders as the main barriers for the development of maritime activities [26]. Also lack of dialogue between public institutions and difficulties in identifying administrative offices responsible for issuing permits, have been addressed by stakeholders. Moreover, it is an obstacle that each sector has its own legal instructions that becomes relevant in case of implementing a MUP.

Policies that apply to the rest of Europe under European Directives or international agreements with regards to energy apply to the Mediterranean area as well. However, unlike other energy sectors, wave energy generation is in an early stage of development and there is no established industry consensus on codes and standards. There are no regional and national legislation specifically addressed to wave energy projects [37]. According to EU legislation, each plan and program, requires the judgment of an Environmental Impact Assessment or Strategic Impact Assessment Commission. Permits to operate the project are only given after this environmental assessment states that the environmental requirements are met. This may be observed as an obstacle to, for instance, new aquaculture activities.
Local commissions are assigned to improve management and modernization of the aquaculture sector. At present, regional governments are in charge of authorisation for aquaculture activities, and also responsible for setting fines and possibly withdrawals of concessions in order to preserve marine biological resources as well as to prevent, discourage and eliminate illegal, undeclared or unregulated fishery. At the same time, companies with permits, are obliged to conduct regular checks and tests, which ensure the proper operation of fish farms. The energy sector is operationalised at national levels by involvements of a total of three Ministries [37].

A core issue for the fishery activities are the subsidies of insurance premium by state and of investment expenditures by regional government. Also a change in the subsidy policy for renewable energy by the Italian government in the near and distant feature could both have positive or negative impact on the realisation of the MUP [1, 24].

Conflicts can be obstacles to MUPS. For instance, tourism activities in the near coast might be affected by fishery activities, and trade and tourist maritime routes might be affected by MUPs. There are also conflicts between long distance offshore fish farming and sustainability, because of high transportation costs [37]. Conflicts have also been appearing in the management of natural protected areas and the implementation of marine plans. A characteristic example is the landscape in Venice, which is regarded as an area under protection. Therefore the development of maritime activities that change the landscape of the area are not socially acceptable. Furthermore, risk of natural disturbance and possibility to harm the biodiversity of

Adriatic Sea (similarly identified by the MERMAID Project) due to human maritime activities seem to be an issue for the public authorities [26]. Furthermore, there might be conflicts with recreational navigation routes, for example from Venice to Rovigno. However, long distance from the coast could be costly and there could be conflicts with planned offshore port and other activities, such as shipping and fishing. As for the case of conflicts with shipping, other ship routes can be assigned [36].

Even though MUPS could contribute to job creation and research potential in support of local and regional economic development, lack of political willingness due to environmental and social concerns is observed a core obstacle [27]. Stakeholders feel insecure and are concerned towards the site location that a MUP could be located with regards to negative environmental impacts and socio-economic impacts. For the case of aquaculture the most vulnerable groups impacted are the fishermen, people working on tourist, transport and storage sectors, whereas in the case of wave energy production, mainly energy suppliers, equipment and machinery sector, as well as marine transport activities are affected [37]. An interdisciplinary approach in selecting the best possible location and the participation of different stakeholders in this selection procedure seems to be the solution to such concerns [1]. Specific economic sectors that could be developed and further supported include tourism related activities, transport construction and storage activities, energy suppliers, equipment and machinery sectors, research and education sectors [37].

One obstacle observed relates to the general lack of knowledge and experiences with offshore energy installations among stakeholders. For instance, they are concerned about possible anchoring problems nearby the platform, and also potential problems with day/night distribution of energy production on the platform.

The highest concern relates to possible negative environmental impacts of MUPS, especially in the case of aquaculture and the risk of eutrophication and pollution. The environmental concerns are higher in cases where there is no explicit information about necessary amount of trips, size of aquaculture ships for daily feeding and transport of fish, size of info about other trips necessary for the MUPS [1, 24]. Furthermore, effects on biodiversity are also considered possible due to the construction and operation of MUPS [37].

4. The Atlantic Site

4.1 Modes of Governance

All Spanish jurisdictional waters are linked to central power, although fully clear in the case of the Canary Islands. As such, sub-national political levels (Autonomous Communities and Municipalities) do not possess any maritime territory. At this stage there are no plans by the national Spanish government that foresee realisation of MUPS in the Atlantic site. MUPS development is not promoted by local, regional or national governments. MUPS is at this stage solely driven by European Union-funded research (MERMAID, MARIBE).

