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Understanding the distribution of economic benefits from improving coastal and marine ecosystems

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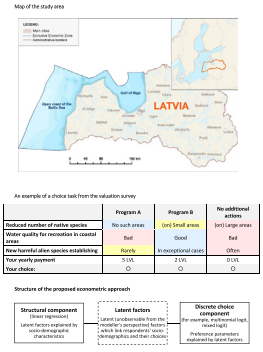
HIGHLIGHTS

- Estimates of welfare benefits from better environmental quality of the coastal and marine waters of Latvia are provided.
- Variation in the benefits related to differences in their socio-demographics is identified.
- A novel approach to account for differences in individuals' preferences using their characteristics is proposed.
- Latvians are willing to pay for protecting biodiversity, and reducing eutrophication, and occurrences of invasive species.
- We observe substantial heterogeneity in values placed on water quality improvements.

GRAPHICAL ABSTRACT



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ABSTRACT

The ecological status of coastal and marine waterbodies world-wide is threatened by multiple stressors, including nutrient inputs from various sources and increasing occurrences of invasive alien species. These stressors impact the environmental quality of the Baltic Sea. Each Baltic Sea country contributes to the stressors and, at the same time, is affected by their negative impacts on water quality. Knowledge about benefits from improvements in coastal and marine waters is key to assessing public support for policies aimed at achieving such changes. We propose a new approach to account for variability in benefits related to differences in socio-demographics of respondents, by using a structural model of discrete choice. Our method allows to incorporate a wide range of socio-demographics as explanatory variables in conditional multinomial logit models without the risk of collinearity; the model is estimated jointly and hence more statistically efficient than the alternative, typically used approaches. We apply this new technique to a study of the preferences of Latvian citizens towards improvements of the coastal and marine environment quality. We find that overall, Latvians are willing to pay for reducing losses of biodiversity, for improving water quality for recreation by reduced eutrophication, and for reducing new occurrences of invasive alien species. However a significant group within the sample seems not to value environmental improvements in the Baltic Sea, and, thus, is unwilling to support costly measures for achieving such

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Socio-demographic characteristics
Hybrid choice model

improvements. The structural model of discrete choice reveals substantial heterogeneity among Latvians towards changes in the quality of coastal and marine waters of Latvia.

1. Introduction

Across the world, coastal and marine water bodies are adversely impacted by a range of stressors resulting from human activities (Halpern et al., 2008; Crain et al., 2009; Korpinen et al., 2012; Solan and Whiteley, 2015). These stressors include nutrient inputs from farmland due to fertilizer applications and livestock wastes, industrial sources, and sewage inputs (Hunter et al., 2012). Introductions of new invasive alien species, which are often brought in ships' ballast waters, constitute another stressor threatening marine ecosystems (Occhipinti-Ambrogi and Savini, 2003). For one major regional waterbody – the Baltic Sea – excessive nutrient inputs, invasive alien species and loss of biodiversity have been identified as factors that substantially undermine its environmental quality and prevent the nine countries which border the Baltic Sea from achieving Good Environmental Status (GES) for the coastal and marine waters under their jurisdictions (Leppäkoski et al., 2002a; Leppäkoski et al., 2002b; Paavola et al., 2005; HELCOM, 2009, 2010).

The environmental quality of the Baltic Sea is particularly endangered by human activities because of an interaction of two effects. First, the sea is surrounded by nine countries whose population density is particularly concentrated in coastal areas and which extensively (and often unsustainably) use marine waters. Second, water exchange is substantially limited due to the very narrow and shallow oceanic connection. The semi-enclosed character of the Baltic Sea basin fosters the accumulation of nutrients and hazardous substances. The adverse impacts of these factors on this marine ecosystem has been acknowledged for many years (as the latest HELCOM report (2016) mentions, "hazardous substances have been on HELCOM's agenda since the late 1970s"), and the Baltic Sea has been identified as one of the most threatened marine environments in the world (WWF, 2011). All nine Baltic Sea countries could benefit from improvements to water quality (for instance, in terms of enhanced recreation opportunities). Improving the quality of the Baltic Sea is thus an important regional environmental management problem, but one which requires coordinated actions by many nations.

