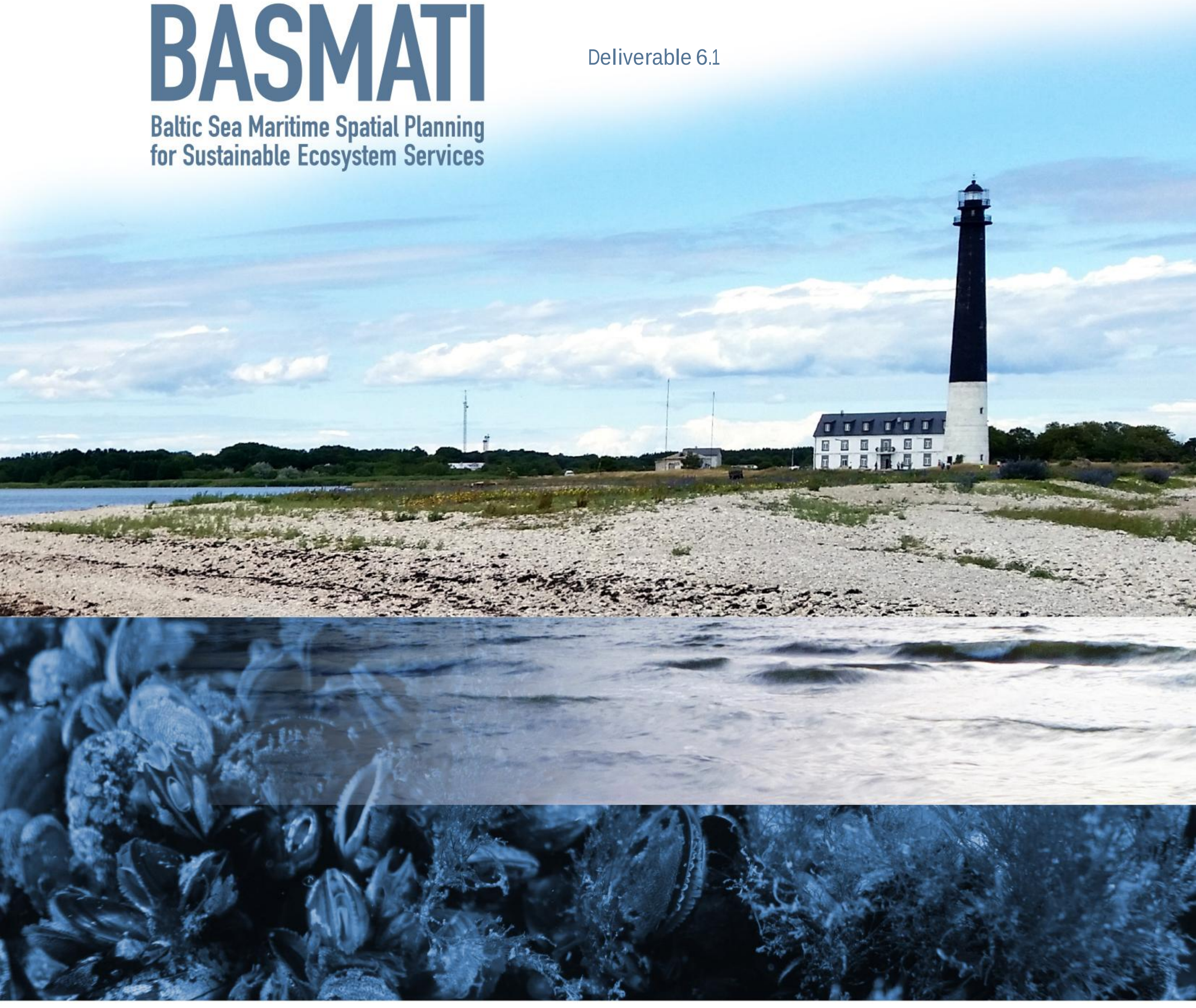
BASMATI

Baltic Sea Maritime Spatial Planning for Sustainable Ecosystem Services

Specification of requirements on data and modelling needs

Deliverable 6.1



BONUS

SCIENCE FOR A BETTER FUTURE OF THE BALTIC SEA REGION

BONUS BASMATI

Specification of requirements on data and modelling needs

December 2017

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Contents

BONUS BASMATI in brief

BONUS call 2015:
Blue Baltic

Project coordinator:
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Project partners:
Aalborg University, Denmark (AAU)
Aarhus University, Denmark (AU)
Finnish Geospatial Research Institute, Finland (FGI)
Latvian Institute of Aquatic Ecology, Latvia (LIAE)
Leibniz Institute for Baltic Sea Research Warnemünde, Germany (IOW)
Nordregio, Sweden (Nordregio)
University of Turku, Finland (UTU)