Still, MSP is currently being implemented in Spain that involve many sectors. For instance, the 2008–2011 Spanish maritime Cluster Strategic Plan [38] stresses the importance of facilitating maritime sub-sectors such as ship-building, fisheries, ports and coastal and cruise tourism. While this could have boosted the Spanish maritime economy, little is expected in terms of growth of value added.

Only the case of renewable energy is central to some public authorities in Northern Spain, with growing market share [39]. Among the different renewable energy technologies, offshore wind is considered most

important for future energy supply. This does not automatically mean that they are interested in MUPS. This is because in Spain, most of the potential areas to be exploited are in deep and very deep waters. Given the local ocean conditions, governmental agencies are more focused on proof floating offshore wind solutions.

Also companies are increasingly getting involved in floating offshore wind developments as well as wave energy new concepts. They are not investing – cash or in kind – in the development of MUPS. Even so, they are interested in taking part in ongoing MUPS research projects (MERMAID, PLOCAN, TROPOS), in order to contribute with specific knowledge. In particular, five companies from Spain have been involved, including Abengoa sea power, Acciano Infrastructures, Ener Ocean and Advance Intelligent Developments. In principle, these could be relevant to future MUPS developments.

While research projects (e.g. MERMAID, TROPOS and MESMA) have encouraged cooperation among stakeholders, they have not cooperated in developing MUPS in this region. Most of the collective efforts are very much focused on enhanced marine renewables and floating offshore wind. There are no spontaneous initiatives from stakeholders to develop MUPS, and no space is demanded for MUPS as such.

Knowledge developments of MUPS appear through research projects (such as MERMAID, TROPOS and MESMA). The Spanish national government has shown great interest in a Canary Islands Oceanic Platform (PLOCAN) [40], with the purposes of designing, constructing and operating an oceanic platform. In this platform, participants take part in research and technology development, and studies MUPS [41].

The MERMAID project has brought together marine sectors such as aquaculture, wind energy, wave energy, mooring and offshore engineering, and other blue economy activities to learn and discuss MUPS. Various governmental agencies have been involved in the process as well. The interaction contributed to social learning. First, it appeared that there is a broad consensus that the development of new marine activities, including MUPS, is of particular interest to Cantabria region where companies and a labour force for whom this can offer new possibilities [1]. Second, there is a shared belief among the stakeholders involved that the harsh ocean condition in the area are a problem for MUP development [1, 23]. The MERMAID project has tackled this concern through testing of scale models to show technical feasibility.

4.2. Obstacles perceived by the stakeholders

The development of MUPS requires – from a political perspective – coordination between different levels of government. In the Atlantic situation, regulation at international level, such as the United Nations Convention on the Law of the Sea (UNCLOS), needs to match to regional regulation – with different governing bodies. Coordination is also needed among new functions of the sea with the position and rights of established interests.

Developments in the Atlantic waters can affect different regions and different EEZ. Cross-border cooperation on MSP would support projects crossing several EEZ such as large-scale offshore wind projects. Currently, the Spanish national government has shown no interest in development of MUPS in the Atlantic water. This complicates cross-border cooperation.

Also, the current permitting procedure is complex. There is insufficient coordination between different administration levels and complex permitting procedure are pointed out as barriers for offshore grid development. The length of getting permission varies greatly depending on type of administration. The administrative procedure is not flexible with new technologies and maritime uses. This was shown in the case of Santoña, a wave energy test site set up as a joint venture production plant. It took six years to obtain

the environmental permits [43]. Five different administrative levels have been involved and more than 33 communications between the administration and the promoter have been carried out. Consequentially, long delays as well as budget overruns can become a reality to new marine developments such as MUPS.

Even though the development of MUPS in the Spanish Atlantic region is only in an experimental phase, stakeholders see clear socio-economic benefits. This development can be relevant for the maritime sector in Cantabria because it offers new jobs and revenues. Also, the Basque coast was found to be vulnerable to demographic pressure, overexploitation of resources and intensive human use of marine space. In this case MUPS can be an option because it 'makes it necessary to approach the marine energy production development planning in an integrated way' [42].

