Marine Policy 42 (2013) 190–197

Contents lists available at SciVerse ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

A spatial typology for the sea: A contribution from the Baltic

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ARTICLE INFO

Article history:
Received 12 February 2013
Received in revised form
25 February 2013
Accepted 7 March 2013

Keywords:
Marine spatial planning
Land use planning
Sea use planning
Baltic Sea
Classification
Marine typology

ABSTRACT

Marine spatial planning (MSP) has a need for spatial delimitation and for the identification of spatial classes. This paper reports on the findings of a pilot study that was undertaken to test the development of a data informed spatial typology for the Baltic Sea. The Baltic Sea is a comparatively shallow sea with nine adjoining countries and intense anthropogenic activities. The aim of the study was to assess the applicability and value of such a spatial typology for MSP. A spatial typology with seven different spatial classes was identified. The approach used here to identify a spatial typology could be used for seas worldwide.

1. Introduction

Maritime regionalism has a long tradition and is part of many policy documents but with confusion and a lack of accuracy [1]. This is a weakness in the implementation of marine spatial planning which has a strong need for the delimitation of spaces and subspaces in various ways. Marine spatial planning needs not only defined spaces where administrative processes can be handled efficiently, it has a need also for meaningful delimitations of planning areas based on spatial characteristics, spatial connectivity and on relations between areas. In land based planning spatial typologies are often key building blocks in developing plans and in distinguishing areas in need of different types of planning response. It frequently makes distinctions for example between urban and rural areas and central business and industrial districts [2]. Not only do the aims and visions but partly also the tools and mechanisms of spatial planning differ depending on the character of the area worked with. Marine spatial planning has yet no commonly recognized categories such as these. In some examples planning areas are defined by legal/administrative borders only (e.g. Massachusetts, Germany). In England, however, although the Marine and Coastal Access Act 2009 restricts marine plans to be within a single marine administrative region (either inshore or offshore), data analyses of human activities and spatial relations [3] has led in some cases to the development of coordinated adjacent plans in inshore and offshore areas at the same time through a single combined process (e.g. East Inshore & East Offshore planning areas) despite of legal constraints [4]. Obviously therefore knowledge about spatial characteristics can have an impact on the design of planning processes as well as on the content of spatial plans.

In general spatial planning and also environmental management has developed various ways to comprehend and to analyze the characteristics of different spatial structures [5–7]. In particular, during the late 1960s the use of quantitative analysis emerged to assist spatial planning in this way [8]. Since then inter-regional comparisons and spatial typologies based on statistical methods have become common tools [9]. Nonetheless, their use in marine spatial planning is still limited [10]. Recent examples from marine and coastal areas are mainly related to the EU-Water Framework Directive [11] or to coastal typologies with regard to marine planning areas [12]. Further work on spatial typologies is currently being conducted within the European Observation Network for Territorial Development and Cohesion (ESPON) which has recently funded projects compiling spatial typologies [13] and a project exploring European Seas Development Opportunities and Risks (ESaTDOR) which includes the development of a maritime region typology [14].

This paper reports on the findings of a pilot study that was undertaken to test the development of a data informed spatial typology for the Baltic Sea. The Baltic Sea is a comparatively shallow sea with nine adjoining countries and intense anthropogenic activities. The area benefits from a large assortment of data

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http://dx.doi.org/10.1016/j.marpol.2013.03.001

on anthropogenic activities and environmental conditions. The aim of the study was to assess the applicability and value of such a spatial typology for MSP.

The paper starts with a short pen picture of the study site covering its environmental, social and economic characteristics and the current status of MSP related activities in the region. This is then followed by an explanation of the methodology used in the typology development and an account of the study findings. The paper concludes with a discussion of key issues raised by the exercise and the implications for future typology development to promote more sophisticated and place sensitive approaches to MSP.

2. The study site

The Baltic Sea is a semi-enclosed sea covering an area of approximately 387,000 km^2 [15]. Connections to other seas exist via the Danish Straits and Kiel Canal only. Limited inflows of saline water together with strong riverine freshwater inflows result in one of the world's largest brackish water bodies. Salinity gradients from west to east and from south to north (e.g. surface salinities of 20 PSU in the Kattegat and 1–2 PSU in the northern Bothnian Bay) have led to a unique mix of marine and freshwater species, as well as to a few true brackish water species. At the same time the limited exchange of water results in water retention times of up to 30 years—along with the organic and inorganic matter it contains [16]. The Baltic Sea, which is home to more than 85 million people in its catchment area, is due to its geographical, climatological, and oceanographic characteristics highly sensitive to environmental impacts of human activities.