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Key theme addressed:
Theme 4.3 Maritime spatial planning from local to Baltic Sea region scale

Subthemes:
Theme 2.3 Integrated approaches to coastal management and Theme 4.1 Governance structures, policy performance and policy instruments

https://www.bonusportal.org/projects/blue_baltic_2017-2020

Project abstract:
Maritime Spatial Planning (MSP) requires a spatially explicit framework for decision-making and on that background the overall objective of BONUS BASMATI is to develop integrated and innovative solutions for MSP from the local to the Baltic Sea Region scale. Based on the results of former MSP projects, the BONUS BASMATI project sets out to analyse governance systems and their information needs regarding MSP in the Baltic Sea region in order to develop an operational, transnational model for MSP, while maintaining compliance with existing governance systems. It also develops methods and tools for the assessments of different plan proposals, while including spatially explicit pressures and effects on marine ecosystem services in order to create a spatial decision support system (SDSS) for the Baltic Sea region to facilitate broad access to information. During the project running until 2020, new data will be produced and tested in assessments corresponding to policy goals. The data will support analysis regarding ecosystem services: provisioning, regulating, and cultural services. A central aim of the project is to facilitate cross-border collaboration and the project is carried out in close cooperation with relevant stakeholders in the Baltic Sea Region. The impact of the project will be facilitated and assessed in transnational case studies, where integrated solutions are required. The local scale will consist of case study areas in the South-West Baltic, the Latvian territorial and EEZ waters including open part of the Baltic Sea and the Gulf of Riga, and across the region, a pan-Baltic case study will be performed.

1 Introduction

Maritime spatial planning (MSP) is widely understood as the evidence-based process, which means that planning decisions needs to be based on sound data and information (e.g. Day 2008, Gilliland and Laffoley 2008, Ehler and Douvere 2009, Stelzenmüller et al. 2013). As a consequence, spatial data comprise the backbone of the information needed in the planning process, even though information which is more challenging to present in spatial format should be equally important, such as cultural and social aspects (Shucksmith et al. 2014, Stamoulis and Delevaux 2015, Gee et al. 2017). Issues concerning for example the usability, the inadequacies, and the aggregation of data are considered in many studies which aim to produce information and methodology to support the planning processes (e.g. Halpern et al. 2008, Klain and Chan 2012, Shucksmith et al. 2014, Caldow et al. 2015, Mangubhai et al. 2015, Sullivan et al. 2015, Fiorini et al. 2016). In addition, the dynamic three-dimensional nature of coastal and sea waters require the modelling of multi-level processes and interactions (e.g. Maxwell et al. 2015, Reiss et al. 2015, Hidalgo et al. 2017). Because many studies and projects already concern the MSP data and modelling, this report only shortly summarizes some of the main findings related to the issues relevant to the BONUS BASMATI case studies. Moreover, the project will, in its work package 3, take a closer look at data properties, availability, and consequences to planning.

The focus of this report is on the data and modelling requirements of the BONUS BASMATI project. The project organises three case studies which act as test beds for the decision support system to be created in the project. Therefore, the report highlights the data and modelling needs from the specific case study perspectives. As these three case studies have different thematic scope and spatial range, each of them are shortly introduced and their data requirements are discussed separately. This report and its annexes set the stage for the data identification process. The list of data and modelling needs will be updated and modified as new requirements are identified during the life cycle of the BONUS BASMATI project.

2 Data requirements in MSP

2.1 The role of data in MSP

MSP processes require information usable in policy making. The MSP information should concern current situation (stocktaking), future scenarios and visions as well as policies and planning decisions (Ehler and Douvere 2009). Spatial data is the central element of the MSP decision support systems (Stelzenmüller et al. 2013). In the early phases of the MSP processes, important steps are the assessment and compilation of the information necessary for the process, the development of the user-friendly and transparent tools for visualizing, integrating, and sharing information, and the development of the clear, reliable, and measurable indicators for monitoring (Halpern et al. 2012). Data can be derived from various sources, such as scientific literature, expert scientific opinions or advice, government sources, local knowledge, and direct field measurements (Ehler and Douvere 2009).

The marine environment is essentially a three-dimensional system, which undergoes temporal changes in short and long time frames. Thus the MSP data can be gathered at any spatial and temporal level, at various levels of detail, and it should cover both coastal and marine areas (Ehler and Douvere 2009). In addition, MSP needs information related to land-based activities, infrastructure and loading, such as the port operations or the riverine input of nutrients. The unbounded and dynamic nature of the environment underlines the need for incorporating a transboundary dimension to the MSP planning, regarding e.g. maritime resources, activities, and the interrelations of the environment, and the participants involved as well as the systems of data management, governance, and policy-making (Jay et al. 2016). While the well-established land use planning and rather recent MSP are challenging to unify because of their differing priorities, different institutional and legal frameworks, and different epistemological approaches, the transboundary interactions require these planning systems to cooperate (Kerr et al. 2014).