There are different social obstacles. First, the high uncertainty about the technological and economic feasibility hamper realization of MUPS. Second, unclear roles and distrust between stakeholders are seen as obstacles. The local fishing community is an important stakeholder and if MUP development interfere with their interests, there will be conflicts. While the development of MUPS can provide new jobs to the fishing community, it is emphasised that it is important to find a way to provide revenues to the local community and/or the fishermen.

The most important obstacles of a particular site relates to waves and depth, and subsequent technical demands that can deal with these challenges. For instance, the Bea of Biscay is known for large waves (up to 20m high). At the Bay of Biscay 1 km off the coast, water depths are circa 100 m, while at 5 km off the coast this has already increased to 400 – 1000 m water depth. The combination of deep water and large waves makes it difficult to design and built secure systems that can withstand these conditions. Also given the negative experiences with buoys (some got loose), it is important to design robust and safe systems [23, 1].

The existing environmental legislation does not explicitly exclude offshore renewable energy installations/infrastructure. Nevertheless, environmental legislation may slow down or hamper in some specific cases of offshore renewable energy installations and infrastructure. This can result from different interpretation of the legislation, for instance, some countries consider the protected areas as 'NO-GO-areas' for ocean energy whereas other are more open to new developments. There is also lack of clarity related to the grid capacity reinforcements at international level. It is important to choose the right site where interference with other functions is minimal. Other uses include e.g. fishing, tourism, transport, entrance to ports, bird and wildlife protection [23].

5. North Sea

5.1. Modes of Governance

The Dutch government has the ambition to realize multi-use of offshore wind farms in the near future. This can be concluded from recent stakeholder meetings, processes and projects initiated as well as facilitated by the Dutch Ministry of Economic Affairs and Ministry of Infrastructure and the Environment. Thus, there is definitely a political will in the Netherlands to promote future MUPS. Nevertheless, so far, the government's approach has been to leave initiatives to the market. The market, however, has not reacted yet. In particular the offshore wind sector has been very hesitant, even opposed, to participate in the development of MUPS, because of the possibility of increased risks, such as collision [44,45,46] and corrosion [47,48]. Moreover, the other use(r)s, for instance seaweed and mussel aquaculture, are currently not in the state yet to (co-)exist offshore and therefore, synergies of potential MUPS cannot yet be guaranteed.

Due to the hesitance of the offshore wind sector to invest in MUPS and financial limitations of the other marine sectors, the Dutch government is exploring risks and opportunities as preparation for potential legal adjustments, i.e. opening up wind farm areas for co-use [49]. Various research activities have been commissioned and funded by the government, such as workshops on multi-use at sea or Triple P @ Sea [53]. In those workshops, several different MUPS designs have been presented and discussed [50]. Because Dutch law at present do not allow shared use and free passage through wind parks, the Dutch government is also currently investigating the risks of opening up the wind parks to free passage and shared use [49].

In general, the single use offshore marine activities of wind power, wave power, mussel cultivation and seaweed cultivation compete. A MUPS setting has the potential to turn the competition into synergies and benefits. In the Netherlands there are already several examples of market parties, taking initiatives towards the development of MUPS. For example, the Dutch offshore aquaculture sector is in the beginning of a new development. While the Dutch blue mussel cultivation is to a large extent likely to remain inshore in the Wadden Sea and Easter Scheldt because mussel farmers are hesitant to go offshore [44], a transition phase to more offshore cultures has started [23], probably triggered by indications that the market potential for mussels might be twice the current market [48, 53]. Regarding the potential for seaweed cultivation, the use of seaweed not only for food and health care products but also for plastic products indicate an increasing need for large quantities [48]. However, the financial and economic feasibility of large scale Dutch offshore seaweed production is unclear and is dependent on the future development of demand and the potential of co-use synergies [48]. Also the offshore wind sector has also taken collective action by editing a "Common Position Paper & QRA regarding Open Offshore Wind Park Access", in response to a ministry report on the risks of multi-use of wind farms [52].

Simultaneously, the Dutch fisheries "Knowledge Circles" is a project for the industry to investigate the possibility of carrying out MUPS with passive fisheries in wind farms [46, 53]. They have commissioned projects as well as lobbied and have been approaching the ministries to move forward their ideas [50]. Those knowledge circles serve as platforms for stakeholders to share knowledge and also to involve researchers for scientific assistance. Other examples of network related to fisheries and MUPS is the "fishers club" and the "Vissen voor de Wind" project. A networking initiative related to offshore seaweed production potential is a Stichting Noordzeeboerderij project, which is explicitly aiming at offshore cultivation tests and at connecting entrepreneurs. The government gives space to develop such self-regulation and learning initiatives through some funds for research and innovations and through the facilitation of the workshops to share knowledge, discuss and develop, and to move forward.

