Accounting for Cultural Dimensions when Estimating the Value of Coastal Zone Ecosystem Services using Benefit Transfer

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Abstract

The process of identifying and quantifying the value of coastal zone ecosystem services provides valuable information to policy makers for the efficient management of the natural resources within the coastal zone boundaries. Benefit Transfer (BT) techniques can be used to value coastal zone ecosystem services at a particular site by using values estimated for similar services at other coastal zone sites. BT is particularly suitable to the valuation of coastal zone ecosystems where the researcher is operating on a scale that may be unfeasible for primary research in terms of valuing a large numbers of services across multiple ecosystems. Benefit Transfer models routinely recognise a variety of socio-economic determinants of values across sites; but cultural factors are rarely incorporated, despite their potential importance. Using cultural dimensions from a previous study that ranked 62 societies with respect to nine attributes of their cultures we develop an index that we use to reweight multiple coastal ecosystem service benefit estimates prior to transfer to our policy site, the Galway Bay coastal zone in the west of Ireland. We examine whether these culturally-adjusted BT estimates are statistically different than simply transferring the unadjusted mean or income-adjusted mean transfer estimates for each coastal ecosystem service to the policy site.

Keywords: environmental valuation, coastal zone resources, ecosystem services, benefit transfer.

JEL: Q51, Q57

This work is an output of the Socio-Economic Marine Research Unit (SEMRU) and was funded through the Beaufort Marine Research Award, which is carried out under the *Sea Change* Strategy and the Strategy for Science Technology and Innovation (2006-2013), with the support of the Marine Institute, funded under the Marine Research Sub-Programme of the National Development Plan 2007–2013.

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1. Introduction

The process of identifying and quantifying the economic value of coastal zone ecosystem services provides valuable information to policy makers for the efficient management of the natural resources within the coastal zone boundaries. Decisions that could affect the quality or quantity of these coastal ecosystem services are often routinely made without taking into account the non-market benefits that would be foregone if the environmental quality of these ecosystems deteriorated. However, undertaking studies to calculate the non-market values of ecosystem services can be expensive and time consuming and when, as is the case with coastal zones, one has multiple ecosystems providing multiple benefits, primary surveys to capture the aggregate value of all non-market benefits at a range of sites may not be feasible. An alternative valuation strategy is Benefit Transfer (BT), where values from study sites are transferred to one or more policy sites. BT involves producing values for ecosystem services in the coastal zone area of interest (often called the policy site) by using values estimated for similar services at one or more other coastal zone sites (often called the study sites). BT is particularly suitable to the valuation of coastal zone ecosystems where the researcher is operating on a scale that may be unfeasible for primary research in terms of valuing a large numbers of services across multiple ecosystems[1].

Across the non-market valuation literature it has been observed that an individual's income levels often have a significant influence on what they are willing to pay (WTP) for changes in public goods such as coastal ecosystem services, and BT has taken this into account with methodologies that go beyond the simple mean value transfer approach by using unit transfer with income

[1] A number of BT exercises have already been reported for coastal zones (Troy and Wilson, 2006; Liu and Wilson, 2008; Brenner et al, 2010; Hussain et al, 2010).

adjustments. However, the cultural surroundings of an individual may have a strong influence on how that person forms their preferences for these goods and services in the first instance. As Turner et al. (2000) point out, individual preferences and values do not exist independently of culturally-defined world views. The non-use and use values of a coastal ecosystem good or service may be perceived differently across different societies and indeed may even be perceived differently within cohorts of the same society due to cultural factors. The socio-cultural context in which ecosystems and other environmental assets exists provides an alternative dimension to environmental valuation studies that needs to be considered in BT exercises.

While a variety of socio-economic and demographic variables may empirically influence stated non-market values, cultural differences across and within countries also seem likely to be important in explaining the variation in values for ecosystem services. Such differences emerge in terms of dimensions such as the degree to which a society encourages and rewards future-oriented behaviours (such as sustainable coastal planning), the degree to which institutional practices encourage collective distribution of resources, and the extent to which a community accepts and endorses authority and status. Such factors may be particularly important in cross-country BT exercises. Using cultural dimensions from a study (House et al., 2004) that ranked 62 societies with respect to nine attributes of their cultures, we develop a cultural index that we the use to re-weight the study site coastal ecosystem service benefit estimates prior to transfer to our policy site, the Galway Bay coastal zone in the west of Ireland. We examine whether these culturally-adjusted BT estimates are statistically different than simply transferring the unadjusted mean or income-adjusted mean value estimates for each coastal ecosystem to the policy site.

In what follows, section 2 briefly outlines the BT approach to environmental valuation and why accounting for cultural differences between policy and study sites might be important. Section 3 examines the cultural dimensions used in creating the cultural index used in the BT calculation, while section 4 describes the policy site in Galway Bay. Section 5 then details the BT methodology used to provide a value for each of the non-market coastal ecosystem services. Section 6 outlines the results of the study and gives both ecosystem services flow values on a per hectare basis and for each ecosystem type as well as an overall estimate for the non-market coastal ecosystem services flow from Galway Bay for the basic unit transfer approach, the income adjusted transfer approach and the cultural factors approach. Finally, section 7 concludes.

2. Benefit Transfer and Cultural Diversity

BT involves transferring economic estimates from previously conducted studies of change in an environmental good or service to value the environmental change at a policy site of the same or similar environmental good or service. From a coastal zone management perspective, such transfer values have a number of potential uses. These include use in the cost-benefit analysis (CBA) of investment projects and policies aimed at managing coastal and near-shore resources (e.g. preservation of coastal wetlands or sand dunes, restrictions on the recreational harvesting of shellfish, and estuary pollution prevention measures), or projects that affect the coastal zone (e.g. road construction, housing development, port extensions); environmental accounting; calculating the marginal external costs as a basis for optimal economic management of the coasts and design of optimal regulatory instruments (e.g. a tax on aggregate extraction from the foreshore or charges on effluent discharges into an estuary). BT could also assist in environmental liability cases, to calculate compensation payments to injured parties for pollution damages to coastal and marine ecosystems.

There are a number of methods of transferring values between the study and policy sites[2]. The most straightforward is to use the un-adjusted willingness to pay (WTP) estimate from one or more study sites, applying their average value to the policy site. This method is referred to as 'unit value transfer'. However, it has been noted that the simple unit value transfer approach may not be suitable for transfer between countries with different income levels and costs of living (Ready et al. 2004 and Navrud and Ready, 2007), whilst the method entirely neglects other sources of variation in values. An extension to the unit value transfer method is where WTP values are adjusted for differences in real incomes, for example, between study and policy sites. If the researcher is using the income-adjusted unit transfer approach then it has been recommended that the population characteristics should be as similar as possible between the study and policy sites (Narvud, 2007).

The next step in complexity of BT is to use a 'function transfer' method. Loomis (1992) argues that transferring the entire benefit function increases the validity and reliability of the transfer. Rosenberger and Stanley (2006) point out that by transferring the benefit function, the practitioner can make adjustments to value estimates based upon a range of characteristics of the policy site as well as characteristics of the benefitting population. This involves using the original WTP function from a study site and using input values from the policy site to generate the mean WTP. Meta-analysis is a more complex form of value function transfer which uses a value function estimated from multiple study results together with information on value determinants for the policy site, to estimate policy site values. Meta-regression analyses assume that there exists an underlying meta-

[2] For practical guides to value transfer for environmental goods, the interested reader should refer to Navrud and Ready (2007) and Bateman et al. (2009).

valuation function that relates the magnitude of empirical estimates of value to characteristics of the study site (Rosenberger and Stanley, 2006). Many meta-regression analyses have been conducted in environmental and natural resource economics; Johnston et al. (2003) being a general example and Wilson and Liu (2008) being a coastal ecosystem example. The use of spatial micro-simulation techniques for BT is another form of value function transfer that has been recently suggested by Hynes et al. (2007) and Hynes et al. (2010).