Because MSP is a future-oriented activity, planning should be able to reveal possible alternative futures, instead of only defining and analysing the existing conditions and maintaining the present state of affairs (Ehler and Douvere 2009). Therefore in the stocktaking phase, obvious trends and developments should be considered in order to be able to estimate spatial pressures in the future. As a consequence, the compilation and mapping of the MSP data are demanding tasks which may require large amounts of time and resources while limiting the resources available for the other important aspects of the spatial planning (Halpern et al. 2012, Collie et al. 2013). MSPs should be commensurate with the available resources (Collie et al. 2013).

However, not all the marine and coastal datasets are useful for marine spatial planning, and therefore data collection should be carefully considered. A general rule is that data should be up-to-date, objective, reliable, relevant, and comparable (Ehler and Douvere 2009). On the other hand, also historical datasets, traditions, and local knowledge are valuable information for MSP, for example in defining the changes of the species abundance, diversity or resilience (e.g. Frans and Augé 2016, von der Heyden 2017). Long-term monitoring programmes are essential for the effective marine management, enabling the adjustments of the management programme, guiding the future planning activities and identifying new research and information needs which may improve the next rounds of the MSP process (Day 2008, Douvere and Ehler 2011). Most of the datasets are spatial, but also nonspatial evidence, such as economic baseline studies, are important, especially when setting the objectives in the early stages of the MSP processes (EASME 2017).

2.2 The MSP data aspects in the EU

A recent study of MSP data examines comprehensively the data and information needs of the EU member states (EASME 2017). Despite the variability in the governance structures and natural surroundings of the member states, there are many similarities in the data requirements regarding the MSP. Some countries are relatively advanced in the MSP and data issues, and some are still in the early phases of the MSP process. The Baltic Sea Region, the target area of the BONUS BASMATI project, is described as a forerunner in transboundary MSP (EASME 2017).

Across all the European Sea basins, there are similarities in the data categories identified relevant to MSP: shipping, energy, mineral extraction, recreation, nature conservation, telecommunications, fishing, underwater cultural heritage, and military. However, differences can be found on the weight given to each sector and, to some degree, of topics included in the data needs of each sector. In addition, there are differences in the level of importance given to the data issues in general. The data needs depend on the planning phase: in the first phase, the stocktaking approach prevails, while in subsequent phases the evidence needs and analyses become more complicated, including the impact assessments, the analyses of the synergies and conflicts, and the inclusion of the future scenarios (EASME 2017).

According to the MSP Data Study from 2016 (EASME 2017), the most significant differences and the most severe shortcomings in the EU member states are the availability of socio-economic and socio-cultural data suitable for the MSP process. Data related to these issues are in many respects missing or not easily usable, which is also a challenge in implementing the ecosystem based approach (EBA). Furthermore, the study indicates that developing the second generation MSP, which requires more analytical information and strategic evidence, has been challenging for the EU member states. The challenges are not dependent on the number of the datasets but the ability to aggregate and interpret the data to fulfil the needs of the planners.

The styles of planning differ in different countries (EASME 2017). One end of the scale is the spatial optimisation and risk minimisation approach. As the focus is on the rational spatial arrangement of the key maritime sectors, the socio-economic evidence of the impacts is less relevant. In the other end of the scale, forward-looking planning includes the elements of participation and aims at integrated economic, social, and ecological objectives. Consequently, the evidence needs in MSP are influenced by the strategic level of the plan, the level of integration pursued, and the degree of stakeholder involvement. The contents of the data infrastructures in the European Sea basins are heavily biased towards describing the state of the environment and the distribution of the human activities while the valuations of social and economic activities regarding the environment are addressed to a much lesser extent.

There are pan-European initiatives, such as INSPIRE (Infrastructure for spatial information in Europe) and EMODnet (European Marine Observation and Data Network), which could provide a solution for the establishing coherence and the harmonisation of the spatial data among the EU member states. EMODnet, for example, provides harmonised transboundary data on some relevant MSP data categories (i.e. bathymetry, geology, seabed habitats, chemistry, biology, physics, and human activities). The HELCOM Map and Data Service (http://maps.helcom.fi/website/mapservice/), on the other hand, is said to be the only data infrastructure including analyses that comprehensively address the interactions in the marine area (EASME 2017).

