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Analysis

Estimating the Benefits of the Marine Strategy Framework Directive in Atlantic Member States: A Spatial Value Transfer Approach

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A R T I C L E I N F O

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A B S T R A C T

This paper uses a combination of the contingent valuation method (CVM) and value transfer (VT) to estimate the value of non-market benefits associated with the achievement of good (marine) environmental status (GES) as specified in the EU Marine Strategy Framework Directive (MSFD) for Atlantic member states. The increased use of geographic information systems in VT means that many VT exercises now include spatial elements such as distance decay and population density. This paper explores impact of distance decay on welfare estimates as well as the impact from the modifiable area unit problem (MAUP) when population density is included as an explanatory variable. These issues can have a large effect on a VT estimate. In this study the overall value for achieving GES for Atlantic member states varied between €2.37billion and €3.64 billion. It was found that the different distance decay specifications changed values between −3% and 82% with a mean absolute difference of 25% and by adjusting the spatial scale in an effort to overcome the MAUP changed aggregate values between 13% and 25% with a mean of 17%.

1. Introduction

The EU Marine Strategy Framework Directive (MSFD) requires member states (MSs) to achieve GES by 2020 in their marine waters by enacting a marine strategy. This marine strategy will be composed of a programme of measures that will improve different aspects of the state of the marine waters as measured by 11 descriptors. Bertram and Rehdanz (2012) note that the MSFD requires that these measures should be cost-effective. MSs will have to assess the social and economic impacts of new measures which should include conducting cost-benefit analyses. MSs may delay or not achieve GES, if the cost of the measures needed are disproportionate. Additionally, the MSFD calls for a social and economic analysis as part of the initial assessment and consideration of social and economic impacts when setting environmental targets. While costs are thought to be easier to estimate for measures, many of the benefits generated by the MSFD will be non-market goods and services (Bertram and Rehdanz, 2012).

Non-use values attached to changes in the marine environment have been previously found to constitute a significant proportion of the total economic value of the benefits produced by changes to marine and coastal environments (Luisetti et al., 2010; McVittie and Moran, 2010). It is expected that the non-use values arising from the introduction of the MSFD will also form a considerable portion of its benefits (Bertram and Rehdanz, 2012). The contingent valuation method (CVM) has been widely used in the valuation of environmental goods and services or for changes to the environment (Darling, 1973; Carson and Mitchell, 1989; Hanemann et al., 1991; Alberini et al., 2005; Bateman et al., 2006; Abdullah and Jeanty, 2011). The method was first used by Davis (1963), and has increased in popularity since a blue ribbon panel in the United States validated its use (Arrow et al., 1993). The CVM estimates values of a non-market good or service by presenting respondents with a hypothetical situation in a survey format. The name of the valuation method derives from the values being 'contingent' on the respondent's willingness to pay (WTP) or willingness to accept (WTA) a change to the good or service being valued.

However, using primary valuation methods such as CVM can be costly and time-consuming. An alternative approach is value transfer (VT) also known as benefit transfer (BT) (Brouwer, 2000; Navrud and Ready, 2007; Johnston et al., 2015). A value transfer occurs when an estimated value, based on original studies (study sites), is transferred to a new application (policy site) (Boyle et al., 2010). This secondary valuation technique negates some of the problems with primary valuation as identified above; namely cost, time and complexity (Rosenberger and Loomis, 2003) but has the disadvantage of the VT practitioner not knowing how close to the actual value they have estimated, the difference known as the transfer error. As well as being time and cost efficient, VT's other advantage is that it can be applied on a scale that would be practicably unfeasible for primary research studies

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in terms of valuing large numbers of services across multiple ecosystems (Troy and Wilson, 2006; Brenner et al., 2010; Plummer, 2009; Hynes et al., 2013). This has been enabled by the recent combination of the VT method with GIS (Geographical Information Systems). The use of GIS in VT had been advocated by some (Lovett et al., 1997; Bateman et al., 2002; Boutwell and Westra, 2013) as a way of improving VT and lowering transfer errors by including more socio-economic characteristics, allowing for spatial differences in preferences or allowing for substitute sites.

This paper explores two issues arising from using spatial methods with VT that can affect the resulting value estimates; the functional form of distance decay measure and the modifiable area unit problem (MAUP). Distance decay is a well-known concept within the non-market valuation literature (Sutherland and Walsh, 1985; Pate and Loomis, 1997; Loomis, 2000; Hanley et al., 2003; Bateman et al., 2005; Bateman et al., 2006; Kniivilä, 2006; Moore et al., 2011; Schaafsma et al., 2013; Jørgensen et al., 2013) and occurs where values tend to decline as one moves further from the site being valued. However, some studies also note that the spatial pattern may not be a monotonic continuous function such that values may be distributed heterogeneously (Campbell et al., 2009; Johnston and Ramachandran, 2014).

The MAUP is a well-known phenomenon in geography (Openshaw and Taylor, 1979; Goodchild et al., 1993; Dark and Bram, 2007), in political science (Darmofal and Strickler, 2016) and to a lesser extent in the economics literature (Doll et al., 2006; Briant et al., 2010; Arbia and Petrarca, 2011). This is the first study to examine the impact of the MAUP on VT. The MAUP arises due to the use of modifiable areal units in quantitative analysis (Openshaw and Taylor, 1979). The arbitrary nature of how spatial data at individual level (or in the form of points) is aggregated and how the results of such analysis are influenced by both the shape and scale of the aggregation and the arbitrary spatial basis of the data used is known as the MAUP (Openshaw, 1984).