Cultural factors have received little consideration to date in the BT literature, despite evidence from other fields of enquiry that such factors are of importance in shaping preferences. Ronen and Shenkar (1985) and Furnham et al. (1994) indicated that societies may be clustered based on similarities in their cultural identity. Inglehart and Baker (2000) and the World Values Survey (World Values Survey Association, 2009) highlight the fact that societies could also be clustered based on their attitudes toward the environment[3]. Existing economic valuation studies show that attitudes are linked to environmental values for coastal zone protection (Nunes et al, 2009)); our speculation is thus that accounting for measurable differences in cultural factors should improve our ability to predict values across sites. Individuals consider their basic cultural values when answering stated preference questions about the environment (Dietz et al., 2005). Wilk and Cligget (2006) point out that economic values reflect the culturally constructed realities, worldviews, mind sets and belief systems of particular societies and/or subsets of society. Preferences are also not exogenous, but rather shaped by social interactions as well as political and power relations operating within a system of local, regional, and global interdependencies (Henrich et al. 2001 and

[3] We considered using the World Value Survey data in developing our cultural index but unlike the GLOBE cultural dimensions dataset Ireland was not included as one of the societies analysed.

Hornborg et al. 2007). Particularly when asked to express values for unfamiliar goods, people may consult their own cultural values and their society's links to the environment when answering stated preference questions in relation to ecosystem services (Dietz et al., 2005 and Hoyos et al., 2009). The importance of cultural attitudes and ethical beliefs in stated preference WTP studies has also been highlighted by Stern et al. (1995), Spash (2000), Pouta (2004) and Ojea and Loureiro (2007). Hoyos et al. (2009) conducted a choice experiment to examine if cultural identity has an influence on the WTP to protect natural resources and noted that failure to take cultural identity issues into account could entail significantly biased results in BT applications. The results of their study showed the significant influence of cultural identity on the WTP to protect natural resources. Therefore, and as highlighted by Brondízio et al. (2010), study site environmental benefit estimates have to be understood as part of the broader cultural context. With this in mind and in the context of ecosystem service BT, variations in cultural factors may be as important to control for as income levels or demographic characteristics of the relevant populations[4].

One further debate in the environmental valuation literature which is of relevance to this paper is that respondents in referendum-style valuation surveys may express citizen assessments that take into account benefits to others rather than act in a purely self-interested fashion. A number of commentators have suggested that respondents will act as "citizens" and adopt a social perspective rather than adopt a purely self-interested approach based on personal well-being, especially when faced with difficult decisions about environmental goods (Howley et al. 2010). Individuals may take a citizen-orientated viewpoint taking into consideration broad ethical and social

[4] For an in-depth discussion in relation to the socio-cultural context of ecosystem and biodiversity valuation the interested reader is directed to Brondízio et al. (2010)

considerations when assessing environmental goods, and may have values that differ when expressed as a citizen relative to being expressed by the same individual acting as a selfish consumer (Alvarez-Farizo and Hanley, 2006). If, as asserted by Blamey et al. (1995), respondents are expressing social or political judgments rather than personal preferences over consumption bundles then this further highlights the fact that there may be a need to account for cultural and societal differences between study and policy sites in a BT exercise, as study site estimates will be influenced by socially held values, attitudes and beliefs concerning public goods and their provision [5].

3. Developing an index of cultural identify: The GLOBE study.

Given the above review of the potential importance of cultural factors in the formation of preferences and values, we developed a cultural dimensions index from a study that ranked 62 societies with respect to nine attributes of their cultures (House et al., 2004). GLOBE (Global Leadership and Organizational Behaviour Effectiveness) was a study designed to explore the effects of culture on leadership, organizational effectiveness, economic competitiveness of societies, and the human condition of the members of the societies studied (House et al., 2004). GLOBE developed nine "cultural dimensions" that would serve as their units of measurement of the differences and similarities between the societies studied. The cultural dimensions were calculated based on the responses of 17,000 individuals to a series of Likert scale questions under nine cultural attribute headings. The average score of these questions under each attribute resulted in the final score for each cultural dimension in each country. The questionnaire reports were

[5] A number of studies such as Ovaskainen and Kniivila (2005) and Mill et al. (2007) have found that individuals express different preferences when adopting a personal or social perspective and that personal and social mean willingness to pay (MWTP) can differ greatly.

complemented by interview findings, focus group discussions, and formal content analyses of printed media. The cultural indicators were then validated against independent measures from other sources such as Hofstede (2001) and figures from the World Values Survey Association. The cultural attributes and dimension scores derived for each country were also checked for reliability and construct validity with multi-trait, multi-method approaches (House et al., 2004).

These cultural dimensions were developed in order to provide concepts and terminology that would enable researchers "to become aware of, to measure, and to talk knowledgeably about the values and practices found in a human culture – and about the similarities and differences among human cultures" (House et al. 2004). The nine cultural dimensions were: Uncertainty Avoidance, Power Distance, Institutional Collectivism, In-Group Collectivism, Gender Egalitarianism, Assertiveness, Future Orientation, Performance Orientation, and Humane Orientation (See Table 1). Each of these dimensions were conceptualized and depicted as a continuum between two extreme poles using a 7-point scale. House et al. (2004) provide a score for each of these dimensions for each of the countries listed in the appendix.

For the purpose of our BT exercise, and following a review of the in-depth descriptions of each dimension provided by House et al. (2004)[6], In-Group Collectivism, Institutional Collectivism and Gender Egalitarianism were deemed not relevant when it came to potential influence on environmental values. Of the dimensions retained for our use, a low score in *Performance Orientation* indicated a society that values harmony with the environment rather than control,

[6] Each dimension is developed and described in detail in its own separate chapter in House et al. (2004).

while a high score indicates a society that values assertiveness, competitiveness and materialism. A high score in *Future Orientation* indicated a society that has a propensity to save for the future, has organizations with a longer strategic orientation, views materialistic success and spiritual fulfilment as an integrated whole, a society that values the deferment of gratification and places a higher priority on long-term success, while a low score indicates a society that has a propensity to spend now, rather than to save for the future, has organizations with a shorter strategic orientation, sees materialistic success and spiritual fulfilment as dualities, requiring trade-offs and values instant gratification and place higher priorities on immediate rewards. A low score in *Humane Orientation* indicated a society where power and material possession motivate people and where values of pleasure, comfort, self-enjoyment have high priority, while a high score indicates a society where values of altruism, benevolence, kindness, love and generosity have high priority. A low score in *Power Distance* indicates a society where civil liberties are strong and public corruption low and where the correct use of limited resources is valued, while a high score indicates a society where only a few people have access to resources, skills and capabilities, contributing to low human development and life expectancies. A low score in *Uncertainty Avoidance* indicated a society that shows less resistance to change and less desire to establish rules to dictate behaviour while a high score indicates a society that shows stronger resistance to change and a stronger desire to establish rules allowing predictability of behaviour. Finally, a low score in *Assertiveness* indicated a society that has sympathy for the weak and values harmony with the environment rather than control while a high score indicates a society that tries to have control over the environment. Although the results of the GLOBE study have not been used previously in an environmental economics context, they have been used by other researchers to compare cultural difference in corporate affairs across countries (Shi and Wang, 2011) and to examine the relationship between national culture and trades union membership (Posthuma, 2009). This latter study highlighted the fact that GLOBE culture constructs were better predictors of this relationship than a number of other measures of cultural identity.