In general, many information gaps still exist regarding the MSP data availability. Though, as a part of the ongoing Interreg project Baltic LINes (http://www.vasab.org/index.php/balticlines-eu), the HELCOM Map and Data Service is further developed into a new web GIS (geographic information system) application: BASEMAPS. The aim of the new service is to enable searching, viewing, and downloading Baltic Sea GIS data referring to the data needs defined by the HELCOM-VASAB Maritime Spatial Planning Working Group that focuses on the transboundary data issues of the MSP in the Baltic Sea (HELCOM-VASAB MSP WG 2017). In addition, the Baltic Sea - North Sea Marine Spatial Data Infrastructure Working Group analyses the possibilities to share the data of the maritime authorities (HELCOM 2017).

3 Data and modelling needs in BONUS BASMATI

3.1 Case Study 1: Latvia

3.1.1 Introduction to the case study

The Latvian case study aims at the creation of a tool for facilitating the identification of the new off-shore Marine Protected Areas (MPAs) and the re-assessment of the location of the existing MPAs in the MSP context. New MPAs are necessary to ensure the adequate protection of the highly valuable benthic habitats providing wide range of ecosystem services, in particular to ensure the connectivity of the MPA networks on national and international scales. The tool will focus on the assessment of the impacts and value of the alternative sea use options (e.g. a MPA vs. an off-shore wind farm), which will be implemented based on the Multi-Criteria Analysis (MCA) methodology and involving interaction with stakeholders.

The Latvian case study addresses the need for the assessment and comparison of the environmental impacts, costs, and benefits of the alternative sea use options and scenarios in relation to the designation of the MPAs to provide support for discussions with the stakeholders and political decision-making for MSP. The tool could also allow assessing the impacts of the new sea use activities on the benthic habitats, for example identifying the most environmentally sensitive marine areas and further research areas.

3.1.2 Specific data and modelling needs of the Latvian case study

The Latvian case study utilises integrated assessment where spatial data layers on Drivers-Pressures-State-Impacts (DPSI) components are needed. 'State' is characterised by variables related to the benthic habitats. Data about the current abundance of flora and fauna are needed to characterise the present state of the marine and coastal environment. 'Drivers' are human activities using the sea and impacting these benthic habitats, and 'Pressures' are caused by these activities. Hence, spatial information about the current and future human uses of the sea is needed. 'Impacts' are characterised by the ecosystem services provided by the benthic habitats and the human welfare gains (benefits) from these ecosystem services, where data on relevant indicators allowing their assessment are needed.

Existing data systems (e.g. HELCOM Map and Data Service, EMODnet), where countries provide national information regularly, are highly important information sources for a sea region scale information systems and modelling tools. It needs to be ensured that the data are updated and therefore are available over time. Therefore, the case study will aim to utilise such data as much as possible (Annex A). Oceanographical data, seafloor characteristics, and physical-chemical data layers are needed in the identification of the suitable benthic habitat locations. In addition to the observed datasets, the case study will also make use of modelled data, especially, when assessing the environmental impacts in the expected hydrographic conditions of the coming years.

The developed tool will allow modelling changes throughout the DPSI "system" in alternative sea use scenarios to elicit and compare their impacts. Thus, information and assessments for the functional relationships between the DPSI elements are needed for the tool (for instance, how various pressures impact various ecosystem elements and ecosystem services). In addition, the data and information on the costs and benefits of the alternative sea use options and scenarios is necessary for comparing the alternatives and analysing the trade-offs. This information will be compiled based on available and on-going research studies, statistical data sources, and stakeholder involvement.

3.2 Case Study 2: Denmark-Germany

3.2.1 Introduction to the case study

The Danish-German case study investigates opportunities for aquaculture in the south-western Baltic Sea. With eutrophication being one of the main environmental issues in the Baltic Sea, nutrient input and outtake needs to be monitored carefully. Opportunities for aquaculture are limited unless nutrient input is mitigated. Taking advantage of the filtering capacity of mussels, mussel farms can be one option to mitigate eutrophication effects. The focus of the case study is on finding suitable sites for the mussel farming and evaluating these sites based on ecosystem services.

Zoning for aquaculture, in particular mussel farming, will be investigated, based on spatial analysis regarding environmental conditions, human activities and farming specific requirements. Alternative locations will be evaluated in terms of effects on ecosystem services (regulating, provisioning and cultural services) in order to identify most suitable areas. The evaluation of potential sites based on ecosystem services is an integral part of the case study and will form the basis of trade-off analysis.

3.2.2 Specific data and modelling needs of the Danish-German case study

The focus of the Danish-German case study is on finding suitable sites for the mussel farming and evaluating these sites based on ecosystem services approaches. The site selection is a step-wise process: i) suitability by environmental conditions, ii) suitability by co-existing human activities and uses, iii) the environmental effects of aquaculture, iv) and the impacts of aquaculture on ecosystem services.

