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Is Demonstrating the Concept of Multi-Use Too Soon for the North Sea?

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Is demonstrating the concept of Multi-Use too soon for the North Sea? Barriers and opportunities from a stakeholder perspective.

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Abstract

Multi-use (MU) has been promoted as a viable approach to the effective planning and mitigation of user-conflicts in the marine realm. Despite several research and pilot projects demonstrating the approach's feasibility and benefits, commercially viable MU applications remain patchy and few. Further, MU is neither systematically applied nor purposively planned for even in the imminent event of incompatible and conflicting use of marine space. This paper seeks to identify barriers and opportunities for mainstreaming MU based on desktop study and iterative stakeholder consultation. The findings reveal that the MU concept was frequently framed as 'co-location' or 'co-existence' and aimed towards mitigating conflict among users. Practice was ahead of theory with little attention to synergistic and efficiency aspects. Barriers for MU application include shortcomings in legislation, sectoral thinking, and burdensome administrative procedures. The main opportunity lies in creating a conducive policy environment where MU risks and transaction costs become low and competitive, respectively. Solutions at the sea basin and national level, upon which further MU application can be anchored, are proposed.

Key words: *Multi-use; North Sea; DABI (Drivers, Added values, Barriers, Impacts) framework; Lessons; Stakeholder engagement.*

1. Introduction

Advancements in research and technology, coupled with ambitious policy objectives (EC 2014a; Toke 2011), promote emerging uses in the marine space such as offshore renewable energy and aquaculture. This is happening when traditional uses such as fishing and maritime transport are expanding and intensifying (Hooper and Austen 2014), resulting in conflicts between different use(r)s, economic sectors (Klinger et al. 2018) and activities (Douvere 2008). For example, installing offshore wind farms (OWFs) in some North Sea areas created tensions as it resulted in the exclusion of fishermen from traditional fishing grounds (Bolongaro 2017; Kafas et al. 2018).

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Several scholars have argued that conflicts between users in the sea are likely to escalate over time (Jansen et al. 2017), highlighting the salience for innovative approaches to the planning of marine space. In response, Multi-use (MU) has emerged as a tool and concept, promoted as a novel approach to the sustainable management of marine space (Buck and Langan 2017; Di Tullio et al. 2017; Christie et al. 2014; Legorburu et al. 2018).

In relation to marine activities Zaucha et al. (2017) defined MU as the intentional joint use of resources in close geographic proximity, involving single or multiple use(r)s, and covering various use combinations. This represents a radical change from the concept of exclusive rights to the inclusive sharing of resources. Sharing of space, infrastructure, or operations (e.g., transport boats) can reduce space demand and allow for other uses, thus contributing to conflict avoidance and efficient use of marine resources (Ansong et al. 2017; Benassai et al. 2014; Kyriazi 2018). Other benefits include, job-creation, development of new sources of goods and services (e.g., recreation, food), income and livelihood diversification for declining or restricted sectors, and mitigating environmental pressures (ICES 2018). MU can also enable the development of uses in locations where this would otherwise not be possible, such as aquaculture, in more exposed offshore areas if combined with OWFs.

Further, Gee and Kannen (2011) argue that MU can enhance Marine Spatial Planning (MSP) as the MSP process envisions the marine space as being planned sparingly, according to Directive 2014/89/EU of the European Parliament and of the Council establishing a framework for MSP (EC 2014b), to leave space to the decisions of others, including future generations. Although the term Multi-Use is not used in the Directive, the concept is anticipated by using the term co-existence, thus underscoring MUs' increasing significance in the policy arena (Boonstra et al. 2018; Schäfer 2009).

However, promotion of MU has mainly been through research projects testing concepts and feasibility of various MU combinations. For example, the EU-funded COEXIST project evaluated competing activities and interactions in European coastal areas across biological, biogeochemical, socio-economic, governance and legal aspects, resulting in the document *Guidance on a Better Integration of Aquaculture, Fisheries, and other Activities in the Coastal Zone*. The 2016-2018

Multi-Use in European Seas (MUSES) project explored the opportunities for MU across five EU sea basins. A comprehensive review of EU-wide research/pilot MU projects (2010-18) uncovered 29 projects (9 EU funded and 20 nationally/privately funded) with at least 24 (83%) of the projects covering the North Sea (NS) basin. The projects have cost over €30 million in total, with EU efforts on MU topics continuing via the ambitious EU BG5 call for proposals on MU demonstration projects.[1] Despite the above efforts, successful MU applications remain limited even in the NS. Currently, MU is not systematically applied despite the current incompatible and conflicting uses of the limited European marine spaces (EEA 2015; Gee 2010). This raises two important questions: assuming the MU concept has considerable benefits and can address potential impacts and conflicts among use(r)s, what then hinders its widespread adoption? Subsequently, what barriers can be removed or minimised and what opportunities need to be enhanced to make MU more commonplace?

This paper aims to address the above questions, constituting a key departure from past studies which focused on exploring the technical and commercial feasibilty of MU. The assumption is that for MU to become mainstream and commonplace, policy-makers and regulators must know which issues to address and what policy environment to create. Lessons from successful or failed approaches to MU can be used by others to instigate and inform their approaches. Therefore, insight from this paper can facilitate this understanding, following Jordan and Huitema's (2014) argument that governance of environmental change requires critical engagement in policy innovation as various policy jurisdictions learn from each other. Becasue the North Sea (NS) has hosted several MU pilot projects, with various levels of success, it is ideal for drawing lessons. To deliver this paper's objectives three aims are pursued: to establish (1) MU framing in key policy documents (macro-regional, national); (2) MU state of art in terms of application, barriers and opportunities for further growth, and; (3) key lessons and insight to further promote MU development in the NS and potentially other seas.

2. Materials and methods

2.1. Study area

[1] http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/bg-05-2019.html

The NS, which is the focus of this paper, has a continental shelf that enjoys a high level of socio-economic importance considering its relative size: approximately 62% of the total EU28 GDP for the year 2016 was generated by six EU countries bordering the NS (Figure 1).

Insert figure 1

Key activities include commercial fisheries, oil and gas (O&G) production, shipping and maritime transport, tourism and offshore renewable energy development (O&G Authority (OGA) 2018). The EU legislative framework, alongside other international, national and local policies, determines the governance of maritime uses, as discussed in Boyes and Elliot (2014), with the potential to shape MU development. Meanwhile, ambitious production and performance targets to deliver considerable environmental and socio-economic benefits (ENTSO-E 2017; Norwegian Ministry of Climate and Environment 2013) can also influence MU adoption. For example, the EU has adopted a Blue Growth agenda (Committee of the Regions 2013), a long-term strategy to support sustainable growth in the marine environment, acting as a driver for the European economy through innovation and growth (Eikeset et al. 2018).

It is estimated that the NS maritime economy represents a Gross Value Added (GVA) of at least €150 billion and employs at least 850,000 people (estimates including Belgium (BE), Germany (DE), Netherland (NL), Norway (NO), United Kingdom (UK), France (FR), Denmark (DK) and Sweden (SW)) (ECORYS 2014). Unprecedented investment in Marine Renewable Energy (MRE) is occurring, with the Ocean Energy Forum (2016) targeting to reduce carbon emissions by over 276 million tonnes annually. Also, there exist ambitious national targets in the region for key sectors: the aquaculture industry in Scotland aims to double its economic performance by 2030 (Scotland Food and Drink 2018). These ambitions are being realised at the same time as human activities are causing unprecedented environmental changes in coastal and marine ecosystems, from habitat destruction, overfishing, and pollution, to the spread of non-indigenous species, all likely to be made worse by the changing climate (EEA 2015). These key facts point to a wide spectrum of economic opportunities and constraints for which the MU concept can find useful application (see Di Tullio et al. 2017; Buck and Langan 2017; Christie et al. 2014; Jansen et al. 2017).