> Knowledge on MUPS is further developed in national scale projects [46, 48] and workshops [54], as well as in EU-FP7 projects (MERMAID, H2OCEAN, TROPOS).For instance, a participatory design process aiming at scoping, envisioning and learning for developing a shared interpretation of MUPS made participating stakeholders more aware of multi-use possibilities in the case of the North Sea site.

5.2. Obstacles perceived by the stakeholders

The lack of a MUPS regulatory framework in the Netherlands and the fact that third party access to offshore wind farms is not allowed are mentioned by stakeholders as important legal obstacles [44]. However, a reconsideration of regulations is probable, and the government has begun to take steps towards reducing the obstacles [57].

In Dutch policies, MUPS are mentioned as a promising way to make the most out of scarce available space [55]. However, currently there is no demand for MUPS. Energy companies have and will build various offshore wind parks but an offshore aquaculture sector is still in its infancy. Consequently, policy-makers and regulators have not yet been substantially challenged to handle request for MUPS permits, and subsidies and a regulatory framework for MUPS are missing [44]. Also, there is no area designated for aquaculture in the Dutch spatial plans for the North Sea. Current practice for offshore wind parks is to forbid other vessels to enter the designated parks, thereby avoiding question on risks and responsibilities, though the Dutch government is currently investigating the risks of opening up the wind parks to free passage and shared use [56].

Although wind energy is currently a profitable business case, it is very dependent on government subsidies [57]. Stakeholders show scepticism against the financial feasibility of combining offshore mussel and seaweed farming with wind energy [44], in particular because wind energy operators are presently reluctant to share their allotted space with other operators due to the risks associated with multiple use, which could have an influence on insurance premiums. The uncertainty of a business case for MUPS is illustrated by the negative profitability of seaweed cultivation and the uncertain profitability of mussel farming at the North Sea case study [57]. However, especially the case for mussels could become financially feasible when reductions on operational and maintenance expenditures can be obtained, e.g. through locations closer to shore than the North Sea case study or substantial synergies with other uses. The case study was not able to illustrate the economic rationale for combining three different uses in one offshore location. Although the single uses at suitable locations could in themselves be financially feasible, the synergies in the North Sea case study are likely to be insufficient to compensate the additional costs caused by the suboptimal factors stemming from the MUPS location in the case study, i.e. an exposed location situated far offshore.

Trust among potential users in MUPS would facilitate future MUPS realization. The discussions between fisheries organizations and wind power companies illustrate the presence of difficult trade-offs in the case of offshore activities. Fishermen organizations argued already from the start of the planning and building of the first Dutch offshore wind farms that there is a need for compensation fees for lost fishing grounds and/or additional employment for fishing vessels, e.g., fishing with static gears and organizing sightseeing trips to the wind farms for tourists. There have also been drafts for new fishing vessel designs, which could make the vessels suitable for service and maintenance work in wind farms. Discussions about these ways to solve trade-off issues have taken place under the umbrella of fishermen organizations with participation of representatives for the government and energy companies. This illustrates the need for trust-building and close collaboration among actors directly or indirectly involved in MUPS, which could be facilitated by the Dutch “poldering tradition” of involving stakeholders [44]. Handling uncertainty is a key. Offshore aquaculture is still in an innovation stage, which complicates MUPS development. What impact MUPS will have on insurance premiums is unknown, and stakeholders perceive that it might be very difficult to insure MUPS [1]. This is also a reason for the offshore wind sector to be reluctant towards turning single-use wind farms to MUPS. It is therefore crucial that potential business synergies and opportunities are clarified [44] and that risks are reduced through a transition process towards implementation of MUPS that preferably starts in a testing format with pilot projects [44].

Stakeholders emphasize that the North Sea case study site is characterized by harsh conditions, which requires reliable anchoring and sufficiently robust constructions [44]. Also, maintenance on the wind farm and cables must always be feasible, which requires a MUPS design where there are satisfactory maintenance lanes through which wind turbines are accessible [44]. There is also a lack of experience in offshore aquaculture but particularly for mussel farming there are incentives for testing offshore cultivation because

the traditional coastal areas for shellfish culture are reaching their carrying capacity, setting limits to further growth of production in those areas [47].