We use the scores across these 6 dimensions across different countries to create a cultural index, which we then employ to reweight our study site coastal ecosystem values. To make them more representative of the Irish population study site, coastal ecosystem values are multiplied by the ratio of the aggregate score on the 6 dimensions for Ireland to the aggregate score for the country where the study site valuation was carried out[7]. The ratio used for each country is provided in Appendix A. The exact BT formula used is presented in the methodology section.

4. Case study: Galway Bay

The coastal zone that surrounds Galway Bay is the policy site in this study. The geographical definition of the policy site was based on coastal waters as defined by the Western River Basin District (WRBD) under the Water Framework Directive (WFD) (CEC, 2000). As shown in Figure 1, the study area comprised 143,430 hectares of water based habitats and 2,840 hectares of terrestrial habitats. The study covered the Irish coastline from Slyne Head in the Northwest of the study area to Blackhead in the south of the study area, a distance of 688 km along the Western coastline of Ireland. With offshore islands included this aggregates up to a shoreline of 1161 km. The site encompasses a variety of temperate coastal ecosystems, represented in its salt marshes, rocky coasts, beaches, intertidal flats, estuaries and coastal lagoons (NPWS, 2010). A significant

[7] In aggregating the scores from each county we first subtracted each of the original dimension score for Performance Orientation, Assertiveness, and Power Distance away from the highest possible value on the likert scale (7) so that for all the cultural indicators used a higher score meant the country was likely to place higher values on ecosystem services than individuals from the policy site.

area of the study site (49,460 km^2, which is 34% of the study area) is also protected under EU "Natura 2000" site designation.

In order to define the land and marine cover typologies within the Galway Bay coastal zone, a database of coastal land and marine cover typologies was set up using the software package ArcMap 9.3. The typology was determined by the available digital cartography and other available geo-referenced data. For terrestrial ecosystems used in the study, CORINE (Devillers et al., 1991) land cover data was used. CORINE aggregates land into parcels of 25 hectares for the purposes of defining land cover types. Beaches, dunes and sands and coastal lagoons less than 25 hectares were excluded from the CORINE data. We were able however to account for these smaller parcels in the policy site using geo-referenced data available from the Ordinance Survey of Ireland (OSI) and in the case of the lagoons from the transitional water geo-data available from the WRBD.

For the near-shore marine ecosystems in the Galway Bay coastal zone, there was much less available GIS data. Research carried out by the Irish Marine Institute under the Infomar program provided information on most of the water covered area in the Bay (84,560 ha) including seabed type (mud, sand, gravel, etc) and bathymetry. From this bathymetry data, the average depth of Galway Bay was estimated to be 29m and this gives an estimated total volume of 40.4 cubic kilometers for the study site. Only three aquatic ecosystems were considered in this study: sea, estuary, and marine seagrass meadows (*Zostera marina*) and kelp forests (*Laminaria spp.*). Sea area was based on the coastal areas defined by the WRBD, estuary area was based on the transitional areas defined by the WRBD (less transitional areas known to be coastal lagoons) and the seagrass area was based on a NPWS study (NPWS 2005) of the Kilkiernan Bay and Islands SAC and Galway Bay Complex while the kelp data was based on data from the Irish Seaweed Centre.

Galway city is the main population centre in the coastal zone with approximately 80,000 residents. Within the bay, new developments in aquaculture such as cod and abalone farming are being piloted, while there has also been a substantial increase in shipping activity in the last decade. Developments in these sectors, coupled with the considerable housing and infrastructural developments that occurred in the Galway Bay coastal zone during the "Celtic Tiger" years of economic growth in Ireland, means that the ecosystems within the Galway Bay coastal zone are under more pressure now than they ever have been in the past. The lack of consideration of coastal non-market goods and services in the planning process in the county has been a contributing factor in the observed depletion and degradation of coastal resources within the bay.

5. Benefit Transfer Methodology

The coastal ecosystem services to be valued were broken down into four groupings following the Millennium Ecosystem Assessment (MEA, 2003), namely supporting services, regulating services, provisioning services and cultural services[8]. In terms of the reference population in the policy site the total number of individuals living in the coastal counties boarding Galway Bay were used to define the extent of the market[9].The next step in the BT process was to define the geographical

[8] The supporting services are those that are necessary for the production of all other ecosystem services but in themselves do not yield direct benefits to humans. They include biochemical cycling, primary production, food web dynamics, biodiversity, habitat and resilience. The regulating services are the benefits obtained from the regulating of ecosystem processes and include and cultural values (Beaumount et al. 2007 and Garpe, 2008). The category of provisioning ecosystem services (such as transport and commercial fishing) which are traded in established markets were not analysed in this paper, as the focus of this study is on non-market services provided in the Galway Bay coastal zone. It should be noted that this breakdown of ecosystem goods and services does not show interactions between different services and groupings.

[9] Galway Bay is a very popular destination for both domestic and foreign tourists and these individuals also make use of the ecosystem services provided by the bay. Due to a lack of data on the actual number of tourists visiting counties Clare and Galway on an annual basis we could not factor this element into our valuation exercise and this means that our estimate of the total value of the non-market ecosystem service flows per year is most likely a lower bound estimate.

area of the site using GIS. This was done as described in the previous section using a number of different spatial datasets. As pointed out by Bateman et al. (1999), the spatial disaggregation of ecosystems and their associated services using a GIS has the advantage of allowing the researcher to visualise the pattern and distribution of ecologically important landscape elements and overlay them with other relevant themes[10].

The next step in the BT process involved a search and analysis of the valuation literature. The number of peer reviewed valuation studies with regard to coastal and marine ecosystems and their goods and services in Ireland is very limited. Therefore, in order to obtain a meaningful sample, the literature search was broadened to European, US and other international studies. The ecosystem valuation literature is most mature in the USA and has a longer history there than anywhere else. European valuation studies, including coastal and marine BT studies have also increased since the late 1980's (Wilson and Troy, 2006; Liu, 2007, Brenner, 2010; McVittie and Moran, 2010). While the bulk of the papers included are peer-reviewed papers, some valuations have also been taken from the grey literature (i.e. government reports, working papers of valuation research institutes).

The next step in the BT exercise involved the actual transfer of the study site estimates identified in the literature review to the policy site. As a starting point a database was created into which all the valuation estimates could be stored and analysed. These ecosystem values then had to be standardised and the services valued in the study site matched to the correct ecosystem service in

[10] Using GIS is a relatively recent extension to the BT method and is used to apportion ecosystem values on a geographic basis to the study site (Bateman et al. 1999 and 2006, Wilson and Liu, 2008).

the policy site. This was achieved by first converting the estimates from the literature to Euro (€) values using the appropriate nominal exchange rate and then by adjusting for inflation based on the Irish consumer price index (CSO, 2010) to covert to 2007 prices.