Whilst intensification of use and the above targets will exert additional pressures on marine space and resources, associated adverse impacts (North Sea Commission 2016; OSPAR 2010; Norwegian Ministry of Climate and Environment 2013) present challenges to effective planning of the NS (EEA 2015). The challenges are exacerbated by a culture of lack of trust among marine resource planners, managers and users, and lack of a comprehensive understanding of the physio-chemical and geo-biological processes that operate in the sea (Duck 2012; Jay et al. 2012). Thus, it is argued that the MU concept and the rationale of spatial efficiency can contribute to addressing the challenges (Stuiver et al. 2016; Kannen 2014), putting the policy environment to support MU application in the spotlight.

2.2. Data collection

To gather lessons and insight from the NS experience to date a two-phase approach was applied. First, extensive desk study (Figure 2) to collect data on: past, existing and proposed MU combinations in the NS; how the MU concept was framed in key documents; how MU was perceived, and; relevant factors for MU development in the NS based on the approach described in Zaucha et al. (2017). Desk study targeted relevant NS documents addressing MU-related policies, regulations, plans, projects reports, and scientific literature, identified via internet search. The keywords ‘multi-use platforms’, ‘co-existence’ and ‘multi-use projects’, were used in google, google scholar, Scopus, and WorldWideScience internet search engines. This returned a total of over 832, 548 hits. By scanning, it was possible to eliminate those that had nothing to do with MU in the European seas, leaving only 132 (many repeated). This led to the compilation of an initial list of MU combinations in the NS and a list of factors determining MU development; further reviewed and validated by stakeholders in the course of three workshops in Poole, Edinburgh and Dundee (UK).

Insert figure 2

The factors were grouped into categories of: Drivers (promoting MUs), Added values (positive effects from MUs), Barriers (hindering MUs), and Impacts (negative effects of MUs) (hereinafter DABI), and further placed under respective sub-categories (policy, regulation, socio-economic, technological, and environmental). This DABI framework became the basis for a subsequent iterative stakeholder engagement.

In the second phase, in-depth interviews were held (face-to-face, or via videoconferencing or telephone) and the preliminary MU combinations and DABI factors identified by the desktop research (Figure 2, step 2) were discussed with key stakeholders who reviewed and refined them based on their expert knowledge, including identifying other existing or potential MU(s) in a country. A semi-structured interview format was employed to allow themes to arising during the interviews to be explored in more detail (Miles and Huberman 1994), whilst ensuring comparability. Stakeholders were identified at the country level by research partners who had accumulated a large database of MU-related stakeholders, across key international, national or local experts including MU developers, policy-makers, regulators, researchers, NGOs and citizens' representatives. A snowballing approach provided additional contacts. Overall, thirty five stakeholders in six NS countries (BE – 5; DE – 5; DK – 4; FR – 1; NL – 4; UK - 16) were consulted between March 2017 and May 2018. Selection of stakeholders was purposive in attempt to cover NS basin MU combinations and various interest groups (public, private, research, local community and NGOs).

Stakeholders were asked to score the importance associated with a DABI factor, as supporting or obstructing an MU (high priority – 3; medium priority – 2; low priority – 1; not relevant, absent, or I do not know – 0), and; identify most relevant MUs for the NS, based on their own judgement (Figure 2, Step 2.3). The scoring system allowed for a quantitative assessment of MU potential and MU effect. MU potential was arrived at by subtracting the average sum of Barriers by country from that of Drivers by country, as an inidcator of the balance between positive and negative forces for developing that MU. MU effect was arrived at by subtracting the average sum of Impacts by country from that of Added value by country, as an indiactor of the balance between perceived positve and negative impacts derived from developing an MU. While such matrices appear convenient in synthesizing and aggregating the overal signficance of the various DABI factors in relation to MU development, they are only reliable for directional guidance: showing if the balance of factors is negative / positive and by how much.

The research team ranked the list of most relevant MUs provided by stakeholders, as follows: MU combinations indicated as having potential in multiple countries were ranked higher; MU combinations frequently indicated by most stakholders were ranked higher; MUs with a broader scale of application within the basin (e.g., OWF) ranked higher than those confined to narrower scales (e.g., MU with wave or tide combinations). The above criteria aimed to encapsulate the various parameters that could frame MU importance across the sea basin (northern and southern part) and avoid over-representing a single country. The DABI information for every MU and the MU potential and MU effect matrices were collected at the country level before being aggregated and synthesised at the sea-basin level.

To distil lessons and insight as to why MU development and application to date was a challenge and what opportunities lay for the future (Figure 2, Step 3), we applied a critical analysis (see Crotty 1998; Paul and Elder 2002) of the DABI factors, posing new viewpoints, reflection, and asking how and why certain things (behaviour, situations, processes) faciltated or constrained MU. This allowed us to explore how different solutions to the constraints could be constructed; but also how these solutions resulted from a specific form of framing.{ HYPERLINK "http://nonsite.org/article/on-problematization" \l "foot_8-8843" } In most cases it was clear what the signficance or implication of a DABI factor was – given the backgrounds, roles and contexts of the stakeholders who made them. We exercised caution to make sure our interprations were defendable within the DABI statements, to as much as possible avoid introducing what cannot be construed to come from them. The data collected from desk study and stakeholder engagement (workshops, interviews) also helped the researchers understand certain issues and provide a context for insight to be drawn.

3. Results

The results are structured following the objectives set out in the paper, i.e. framing of MU in policy, MU application and further potential, and lessons and insight from NS experience.

3.1 MU framing in policy

No single overarching definition of MU was found. At the NS regional level, no explicit reference to MU was made in the North Sea Region 2020 Strategy (North Sea Commission 2016), although the concept was hinted at in the Strategy's priority of managing maritime space to address existing and increasing pressures from competing use(r)s, to achieve a balance between environmental protection and Blue Growth. The OSPAR Convention Decision 98/3, unintentionally frames MU concept from a constrained position, asking that O&G decommissioned installations be completely removed unless derogation is granted. This could preclude O&G-related MU combinations involving decommissioned/repurposed installations, e.g. 'rigs-to-reefs' (see Jagerroos and Krause 2016), thus framing MU development. No coordinated approach existed in the NS for streamlining MU objectives, targets or mechanisms, either vertically (across policies) or horizontally (across sectors). The documents studied did not reveal any detailed operational guidelines on how to proactively promote the synergistic and efficiency aspects of MU.

At the national level, reference to MU was ad hoc and used various terminologies like 'co-location', 'co-existence', 'multi-purpose platform', 'joined use' or 'multiple use of space'. Often, the terms were absent in national policy or in national marine management plans but present at regional or MSP levels (e.g., France). In other cases, national policy was sectoral (Table 1) and did not proactively promote MU (e.g., Germany). 'Multiple use of space' was mentioned on numerous occasions within the Belgian MSP (2014 Royal Decree) and described as an overarching objective (Ch. 1, 87), with the Germany MSP framework designating priority areas to specific uses, while other uses are not permitted (Schupp and Buck 2017).

