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An economic perspective on oceans and human health

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Human health and wellbeing are intrinsically connected to our seas and oceans through a complex relationship comprising both positive and negative influences. Although significant public health impacts result from this relationship, the economic implications are rarely analysed. We reviewed the literature to assess current knowledge on the economic valuation and impacts of ocean and human health interactions in a European context. Quantitative analyses on the economic impacts of varying ocean-health interactions were limited. Common challenges to economic assessment included the difficulty in obtaining estimates for indirect healthcare costs, under-reporting of illness and the lack of standardization of surveillance data on illnesses, when available. It was also evident that non-market values, such as health promotion and psychological benefits are underrepresented in economic assessments, most likely because of the lack of standardized valuation methods for such non-market values. We provide recommendations to improve knowledge of ocean and human health linkages and progress future assessment of its economic implications in Europe.

Keywords: Oceans and human health, Blue Growth, wellbeing, economic assessment, Blue Gym

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INTRODUCTION

There is increasing recognition in Europe that the links between the seas and oceans on one hand, and human wellbeing on the other, are highly important but poorly understood from a public health standpoint. Understanding ocean and human health interactions is, therefore, the focus of a growing research field, applying expertise from across the natural and social sciences. From a policy perspective, there are significant potential benefits to addressing ocean–human health interactions from the point of view of reducing disease burden and increasing the quality of life for European citizens. However, there are also significant economic implications across the full spectrum of ocean and human wellbeing interactions. The economics of ocean and human health interactions is also in its infancy as a research area and is sparsely addressed in the literature. Yet, taking account of such implications is an important contributor to achieving sustainable growth as part of Europe's Blue Growth strategy.

Coastal environments are the most valued locations globally. By calculating the economic value of goods and services provided by coastal ecosystems, Martínez *et al.* (2007) estimated that altogether, coastal ecosystems contribute 77% of the value of global ecosystem-services calculated by Costanza *et al.* (1997). Such global ecosystem services include raw materials and food, coastal protection, water purification, carbon sequestration, tourism and recreation (Barbier *et al.*, 2011), all of which influence human health and wellbeing. Although the ocean has many positive influences on human health and wellbeing, negative influences also exist in the form of climate change and extreme weather and illness as a result of exposure to harmful algal blooms and water or vector-borne pathogens (Fleming *et al.*, 2014; Tyson *et al.*, 2004).

Oceans and human health is an important research area for Europe considering the proportion of the population living by the coast and the amount of low-lying coastal areas (EEA, 2006). With a coastline 89 000 km in length, Europe has an estimated coastal population of at least 200 million (Depledge *et al.*, 2013), and in line with worldwide trends, population sizes along Europe's coasts are increasing. At the same time, Europe's maritime economy, with political support under the auspices of the EU Blue Growth strategy,[1] is increasing in magnitude and in terms of its environmental impact (Boyes & Elliott, 2014), a pattern with implications for human health. Introduced in 2012, the Blue Growth strategy recognizes the importance of seas and oceans as drivers of the European economy, and their potential for growth and innovation, with a focus on the aquaculture, coastal and maritime tourism, biotechnology, mineral resources and renewable energy sectors (European Commission, 2014).

The valuation of oceans and human health in terms of economic impacts is recommended as a priority area for research in Europe, with suggested areas comprising both opportunities and risks associated with those sectors targeted for expansion by the Blue Growth strategy and cumulative direct and indirect impacts on ecosystems and on human health and wellbeing (Fleming *et al.*, 2014). Economic studies on human health impacts which quantify and provide data on public health issues can contribute to addressing current and future challenges such as risks from marine-borne

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[1]http://ec.europa.eu/maritimeaffairs/policy/blue_growth/

disease through increased understanding of the incidence and cost of disease (in terms of lost productivity and cost of treatment) so that economically optimal management strategies can be achieved (Ralston *et al.*, 2011). Economic studies also serve to highlight gaps where further research is needed to establish the linkages and quantify population risk (e.g. burden of disease) for various environmental risk factors (Prüss-Üstün & Corvalán, 2006). Such studies also play an important role in informing and raising public awareness about risks and benefits to human health, which can alter human behaviour that in turn has economic repercussions. For the purposes of this article, we carried out a review of the literature addressing specifically the economic valuation and impacts of ocean and human wellbeing interactions in a European context.

STATE OF KNOWLEDGE

Quantitative analyses on the economic impacts of varying ocean–human health interactions are limited and this is particularly the case for Europe. Worldwide, more than 60 000 cases of poisoning by exposure to harmful algal blooms are reported each year (Van Dolah, 2000); the global burden of human disease caused by sewage pollution of coastal waters is estimated at 4 million lost 'person-years' annually, which equates to an economic loss of approximately US$ 16 billion a year (van de Guchte & Vandeweerd, 2004); an estimated 250 million cases of gastroenteritis occur worldwide each year as a result of bathing in contaminated water (van de Guchte & Vandeweerd, 2004); annually, an estimated 4 million cases of infectious hepatitis A and E result from consuming raw or lightly steamed filter-feeding shellfish harvested globally from polluted coastal waters (Shuval, 2003); and it is estimated that each year around the world, there are in excess of 50 million cases of respiratory disease caused by swimming and bathing in wastewater-polluted coastal waters (Shuval, 2003).