As discussed previously we choose an adjusted unit transfer rather than a function transfer approach given the multiple ecosystem services being estimated across a range of coastal ecosystems. In the analysis below three different types of unit value adjustment of increasing sophistication were carried out in the transfer of study site benefit estimates to our coastal zone policy site in Galway Bay. The first was an unadjusted BT where the average of the estimates of WTP for service *k* generated by ecosystem *i* in all study sites S was used as the WTP value for service *k* generated by ecosystem *i* at policy site, *p* ($V(ES_{ki})p$); i.e. the study site estimate is left unadjusted except for adjusting for the exchange rate and inflation:

$$V(ES_{ki})_p = V(ES_{ki})_s \times Ex_q \times CPI$$

where $V(ES_{ki})_s$ is the original WTP estimate for service *k* generated by ecosystem *i* at study sites *s*, Ex_q is the euro county *q* exchange rate in the relevant year and CPI is the consumer price index used to adjust to 2007 prices. It has previously been shown that when BT analysis is restricted to only include similar sites (in terms of the characteristics of those sites and their surrounding populations) transfer errors are minimised when simple mean value methods are applied (Bateman, 2005). Effectively, the unadjusted unit transfer approach assumes that sites are identical in all measurable characteristics (or that characteristics are not significant determinants of WTP). This assumption aside, the unadjusted value transfer approach has remained popular in the literature due to its simplicity and the ease with which it can be applied once suitable original studies have been identified. If the differences between the characteristics of an original study site and the policy site are significant determinants of WTP, then this transfer approach will fail to reflect likely divergences in WTP at the study and policy sites. To partly account for this many BT studies adjust the BT estimates by reweighting the transfer estimates by the ratio of GDP per capita at the policy site to the GDP per capita of the study sites. Therefore, the second type of transfer adjustment conducted below is unit transfer with income adjustments.

$$V(ES_{ki})_p = V(ES_{ki})_s \times Ex_q \times CPI \times \left(\frac{y_p}{y_s}\right)^e$$

where y_s and y_p are the income levels at the study and policy site, respectively. Since we did not have data on the actual income levels of the affected populations at the policy and study sites, national Gross Domestic Product (GDP) per capita figures have been used as proxies for y_s and y_p. The term *e* is an estimate of how the WTP for the ecosystem service in question varies with changes in income). In this paper, we assume *e* is equal to one which implies that the ratio of WTP at sites *s* and *p* is equivalent to the ratio of per capita incomes in Ireland and the home country of the study site (i.e. $\frac{WTP_p}{WTP_s} = \frac{y_p}{y_s}$).

Unique to this study we develop a third unit transfer methodology whereby we account not only for the differences in income across study and policy sites but also for the cultural similarities of the policy site location and the study sites using the "Cultural Dimensions" scores discussed in section 3.

$$V(ES_{ki})_p = V(ES_{ki})_s \times Ex_q \times CPI \times \left(\frac{y_p}{y_s}\right) \times C_q$$

In calculating this Cultural Unit Transfer formula we first needed to create the cultural parameter C_q. The culture parameter is an index based on the 6 cultural dimensions from House et al. (2004). Each dimension for each of the 62 societies in the study was given a rating on a Likert scale from 1 to 7[11]. The final cultural index for a study site in country q (C_q) is calculated using:

$$C_q = \sum_{d=1}^{6} \theta_{dIre} \Big/ \sum_{d=1}^{6} \theta_{dq}$$

where θ_{dq} is the score for cultural dimension *d* in country *q* and θ_{dIre} is the score for cultural dimension *d* in Ireland. Countries with a lower aggregate score across all cultural dimensions than Ireland[12] are expected to undervalue ecosystem services and therefore that country's study values are adjusted upward using the cultural parameter in the BT whereas countries with a higher aggregate score across all cultural dimensions than Ireland are expected to overvalue ecosystem services compared to Ireland and their associated study values are adjusted downwards using C_q. The value of C_q used for each country and for the different societal clusters is provided in Appendix A.

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[11] In creating our index we converted the Performance Orientation, Assertiveness, and Power Distance indicators so that a higher rather than a lower score meant the country was likely to place higher values on ecosystem services. This was done simply by subtracting the original dimension score away from the highest possible value on the likert scale (7).

[12] The GLOBE study also provided cultural dimension scores for societal clusters. These clusters represented groups of countries which had similar cultures (e.g Nordic Europe, Latin America, Eastern Europe. We had 4 coastal ecosystem valuations for which the GLOBE study did not provide country specific dimension ratings for. In these cases we used the scores of the country's associated societal cluster to calculate the cultural index for the particular studies. Therefore we used the Eastern Europe cluster scores for Estonia and Lithuania based studies, and the Latin American cluster scores for Chile and Uruguay based studies.

The final step in the BT process involved calculating the total non-market value of ecosystem services in the Galway Bay coastal zone using the 3 transfer approaches outlined above. To accomplish this, the average estimates of $(V(ES_{ki})p)$ for each of the 18 supporting, regulating and cultural ecosystem services (where an estimate had been found) were multiplied by the area of the associated ecosystems in the Coastal zone and then aggregated[13]. Recreation participation rates were calculated for the reference population in the coastal zone using figures from a Marine Activities Report produced by the Economic and Social Research Institute (ESRI, 2004)[14] while the carbon price of €15/tC set by the Irish government in the 2010 budget (Budget, 2009) was used in this study to calculate the value of atmospheric regulation in the bay (converted to 2007 prices it is €15.09/tC). Following Troy and Wilson (2006) and Brenner et al. (2010), the total economic value (TEV) of ecosystem services from the Galway Bay coastal zone was then calculated as:

$$TEV = \sum_{k=1}^{K} A(L_i) \times V(ES_{ki})_p$$

where $A(LU_i)$ is the area of land (hectares) of ecosystem i. The resulting aggregate value estimates were then mapped across the Galway Bay coastal zone showing the value of the annual flow of services provided by each ecosystem per annum. Analyses and maps were produced with the GIS software ArcMap 9.3. The results of each of the unit transfer approaches used are presented in the next section.

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[13] As ecosystems themselves are distributed spatially, it also makes sense to value their goods and services in a spatial manner such as Euro per hectare (Constanza et al. 1997 and Troy and Wilson, 2006). However, many non-market valuation studies present findings in terms of values per person or per household per year. Simular to Splash and Vatn (2006) we converted to values per hectare by aggregating the per person or per household estimates by the relevant population and then distributed across the ecosystem areas.

[14] The ERSI study calculated participation rates and average number of trips taken by participants across various marine and coastal recreational activities. The participation rates multiplied by the average number of trips per activity per year was used in our study in order to estimate the total use of the bay by the reference population in the year 2007.

6. Results

The literature review component of the BT process identified 209 valuation studies related to marine and coastal ecosystem services, of which 193 valuation estimates could be used. Those deemed unusable were mostly due to the lack of data at the policy site (e.g. hedonic pricing estimates for the value added to houses due to proximity to the coast had to be dropped due to lack of GIS data on the housing stock in the policy site). The 193 valuation points were therefore taken from 107 studies of which 71 were peer-reviewed papers and the other 36 comprised of PhD theses, university working papers and technical reports. In terms of the types of valuation across the 107 studies, 75 were contingent valuation, 21 were travel cost, 1 was restoration cost, 6 were choice experiments, 6 were contingent ranking and 7 used the production function method[15].

Several of the relevant ecosystem services across the different coastal biomes could not be assigned a value as there was not sufficient information, e.g. there were no available values for the cultural services of science and education, cultural heritage and inspiration or the regulating service of local climate control across any of the coastal ecosystems. These data gaps are not unique to this study. Due to these data gaps and also the use of lower values when lower and higher estimates were reported rather than means, there is a high probability that our BT exercise is

[15] Note that the number of methodology types adds up to more than one per study as some papers used (compared) two or more types of valuation methodologies, e.g. travel cost and contingent valuation. The values used for atmospheric regulation was based on our own calculations using data on carbon sequestration for different ecosystem types and the Irish governments carbon price in Budget 2010 of €15 per tonne.

likely to be an underestimate of the current value of ecosystem service flows in the Galway Bay coastal zone[16].

Total non-market values by ecosystem service and by biome.