Insert table 1

However, the co-existence of uses inside priority areas was feasible. In relation to OWF/Fisheries MU, the German MSP granted fisheries special considerations, but not rights (Schupp and Buck 2017), inside other uses' priority areas. This highlights a power disparity between the two users, with the OWF industry having much larger operations and revenues across Germany than fisheries. In the Netherlands, until 2018, fishing vessels were not allowed to enter OWF zones. However, since May 2018, three OWFs have allowed vessels (under 24m) to enter this space, facilitating MU activities like fishing under certain conditions (National Waterplan 2016-2021) (Ministry of Infrastructure and the Environment and Ministry of Economic Affairs 2015). In Denmark it was envisaged that the MSP under development would mention and address 'multi-use'. The NS nations exhibited various levels of openness to MU application, from more proactive approaches in the UK and Denmark to more low-key approaches like in France and Germany. However, presumptions against the combination of certain activities, especially OWFs and fisheries (Bolongaro 2017), have existed until recently. Only maintenance vessels were allowed within the distance of 500m from OWFs while active fishing was not permitted, although four zones had opened for aquaculture in OWFs in Belgium.

MU is promoted in the Scottish National Marine Plan (Marine Scotland 2015), and the UK Marine Policy Statement (HMG 2011) requires the MSP process to enable the co-existence of compatible activities, e.g., aquaculture and other marine activities. Co-existence was defined in the English East Inshore and Offshore Marine Plans as "including activities in the same area, but vertically or laterally separated", e.g., Carbon Capture and Storage (CCS) with cables and pipelines installed in close proximity to reduce impact upon other users of the marine area (HMG 2014, 106-107). Co-location was defined as including activities in the same space, e.g., an aquaculture farm located inside the OWF zone (MMO 2013). By mentioning O&G decommissioning/repurposing (including wind energy or hydrogen storage or CCS) (Policy CCS2, Articles 337; 339), this is considered a forward-looking MU-friendly policy with practical relevance as the NS hosts several installations to be decommissioned in the next 20 years (Fowler et al. 2018). The 2017 French National Sea and Seashore Strategy Framework prioritised the stimulation of Blue Growth economy via synergies among existing and novel uses without suggesting a clear strategy to do this.

3.2 MU application, barriers and opportunities and further potential

3.2.1 State of art

A total of 10 MU combinations were found to be relevant for the NS, mostly involving 'hard MU' combinations. Hard MUs, mostly in the north, require medium-long term installation of major industrial and engineering infrastructures (e.g., platforms for offshore wind energy production or oil and gas extraction). In contrast, Soft MUs, mostly in the south, involved fleeting use and as such do not demand large infrastructures (e.g., small-scale fisheries, recreation and tourism) (Bocci et al. 2019). MU application in the NS was led by renewable energy and aquaculture, reflecting favourable resource availability (Kalogeri et al. 2017), site bathymetry and conditions, and the influence of technology, policy and regulations at EU, national and local levels. The establishment of OWF, aquaculture, fisheries and tourism sectors meant that there were adequate skills and administrative procedures, familiarity and handling. However, the sectoral procedures were not conducive to MU application given that the spectrum of MU risks, technological and commercial requirements, were vastly different, requiring inter-sectoral collaboration.

No MU was initially commissioned as such: instead, an established first user, e.g., OWF, was granted exclusive rights in an area, followed by the second user, e.g., fishery. Two rationales for MU application were identified: conflict avoidance/enhancing compatibility of activities and achieving/enhancing synergies between activities. Specific funding targeted at MU was limited in the NS although some private actors were investing in MU, e.g., the Colyrut Group in Belgium, funding mussels in OWFs; and Lloyds Registry in the Netherlands, funding health and safety and risk assessments to OWF developers (SOMOS Project). The highest number of existing MU combinations are seen in the UK (4) and Denmark (3). The most relevant MU combinations for the NS were identified as: OWF and aquaculture, OWF and fisheries and OWF and tourism, further described in the overview below (Table 2).

Insert table 2 here

OWF and Aquaculture

This MU involves either the direct attachment of aquaculture installations (fish, shellfish and seaweed) like cages or long-lines to OWF turbine foundations or the co-location of aquaculture installations within the security zone of OWFs (Buck et al. 2017). Barriers relate to the lack of an adequate regulatory framework, an unclear insurance policy framework, as well as risks and difficulties in combining MU technologies (Table 3). The study found a few pilots and no commercial developments. In Belgium, the privately funded and EU-supported EDULIS project studied the feasibility of mussel cultivation within two OWFs.

Insert table 3 here

OWF and Tourism

This MU involves OWFs and tourism activities (boat trips) or joined onshore and offshore infrastructure and operational activities (information centres or museums). Boat tours to OWFs are organised at Thorntonbank in Belgium and several locations in the UK (Rampion, Scroby Sands, and Sheringham Shoal OWFs). In Denmark, diving within the OWF security zone, marketed as 'hunting for treasure' was shown to be an up-and-coming trend, with studies showing positive effects for public acceptance (Wizelius 2007). In the UK, OWF developers provided funds, directed at tourist activities, to local communities. Although intended to win local support for project developments, these funds could inadvertently drive MU by acting as a mechanism for drawing ordinary fishers into the Blue Growth sector. For example, ordinary fishers taking tourists to the OWFs – although the harsh environment in exposed OWF locations and great distances offshore may not be conducive. The DABI highlghts (Table 4).

Insert table 4 here

OWF and Fisheries

This MU had different regulations applying to OWF exclusion zones during the development and operational stages of OWFs. Spatial conflicts with traditional users, such as fishers, ranged from exclusion to the negative socio-economic effects on individual fishers and fishery-dependent coastal communities (Bolongaro 2017). This was found to be of concern in Germany where installed OWFs had grown exponentially (Schupp and Buck 2017). This MU was relevant for sharing space, human resources (e.g., technical staff), infrastructure and other technical resources (e.g., vessel access, port facilities) (Schupp and Buck 2017). In Scotland, commercial fisheries (especially static gears) and OWFs were considered compatible and co-location of their activities was possible. Although policy allowed for the reinstatement of commercial fishing activities after the construction of OWFs, this MU was not identified by stakeholders as having potential for development in the UK.

A 2011 study in Belgium found that fishermen using passive methods could fish in OWF zones under strict legal conditions (Van Koningsveld 2017); as species increased in these zones and could be caught by small-scale passive fishing methods without impacting the sea floor (Blyth-Skyrme 2010). This means that important socio-economic streams can be created when small-scale actors exploit the area within OWFs. Boonstra et al. (2018) also provided evidence of local small-scale fishers economically and efficiently harvesting fish in case studies from Sweden and Norway. Barriers to this MU stemmed from the perceived risk of fishing operations within the OWF, high insurance costs, as well as integrating health and safety (Table 5), and uncertainty regarding the cumulative and in-combination impacts.

Insert table 5 here

3.2.2. MU potential and MU effect

A spectrum of constraints (see Barriers and Impacts) and opportunities (see Drivers and Added vales) for MU application in the NS can be seen in the DABI results of the three most relevant MU combinations (Tables 3, 4 and 5). Most barriers relate to policy, regulations and socio-economic factors, perhaps highlighting where ameliorative interventions should focus. Key barriers included lack of MU-friendly policies, sectoral thinking and burdensome administrative procedures (e.g., separate permits for each use), risk liability and legacy costs. When MU potential was computed, based on DABI scores from stakeholders, the result was near zero (Figure 3a): implying that the forces acting for and against MU application were balanced, with no clear incentives towards MU.