Despite these estimates, to date there are no good data on the overall impacts of human disease that arise from the ocean (Grimes *et al.*, 2012). Similarly, there are few data on the extent of waterborne diseases and public health effects in Europe and a lack of economic studies that estimate associated costs, partly due to the lack of human health considerations in European marine research to date (Depledge *et al.*, 2013). Outbreaks of seafood-borne illnesses have occasionally been reported in Europe (e.g. Martinez-Urtaza *et al.*, 2005; Boxman *et al.*, 2006; Le Guyader *et al.*, 2008) and it is reported that microbial contamination of bathing water, primarily in the Mediterranean Sea, is responsible for more than 2 million cases of gastrointestinal disease annually (Stanners & Bourdeau, 1995). This is significant because the Mediterranean is currently the world's leading tourist area, accounting for approximately 35% of all international tourist arrivals and revenues globally (Farsari *et al.*, 2007).

To date, studies dealing with economic costs related to oceans and human health have predominantly been carried out in the USA with a focus on harmful algal blooms, specifically the Florida red tide blooms. Florida red tide blooms are primarily associated with the blooms of the toxic dinoflagellate, *Karenia brevis*. They have been documented on the Florida west coast since the 1800s and, more recently, have spread as far as the eastern coast of Mexico (Fleming *et al.*, 2011). Hoagland *et al.* (2002) estimated the economic effects of harmful algal bloom events in the USA over the period of 1987–1992, focusing on public health, commercial fisheries, recreation and tourism, and monitoring and management. Noting that the type and amount of economic data available were limited and that many of the results are preliminary in nature, they estimated that nationwide, the average annual economic impact was in the order of US$ 50 million (Hoagland *et al.*, 2002).

More recent studies on the human health effects of Florida red tide blooms found that bloom events were significant predictors of emergency department visits and hospital inpatient admissions for both respiratory and digestive illnesses for residents and coastal tourists. In addition, annual costs of illness ranged from US$ 60 000 to $ 700 000 annually (Hoagland *et al.*, 2009, 2014).

Using a different approach, Dyson & Huppert (2010) estimated the hypothetical regional economic impact of a year-long closure of four recreational razor clam beaches on the Washington coast due to harmful algal bloom outbreaks. They estimated that the reduction in expected visitor expenditures would cause a US$ 11.36 million per year reduction in coastal county incomes due to reduced recreational activity, and an almost US$ 2 million per year reduction in incomes due to lack of tribal and non-tribal commercial harvest of razor clams. Analysing seafood-borne illnesses in the USA, Ralston *et al.* (2011) estimated that the health consequences have annual costs of approximately US$ 650 million, including US$ 350 million due to pathogens and marine toxins specifically identified as causing food-borne disease and US$ 300 million due to seafood-borne disease with unknown aetiology.

Such calculations of the economic costs associated with ocean–human health interactions are of increasing importance as negative health impacts are projected to increase in relation to the marine environment. For example, in the past three decades, harmful algal blooms have become more frequent, more intense and more widespread. This is, in part, ascribed to climate changes (Glibert *et al.*, 2005; FAO, 2012), representing an increased threat to public health as coastal populations and the popularity of water-based recreational activities increase (Backer & McGillicuddy, 2006). In addition, *Vibrio*-related illnesses (*Vibrionaceae* are a family within the Gammaproteobacteria and are common natural members of marine and estuarine bacterial plankton communities; Böer *et al.*, 2013) are reported to be increasing worldwide including fatal acute diarrheal diseases such as cholera, gastroenteritis, wound infections and septicaemia (Vezzulli *et al.*, 2013). Notably, higher water temperatures, a known impact of climate change, can lead to an increase in the growth rate of pathogens such as *Vibrio* species (Lindgren *et al.*, 2012). Within Europe specifically, there is growing concern that *V. vulnificus* and *V. parahaemolyticus* may represent an important and increasing clinical problem as a result of increasing water temperatures and factors such as the increasing global consumption and trade of seafood produce (Baker-Austin *et al.*, 2010). In line with these predictions, there is evidence that the number of reported *Vibrio*-related wound infections associated with recreational bathing in northern Europe has increased within the last decades (Böer *et al.*, 2013). While a limited research effort aims to address the public health implications of these negative health impacts, we are entirely lacking in information on the corresponding economic impacts.