In stakeholders' opinion, MUPS must not have a detrimental effect on the existing ecosystem, which makes investigations through environmental impact assessments crucial [44]. Some stakeholders are interested in the potential of realizing ecological valuable zones within wind parks, which is supported by some scientists [59]. However, a potential problem is that hard structures in an otherwise sandy environment might form "stepping stones" for invasive species [59]. This illustrates that it is at present not clear what environmental risks might be introduced through MUPS, which is evident by the fact that many stakeholders are uncertain about potential environmental benefits [44]. For example, while mussel and seaweed farming might improve water quality through its need for nutrients, ecosystem effects could arise as less nutrients could become available for single-cell algae [44]. This uncertainty about environmental risks is not least sensitive for the offshore wind sector, which has a strong preference for not becoming involved in a process of negative news in media]. On the other hand, MUPS also provide an opportunity to enhance the sustainability image of the offshore wind sector as well as for other MUPS actors.

6. Baltic Site

6.1 Modes of Governance

The idea of MUPS is mainly supported at European level by the European Commission, and no public stakeholders have decided that a MUP will be realised at local or regional level. Instead, different uses of the Baltic Sea Region are emphasised in MSP [60], which has been a transnational issue from the start in 2001. The area around Denmark, including the Danish part of Kriegers Flak, is not yet a regulated area [61].

There are no plans or visions yet to have MUPS realised by the public sector in Denmark. Apart from a vision developed by the project BaltSeaPLan [62], which mentions the need for spatial efficiency and the need to promoting co-use, synergies and multiple spatial use, there are not any official plans or visions on multi use of marine space in the Baltic Sea. There is a political goal in Denmark to be completely independent of fossil fuels by the year 2050. Thus, there is a lot of focus on renewable energy sources, where off-shore wind farms are of high interest, especially since land based windfarms increasingly are perceived as negative.

Further, with regard to aquaculture, there is a political vision to increase the production, but at the moment there is public scepticism against consumption of farmed fish due to e.g. medicine residues in the fish, environmental impact of fish farming, and farming conditions [63], as well as rather strong regulation. The new Danish aquaculture strategy for 2014-2020 aims at increasing the total production with 25% before 2020 [64]. At the same time they aim at increasing the ecological production, complying with existing environmental legislation and decreasing 20% nitrogen per tonne produced fish, as well as increasing export of fish and shellfish by 25% and of feed and technology by 200%. In the strategy, there are also plans to clearly designate areas off-shore for fish and shellfish production, but also for compensation constructions for sea weed and mussels to compensate for nutrient release, i.e. so called integrated multi-trophic aquaculture (IMTA). Thus, there is already today promotions to establish IMTA which can be seen as a MUPS although the primary purpose is nutrient-neutral rather than efficient use of marine space. However, the legislation for establishing IMTA is not yet in place. Moreover, IMTA has not proved to be economically viable.

There is currently no competition in Denmark for developing MUPS as it is still too high risk and too few synergies to invest in combination of wind and aquaculture. Still, companies involved in research projects on MUPS (MERMAID, TROPOS and H2OCEAN)have invested by means of in-kind in participating in these R&D projects. Moreover, aquaculture companies have been investing (primarily by cash, in-kind and by getting external funding) in exploring the possibilities for integrated multi-trophic aquaculture (IMTA), which however, is not a fully integrated MUPS with regard to combining energy and food production. The idea of IMTA builds on that nutrient release from fish farms can be neutralised by having e.g. mussels or sea weed adjacent to the fish farm. So far, millions have been invested where the main driver is to be able to increase the production of aquaculture in the Baltic. The potential for increasing aquaculture in the Baltic is very high, but the development is hindered by a modest aquaculture strategy and strict regulations on N-release in Denmark. The aquaculture industry would also benefit if they had the possibility to join a MUPS combining wind energy production and fish farming since they would be able to expand their production [24]. Due to current regulation on N-release from fish farming, aquaculture companies are more or less forced to implement IMTA as a remedial activity. It is at the moment very difficult to get new licences for establishing any new fish farms to implement IMTA at sea in Denmark.