In order to identify areas where mussels find suitable conditions to grow spatial information about environmental properties is required. Oceanographic data, such as information on the local bathymetry, seafloor characteristics, and physical-chemical properties of the water masses, are needed. Second, information on the spatial reservations for both existing and planned infrastructure (e.g. harbours, wind farms) as well as other human activities and uses (e.g. shipping lanes, dumping sites, and nature protection areas) are required (Annex B). Also, information about farming specific requirements, such as maximum distance allowed to the next harbour need to be obtained.

To estimate the impact of an aquaculture site, data on the present state of the marine and coastal environment and models on ecosystem processes are necessary. For example, information on characteristic flora and fauna or areas with frequent oxygen deficiency are needed. Models on prevailing currents and nutrients flows can then be utilised to simulate the sources and sinks of nutrients and derive the possible effects of aquaculture on the ecosystem. Also, the modelling of the nutrient flows is the basis to estimate at what distance and angle to a fish farm the mussel farms are to be placed to obtain the best solution. A suitable model already exists and has been tested in Limfjorden, Denmark. It consists of a coupled hydrodynamic and biogeochemical model and will be adapted to the potential sites for mussel farming in the south-western Baltic. These modelling efforts require a large amount of biogeochemical data related to concentrations on different forms of nitrogen and phosphorus in water and sediments, as well as other information on the biogeochemistry of the case study area.

To assess the impacts of aquaculture on ecosystem services provided in the respective areas, data on relevant indicators for provisioning, regulating, and cultural services are necessary. The meaningful results of the analysis depend on the appropriate scale and resolution of data. This case-study focuses on alternative site selection on a local scale, but can serve as an example for other areas in the south-western Baltic Sea.

3.3 Case Study 3: Pan-Baltic

3.3.1 Introduction to the case study

The Pan-Baltic case, covering the entire Baltic Sea area, concentrates on international and offshore activities, i.e. maritime tourism and commercial shipping. The aim is to produce information on stakeholder views and requirements concerning the transboundary and cross-border aspects of the maritime spatial planning and the related decision support systems. New knowledge is acquired by questionnaires and interviews which also serve stakeholder involvement and interaction at the Baltic Sea space in a transboundary context.

Tourism and maritime transport differ in terms of spatial requirements and exploitation of marine and coastal ecosystem services (MCES). Both business sectors have synergies and conflicts with other activities using the sea and MCES. The Pan-Baltic case will query, for example, the estimates for the future spatial needs regarding both industry sectors, as well as their conceptions on ecosystem services, MSP, and stakeholder involvement. The focus group will include stakeholders in the Baltic Sea riparian countries and international organizations representing the maritime traffic and tourism in transboundary context.

3.3.2 Specific data and modelling needs of the Pan-Baltic case study

In the Pan-Baltic case study, the basic data needs are in many respects similar to the needs of the other two cases. There is a need to have information on the current human uses and the current environmental status of the sea areas. In addition, there are data requirements related to the MCES linked to tourism and marine transportation. The study will produce new data based on the expert knowledge of the respondents and interviewees. They, on the other hand, will be provided with background data from existing data sources as well as the modelling results of other work packages of the BONUS BASMATI project. Specific to the Pan-Baltic case study is that it emphasises the transboundary and cross-border perspectives as well as the scalability of the data from detailed local assessments to Baltic-wide generalizations.

For both tourism and maritime transport, the issues concerning the use of sea space, the assessment of conflicts and synergies with other sea businesses and sea uses, as well as the issues of safety and security are important. To assess these issues, the information of the present uses as well as estimates of their future developments is required. However, not only the locations of anthropogenic activities are important, but also the intensity of the human influence is relevant in estimating the effects of coexistence of several types of human activities.

The challenge of the transboundary MSP data is the spatial continuity over the state borders and limits of territorial waters. There should be no discontinuities, for example, in planning shipping routes or nature protection areas. While the Baltic Sea region is regarded to be in the forefront of the transboundary MSP data exchange, these processes still needs to be further developed (Backer 2011, EASME 2017). Therefore, a potential challenge of the Pan-Baltic case study is the harmonization of those datasets, which have been collected by different actors by using varying data standards.

Even though transnational MSP data needs are simpler than national data needs in terms of scope and level of detail, there is a challenge to provide data and perform modelling from Baltic-wide datasets. For the most part, the Pan-Baltic case aims to rely on the existing datasets and information from HELCOM and recent projects, such as Baltic LINes and Baltic SCOPE (Nicolas et al. 2016, HELCOM 2017), as well as on decision support systems developed for the Baltic Sea planning processes, such as Baltic Nest Decision Support System (Annex C, Wulff et al. 2013).