A breakdown of the benefit value per ecosystem and by non-market service using the 3 transfer methodologies is shown in Table 2. Moving from the un-adjusted unit transfer approach to the unit transfer with income adjustments results in significant changes in the predicted value of the coastal ecosystem services across many of the different biomes. For example, the benefit value associated with the cultural services of recreation and aesthetics for the biome of beaches, dunes and sand approximately doubles in value once the differences in income levels between the study and policy sites are accounted for. On the other hand, the base studies feeding into the service values for the legacy of nature across all the biomes (9 studies in total) were from countries closer to Ireland in terms of GDP per capita. This is reflected by the fact that the unadjusted unit transfer value and the unit transfer with income adjustments for this service are similar in magnitude.

The difference in magnitude of the value estimates between the unit transfer with income adjustments and the cultural factors-adjusted BT approach is much less than that between the un-adjusted unit transfer approach and the unit transfer with income adjustments. This may be a result of the high correlation between the cultural dimension scores used in the calculation of the cultural adjusted BT estimates and national income (something that was noted by House et al. 2004).

[16] The largest numbers of studies was for the sea (84) and beach, dunes and sands (39) ecosystems. This is probably due to the fact that these are the most visible, well known and used of the ecosystems within any costal zone. Beach and sea ecosystems have a high number of associated literature valuation studies for recreation services (17 for beach , 42 for sea) although beach also has a high number of associated sediment retention (12) valuation studies as well. The next highest number of valuation points is for the salt marsh ecosystem in which the ecosystem values of recreation (10) and eutrophication mitigation (6) are the most common valued in the literature. Estuaries have a similar number of values from the literature as salt marches and similar to salt marshes most of them are for recreation (10) and eutrophication mitigation (13). The other types of ecosystem services present in table 2 are perhaps less familiar to the general public and this has probably contributed to a lower number of associated valuation studies.

Interestingly, however, when the difference between unadjusted unit transfer estimates and the unit transfer with income adjustment estimates are small, the difference between unit transfer with income adjustment estimates and the cultural factors-adjusted BT estimates tends to be large. In all cases, except for recreational services from the salt marches and primary production from the sea, the cultural adjusted transfer estimates were higher than the income adjustment transfer estimates. The cultural factors-adjusted transfer estimates were lower than the income adjustment transfer estimates for recreational services from salt marches and primary production from the sea, as the summation of aggregate cultural dimension scores for the country of origin of the studies associated with these categories were higher than those for Ireland, which resulted in a lower cultural parameter or index value being used in the transfer calculation. In particular, many of these studies came from Scandinavian countries which as can be seen from table A1 have a lower cultural index value than Ireland.

The highest ecosystem values per hectare (shown in Table 2) was found to be for *coastal lagoons* (€208,533 using the cultural transfer methodology) which is mainly due to their value in regards to eutrophication mitigation (€152,099)[17]. The next highest value on a per hectare basis was for *beach, dunes and sand* (total non-market ecosystems service value were estimated at €88,371, €184,726 and €192,115 for the unadjusted, income adjusted and cultural unit transfer methodologies respectively). Similar to many other coastal ecosystem service valuation studies (e.g. Troy and Wilson, 2006, Liu, 2007) which found that beaches are a highly valued coastal ecosystem type, the high values are found to be mainly due to their recreational value. Beaches

[17] A cautious view needs to be taken with regard to this eutrophication mitigation value estimate as it is based on only two contingent valuation studies. Nevertheless, the Galway Bay area has a high proportion of the coastal lagoons in Ireland and many of them are vulnerable to eutrophication due to the karstic nature of the Galway Bay geology.

were also associated with high service values for sediment retention, pollution control, aesthetic value and the legacy of nature.

The *sea* was found to have low service values when compared to the other ecosystems on a per hectare basis (Table 2) due to the large area it covers (95% of the study area), but as can be seen from Table 3, the aggregated area of the sea provides the highest total ecosystem value in 2007 (ranging from €252 million to €327 million to €337 million for the unadjusted, income adjusted and cultural unit transfer methodologies respectively. This represents approximately half of the total value of the non-market ecosystem services flow of the Galway Bay coastal zone (Table 3). The highest values associated with the *sea* ecosystem measured here are for eutrophication mitigation and primary production. Similar to *sea*, the highest valuation of any ecosystem service within the *estuaries* is eutrophication mitigation. *Estuaries* are also unique in this study as they have a cost (or negative benefit) associated with the atmospheric regulation ecosystem service (-€91). The carbon production of estuaries was found to outweigh the aggregated value of carbon sequestered in the sea, salt marshes and seagrasses so that the study site would seem to be a net producer of carbon dioxide.

Salt marshes have the third highest value on a per hectare basis but, as can be seen from Table 3, account for only approximately 5% of the total ecosystem services value flow within the Galway Bay coastal zone. The highest value service associated with this ecosystem is eutrophication, but it should also be noted that salt marshes were found to provide the highest value per hectare for atmospheric regulation (carbon sequestering)[18]. The contribution of *intertidal flats* and *sea grasses and kelp beds* to the total ecosystems services flow was found to be less than 1% in each case reflecting the low number of services in these ecosystems for which values were available.

Table 4 shows the total contribution of each ecosystem service (for which estimates were available) to total non-market ecosystem services value. Regulating services contribute the highest non-market values, representing over half (63% using the cultural adjusted transfer estimate) of the total ecosystems service flow value. This is due to the contribution being made by the service of eutrophication mitigation. The second highest valued ecosystem service was the cultural service of recreation. Recreation in the coastal zone, which is due to the direct interaction most people have with the ecosystems in Galway Bay, was valued at €91,596 using the cultural unit transfer approach and accounts for 14% of the total non-market value of ecosystem services in the coastal zone.

Valuing changes in ecosystem service flows.

The total ecosystem service values outlined above are useful to highlight the relative contribution of the coastal ecosystem services and biomes to human well-being. However, marginal changes in ecosystem service values provide more usable information for typical planning decisions. For example there is currently a planning proposal in place to expand the port in Galway city to facilitate vessels with capacity above 6,000 tonnes. It is envisaged that the development of the new port will also allow the Port Company to bring a significant number of cruise vessels to the heart

[18] The value of atmospheric regulation does not change across the different unit transfer approaches as it is not based on previous study site estimates but on calculations relating to the price of carbon in Ireland and the level of carbon produced.

of Galway city. The proposed development will consist of 23.61 hectares of land reclamation. The development will extend 917m out to sea providing 660m of quay berth to –12m Chart Datum (CD) depth serviced by a –8m CD channel depth. The dredging of a 400m diameter turning circle to –8m CD is also planned to accommodate the larger cruise liners. The development will involve the permanent covering over of approximately 4.7 hectares of intertidal flats and the reduction in estuary area by approximately 18 hectares. Using the per hectare values presented in Table 2 (for values per hectare for intertidal flats and estuary[19]) and assuming a discount rate of 10% we estimate that the net present value of the foregone non-market ecosystem services as a result of the harbour development would be €1.4 million €2.7 million or €2.9 million per hectare using the unadjusted, income adjusted and cultural factor adjusted transfer values respectively[20].

Testing validity

A successful indication of the overall worth of the transfer approaches adopted in this study would be indicated by whether or not the transferred values are similar to equivalent primary estimates for the policy site on the basis of some statistical criteria. Transfer errors are of great concern in the BT literature, as this indicator is of primary importance in providing confidence in the final valuation of the policy site (Colombo and Hanley, 2008). While one of the main reasons for using BT to measure the ecosystem service values in the Galway Bay coastal zone is the lack of primary estimates for the policy site, we can still test our alternative unit transfer approaches against one

[19] The value per hectare for estuary does not include the recreation figures in table 2 as the new port will not adversely effect any existing water based recreation activity in the area.