Other investments that have been done by Danish companies is to look at the combined use of wind and wave energy. One example is the Floating Power Plant A/S (FPP), which combines innovative wave energy conversion with floating wind turbines. The company runs an EU funded project POSEIDON and has a test platform in the Baltic Sea. Further, the company Hexicon AB situated in Stockholm, Sweden, has developed an off-shore solution primarily for wind energy production but states at its web page that it is possible to integrate complementary technologies to use the platform for multi-purpose: e.g. wave power, tidal power, solar power, desalination, fish farming, and oxygenation.

Cooperation between and learning among stakeholders have been observed in research projects (MERMAID, TROPOS and H2OCEAN), which have contributed also to learning. The stakeholders have gotten much more realistic about synergies and costs. Also spontaneous initiatives to develop MUPS have been observed among stakeholders who took part in research projects (e.g. SUBMARINER), such as smaller initiatives to look for the possibility to grow mussels in combination with wind farms.

Especially linked with energy production, the authorities are quite open to discuss new initiatives. Furthermore, the Danish AgriFish Agency (part of Ministry) supports IMTA related initiatives. In particular, Kriegers Flak is suggested as a case study site (in a project called BalticSCOPE) suitable for energy, sand and gravel, cable and pipelines, fishing, environment, shipping, to explore cross-boundary cooperation on MSP. However, MUPS is not a specific topic.

There is also, a network of Baltic actors (the so-called SUBMARINER network 2010 - 2013). The project aimed at testing and evaluating new and innovative uses and technologies, and is still platform for these actors. Testing and developing of MUPS has not been a primary objective, but could become so in the future.

Also several transnational network initiatives around MSP in the Baltic Sea Region [60], such as around ocean based energy production in Sweden (e.g. VINNOVA, Offshore Vast). They have carried out a pre-study on establishing a test-bed for ocean based energy production of the west coast of Sweden. In this pre-study they are acknowledging the possibility of the combination of off shore wind and wave energy [65].

6.2. Obstacles perceived by the stakeholders

MUPS combining the energy sector and the aquaculture sector is a new area in Danish planning. In line with the implementation of the Water Framework Directive and the Marine Strategy Directive, Denmark has just started to look at spatial planning of the sea areas with a focus on the different interest and stakeholders.

The Danish aquaculture is strictly regulated by national, international and regional environmental, planning and nature rules and directives. Before establishing or extending a fish farm in Denmark an EIA (Environment Impact Assessment), HIA (Habitat Impact Assessments), eventual a permission for water use and a permission for placement in land or sea must be obtained. The process will include several public hearings, and the experience is that the process takes more than one year. At the moment, it is a challenge for fish farm companies to get permits [23].

For development and establishment of offshore wind park projects in Denmark, three licenses are required, are granted by the Danish Energy Agency [67]: (1) license to carry out preliminary investigations, (2) license to establish the offshore wind turbines, (3) license to exploit wind power for a given number of years, and – in the case of wind farms of more than 25 MW – an approval for electricity production. There are noise and spacing rules, an EIA (Environment Impact Assessment) has to be carried out including e.g. visual impact, noise, shadow, impacts on nature.

The existing regulations could function for co-existence of windmill parks and aqua-culture. However, the regulations for windmill parks origins from that of oil- and gas off-shore platforms with a very high concern about safety issues, whereas the regulations for aquaculture has a different mind-set. The two sectors are governed by different sets of authorities and regulations, and thus it is a challenge to get these together and work towards a common goal.

Off-shore (and land based) wind parks are highly depending on subsidies for companies to be prepared to invest. There is a great concern about the high costs of off-shore wind farms, and incentives [66] (such as more flexible time plans without economic penalties and reduction of risks for the developer) have been created by the Danish government to increase the competition in the tender biddings for new wind farms to decrease costs. In addition, there are also voices raised against the costs for the high political ambitions and the new right-wing government may be reluctant to be as proactive with regard to increase renewable energy production as the former governments (See for example a recent analysis from CEPOS, an independent, right-wing/liberal think). The MERMAID project did not succeed in showing clear financial incentives for wind energy producers to join MUPS which integrates aquaculture and wind energy production [24].

