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Valuing the benefits of improved marine environmental quality under multiple stressors

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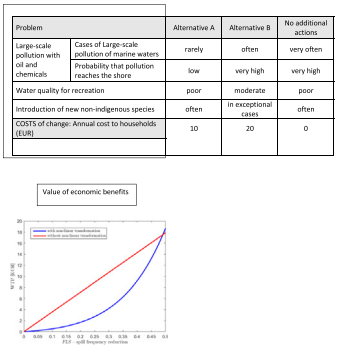
HIGHLIGHTS

- Economic benefits of water quality improvements are estimated.
- The case study used is the Baltic Sea; benefits are estimated for Estonia.
- Multiple stressors approach is used in a discrete choice experiment framework.
- A new approach allowing for non-linear utility function is devised and implemented.

GRAPHICAL ABSTRACT



Problem		Alternative A	Alternative B	No additional actions
Large-scale pollution with oil and chemicals	Cases of Large-scale pollution of marine waters	rarely	often	very often
	Probability that pollution reaches the shore	low	very high	very high
Water quality for recreation		poor	moderate	poor
Introduction of new non-indigenous species		often	in exceptional cases	often
COSTS of change: Annual cost to households (EUR)		10	20	0

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ABSTRACT

Many marine ecosystems are under increasing pressure from multiple stressors. In the Baltic Sea, these stressors include oil and chemical spills from shipping, nutrient run-off from land and the introduction of non-indigenous species. All of these pressures have been growing over recent years. Increasing pressures lead to reductions in environmental quality, which produce negative effects on human well-being. In this paper, the choice experiment method is used to estimate the benefits to people in Estonia resulting from reductions in pressure from multiple stressors in the Baltic Sea. The main results show that, firstly, respondents have a positive, statistically-significant willingness to pay to reduce each of the three stressors analysed. Secondly, the average willingness to pay for the improvement in the quality of all Estonian marine waters to achieve Good Environmental Status is around 65 euro per household per year, with a 95% confidence interval of 48–77 euro. Thirdly, the greatest share of value of this total economic benefit is derived from the willingness to pay for reductions in the risk of large scale oil and chemical spills.

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1. Introduction

The Baltic Sea is often considered to be one of the most polluted seas in the world (WWF, 2011). Baltic Sea ecosystems are impacted by multiple human-derived pressures, such as eutrophication, pollution by hazardous substances, marine transportation, diminishing biodiversity, overfishing, climate change, invasive species, and marine litter (Huhtala et al., 2009; HVM, 2013). Furthermore research has shown that, on average, these pressures act in a synergistic manner, increasing negative impacts beyond what would be anticipated from the addition of independent pressures (Crain et al., 2008; Solan and Whiteley, forthcoming). Thus the combined impact of individual pressures has been a reduction in the environmental quality of many parts of the Baltic Sea (HVM, 2013).

The Marine Strategy Framework Directive (MSFD) was adopted by European Union (EU) in 2008 to improve the protection of European marine areas, which form a foundation for marine-related economic and social activities. The MSFD specifically aims to achieve Good Environmental Status (GES) of the EU Marine waters by 2020 (European Commission, 2012a). The Directive requires each EU country, within the framework of their national marine strategy, to provide an assessment of the state of the environment by 2012 and a Programme of Measures (POM) by 2015 through which they plan to reach the GES target by 2020 (European Commission, 2012b). Such measures are best undertaken when the benefits outweigh the costs of implementing these measures. The MSFD requires impact assessments, such as cost–benefit analysis, on the planned programme. In this context, estimates of the benefits of POM implementation should be articulated in monetary terms in order to be comparable with implementation costs.

The support and/or new requirements for socio-economic analysis under policies such as the MSFD and the HELCOM Baltic Sea Action Plan (BSAP; COWI, 2007) have instigated Baltic Sea-focused environmental economic research on public preferences. These economic valuations of public preferences of various marine related issues have been performed for the purpose of providing input to national and transnational marine policies. Helin et al. (2010) propose a framework for accounting for and valuing the total benefits that society derives from the Baltic Sea, through its ecosystem services. While they found that no single valuation method could sufficiently account for the range of values, they note that it is possible to combine stated and revealed preference methods to supplement market value estimates. The transnational study of environmental valuation performed by Ahtiainen et al. (2014) assessed stated public preferences using willingness to pay (WTP) for the management of eutrophication and related distributional effects. Another transnational study by Czajkowski et al. (2015) estimated the change in the value of recreational benefits linked to changes in perceived water quality of the Baltic Sea.