[20] We obviously do not include here any calculation of the provisioning ecosystem services that will be created as a result of the harbour development. With the construction of berthing facilities for general cargo vessels, oil tankers, passenger vessels, fishing vessels and container vessels, Roll on/Roll off facilities, berths for naval/ research vessels and a marina providing 216 amenity berths, the NPV of such provisioning services are likely to very significant.

recent beach recreational demand study that was conducted in the Galway bay coastal zone. Using a travel cost model, Barry et al. (forthcoming) estimated the value per trip to a beach site in the Galway Bay coastal zone to be €22.23 per person[21]. The population estimate of per-trip consumer surplus was estimated with 95% confidence to be between €16.94 and €31.55. Our equivalent transfer estimates for beach based recreation values were €18.59, €24.02 and €24.80 per person per trip for the unadjusted, income adjusted and cultural unit transfer methodologies respectively. Following Bateman et al. (2000), the transfer error for ecosystem service, *k* (in this case beach based recreational demand), is calculated as:

$$TransferError_k = \frac{(TransferredEstimate_k - PolicySiteEstimate_k}{PolicySiteEstimate_k} \times 100$$

This results in a transfer error of 16%, 8% and 11% for the unadjusted, income adjusted and cultural factor-adjusted transfer methodologies respectively. These are much lower transfer errors than usually found in the literature.

7. Discussion and Conclusions

This study applied a BT approach to the valuation of ecosystem services in the coastal zone of Galway Bay. Un-adjusted, income-adjusted and cultural factor-adjusted unit value transfer approaches were compared in terms of their impact on the size of the resulting ecosystem service values per hectare at the policy site. The adjusted unit transfer approach was seen as most appropriate way of transferring benefit values both within Ireland, and between Ireland and other

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[21] This study estimate was not used in the benefit transfer exercise.

countries especially since we were dealing with multiple services across multiple ecosystems, which made the use of a value function transfer approaches more difficult. It should also be noted that some researchers (e.g. Navrud, 2007) have found that unit transfer methods can produce lower transfer errors than the more complex procedures of value function transfers due to the low explanatory power of willingness-to-pay (WTP) functions of stated preference studies, and the fact that methodological choice, rather than the characteristics of the site and the affected populations, has a large explanatory power in meta-analyses.

It is generally recommended that in the literature review phase of BT the researcher should identify and use only similar studies from the same country or other closely located countries (which share the same type institutional and cultural context). This recommendation is based on value transfer validity tests showing that studies which are closer spatially tend to have lower transfer errors (Lindhjem and Navrud 2008). Adjusting transfer estimates using the cultural index developed in this paper should allow a wider range of studies to be employed in the BT exercise, since this index allows some statistical control over one reason behind spatial patterning in values. In our study, we find that the transfer error for the cultural ecosystem service of beach based recreation is very low when we apply the unit transfer approach, especially when we have controlled for income and cultural differences between the study and policy sites. However, given the wide range of ecosystems being examined and the absence of any appropriate primary valuation studies related to any of the other ecosystem services for the policy site, our simple BT test cannot be taken as proof of how successful our adjusted unit transfer approaches have been. The transfer errors associated with some of the other ecosystem services could be much larger.

A key objective of this paper was to examine if adjusting for cultural differences in the BT approach used had a significant impact on the size of the transfer value estimates. We found that once differences in income levels have been accounted for, the differences in cultural dimensions between study and policy sites actually have little impact on the magnitude of our valuation estimates. While using the un-adjusted unit transfer adjustment would have led to a substantial under-estimate in the total non-market value of the coastal zone ecosystems compared to the income-adjusted BT approach (the income adjusted BT total non-market value estimate was 32% greater than the unadjusted BT estimate), the cultural factor-adjusted BT estimate of total ecosystem service value from the Galway Bay site (€661m) was only 4.2% larger than the income-adjusted BT estimate. This may reflect what Hofstede (2001) referred to as the confounding relationship between wealth and other cultural dimensions. He argued that wealth itself is an integral part of a country’s culture and will be highly correlated with other cultural dimensions. House et.al. (2004) were also aware of such correlation. It should be noted however that the majority of our study site estimates (85%) came from what House et al. (2004) refer to as the “Anglo societal cluster” of countries (Ireland, England, Canada, USA, New Zealand and South Africa) which are very similar in terms of factors such as ethnic and linguistic similarities and migration patterns originating centuries ago from areas in Northern Europe.

Due to these similarities, the countries within the Anglo cluster tend to have very similar scores in terms of the cultural dimensions used to calculate the cultural BT estimates (see table A1) which means that for the majority of the estimates transferred, the cultural parameter, C_q, is close to unity and there is therefore no significant change in the cultural adjusted transferred values from those calculated using the income adjusted BT formulae. A BT exercise with studies from a more diverse range of countries may result in a more significant influence of the cultural dimensions on transfer estimates. We did note, however, that when the difference between the unadjusted unit transfer estimates and the unit transfer with income adjustment estimates were smaller, the difference between the unit transfer with income adjustment estimates and the cultural adjusted BT estimates tended to be larger and via versa. Therefore, while economic forces may have a moderating influence on the role of cultural factors in determining willingness to pay for environmental goods and services, the fundamental attitudes and beliefs of different societies may still have an important role to play in how those societies form their preferences.

This study mirrored the results in other similar studies (Brenner et al (2010) Williams et al. (2003)) in that coastal ecosystem services which have a larger direct impact on human welfare were found to have a greater number of associated valuation studies, i.e. recreational studies, water quality studies (eutrophication mitigation and pollution control) and sediment retention[22]. However, whilst such total economic value estimates are useful to highlight the relative contribution of ecosystem services to human well-being, they are less useful from a management perspective, since it is marginal changes in ecosystem service values which provide more information for typical planning decisions – since we do not face a complete loss of all ecosystem services in Galway Bay.

Our estimate of the total value of the non-market ecosystem service flows per year is most likely a conservative estimate due to data gaps and the coarseness of some of the study area data. Further

[22] The high number of biodiversity studies is also thought to be a reflection of the value people place on protecting well known endangered wildlife species as many of the studies are concerned with immediately recognisable coastal birds and mammals (e.g. otters, whales and seals).

research on the valuation of coastal ecosystem goods and services is recommended, particularly in areas which currently could not be valued here, such as resilience and cultural heritage. More studies are also particularity needed in the Irish case where very few of such primary valuation exercises have been carried out for coastal ecosystems services. Estimates in this paper were also only based on the population in the defined coastal zone area. The lack of incorporation of accurate figures on the number of tourists visiting counties Clare and Galway into our valuation exercise will be another reason why our estimate of the total value of the non-market ecosystem service flows per year is most likely a lower bound estimate.

It should also be noted that our use of BT means that each of the ecosystem services were valued separately; no account was taken of the fact that there are linkages between services (e.g. habitat fishery and storm protection) that could mean that the ‘integrated’ benefits might exceed the valuation of each single ecosystem service on its own. As Hanley and Barbier (2009) point out, future research is needed to develop multi-service ecosystem modelling to understand more fully what values are lost and gained when integrated coastal ecosystems are disturbed. These caveats aside, the results demonstrate the range of ecosystem service values within Galway Bay and should increase awareness and commitment to sustainable coastal management within the study area.