However, national, regional, or local datasets are required as well in the Pan-Baltic case. For example, data related to tourism in a transboundary context, needs to be collected and combined from various data sources and types. Transboundary aspects in the Pan-Baltic case include different geographies, administrative borders as well as cross-sectoral issues. Land-sea interactions and borders are another challenge in this case study, especially concerning the coastal and maritime tourism. The emphasis of the Pan-Baltic case is on the activities that are directly connected or affect the coastal and sea waters. The Pan-Baltic case study could benefit from big data resources, such as shipping data tracked by the automatic identification system (AIS) or mobile positioning data describing the movements of tourists.

4 Discussion and conclusions

The wide range of the data and modelling needs of the BONUS BASMATI case studies reflect the high number of different types of information usable in the MSP related processes (Annexes A–C, see also e.g. Ehler and Douvere 2009, Stamoulis and Delevaux 2015, EASME 2017). All the cases require information on the current and planned uses of the sea space and on the restrictions on the use of the coastal and marine environment. A major part of the data needs is about the current situation, indicating that the case studies in many respects address the first phases of long-term, iterative MSP processes. This also reflects the nature of the BONUS BASMATI project which aims to build the scientific basis concerning issues of MSP governance, stakeholder involvement, and ecosystem approach.

The emphases of the case studies differ from the local and regional scale of the Latvian and Danish-German studies to the Baltic-wide needs of the Pan-Baltic case study. The first two rely on the observations and modelling of the physical, biological, and chemical properties of the marine environment, while the Pan-Baltic study primarily requires data on human activities in the sea area and additionally information on marine environment at the general level. Compared with the data and information used by the MSP planners in the EU member states (EASME 2017), the physical, chemical, and biological information as well as the activities and uses of the seascape are emphasized in these BONUS BASMATI case studies. Spatial policies and socio-economic aspects are included according to the specific needs of each case study even though they are not yet specified in the Annexes A-C.

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Annex A

Data and modelling needs of the Latvian case study

Data needed	Time scale	Spatial resolution	Confidence
bathymetry	present state	scale of marine spatial plan / quantitative	observations
geology	present state	scale of marine spatial plan / quantitative	observations
near-bottom temperature	present state	scale of marine spatial plan / quantitative	observations
near-bottom salinity	present state	scale of marine spatial plan / quantitative	observations
near-bottom oxygen	present state	scale of marine spatial plan / quantitative	observations
near-bottom current velocity	present state	scale of marine spatial plan / quantitative	observations
water transparency	variable; past, present, future	local scale	observations
substrate coverage of macrovegetation	present state	scale of marine spatial plan / quantitative	observations
biomass of macrovegetation	present state	scale of marine spatial plan / quantitative	observations
species diversity of macrovegetation	present state	scale of marine spatial plan / quantitative	observations
substrate coverage of macrofauna	present state	scale of marine spatial plan / quantitative	observations
biomass of macrofauna	present state	scale of marine spatial plan / quantitative	observations
species diversity of macrofauna	present state	scale of marine spatial plan / quantitative	observations
substrate coverage of soft bottom macrofauna	present state	scale of marine spatial plan / quantitative	observations
biomass of soft bottom macrofauna	present state	scale of marine spatial plan / quantitative	observations
species diversity of soft bottom macrofauna	present state	scale of marine spatial plan / quantitative	observations
fish catches	present state	1x1km	reports
fish species occurrence	present state	1x1km	reports
fish species abundance	present state	1x1km	reports

fish species population structure	present state	1x1km	reports
occurrence of seabird species	10yr breeding season mean	1x1km	observations
seabird abundance	10yr breeding season mean	1x1km	observations
nitrogen content in benthic biota	present state	scale of marine spatial plan / quantitative	observations
phosphorus content in benthic biota	present state	scale of marine spatial plan / quantitative	observations
carbon content in benthic biota	present state	scale of marine spatial plan / quantitative	observations
primary production of macroalgal species	present state	scale of marine spatial plan / quantitative	observations
growth rates of macroalgal species	present state	scale of marine spatial plan / quantitative	observations
mussel production	present state	scale of marine spatial plan / quantitative	observations
mussel filtration capacity	present state	scale of marine spatial plan / quantitative	observations
nitrogen content in sediments	present state	scale of marine spatial plan / quantitative	observations
phosphorus content in sediments	present state	scale of marine spatial plan / quantitative	observations
carbon content in sediments	present state	scale of marine spatial plan / quantitative	observations
fishing grounds	present use	local scale	expert knowledge
windfarms	present, future next 50yrs	exact	official documents
shipping lanes	present use, future next 10yrs	exact	official documents
oil extraction	present, future next 10yrs	exact	official documents
aquaculture	present, future next 10yrs	exact	official documents
cables & pipelines	present, future next 10yrs	exact	official documents
nature protection sites	present, future next 10yrs	exact	official documents
dumping sites	present, future next 10yrs	exact	official documents