The MAUP occurs through two effects; (1) the scale effect when aggregation of high resolution (i.e. a large number of small areas) data to a lower resolution (i.e. a smaller number of larger areas) and (2) the zoning effect where spatial units to which the higher-resolution data are aggregated are arbitrarily created by some decision-making process and represent only one of an almost infinite number of possible constituencies (Reynolds, 1999). This latter issue creates the gerrymandering problem in political science (Wong, 2009). The MAUP issue in this paper is explained in more detail in Section 3.

This paper adds to the marine valuation literature by using the CVM to estimate the value of the non-market ecosystem service benefits associated with the achievement of GES as specified in the EU MSFD and it is the first paper to highlight the MAUP in VT. A “value function transfer approach” based on the CVM results of achieving GES is employed to transfer values to five EU Atlantic MSs. The paper also explores the differences arising from how distance decay is specified in the VT function.

In what follows, Section 2 provides a brief review of marine valuation studies, the description of the MSFD and its requirement for economic valuation and VT. Section 3 outlines the spatial issues addressed in this paper. Section 4 describes the CVM that is used to estimate the value of achieving GES in Irish marine waters and the VT methodology. Section 5 details the results and finally the discussion and conclusions are presented in Section 6.

2. The Marine Strategy Framework Directive and Marine Environmental Valuation

The MSFD (2008/EC/56) requires that EU MSs achieve GES by 2020 in their coastal and marine waters. GES is measured using 11 descriptors. When all 11 descriptors are at good status then the marine region/sub-region will have achieved GES. Achieving GES will be met by protecting, maintaining and preventing deterioration of the marine ecosystems and also by preventing polluting inputs being introduced into the marine environment. These targets are to be achieved by developing and implementing measures that will manage human activities to ensure a balance between sustainable use of the waters and conservation of marine biodiversity (Long, 2011).

The MSFD builds on previous EU legalisation in the environmental area such as the Water Framework Directive (WFD) (2000/60/EC). The MSFD complements the efforts of the WFD within coastal water bodies where the two Directives overlap by allowing for interaction of management plans. MSFD does not apply to transitional waters which are solely covered by the WFD. This process may not be seamless. Borja et al. (2010) have identified some potential conflicts between the two directives due to issues of spatial application.

A number of commentators, including the EU Commission, have found deficiencies in the manner MSs developed marine strategies and the lack of co-ordination between MSs leading to lack of coherence in what GES is, even within the same regions/sub-regions and noting the lack of ambition in the programme of measures announced to-date (EC, 2014; Hanley et al., 2015; Oinonen et al., 2016). The deficiencies could be considered a fulfilment of the concerns highlighted by some (Long, 2011; Van Leeuwen et al., 2012) of the willingness of MS to implement the MSFD and improve the status of their marine waters. Most recently this has led to a revision in how GES is measured (EC, 2017)

Four main requirements have been identified within the MSFD by Bertram and Rehdanz (2012) that require valuation of the benefits generated by the MSFD. These are:

- An initial assessment of a Member States' marine waters, including economic and social analysis (ESA) of the use of those waters, and of the cost of degradation of the marine environment (Art.8.1(c) MSFD).
- Establishment of environmental targets and associated descriptors describing GES, including due consideration of social and economic concerns (Art.10.1 in connection with Annex IV, No. 9 MSFD).
- Identification and analysis of measures needed to be taken to achieve or maintain GES, ensuring cost-effectiveness of measures and assessing the social and economic impacts including cost-benefit analysis (Art.13.3 MSFD).
- Justification of exceptions to implement measures to reach GES based on disproportionate costs of measures taking account of the risks to the marine environment (Art.14.4 MSFD).

Estimating the value of coastal and marine ecosystem services is even more difficult than estimating the value of their terrestrial counterparts as the majority of coastal ecosystem services are not traded in established markets where they command a price (fish consumption and established marine energy sources being obvious exceptions) (Beaumont et al., 2007; McVittie and Moran, 2010). Also, for changes to the marine environment as envisaged by the MSFD, the impact on non-use values is expected to be much larger relative to use values (McVittie and Moran, 2010; Bertram and Rehdanz, 2012). This is due to a combination of a lower number of direct users for the ecosystem services and the smaller area over which these users operate (i.e. mainly restricted to the coastal zone). The CVM employed in this paper allows us to pick up both the use and non-use values associated with achieving good environmental status as described in the MSFD.

In a review of valuation studies related to coastal and marine environments in the Black Sea and Mediterranean, Remoundou et al. (2009) found that CVM was the most common valuation methodology used, being used in six of the thirteen studies reviewed. Nunes and van den Bergh (2004) used a joint travel cost (TC) - CVM survey to estimate the value in preventing harmful algae blooms (HAB) for the Dutch coastline. Carson et al. (2003) used CVM to estimate the non-use value or passive value of an oil spill in Alaska and estimated a mean WTP of $79.20 based on a modified Weibull distribution. Elsewhere, Ressurreição et al. (2012) undertook a CVM with 1502 respondents in three sites (Azores islands (Portugal), the Isles of Scilly (UK) and in the