Aquaculture has great opportunities in remote areas in Denmark in terms of growth and jobs [24]. However, there is opposition to aquaculture from NGO's especially about emission of nutrients and interaction with habitats and species. Primary focus areas from the NGO's are the discharge of nutrients and the use of antifouling to the nets. Thus although the renewable energy sector offshore gains a lot of goodwill (except with regard to the high costs), the aquaculture industry struggles with public images of eutrophication and release of antibiotics. Further, after the first stakeholder meeting on the Baltic case [23], it was stated that a MUP will potentially affect the landscape, and that there should preferably not be any effect on views from shore. With regard to Kriegers Flak, located around 30 km off shore, the wind farm will rarely be visible from the coast, except in very clear weather conditions. Stakeholders taking part in the Baltic case study of MERMAID expressed an urgent need to develop clear procedures for stakeholder involvement among the countries involved in Kriegers Flak (Denmark, Germany, Sweden) [23].

There does not seem to be any technical obstacles for implementing neither a wind park nor fish farms at the Baltic site that has been studied in the MERMAID project, on the contrary: conditions are favourable [1]. However, with regard to the combination of wind parks and fish farms at sea, there are practical problems [23]: there is a potential risk of internal damages, e.g. anchors of the fish farm drifting into the power supply cables, or fish cages damaged by the wind turbine construction. In order to reduce the risks, the MUP must be clearly marked out and technical monitoring equipment must be installed. A thorough risk assessment is needed. Possibly two shipping routes that pass Kriegers Flak need to be changed, for instance the Ferry to Travemünde. Good guidelines and rules are needed to ensure safety of the people, the vessels, the cages and wind turbines involved. At the moment, there are no insurances that will cover the excess risks that a combination of aquaculture and wind energy would infer.

After the first stakeholder meeting a number of environmental and ecological obstacles were stated [23]. Parts of the sea bed area will be occupied by the foundations of the wind turbines and parts of the sea by the fish cages. This will have an effect on the habitats and their living environment. The foundation and scour protection of wind turbines have proved to become an artificial reef in which algae and invertebrates appear to do well and the fish cages should be positioned such that those artificial reefs and their habitats are not disturbed.

7. Conclusions and implications for policy-makers

This paper reviews governance conditions in a total of four case studies, including the Mediterranean Sea, the Atlantic Site, the North Sea and the Baltic Sea Region. In each case study, the different modes of governance, with reference to hierarchical-, market- and network-governance, as well as self-governance and knowledge governance, are explored. Moreover, specific policy, economic, social, technical, environmental and legal (PESTEL) obstacles that stakeholders have faced in the study sites are identified. With these contributions, the aim of this paper is to contribute to the discussion on the development of MUPS, particularly for energy production and aquaculture from a governance perspective.

Comparing the case studies across modes of governance and PESTEL obstacles, we observe that the highest ambitions appear in the North sea case study to develop and explore the implementation of MUPS. In the Baltic Sea Region (Denmark), different MUPS arrangements are identified where sea weed and mussels are used in combination with off-shore for fish and shellfish production to compensate for nutrient release. Still, all case studies refer to ongoing MSP, which involve the coordination of many sectors, and which may consider MUPS in future when getting more familiar with it.

In both the Mediterranean and the Atlantic cases, the efforts made through research projects are the most important, in which the sectors actively have been involved. Through dialogues, increased attention and credibility of MUPS have developed, and is now seen to be relevant to future governance strategies. The research projects also allowed learning among participants, which can be useful to future innovation.

Still, all case studies have reflected on core obstacles along the PESTEL framework. In the Mediterranean case the environmental and ecological arguments linked with the process of design and development of MUPs are particularly strong. More explicitly, criticism related to emission of nutrients and interaction with habitats and species, affecting the biodiversity due to aquaculture activities. However, they argue that a careful selection of the site and construction of the MUPS, could result in more limited environmental and ecological impacts.

In the Adriatic Sea, the most important obstacles of a particular site relates with particular conditions of waves and depth, and the subsequent technical demands that can deal with these challenges. The combination of deep water and large waves makes it difficult to design and built secure systems that can withstand these conditions. Also other conditions could be relevant, such as distance to platform offshore. [69, 70]

In the Baltic Sea Region the dominating mode of governance and potential obstacles is on the market conditions and the political ambitions for the wind farms. For the aquaculture sector, it is more on the regulatory side and public opinion, the political strategies and visions on aquaculture is not in line with the regulatory practice. For the combined use, the aquaculture sector sees an economic opportunity, i.e. a potential to increase production if they could get permits to co-exist with windfarms. However, the economic incentives for wind energy producers is still too low in comparison with the increased project risks and thus potentially costs, for them to be able to invest [24].