Insert figure 3a here

When MU effect was calculated the result was similarly near zero implying that the stakeholders did not perceive significant net benefits from MU (Figure 3b).

Insert figure 3b here

The greater the MU potential and MU effects, the greater the possibility for MU application to be realised because the driving forces will outweigh those against. Zaucha (2019) argues that such a policy environment can make MUs proliferate and potentially exploit economies of scale and **{** HYPERLINK "https://en.wikipedia.org/wiki/Network_effect" \o "Network effect" **}**, thus becoming a more self-sustaining and mainstream option. However, this convergence will be a challenge because of incomplete information about the full costs and benefits in the MU life cycle.

Moreover, Klinger et al. (2018) argue that poor understanding of the mechanisms for the implementation of integrated policies can hamper applications which require bold inter-sectoral collaboration, such as MU. Because the NS is a contested area, with conflicts rooted in different perceptions, values and attitudes (Kannen 2014), Klinger et al.'s (2018) suggestions of inter-sectoral engagement can help create conducive policy environments where MU potential and MU effects are high enough to drive more MU application.

3.3 Key lessons and broader insights gained by the authors.

From the results we highlight seven key lessons and broad insights: which the NS and other marine jurisdictions can use to reflect towards making MU application mainstream. This acknowledges the complex factors that go into the successful application of MU, while seeking synergistic benefits from various often established, traditional and independent use(r)s which are now required to share the same marine space in a way that they have not done before. First, MU practice is forging ahead of its theorisation whilst remaining a relatively new concept to stakeholders. Current application has pursued a reactive approach of conflict avoidance and mitigation. Notions of synergy and efficiency, acknowledged as key benefits of MU, are yet to be sufficiently elaborated, to make the MU concept easier to appreciate and its benefits more explicit. Second, there were no single agreed MU definition and accounting principles, meaning that calibrating MU practice can be difficult. Yet such principles could facilitate the communication of what MU is doing and achieving.

Third, approaches to MU vary among countries, underpinning how different contextual conditions, degrees of openness to the MU concept, policies supporting MUs and biogeographic conditions, determine MU opportunities and applications. Some countries (UK, Belgium) are more advanced in articulating MU in national and regional MSPs (Table 1); past and existing MU projects are still largely dependent on research grants. However, country-based opposition to certain MU activities, e.g., aquaculture or decommissioned O&G rigs left in situ in the NS (Germany) means that MUs may face different requirements for social license to operate. Countries with a scarcity of marine space (Belgium) and heightening conflicts among use(r)s (Germany, UK), were more inclined towards MU as a rational response. However, sectoral policies could still prove restrictive, even where a strong desire to develop a Blue Growth economy existed. For example, Scottish government policy precluding finfish aquaculture in a large section of the Eastern Coast of Scotland (Marine Scotland 2015) could hinder related MU application. Also, as the multilateral level the OSPAR decision to have clean seabed makes it difficult for countries to permit decommissioned/repurposed related MU applications.

Fourth, countries where MSP process was advanced seemed more aware of issues around MU compared to countries in which the MSP process was less advanced. However, MSP doesn't need to be in place for MU to exist and *vice versa*, although an MSP which explicitly refers spatial sector policies or synergies can underpin the rationale for MU. Fifth, even where stakeholders are open to MU like in the NS, unlocking MU potential requires convincing individual actors using demonstrable data. OWF developers were concerned about barriers in licensing MU and liability risks, meaning that concerted attention should focus on at least addressing their fears if more OWF-related MUs are to become mainstream. While private investment was increasingly getting involved, business stakeholders exhibited scepticism about the risks associated with MU and are keen to first see convincing demonstration of feasibility. However, regulators emphasize the need for clear regulatory guidelines to support practical and technical MU-related procedures (e.g., licencing).

Sixth, in terms of knowledge, there was poor understanding of MU implications for sustainability. Furthermore, stakeholders seemed aware of relatively fewer factors related to MU impacts and added values, indicating that further dissemination and/or research was needed. Nevertheless, MU progress in the UK (e.g., OWF/Tourism), the Netherlands and Denmark (sea gardens), suggested sophisticated consumers or investors not afraid of technological risks (cf. floating wind energy platforms). In terms of future issues, MUs in highly innovative emerging sectors (e.g., involving hydrogen-based energy) were not mentioned by most stakeholders, indicating that most were not aware of the full spectrum of MUs or that some MUs remained niche.

Finally, in terms of methodology, the DABI framework provided a useful systematic approach and tool for mapping and analysing the wide spectrum of factors relevant to MU application. However, a few statements were not clearly elaborated and some DABI factors, e.g., barriers, could be distinguished as either real or perceived, with implications for how to address them. According to

Zaucha et al. (2017), perceived barriers reflected the subjective nature of certain assumptions, attitudes and values of people (Gee 2010); including understanding of certain documents, processes, risks, situations or actors (including persons or entities); traditional single-sector approaches; lack of knowledge due to immaturity of concept; and lack of trust and/or transparency. Addressing them will require differentiated approaches comprising well-informed engagement with relevant stakeholders. Real barriers related to existing conditions or boundaries anchored in regulations, policy or even investment/funding opportunities, addressed through active control and decision-making (policy intervention).

4 Conclusion and recommendations

This paper was motivated by the realisation that despite increasing interest in Multi-use (MU) as a novel approach to the sustainable management of marine space, MU application remained low. Therefore, it was assumed that to make MU application more commonplace, existing barriers should be removed and opportunities for MU enhanced. To exlore how this can be done, this study pursued three objectives, based on experience from the NS. To establish: 1) MU framing in key policy documents (macro-regional, national); 2) MU state of art in terms of application, barriers and opportunities for further growth; and 3) Key lessons and insights to promote MU. This was achieved following a desk-based study supplemented by perspectives from stakeholder engagement.

From the results it is concluded MU application is in its early stages and picking up in the NS; with enough experience to offer lessons and insight that can be reflected upon and used to create a more conducive policy atmosphere for MU. Challenges in framing MU exist, as the MU concept is neither defined nor its principles of synergy and efficiency clearly elaborated. No coordinated attempts to mainstream MU exist, with ad hoc references and no clear implementation strategies or guidelines across national and lower level documents. Nevertheless, the MU concept remains central to the MSP process and is variously referred to as co-location, co-existence, multi-use, among other terms, in various countries.

In terms of MU application, the NS is led by ‘Hard MU’ combinations involving mostly renewable energy and aquaculture. No MU was initially commissioned as such. Instead, an established first user, e.g., OWF was granted exclusive rights in an area, followed by the second user, e.g., fishery. The rationale for existing MUs was to avoid conflict, enhance compatibility of activities and enhance synergies between activities, although no guidance for the latter exist.

Key barriers reside in the governance of the marine sector, where policies signalling MU potential and MU effect were not convincing potential actors in MU application. As MU potential and MU effects were low, from both perceived and real barriers held by stakeholders, a key conclusion is that there currently exists little pull/push factors towards MU. The most promising opportunities lay in interventions (policy, regulatory, administrative policy, incentives, skills, technology) aimed at reversing the barriers and improving overall MU potential/net effect. Whatever policy-makers and regulators do, the opportunities primarily lie in creating an environment where full-life cycle risks are low and the incentives to engage in MU are significant, backed by data from successful trials.