The statistical robustness of the cultural dimensions used in this paper have been previously tested in terms of their relationship to organisational structure and leadership theory by House et al (2004) and in terms of their relationship to union membership by Posthuma (2009). This however is the first use of the cultural dimensions from an environmental valuation perspective. Ideally, the use of a specific cultural dimension in relation to a society’s attitudes towards the environment would have been more desirable than using dimensions that indirectly have an impact on society's environmental preferences. This was not possible with the GLOBE study. The use of the World Value (WV) Survey (World Value Survey Association, 2009 and Inglehart and Baker, 2000) would allow the researcher to use similar type cultural scores to those in the GLOBE study to adjust value estimates. The world value survey also has the advantage of including societal scores in terms of attitudes to both global and local environmental issues. Therefore, these may be more appropriate cultural scores to use in an environmental BT exercise. They were not used in our case, as Ireland was not included as one of the 52 countries where the survey was conducted, but the use of these WV environmental cultural scores in BT is an avenue for further research.

Finally, it should be stated that by mapping ecosystems and linking them to reliable estimates of ecosystem service value flows generated from a BT process, we can assist decision makers with responsibility for coastal zone management as they attempt to manage coastal zone development in a manner that maximizes the delivery of value to society while minimizing forgone market opportunities. A combination of driving pressures, including climate change, coastal infrastructural development and coastal natural resource exploitation is causing an escalation in the rate of environmental change in coastal areas. As a result coastal zone policy in Ireland and Europe is being re-orientated towards a more flexible and adaptive approach, while linked marine and water catchment management is also being reformulated under policies such as the Marine Strategy Framework Directive and the Water Framework Directive. One of the key aims of these and other coastal management polices is to ensure that the values provided by ecosystem services in the coastal zone are considered in all decisions that have an impact on coastal ecosystems and habitats. When these coastal ecosystem service values are not revealed through market outcomes, the efficient management of these services requires the use of estimation procedures, such as that developed in this paper in order to measure, what can be, as shown in this paper, their substantial non-market value.

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Figure 1. The Galway Bay Coastal Zone with Associated Ecosystems

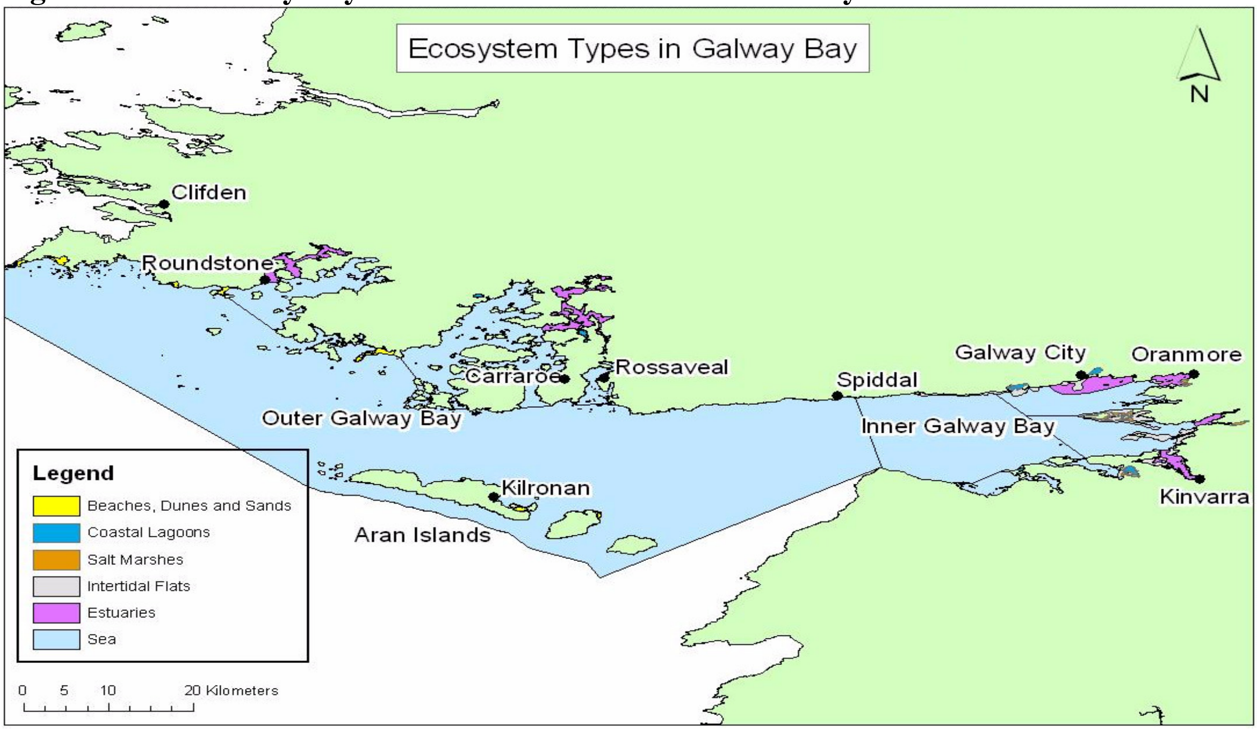

Figure 2. Average yearly non-market coastal ecosystem service value flows per hectare for Inner Galway Bay using Cultural BT procedure