In the North Sea, the market for offshore wind is considerably more developed in comparison to other types of potential offshore uses, such as mussel and seaweed cultivation, which is still in a very early stage with respect to offshore production. Nevertheless, offshore wind developers and energy utilities are still struggling to minimize risks accompanying their offshore activities. This is a major issue why they in general seem reluctant to cooperate with MUP developments. Once another type of use is more mature for offshore production, it might be a reliable sparring partner for the offshore wind industry, enhancing the opportunities for MUP development. In particular offshore mussel farming still has to be tested in a single-use format. Only once this has been tested and confirmed, it makes sense to develop MUPS that combine an offshore activity with offshore mussel farming. Seaweed farming is still at an even earlier stage, so there are even more uncertainties to be sorted out and conditions for offshore framing to be tested. Also, other users are not so financially strong to become an interested and reliable partner for the offshore wind farm developers in terms of sharing risk and liability. Another constraint is that subsidies are available for offshore wind farm developers, but not for other use(r)s.

Across case studies several important obstacles for MUPS development have been identified. They include the lack of a MUPS regulatory framework, limited financial incentives for MUPS, and substantial technological and environmental uncertainties. We also conclude that the present governance is not likely to be sufficient for removing those obstacles. A reliance on market forces is at present not enough for realizing MUPS. A clear regulatory framework, which also provides opportunities for third-party access to wind farms, is needed. The considerable uncertainties associated with MUPS are a strong motive for the government to also provide incentives for knowledge development and trust building. The current initiatives of organizing workshops in which stakeholders participate and learn from each other are likely to be fruitful, as are initiatives for launching pilot projects for testing offshore aquaculture production. While those pilot projects might be carried out in a single-use mode, they are still likely to build a basis for MUPS initiatives because they would help reducing uncertainties related to technology, production capacity and environmental effects. Once offshore aquaculture uses become more developed and an appropriately promoting MUPS regulatory framework is in place, there is a better chance that market governance can work for MUPS development.

While MUPS clearly can provide opportunities for future Blue growth, this paper gives an overview of what different regions have found to be challenging at this stage. Still, the challenges are not to overcome, we just need to be creative and conduct sufficient research on this topic. Also in future research it is recommended to use a PESTEL framework to gather a full picture of what matters, while combining with intensive

stakeholder consultations. In future, an improved understanding of how self-governance, network governance and knowledge governance arrangements can be implemented in a strategic and responsible manner, will be critical to future MUPS developments.

This research supports the following ambitions

- The development of clear policy frameworks at all levels to offshore multi-use platform development, including a clear and agile licencing procedure, will make developers more willing to invest in MUPS. This policy framework should adhere to the principles of MSP to foster sustainable use of marine space [68].

- It is recommended to create mechanisms for financial support to make the investments attractive to developers. Similarly to what generally occurs in land-based innovative technological projects, the start-up of MUPS comes with substantially higher investment costs and risks compared with business-as-usual projects.

- It is relevant to assure protection of the marine ecosystem by licensing procedures based on site-specific environmental studies and to guarantee the implementation of an environmental monitoring system in the designated marine areas for MUPS development. In order to understand if and how the environment is being affected by the project, and to avoid, minimize and eventually offset the adverse significant negative impacts, an environmental monitoring program is necessary. Depending on the specific uses within the MUPS, the environmental monitoring system could focus on issues such as e.g. spreading of invasive species, biodiversity, underwater noise and electromagnetic radiation, water pollution, along the lifetime of the project, preceded by environmental baseline studies.

- The projects that have conducted research with the aim of involving different stakeholders have shared and increased knowledge as well as expressed their views regarding the difficulties with the development and implementation of MUPS. It is recommended to get familiar with this knowledge. This helps taking into account a variety of institutional, technical, environmental, financial and socio-economic aspects in MSP and for developing policy instruments that can support the development, implementation and running of MUPS.

- The recommendation is to engage different stakeholders in spatial planning and when developing policy instruments for offshore MUPS. Important stakeholders are business partners and the potential future developers, environmental authorities, local or regional administration, relevant professional associations, local NGOs, and research institutes..

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Abbreviations

The following abbreviations are used in this manuscript:

NGO: non-governmental organization

MUPS: Multi-Use Platform at Sea
MSP: Marine Spatial Planning

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