In terms of lessons, each MU was very context-specific, making direct lesson transfer from the NS to another sea basin very difficult. That MUs in the northern part of the NS are very different from those in the south of the NS, is testament to the challenges involved in transferring lessons from one place to another. Therefore, the lessons and insight in section 3.3 should be viewed as useful points for reflection when considering how to create conducive environments for MU application. Given that the NS marine environment presents an energy resource with significant potential for Blue growth, to perceive MU less as a constraint and more as an opportunity, our specific recommendations include:

- defining economic incentives and achieving enough demonstration of MU concept and viability;
- inserting MU-friendly regulations and MU conditions into MSPs and monitoring how they work to facilitate incremental learning;
- capacity building and awareness raising about MU across all stakeholders;
- as NS space is limited agreeing common standards can help address issues of a transboundary nature.

As the differences in policy between the NS countries might provide different starting points for the development of the MU concept: a NS-wide macro-regional policy agenda can acknowledge NS countries' common interests in safeguarding the long-term viability of shared NS resources via MU. This while developing standards and related consenting regimes to expedite MU applications. To address lack of knowledge, poor communication between sectors and, allow for user-driven approaches, efforts at increasing the collaboration of maritime clusters are recommended. This can borrow from a MU community of practice recently formed in the Netherlands, which can be augmented by a Gateway or Portal, to act as a one-stop repository of data on MUs, actors, case studies, funding, and EIAs, for interested parties to tap into.

With the global Blue economy producing $2.5 trillion in marine product per year, and providing a livelihood for 10–12% of the world's population (Koundouri 2014), MU can contribute to the growing interest in how these values can be enhanced in a sustainable way and mitigate conflicts among use(r)s. To this end, this paper has served the purpose of distilling some relevant lessons and insight from the NS, which can focus the minds of those looking to make MU mainstream. Research should explore what parameters and calibrations characterise synergistic and efficiency aspects of various MU applications, start generating data to quantify MU full-life cycle risks and benefits to help convince stakeholders about MU benefit, and create an environment where investors find MU attractive and easy to apply.

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References

Ansong, J., Gissi, E. and Calado, H. 2017. An approach to ecosystem-based management in maritime spatial planning process. *Ocean and Coastal Management* 141: 65-81.

Belgian Royal Decree. https://www.health.belgium.be/sites/default/files/uploads/fields/fpshealth_theme_file/19094275/Summary%20Marine%20Spatial%20Plan.pdf (last accessed 23 May 2018).

Benassai, G., Mariani, P., Stenberg, C. and Christoffersen, M. 2014. Sustainability Index of potential co-location of offshore wind farms and open water aquaculture. *Ocean and Coastal Management*, 95: 213-218.

Blyth-Skyrme, R.E. 2010. Options and opportunities for marine fisheries mitigation associated with windfarms. Final report for Collaborative Offshore Wind Research into the Environment contract FISHMITIG09: https://www.thecrownestate.co.uk/media/5941/ei-km-in-pc-fishing-012010-options-and-opportunities-for-marinefisheries-mitigation-associated-with-windfarms.pdf (last accessed 10 March 2017).

Bocci, M., Sangiuliano, S.J., Sarretta, A., Ansong, J.O., Buchanan, B., Kafas, A., Caña-Varona, M., Onyango, V., Papaioannou, E., Ramieri, E., Schultz-Zehden, A., Schupp, M.F., Vassilopoulou, V. and Vergı´lio, M. 2019. Multi-use of the sea: A wide array of opportunities from site-specific cases across Europe. *PLoS ONE* 14(4): e0215010. https://doi.org/10.1371/journal.pone.0215010.

Bolongaro, K. 2017. Fishermen and wind farms struggle to share the sea, 2017/12/14. https://www.politico.eu/article/fishermen-offshore-wind-farms-struggle-to-share-sea/ (last accessed 29 March 2018).

Boonstra, W. J., Valman, M. and Björkvik, E. 2018. A sea of many colours – How relevant is Blue Growth for capture fisheries in the Global North, and vice versa? *Marine Policy* 87: 340–349.

Boyes, S.J., and Elliott, M. 2014. Marine legislation – The ultimate 'horrendogram': International law, European directives & national implementation. *Marine Pollution Bulletin* 86, (1–2): 39-47.

Buck, B.H., and Langan, R. (eds.). 2017. *Aquaculture Perspective of Multi-Use Sites in the Open Ocean.* Cham: Springer International Publishing AG.

Buck, B.H., Krause, G., Pogoda, B., Grote B., Wever, L. Goseberg, N.. Schupp, M.F et al. 2017. The German Case Study: Pioneer Projects of Aquaculture-Wind Farm Multi-Uses. In*: Aquaculture Perspective of Multi-Use Sites in the Open Ocean,* ed. B. H. Buck., and R. Langan, 253-354. Cham: Springer International Publishing AG.

Christie, N., Smyth, K., Barnes, R. and Elliott, M. 2014. Co-location of activities and designations: A means of solving or creating problems in marine spatial planning? *Marine Policy* 43: 254-261.

Committee of the Regions. 2013. Opinion. Blue growth opportunities for marine and maritime sustainable growth COM(2012) 494 final. Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions.

Crotty, M. (1998). The Foundations of Social Research: Meaning and Perspective in the Research Process. London, Sage Publications Ltd.

Di Tullio, G.R., Mariani, P., Benassai, G., Di Luccio, D. and Grieco, L. 2017. Sustainable use of marine resources through offshore wind and mussel farm co-location. *Ecological Modelling* 367: 34 – 41.

Douvere, F. 2008. The importance of marine spatial planning in advancing ecosystem-based sea use management. *Marine Policy* 32(5): 762-771.

Duck, R.W. 2012. Marine spatial planning: managing a dynamic environment. *Journal of Environmental Policy and Planning* 14(1): 67-79.

ECORYS. 2014. Study on Blue Growth and Maritime Policy within the EU North Sea Region and the English Channel. Final Report FWC MARE/2012/06–SC E1/2012/01 (last accessed 13 January 2018).

Eikeset, A.M., Mazzarella, A.B., Davíðsdóttir, B., Klinger, D.H., Levin, S.A., Rovenskaya, E. and Stenseth, N.C. 2018. What is blue growth? The semantics of "Sustainable Development" of marine environments. *Marine Policy* 87: 177-179.

ENTSO-E. 2017. The Ten-Year Network Development Plan and Regional Investment Plans. **{** HYPERLINK "https://www.entsoe.eu/about-entso-e/system-development/the-north-seas-countries-offshore-grid-initiative-nscogi/Pages/default.aspx" **}** (last accessed 19 February 2019).

European Commission. 2014a. The Ocean of Tomorrow Projects (2010‑2013) - Joint Research Forces to Meet Challenges in Ocean Management. European Commission.

European Commission. 2014b. DIRECTIVE 2014/89/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 July 2014 establishing a framework for maritime spatial planning. *In:* UNION, E. (ed.) *L 257/135*. Brussels: Official Journal of the European Union.

EEA (European Environmental Agency). 2015. The European environment — state and outlook 2015 A comprehensive assessment of the European environment's state, trends and prospects, in a global context. [https://www.eea.europa.eu/soer] (last accessed 11 May 2018).