To date, no study has assessed the economic value to Estonian society of changes linked to specific stressors in Estonian marine waters in order to achieve Good Environmental Status. Such benefit calculations are called for in the context of MSFD POM. This paper, therefore, examines the monetary benefits to society of improving the environmental quality of the marine environment which is subject to multiple pressures which have been increasing over time. We focus on the economic benefits of achieving the GES levels by 2020 for the specific MSFD descriptors of eutrophication, concentrations of contaminants (in connection with risk of large-scale oil spills), and the introduction of non-indigenous species, all of which are considered to be among the problems considered significant for the Baltic Sea (HVM, 2013). These three concerns were also considered relevant for Estonian marine waters according to the expert assessment performed as a part of the process of developing Estonian POM for MSFD (SEI Tallinn et al., 2016). This research estimates the monetary benefits of improvement measures for these three issues through a stated preferences study applied to the entire Estonian marine area. The analysis assesses people's attitudes towards the environmental quality of the Estonian marine waters, specifically their preferences for alternative policy options for improving the quality to the GES levels specified by the MSFD.

2. Environmental problems of the Estonian marine area

The Estonian marine area includes the Gulf of Riga, the Gulf of Finland, the Moonsund Archipelago, as well as Estonian open waters of the Baltic Proper (Fig. 1). Despite some differences between these basins, they share three main environmental concerns — the risk of large-scale oil and chemical spills and pollution, eutrophication and the introduction of non-indigenous species.

2.1. Risk of oil and chemical spills and pollution

The Estonian Initial Assessment for the MSFD concludes that in terms of contamination with hazardous substances, including oil, the state of Estonian waters is “good” in the context of GES, especially compared to other regions of the Baltic Sea (TÜ EMI, 2012). However, the challenging geography of the Baltic Sea (narrow straits, shallow areas, winter ice cover in the Gulf of Finland) combined with heavy and increasing maritime traffic between its busy ports means an increasing risk of major pollution accidents (HELCOM, 2010).

In general, the number and size of ships has increased and is rising. Of the approximately 2000 ships in the Baltic Sea at any one time, about 20% are oil tankers which can carry up to 150,000 Mg of oil and are considered high risk. Furthermore, the amount of Russian oil exported through Baltic ports is expected to reach 180 million Mg in 2020 due to improved capacity of Russian oil terminals. Tankers coming from these Russian oil terminals must pass through the Gulf of Finland to get to other oil terminal ports in the Baltic Sea. While no major oil spill has taken place since 2004, 120–140 shipping accidents take place in the Baltic Sea annually (HELCOM, 2009d). These numbers have increased along with traffic. Tankers account for around 10–15% of the ships involved in accidents. Furthermore, while many tankers are now double hulled, at least two of the 21 tankers involved in accidents in 2012 were single hulled and the hull type for 43% of the tankers involved in accidents is unknown (HELCOM, 2014a). In addition to oil, cargo ships carrying hazardous substances, such as chemicals, also pose a risk (HELCOM, 2010).

There are two aspects of oil and chemical spills which are particularly relevant to this paper. The first is the risk of large-scale oil and chemical spills: the potential frequency or likelihood of a spill which impacts marine waters. Secondly, there is the potential for the oil and chemicals released by such a spill to pollute the coastline.

Possible measures to reduce the risk of oil and chemical pollution of marine waters include traffic control measures, such as entering into international agreements to improve traffic safety and enhancing traffic control in the Baltic Sea and the Gulf of Finland. Currently, Estonia is a member of the International Maritime Organization as well as the Helsinki Commission, and additionally has a bilateral agreement with Finland on the Cooperation in Combating Pollution in the Marine Environment.

In order to reduce the number of cases of oil and chemical coastal pollution, a number of potential measures can be implemented such as the earlier detection of marine pollution incidents and increased capacity to halt the spread of spills and treat pollutants in the sea once an incident has occurred. This can include measures such as training of all relevant authorities and volunteers, studies on safer operating methods, providing instructions and guidelines on rescue preparedness and rescue operations, and the purchase of new vessels and aircrafts for monitoring (SEI Tallinn et al., 2016). Estonia's capacity for dealing with oil spills is limited to four oil response vessels and equipment, which can be supplemented with smaller oil combating vessels owned by the major ports (Estonian Police and Border Guard Board, 2016). In regards to the “hazardous and noxious substances” type of marine pollution, the current capacity is considered very limited in terms of monitoring