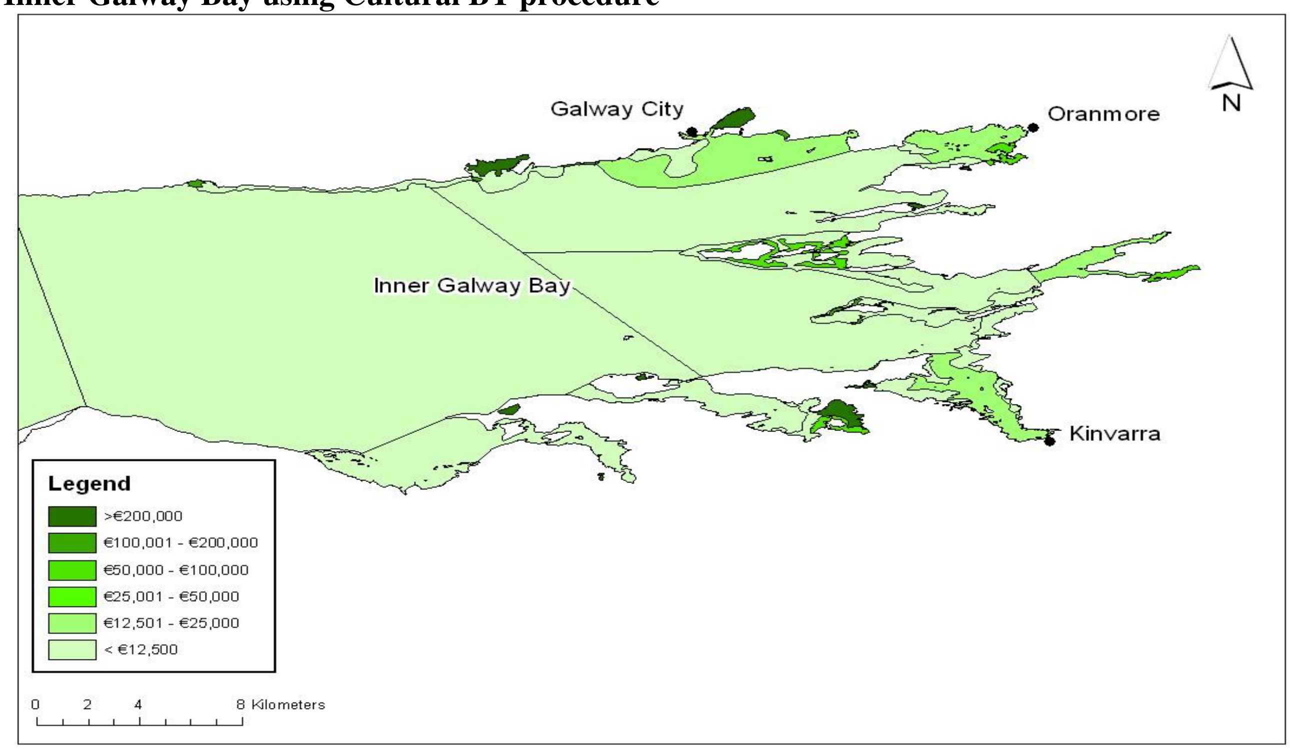

Table 1. The Nine Dimensions of the Culture Measurement in GLOBE Model

Power Distance	Degree to which a culture's people are separated by power, authority, and prestige
In-Group Collectivism	Degree to which a culture's people take pride in and feel loyalty toward their families, organizations, and employers
Institutional Collectivism	Degree to which individuals are encouraged by institutions to be integrated into broader entities with harmony and cooperation as paramount principles at the expense of autonomy and individual freedom
Uncertainty Avoidance	Degree to which a culture's people seek orderliness, consistency, and structure
Future Orientation	Degree to which a culture's people are willing to defer immediate gratification for future benefits
Gender Egalitarianism	Degree to which a culture's people support gender equality
Assertiveness	Degree to which a culture's people are (should be) assertive, confrontational, and aggressive
Humane Orientation	Degree to which a culture's people are (should be) fair, altruistic, generous, caring, and kind toward others
Performance Orientation	Degree to which a culture's people (should) encourage and reward people for performance

Table 2 - Non-market value of ecosystem services provided by each land and marine cover type in Galway (€000/ha/yr in 2007)

	Beaches, Dunes, Sand	Salt Marshes	Intertidal flats	Coastal Lagoons	Estuaries	Sea
Supportive services						
Primary production		27.9 (35.8) *38.1*				0.23 (0.28) *0.26*
Biodiversity		6.5 (8.5) *8.7*	1.3(1.7) *1.8*		1.6(2) *2.1*	0.09 (0.11) *0.11*
Habitat		6.4 (8.2) *8.8*	0.2(0.25)*0.26*			0.06 (0.07) *0.08*
Regulating services						
Atmospheric regulation		0.03 (0.03) *0.03*			-0.09 (-0.09) -*0.09*	.002 (.002) *.002*
Sediment retention	27.8 (35.9) *38*	2.8 (3.6) *3.9*				
Biological regulation						0.03 (0.04) *0.04*
Pollution control	8.7 (24.4) *25.5*				0.66 (1.25) *1.4*	0.01 (0.02) *0.02*
Eutrophication		12.1 (16.3) *17.2*		109 (142.8) *152*	5.3 (11.5) *12.2*	1.2 (1.6) *1.7*
Cultural services						
Recreation	43.2 (110.6) *113.6*	3.6 (4.7) *4.4*		4.6 (5.9) *6.4*	0.95 (1.2) *1.3*	0.02 (0.03) *0.03*
Aesthetic value	2.7 (6.2) *6.8*					0.06 (0.07) *0.07*
The legacy of nature	5.9 (6.2) *6.7*	23.1 (29.7) *31.6*		30.9 (45.3) *50.1*		0.04 (0.06) *0.07*
Total	**88.3 (184.7)** ***192.1***	**82.5 (106.9)** ***112.8***	**1.6 (2)** ***2.1***	**145 (194)** ***209***	**8.4 (16)** ***17***	**1.6 (2)** ***2.1***

Standard font figures indicate estimate values calculated using the unadjusted BT formulae. Figure in brackets indicates estimate value calculated using the income adjusted BT formulae while figure in italics indicates estimate value calculated using the Cultural adjusted BT formulae. Empty cells indicate lack of value data.

Table 3. Total ecosystem value flow for Galway Bay (2007)

Ecosystem Type	Area (Hectares)	Unadjusted (€000)	GDP Adjusted (€000)	Cultural Adjusted (€000)
Beaches, Dunes, Sand	691	61,064 (14.1)	127,645 (20.1)	132,751 (20.1)
Salt Marshes	279	23,023 (5.3)	29,844 (4.7)	31,476 (4.8)
Intertidal Flats	1,584	2,511 (0.6)	3,233 (0.5)	3,334 (0.5)
Coastal Lagoons	400	58,001 (13.3)	77,693 (12.2)	83,413 (12.6)
Estuaries	3,976	33,602 (7.7)	63,594 (10.0)	67,433 (10.2)
Sea	139,386	252,393 (58.1)	327,033 (51.5)	337,336 (51)
Seagrass and Kelp	1,622	3,939 (0.9)	5,798 (0.9)	6,011 (0.9)
Total	**146,316**	**434,532** (100)	**634,842** (100)	**661,755** (100)

Figures in brackets indicate what percentage each ecosystem type contributes to total ecosystem value.

Table 4. Total service value flow for Galway Bay

	Unadjusted		**GDP Adjusted**		**Cultural Adjusted**	
Ecosystem Service	*Ecosystem services value (€000)*	*%*	*Ecosystem services value (€000)*	*%*	*Ecosystem services value (€000)*	*%*
Supportive services		**18**		**15**		**15**
Primary production	40,407	9	49,466	8	46,571	7
Biodiversity	22,371	5	29,081	5	29,452	5
Habitat	14,384	3	19,424	3	20,518	3
Regulating services		**64**		**62**		**63**
Atmospheric regulation	-120	-0.02	-120	-0.02	-120	-0.02
Sediment retention	20,026	5	25,804	4	27,314	4
Biological regulation	3,942	1	5,038	1	4,894	1
Pollution control	10,357	2	24,212	4	25,714	4
Eutrophication mitigation	243,754	56	337,015	53	356,135	54
Cultural services		**18**		**23**		**23**
Recreation	39,404	9	88,873	14	91,596	14
Aesthetic value	10,990	3	15,338	2	15,552	2
The legacy of nature	29,017	7	40,711	6	44,130	7
Total	**434,532**	**100**	**634,842**	**100**	**661,755**	**100**

Appendix A

Table A1. Cultural Index for Specific Countries and Societal Clusters relative to Ireland.

Country	Culture Index	Country	Culture Index	Country	Culture Index
Albania	1.05	Indonesia	1.03	South Korea	1.17
Argentina	1.14	Iran	1.12	Spain	1.17
Australia	1.02	Ireland	1	Sweden	0.91
Austria	1.02	Israel	1.04	Switzerland	1.01
Bolivia	1.04	Italy	1.12	Taiwan	1.05
Brazil	1.12	Japan	1	Thailand	1.04
Canada	0.98	Kazakhstan	1.1	Turkey	1.13
China	1	Kuwait	1.03	United Kingdom	1.03
Colombia	1.17	Malaysia	0.95	United States	1.06
Costa Rica	1.03	Mexico	1.08	Venezuela	1.1
Denmark	0.9	Morocco	1.17	Zambia	1.02
Ecuador	1.08	Namibia	1.05	Zimbabwe	1.07
Egypt	1.01	Netherlands	0.97	**Societal Cluster Scores**	
El Salvador	1.15	New Zealand	1.01	Anglo	1
Finland	0.96	Nigeria	1.1	Confucian Asia	1.03
France	1.11	Philippines	1.03	Eastern Europe	1.11
Georgia	1.11	Poland	1.14	Germanic Europe	1
Germany	1.07	Portugal	1.05	Latin America	1.08
Greece	1.16	Qatar	1	Latin Europe	1.08
Guatemala	1.15	Russia	1.15	Middle East	1.04
Hong Kong	1.11	Singapore	1	Nordic Europe	0.91
Hungary	1.23	Slovenia	1.09	Southern Asia	1.01
India	1.02	South Africa	1.06	Sub-Saharan Africa	1.04