Fowler, A.M., Macreadie, P.I., Jones, D.O.B. and Booth, D.J. 2014. A multi-criteria decision approach to decommissioning of offshore oil and gas infrastructure. *Ocean and Coastal Management* 87: 20-29.

Gee, K. 2010. Offshore wind power development as affected by seascape values on the German North Sea coast. *Land Use Policy* 27:185–194.

Gee, K., and Kannen, A. 2011. Vision 2030: Towards the sustainable planning of the Baltic sea. BaltseaPlan. Hamburg: Baltic Sea Region Programme 2006-2013.

HM Government. 2011. UK Marine Policy Statement. https://www.gov.uk/government/ publications/uk-marine-policy-statement (last accessed 10 January 2018).

HM Government. 2014. East Inshore and East Offshore Marine Plans. Defra, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/312496/east-plan.pdf (last accessed 10 February 2018).

Hooper, T., and Austen, M. 2014. The co-location of offshore windfarms and decapod fisheries in the UK: Constraints and opportunities. *Marine Policy* 43: 295 - 300.

ICES. 2018. Report of the Workshop on Co-existence and Synergies in Marine Spatial Planning 661 (WKCSMP) in Edinburgh, Scotland. Copenhagen, Denmark.

Jagerroos, S., and Krause, P.R. 2016. Rigs-To-Reef; Impact or Enhancement on Marine Biodiversity. *Journal of Ecosystem and Ecography* 6: 187.

Jansen, H.M., Burg, S.C.D., Bolman, B., Jak, R.G., Kamermans, P., Poelman, M. and Stuiver, M. 2016. The feasibility of offshore aquaculture and its potential for multi-use in the North Sea. *Aquaculture International* 24: 735–756.

Jay, S., Ellis, G. and Kidd, S. 2012. Marine Spatial Planning: a new Frontier? *Journal of Environmental Policy and Planning* 14 (1): 1-5.

Jordan, A., and Huitema, D. 2014. Policy innovation in a changing climate: Sources, patterns and effects. *Global Environmental Change* 29: 387-394.

Kafas, A., Donohue, P., Davies, I. and Scott, B.E. 2018. Displacement of existing activities. In: *Offshore Energy and Marine Spatial Planning* (ed). K. L. Yates, and C.J.A. Bradshaw, 88-112. Abingdon: Routledge.

Kalogeri, C., Galanis, G., Spyrou, C., Dimantis, D., Baladima, F., Koukoula, M. and G. Kallos. 2017. Assessing the European OW and wave energy resource for combined exploitation. *Renewable Energy* 101: 244-264.

Kannen, A. 2014. Challenges for marine spatial planning in the context of multiple sea uses, policy arenas and actors based on experiences from the German North Sea. *Regional Environmental Change* 14: 2139-2150.

Klinger, D. H., Eikeset, A.M., Davíðsdóttir, B., Winter, A-M. and Watson, J.R. 2018. The mechanics of blue growth: Management of oceanic natural resource use with multiple, interacting sectors. *Marine Policy,* 87: 356-362.

Koundouri, P (ed). 2014. *The Ocean of Tomorrow. Investment Assessment of Multi-Use of OffshorePlatforms: Methodology and Applications* - volume 1, Cham, Springer.

Kyriazi, Z. 2018. From identification of compatibilities and conflicts to reaching marine spatial allocation agreements. Review of actions required and relevant tools and processes. *Ocean and Coastal Management* 166:103-112.

Legorburu, I., Johnson, K.R. and Kerr, S.A. 2018. Multi-use maritime platforms - North Sea oil and offshore wind: Opportunity and risk. *Ocean and Coastal Management* 160(15): 75-85.

Marine Scotland. 2015. Scotland's National Marine Plan - A Single Framework for Managing Our Seas. Available at: http://www.gov.scot/Resource/0047/00475466.pdf (last accessed 10 March 2019).

Miles, M. B., and A.M. Huberman. 1994. *Qualitative Data Analysis*. Thousand Oaks: Sage.

Ministry of Infrastructure and the Environment and Ministry of Economic Affairs. 2015. National Water Plan 2016-2021. The Hague, NL: Ministry of Infrastructure and the Environment

MMO (Marine Management Organisation). 2013. Potential for co-location of activities in marine plan areas. A report produced for the Marine Management Organisation. MMO. MMO Project No1010.

North Sea Commission. 2016. *North Sea Region 2020 Strategy*. Gothenburg, Sweden: CPMR North Sea Commission.

Norwegian Ministry of Climate and Environment (2013). Integrated Management of the Marine Environment of the North Sea and Skagerrak (Management Plan). Oslo: Norwegian Ministry of Climate and Environment.

Ocean Energy Forum. 2016. Ocean energy strategic roadmap 2016: Building ocean energy for Europe. Brussels: Ocean Energy Forum.

OGA (Oil and Gas Authority). 2018. Decommissioning strategy. https://www.ogauthority.co.uk/media/1020/oga_decomm_strategy.pdf (last accessed 13 March 2019).

OSPAR. 2010. Quality status report 2010. OSPAR Commission, https://qsr2010.ospar.org/en/index.html (last accessed 22 September 2018).

Paul, R., and Elder, L. 2002. *Critical Thinking*. New York, Prentice Hall.

Schäfer, N. 2009. Maritime Spatial Planning: About the Sustainable Management of the Use of Our Seas and Oceans. In: *Understanding and Strengthening European Union-Canada Relations in Law of the Sea and Ocean Governance,* eds. T. Koivurova, A. Chircop, E. Franckx, E.J. Molenaar, and D.L. Vanderzwaag. Rovaniemi: Finland University of Lapland Printing Centre.

Schupp, M.F., and Buck, B.H. 2017. Case Study 1c: Multi-Use of Offshore Windfarms with Marine Aquaculture and Fisheries (German North Sea EEZ – North Sea). Edinburgh: MUSES Project. https://sites.dundee.ac.uk/muses/wp-content/uploads/sites/70/2018/02/ANNEX-3-CASE-STUDY-1C.pdf (last accessed 10 May 2019).

Scotland Food and Drink. 2018. Aquaculture Growth to 2030 – a Strategic Plan for Framing Scotland’s seas. Scotland Food and Drink, Edinburgh. http://scottishsalmon.co.uk/wp-content/uploads/2016/10/aquaculture-growth-to-2030.pdf (last accessed 22 March 2019).

Stuiver, M., Soma, K., Koundouri, P., van den Burg, S., Gerritsen, A., Harkamp, T. and Dalsgaard N. et al. 2016. The Governance of multi-use platforms at sea for energy production and aquaculture: challenges for policy makers in European seas. *Sustainability* 8(4): 1-19.

Toke, D. 2011. The UK offshore wind power programme: a sea-change in UK energy policy? *Energy Policy* 39: 526-534.

Van Koningsveld, M. 2017. Eco-friendly design of scour protection: potential enhancement of ecological functioning in offshore wind farms. Towards an implementation guide and experimental set-up. https://www.researchgate.net/publication/315589657_Eco- 96 friendly_design_of_scour_protection_potential_enhancement_of_ecological_functioning_in_offshore_wind_farms_Towards_an_implementation_guide_and_experimental_set-up. (last accessed 22 September 2018).