This sea is comparatively small with only very few areas having a distance of more than 50 nm to the nearest coastline which facilitates a high density of anthropogenic activities. Entering or leaving the Baltic Sea 93,057 ships passed the two entrances Skaw and Kiel Canal in 2009 [17,18]. Estimations assume that more than 1.6 million leisure boats of all sizes are used [17]. Commercial offshore fisheries of cod, herring, sprat, and salmon are in decline but these remain significant mainly in the south and central Baltic [19]. Coastal tourism is the most important economic sector of some regions especially in the south-west. Two oil platforms, gas pipelines, various cables, and mineral extraction complete the picture [17]. In light of the European "20–20–20" climate and energy targets [20] and of partly even more ambitious national renewable energy strategies [21–23] the construction of offshore wind farms is currently planned especially but not only for southern and western parts of the Baltic Sea.

The environmental sensitivity of the region together with strong anthropogenic pressures has been recognized by bordering coastal countries for many decades. As a result the intergovernmental Helsinki Commission (HELCOM) was founded in 1980 (based on the Helsinki Convention from 1974, later replaced by the 1992 convention). HELCOM strives for sustainable management of the Baltic Sea and has been strong in assembling and disseminating spatial data related to the area. As a consequence data availability is relatively good in comparison to other European seas.

So far, MSP in the Baltic Sea has been formally implemented only by Germany. Currently Latvia, Lithuania, Poland, and Sweden are preparing for the introduction of marine planning. Denmark, Estonia, Finland, and Russia have no specific legal framework on MSP, but various sectorial regulations rule maritime activities in these countries. The joint HELCOM-VASAB Maritime Spatial Planning Working Group [24] pursues the goal to ensure cooperation among the Baltic Sea Region countries for coherent regional MSP processes in the Baltic Sea. Among others, this includes the search for a common understanding for a Spatial Vision for the Baltic Sea. The region is therefore well placed to develop a data informed typology of marine regions and also to benefit from its production.

3. Methodology/approach

In formulating a suitable methodology for the development of an MSP related spatial typology of the sea, an initial conceptualization of the purpose and scope of such a typology was undertaken. Informed by the ecosystem approach [25] it was considered that such a typology should be able to support MSP ambitions to:

- promote integrated planning and management of human activities;
- support sustainable development of marine resources;
- reflect complex interactions between human activity and the environment including those between the land and sea; and
- draw upon all forms of relevant information.

With this in mind it was considered that the typology should draw together as comprehensively as possible information related to the spatial distribution of anthropogenic uses and claims on the sea itself, environmental impacts associated with human activity and indicators of land based pressures on the marine environment such as population and maritime employment.

3.1. Steps in typology development

In order to formulate a spatial typology for the Baltic Sea a stepped approach was adopted building upwards from single data sets to produce an overall synthesis of the data and a final marine region typology map. The steps were as follows:

1. Selection of datasets
   An initial review was undertaken of available data sets and established indices related to human use of the sea, environmental impacts associated with human activity and land based population and maritime related employment. Suitable data sets and indices were selected for input to the typology based on the following criteria:
   A. *Geographical extent and scale:* to enable complete coverage of the Baltic sea data sets had to cover the region as a whole and be sufficiently detailed, i.e. for land based data at a resolution below NUTS 0 level and for sea based data at a resolution capable of mapping onto a least a 5×5 km^2 grid.
   B. *Spatial reference:* for data to be mapped, it was essential that the original data source came in a GIS-compatible format.
2. Index calculation
   Having identified suitable data sets and where not already present, normalized values for each variable were developed to enable aggregation and production of spatial distribution maps based on at least a 5 km $\times$ 5 km grid system.
3. Production of composite maps
   In order to identify possible relationships between the varying spatial distributions of sea related anthropogenic activity, environmental impacts and landward characteristics, datasets were combined into two composite maps. The first brought together sea based datasets with data related to population density and the second with sea based data sets and maritime employment. From this exercise a judgement could be made about whether landward data sets were relevant for inclusion in the typology.
4. Applying the typology
   In the final stage, a qualitative typology map was created characterizing the varying intensity of human use and pressure on the Baltic Sea.