Annex B

Data and modelling needs of the Danish-German case study

Data needed	Time scale	Spatial resolution	Confidence
bathymetry	present	regional scale	modelled data
temperature	present seasonal variations (mean over the past years in the growth season)	regional scale	modelled data
salinity	present seasonal variations (mean over the past years in the growth season)	regional scale	modelled data
oxygen	present seasonal variations (mean over the past years in the growth season)	regional scale	modelled data
chlorophyll	present seasonal variations (mean over the past years in the growth season)	regional scale	modelling, satellite data
bottom velocity	present seasonal variations (mean over the past years in the growth season)	regional scale	modelled data
substrate	present	regional scale	modelled data
abundance of eiders	present seasonal variations (mean over the past years in the growth season)	regional scale	modelling
platforms & wind parks	existing & planned	exact	official reports
extraction sites	existing & planned	exact	official reports
dumping sites	past (munition dumping grounds), existing & planned	exact	official reports
cables & pipelines	past, existing& planned	exact	official reports
shipping	existing & planned	exact	official reports, AIS data
fishing	existing	regional scale	official reports, VMS data, expert knowledge
aquaculture	existing & planned	exact	official reports, expert knowledge
recreation areas	existing	regional scale	official reports, expert knowledge
nature protection sites	existing & planned	regional scale	official reports
(land-based point-pollution)	existing	exact	official reports
locations of finfish farms	existing & planned	exact	official reports

ambient nutrient concentration	present seasonal variations	regional scale	modelling
natural blue mussel abundance	present seasonal variations	regional scale	modelled data
recruitment rate of blue mussels	daily rate (time scale can be chosen by model)	local scale	modelling
growth rate of blue mussels	daily rate (time scale can be chosen by model)	local scale	modelling
mortality rate of blue mussels	daily rate (time scale can be chosen by model)	local scale	modelling
oxygen	initial conditions to be chosen for modelling	local scale	modelling
NO3 concentration	initial conditions to be chosen for modelling	local scale	modelling
NH4 concentration	initial conditions to be chosen for modelling	local scale	modelling
PO4 concentration	initial conditions to be chosen for modelling	local scale	modelling
MePO4	initial conditions (time scale can be chosen by model)	local scale	modelling
MP-C concentration	initial conditions (time scale can be chosen by model)	local scale	modelling
MP-N concentration	initial conditions (time scale can be chosen by model)	local scale	modelling
MP-P concentration	initial conditions (time scale can be chosen by model)	local scale	modelling
detritus-C concentration	initial conditions (time scale can be chosen by model)	local scale	modelling
detritus-N concentration	initial conditions (time scale can be chosen by model)	local scale	modelling
detritus-P concentration	initial conditions (time scale can be chosen by model)	local scale	modelling
zooplankton-C concentration	initial conditions (time scale can be chosen by model)	local scale	modelling
zooplankton-N concentration	initial conditions (time scale can be chosen by model)	local scale	modelling
zooplankton-P concentration	initial conditions (time scale can be chosen by model)	local scale	modelling
pore water O2 concentration	initial conditions (time scale can be chosen by model)	local scale	modelling
pore water NH4 concentration	initial conditions (time scale can be chosen by model)	local scale	modelling
pore water PO4 concentration	initial conditions (time scale can be chosen by model)	local scale	modelling
sed-OC concentration	initial conditions (time scale can be chosen by model)	local scale	modelling

sed-ON concentration	initial conditions (time scale can be chosen by model)	local scale	modelling
sed-OP concentration	initial conditions (time scale can be chosen by model)	local scale	modelling
sed-MePO4 concentration	initial conditions (time scale can be chosen by model)	local scale	modelling
max PO4 uptake rate	daily rate (time scale can be chosen by model)	local scale	modelling
max N quota in MP	time scale can be chosen by model	local scale	modelling
max P quota in MP	time scale can be chosen by model	local scale	modelling
min N quota in MP	time scale can be chosen by model	local scale	modelling
min P quota in MP	time scale can be chosen by model	local scale	modelling
max N remineralisation rate	daily rate (time scale can be chosen by model)	local scale	modelling
max P remineralisation rate	daily rate (time scale can be chosen by model)	local scale	modelling
min P quota in detritus	time scale can be chosen by model	local scale	modelling
Ivlev constant in zooplankton grazing	time scale can be chosen by model	local scale	modelling
max zooplankton grazing pressure at 0 °C	daily rate (time scale can be chosen by model)	local scale	modelling
Ivlev constant in zooplankton mortality	time scale can be chosen by model	local scale	modelling
max zooplankton mortality at 0 °C	daily rate (time scale can be chosen by model)	local scale	modelling
depth of sediment layer	time scale can be chosen by model	local scale	modelling
max P remineralisation rate	daily rate (time scale can be chosen by model)	local scale	modelling
max N remineralisation rate	daily rate (time scale can be chosen by model)	local scale	modelling
min N quota	time scale can be chosen by model	local scale	modelling
min P quota	time scale can be chosen by model	local scale	modelling
sorption rate	daily rate (time scale can be chosen by model)	local scale	modelling
desorption rate	daily rate (time scale can be chosen by model)	local scale	modelling
oxygen threshold concentration	time scale can be chosen by model	local scale	modelling