Wizelius, T. 2007. *Developing Wind Power Projects: Theory and Practice*. London: Earthscan.

World Atlas. 2017. Available at: https://www.worldatlas.com/aatlas/infopage/northsea.htm (last accessed 11 March 2018).

Zaucha, J. 2019. Can Classical Location Theory Apply to Sea Space? In: *Maritime Spatial Planning, Past, Present, Future*, eds. J. Zaucha, and K. Gee. London: Palgrave.

Zaucha, J., Bocci, M., Depellegrin, D., Lukic I., Buck, B., Schupp, M., Caña-Varona, M., Buchanan, B., Kovacheva, A. and Karachle, P.K. 2017. Analytical Framework (AF) – Analysing Multi-Use (MU) in the European Sea Basins. Edinburgh: MUSES project.

Figure 1: The North Sea basin (World Atlas 2017). Countries assessed for the purpose of the present analysis are France (FR), Belgium (BE), the Netherlands (NE), Germany (DE), Denmark (DK) and the United Kingdom (UK). Within the framework of the MUSES project Sweden was assigned to the Baltic Sea marine region.

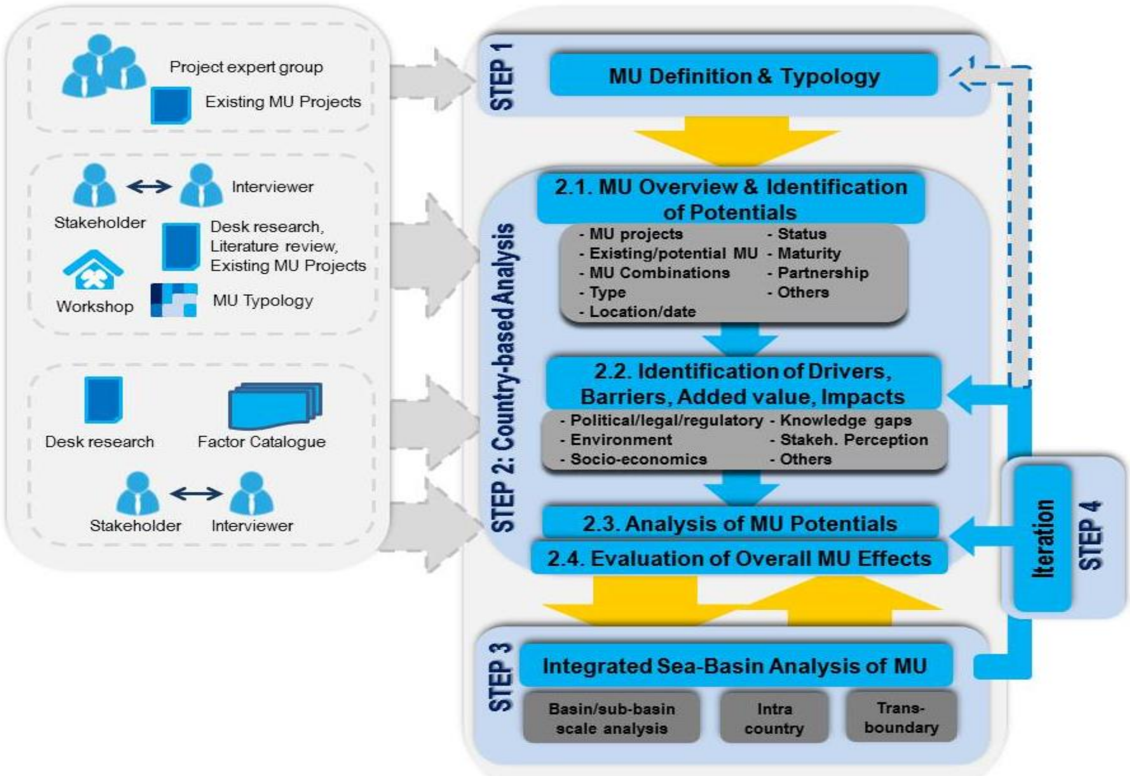

Figure 2: Flow chart of methods used for data collection and analysis (Source: Zaucha et al. 2017).

Table 1. Coverage of MU concept in key documents at various levels by nation.

Country	National policy	Individual administration	Economic incentives	MSP	Strategic documents
BE	YES	YES (Belgian MSP)	YES (Not policy-driven: companies active in driving MU (e.g. Colruyt group)	YES	NO
DE	NO	NO	NO	YES	YES (German MSP)
DK	NO	NO	NO	NO (MSP under development, expected to consider MU)	NO
FR	NO	NO	NO (R&D)	NO (Present at MSP or Integrated Maritime Policy (IMP) and Blue Growth	YES (Planned sector actions (marine renewables))
NL	YES (North Sea 2050 Spatial Agenda)[1]	NO	NO	YES (Annex of National Waterplan addresses MU as an objective)	NO
UK*	YES (Marine Policy Statement, 2011)	YES (Scottish, Welsh National Marine Plans; sub-national/regional plans)[2]	NO (Not as MU but available from sectoral policies)	YES (UK, sub-national, regional Plans)	YES

[1] MU is not directly mentioned but implicitly supported in general and sectoral policies; [2] MU provided for in R&D.

Table 2. Overview of MU combinations in the NS countries (existing and potential).

MU	DE	DK	NL	BE*	UK	FR
OW & Wave						
OW & Environmental protection						
OW & Shipping terminal						
OW & Fisheries	E					
OW & Tourism					E	
OW & Aquaculture						
Wave & Aquaculture						
Fisheries & Tourism & Environmental Protection						
Aquaculture & Environmental protection		E		E	E	
Wave & Tide						
O&G Decommissioning / repurposing						

Grey: Existing (commercial or pilot), past or on-going (indicated with 'E'); **Striped**: Potential (one use in place); **Striped horizontal**: potential (none of the uses in place); **Black**: MU evaluated during desk-based research but not suggested by stakeholders. * In Belgium, 'environmental protection' should be understood as 'coastal protection', i.e. protection against waves, sea level rise and associated risks.

Table 3. OWF/Aquaculture DABI highlighting specific countries (in brackets) where they apply.

Drivers	Barriers
Legislation, Policy • EU: Blue Growth, Renewable energy, Climate change, Fishery policies (Aquaculture strategies) • National & sub-national MSPs • Boat ban in OWFs made aquaculture an attractive economic option (BE) **Socio-economic** • Funding opportunities (R&D) • Successful MU trials • Skilled labor force • Proximity of ports for operations & maintenance • Energy sector players initiating investments (UK) • Demand for seafood products • "Green credentials" for developers • Increased economic potential through cooperation & sharing of resources **Technological** • Advancements in technology **Research** • MU pilots create more value whilst lowering costs	**Legislation, Policy,** • No specific regulatory framework • Policy-makers' & regulators' limited experience with MU • Health & Safety concerns • Lack of tradition for cooperation between sectors • Inconsistent policy-making within countries • Low interest from industry, benefits unclear (DK, BE) • No incentives • Bans, e.g. breeding mussels on commercial scale not allowed (BE); presumption against finfish aquaculture in east coast of Scotland • Lack of political encouragement, legal & planning incentives. **Socio-economic** • Unclear insurance policy • Lack of larger pilots, funding for scaling up • High labour costs for open sea aquaculture • MU finance risks • Opposition to aquaculture (DE) **Technological** • Design and technological risks • Moving aquaculture offshore has added costs • Difficult to make sufficient economies of scale (BE) • Risks & difficulties in combining MU operations (NL) • Suitable sites for MU
Added Values	**Impacts**
Socio-economic • Lower operational costs through shared resources (e.g. vessels, ports) & integration of health and safety **Environmental** • Restocking of fish species; enhanced ecosystem services • Spatial efficiency & decreased human footprint • Green credentials ease obtaining social license to operate (DE).	**Socio-economic** • Tensions & conflicts between users • Increased traffic & navigation risks • Livelihood diversification of certain users (fishers) requires considerable investment **Environmental** • Risk of eutrophication, disease, escapees into the wild • Fishing inside OWFs reduces de-facto protected areas around installations (increasing pressure on benthic ecosystem)

	• Birds attracted by fish waste (bird collisions).