In 2008, the European Commission (2008) issued the Marine Strategy Framework Directive (MSFD), providing a regulatory framework aimed at effective protection of the European Union (EU) marine waters. The major objective of the MSFD is the attainment of Good Environmental Status (GES)[1] in marine waters of EU member states by 2020. What constitutes GES is determined by member states according to the qualitative descriptors provided in the MSFD. When divergence between the actual condition of the marine environment and GES is expected, appropriate measures need to be undertaken. Every member state must have developed a program of measures for achieving GES by the end of 2015 and update it every 6 years. In order to support the selection of the appropriate measures, the MSFD requires countries to undertake impact assessments, which may include the use of cost-benefit analysis (European Commission, 2008; CIS, 2014).

The aim of this paper is to understand and quantify how the economic benefits from improving the environmental status of the Baltic Sea vary across people within a country, since this will partly determine political support for costly measures to improve water quality. We take the example of Latvia and examine the preferences of Latvian citizens towards the improvements of coastal and marine waters. While the fundamental aspects of the marine environment for which improvements are needed can be easily identified, and while the costs of the improvement actions can be readily estimated (e.g., Wulff et al., 2014), the valuation of the benefits from undertaking these actions is challenging. This is mainly due to the fact that most of these benefits are not valued by the market. To assess the value of improvements for the potentially-benefiting population of Latvia, we employ the stated preference discrete choice experiment (DCE) method. A representative sample of 1247 Latvian citizens is utilized. In addition to economic benefit estimates, the DCE approach allows one to identify which aspects of improvements are considered most important by respondents. To capture the multidimensionality of the coastal and marine waters improvements, survey respondents are asked to state their preferences towards avoiding reductions in marine biodiversity, having better water quality for recreation, and limiting new occurrences of invasive alien species.

Additionally, this paper addresses the problem of modelling the observed preference heterogeneity. "Preference heterogeneity" describes the way in which the values which people obtain from environmental improvements (or indeed any other kind of benefit) vary across a population. We use this study to illustrate a new method of accounting for variability in preferences related to observable differences in socio-demographic characteristics of respondents. The approach we propose is more statistically efficient than the typically used "two-step" approaches, because we simultaneously estimate the links between socio-demographic characteristics and latent (unobservable from the modeler's perspective) factors, and the links between these latent factors and respondents' preferences. This allows a quantification of how the benefits of improvements to GES vary across the sample of respondents, and by inference, across the population.

2. Previous studies on valuation of the Baltic Sea environment

One of the major threats to the Baltic Sea is eutrophication, and this problem is addressed in several studies. Eutrophication occurs because of excess nitrogen and phosphorus inputs to waterbodies from detergents, fertilizers, livestock wastes and sewage. The economic value of reductions in eutrophication has been measured in the Stockholm archipelago of Sweden (Söderqvist and Scharin, 2000) and in Lithuania, Poland and Sweden (Markowska and Żylicz, 1999), as well as over the entire Baltic area (Ahtiainen et al., 2014). All these studies employ the contingent valuation method to evaluate various improvement scenarios related to reduced eutrophication. DCE have also been used to assess the value of changes to the Baltic Sea with respect to other characteristics of the marine ecosystem. Eggert and Olsson (2009) carry out a survey among residents on the west coast of Sweden to estimate the welfare benefits of improved coastal water quality which is described in terms of the coastal cod stock level, bathing water quality and a biodiversity indicator. Kosenius (2010) examines the willingness to pay (WTP) of citizens for better water quality in the Gulf of Finland, and considers improvements with regard to water clarity, the abundance of coarse fish, the status of macro algae such as bladder wrack, and the occurrence of blue green algae blooms. Kosenius and Ollikainen (2015) evaluate actions undertaken within the Baltic Sea Action Plan in the areas of the Finnish-Swedish archipelago and the Lithuanian coast, which aim at healthy aquatic vegetation, conservation of currently pristine areas, and the protection of fish stocks. Karlõševa et al. (2016) look at the preferences of Estonian households between developing offshore sites into wind farms or establishing marine protected areas. Tuhkanen et al. (2016) investigate how Estonians evaluate reductions

[1] The MSFD defines GES as "the environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive within their intrinsic conditions, and the use of the marine environment is at a level that is sustainable, thus safeguarding the potential for uses and activities by current and future generations" (European Commission, 2008, art. 3(5)).