velocity fields	hourly means or finer (e.g. 1/4 hourly means)	local scale	modelling
blue mussel production	present state, future predictions	local scale	modelling
nutrient reduction by blue mussels	present state, future predictions	local scale	modelling
reduction of algae mats on nearby beaches	present state, future predictions	local scale	modelling
sediment conditions beneath and close to the mussel farm	present state, future predictions	local scale	modelling
scientific studies on blue mussel farming	present	national scale	reports

Annex C

Data and modelling needs of the Pan-Baltic case study

Data needed	Time scale	Spatial resolution	Confidence
administrative borders	present	Baltic scale, national, local scale	official
maritime spatial plan areas	present	national scale	official
seabed relief and bathymetry	present	regional – Baltic-wide	observations / modelling
wind and wave action	present state and future predictions	regional – Baltic-wide	observations / modelling
habitat directive habitats requiring a specific protective regime	present state and future predictions		modelled
Natura 2000 sites	present	local scale	official
marine protected areas	present	local scale	official
marine national parks	present state and future predictions	local scale	official
UNESCO biosphere reserves	present	regional scale	official
military areas	present state and future predictions	local scale	official
munition disposal sites	present	local scale	observations
priority areas for activities	present state and future predictions	regional	official / land use maps
reservation areas for activities	present state and future predictions	regional	official / land use maps
exclusion areas for activities	present state and future predictions	regional	official / land use maps
other management designations	present state and future predictions	regional	official / land use maps
long terms strategies and spatial visions	present state and future predictions	regional / national strategies	reports
population estimates	present state and future predictions	regional - Baltic-wide scale	expert knowledge / reports
density of vacation (summer) residences	present state and future predictions	regional	expert knowledge / reports
IMO routes	present	local – Baltic-wide	official

fairways	present	local – Baltic-wide	official
anchorages	present	local	official
ferry routes	present	local – Baltic-wide	official
port locations	present		official
import/port/year	time-series, present state	million tons	reports
export/port/year	time-series, present state	million tons	reports
depth of port fairways	present state, future plans		reports
underwater noise	present	Baltic-wide	observations/modelling
atmospheric emissions	time-series, present state	regional – Baltic-wide	observations/modelling
emissions to water	time-series, present state	regional – Baltic-wide	observations/modelling
marine litter	time-series, present state	regional – Baltic-wide	observations/modelling
shipping accidents	time-series, present state	regional – Baltic-wide	observations
AIS data	present state (1-2 yrs data)	regional – Baltic-wide	observations/modelling
fishery harbours	present state (1-2 yrs data)	regional – Baltic-wide	official/reports
vessel movements to and from ports	present state (1-2 yrs data)	regional – Baltic-wide	observations/modelling
expected annual ship movements for maintenance	future predictions		reports
recreation and tourism areas	present	local	official
leisure/sporting activity sites	present	local	reports
marinas	present	local	official
distribution of water-related sports/activities	present	local	reports
distribution of tourists (bed nights)	present	local	reports
distribution of accommodation services, number of night's lodging	present	local	reports
underwater cultural heritage/world heritage sites	present	local	official/reports/expert knowledge

underwater parks/diving destinations/ wrecks	present	local	reports
leisure and small boat routes/ movements	present	local	official/reports/expert knowledge
mobile data concerning the movement of tourists	present	local	observations
potential aquaculture areas	future predictions	local - regional	modelled data
important fishery areas	present	local - regional	reports
spatial distribution of fishing activity	present	local - regional	reports
location of existing wind farms	present	local - regional	official
location of existing fish farms	present	local - regional	official
designated aquaculture areas	present	local - regional	
electricity cables and lines, high voltage cables/lines	present	local - regional	official
pipelines	present	local - regional	official
safety zones / construction fields	future predictions	local - regional	official
(energy) platforms	future predictions	local - regional	official
sand and gravel extraction sites	present	local - regional	official
HOLAS II holistic ecosystem health status assessments 2011-2015	present	Baltic-wide	modelled data
Baltic Sea pressure and impact Index	present	Baltic-wide	modelled data
risk areas (collisions)	present	Baltic-wide	modelled data
environmental vulnerability	present	Baltic-wide	modelled data
spawning and nursery areas	present	regional	observations/modelled data

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