Table 4. OWF/Tourism DABI highlighting specific countries (in brackets) where they apply.

Drivers	Barriers
Policy / regulations • EU & national Blue Growth, Renewable energy, Climate policies • MU pilots (UK) • Key stakeholders showed positive attitude (UK) **Socio-economic** • Funds allocated for integration of tourism with OW (UK) • Existing examples of MU • Income sources	**Policy / regulations** • No permitting system, EIA for MU • Policy-makers and regulators have no experience with MUs **Socio-economic** • Local communities, e.g. fishers might object to OWFs (UK) **Environmental** • Harsh physical conditions in exposed OWFs
Added Values	**Impacts**
Socio-economic • Benefits for rural areas with few livelihood alternatives • Mitigates negative impacts on excluded maritime users – livelihood diversification (UK).	**Socio-economic** • Increased traffic & navigation risks • Certain users (fishers) require considerable investment.

Table 5. OWF/Fisheries showing DABI highlighting specific countries (in brackets) where they apply.

Drivers	**Barriers**
Policy / regulations • EU: Blue Growth policy, Renewable energy policy, Climate policy, Fishery policy • MSP promotes MU • Targets for fish **Socio-economic** • Pilots demonstrate feasibility • Energy sector offering funding for fishers • Revenue and jobs **Technological** • Some fishing techniques are efficient & result in less discards (BE)	**Policy/ regulations** • Integrating Health & Safety concepts is complex • Bottom stirring activities disallowed in OWFs (NL) • Only maintenance vessels for OWF allowed within 500m (BE) • Fishery & sailing not permitted within OWFs (BE, NL) • Unclear insurance policy framework **Technological** • Combining OWF & fisheries structures and operations (NL) • Inadequate data on costs & performance • Risk of damages to infrastructure & insurance cover
Added values	**Impacts**
Socio-economic • Eases obtaining social license to operate for OWF • Lower operational costs; sharing of health & safety concepts • Specific fishing techniques must be used - efficient & less discards **Environmental** • Spatial efficiency frees up areas for other uses • Increased production from MU reduces pressure from wild fisheries • Created refuge helps restock some fish species	**Environmental** • Increased shipping noise, fishing pressure, on benthic ecosystem (DE) • Fishing vessels dump fish waste, attract birds, expose birds to risk

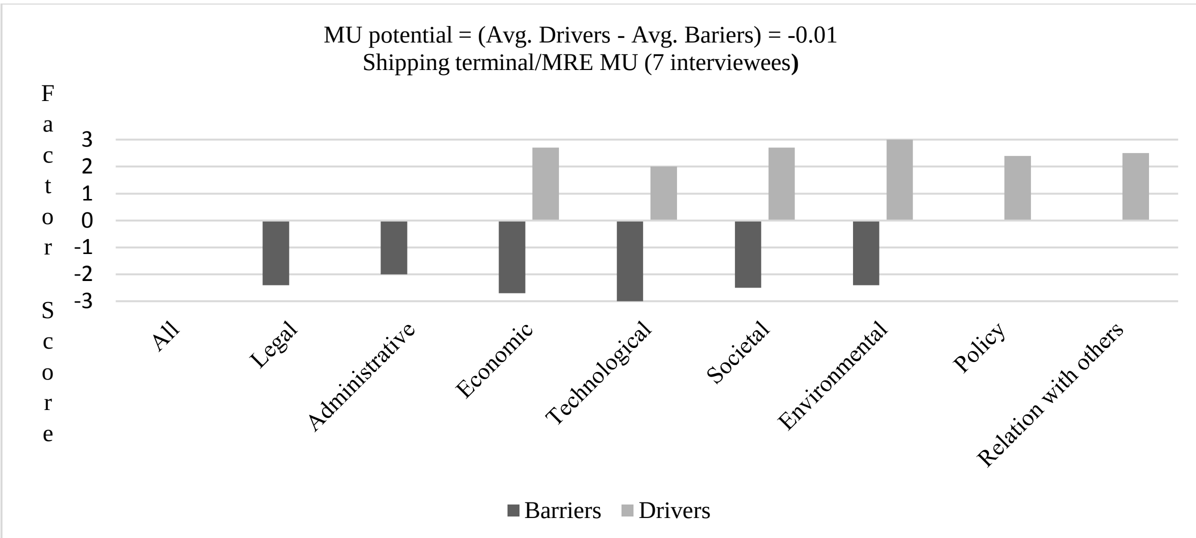

Figure 3a: MU potential: comparison of averages of driver and barrier scores.

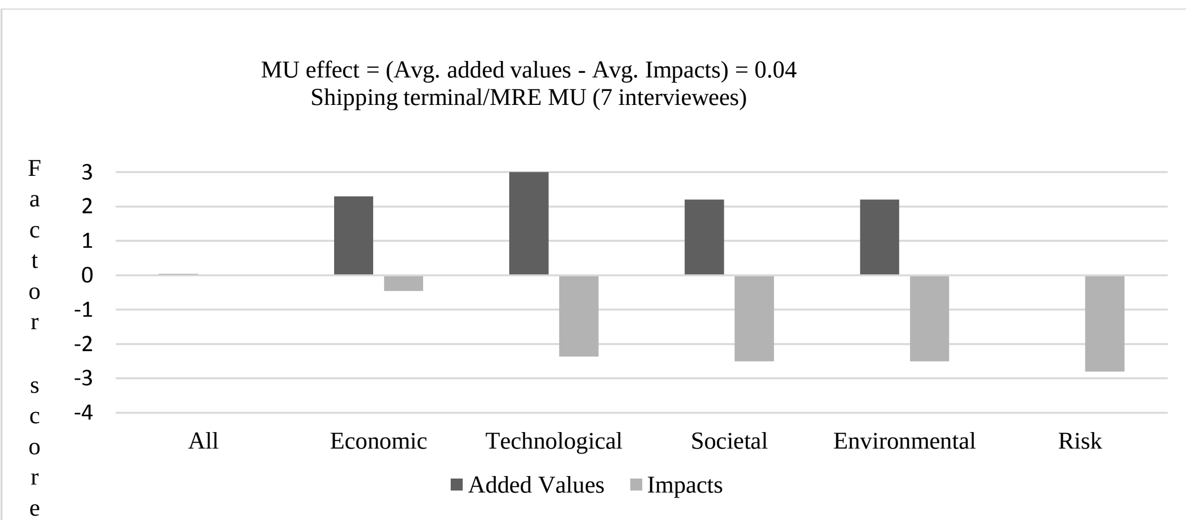

Figure 3b: MU effect: comparing averages of driver and barrier scores.