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Equally important is calculation of the positive economic effects resulting from ocean and human health interactions. A significant potential contributor in this regard is the 'Blue Gym' concept which refers to using the coastal environment specifically to promote health and wellbeing by increasing physical activity, reducing stress and building stronger communities (Depledge & Bird, 2009). A number of studies from the UK are elucidating the Blue Gym concept further with recent findings indicating that good health (both mental and physical) is more prevalent the closer one lives to the coast with the positive effects of coastal proximity greater amongst more socio-economically deprived communities (Wheeler *et al.*, 2012); feelings of restoration are greater after coastal visits compared with other categories of natural environment (White *et al.*, 2013a); there is a positive association between self-reported health and living near the coast (White *et al.*, 2013b); beaches encourage families to be physically active, increase social and family interaction, engage with nature and are associated with fun and stress relief (Ashbullby *et al.*, 2013); and the likelihood of meeting recommended guidelines on physical activity per week increase with coastal proximity (White *et al.*, 2014).

The positive effect of coastal environments on human health and wellbeing and the preference of many people to spend their leisure time at the coast have many economic implications. The EU Blue Growth strategy recognizes coastal tourism as the largest maritime sector employing over 3.2 million people and generating a total of €183 billion in gross added value across the EU.[2] However, an area that is yet to be investigated is the translation of the Blue Gym effect into healthcare savings. Taking obesity as an example of a disease to which lifestyle factors contribute, the British foresight report 'Tackling Obesities: Future Choices' estimates that the UK's National Healthcare System costs attributable to obesity and being overweight are projected to double to £10 billion per year by 2050, with wider costs to society and business estimated to reach £49.9 billion per year (Government Office for Science, 2007). As noted by Depledge & Bird (2009), there is a substantial body of evidence that indicates that taking outdoor exercise offers genuine benefits in treating or even avoiding the onset of obesity, depression and many other conditions currently on the rise and which can potentially save health services large amounts of money.

CHALLENGES

Further studies are needed to determine the economic implications of oceans and human health interactions in Europe. However, quantifying those economic implications is not without its challenges. A common drawback referred to in studies concerning water-borne illnesses is the issue of under-reporting. Factors contributing to under-reporting include patients not attending a doctor, misdiagnosis or failure to recognize the illness as resulting from a marine-borne agent, and illnesses not being reported to public health officials (Newell *et al.*, 2010; Ralston *et al.*, 2011). Furthermore, surveillance data on illnesses, when available, are not standardized and a remaining challenge is to establish surveillance systems that assess the level, source and severity of food-borne illnesses (Todd, 2006). In the case of Europe, available data on waterborne diseases and outbreaks are often incomplete and inconsistent for reasons that include differences in recording and reporting procedures, disease classification and financial restrictions, and variation in the legal basis for reporting between different countries (EEA and WHO, 2002). Current EU-wide surveillance of infectious diseases is either indicator-based (annual country-level reporting of confirmed human cases) or event-based (detection of individual disease outbreaks through 'epidemic intelligence' which refers to the identification, verification, assessment and investigation of potential health threats) (Lindgren *et al.*, 2012). However, reporting of infectious diseases varies widely within Europe as some European countries rely on voluntary as opposed to mandatory reporting systems (Knowles *et al.*, 2007).

An additional ongoing challenge to economic assessments is incorporating non-market values into studies, i.e. values for which a price cannot be found in the economic marketplace (Ciscar *et al.*, 2014). In the most simplistic economic models, the value of the environment is reduced to resources that can be directly harvested, mined or otherwise used by humans (Hylland, 2006). Health impacts often do not lend themselves to such valuation and hence, there is a need for ways of recognizing and measuring health aspects that cannot be directly valued, such as the psychological benefits people experience as a result of the Blue Gym concept.

OPTIONS FOR IMPROVING ECONOMIC IMPACT ASSESSMENT

There are a number of recommended actions that can be taken to improve knowledge of oceans and human health linkages and progress future assessment of its economic implications in Europe. These include:

- *Enhancing understanding of oceans and human health*: Increasing our understanding of the links between oceans and human health, for example through further investigation of how rising water temperatures will affect the proliferation and distribution of pathogens, how to improve diagnosis of marine-related illnesses and further study on the Blue Gym concept, will improve the accuracy of economic studies assessing the benefits and risks of coastal interactions. This requires an interdisciplinary effort.
- *Increased reporting of marine-related illnesses*: A standardized reporting system in Europe for recording confirmed and suspected marine-related illnesses will improve the issue of under-reporting and, in turn, the accuracy of relevant economic studies.
- *More emphasis on non-market values*: Guidelines on measurement and inclusion of non-market values in studies, such as stress relief, will contribute to capturing benefits and risks that are currently underrepresented but have significant economic effects.
- *Increased communication*: Providing the public with information on oceans and human health impacts can influence behaviours that in turn have economic impacts, such as harnessing the Blue Gym concept to encourage increased physical activity and decrease health-care costs.

[2] http://ec.europa.eu/maritimeaffairs/policy/coastal_tourism/index_en.htm

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- *Implementing more comprehensive surveillance*: Standardizing current surveillance systems between European member states and expanding them to include potential new threats such as pathogenic *Vibrio* species will allow for an improvement in determining and addressing risks.
- *Enhancing Europe's leadership in the field*: Aligning economic impact studies in the area of oceans and human health with Europe's Blue Growth strategy provides an opportunity for Europe to build its research capacity and leadership in this emerging research field.

CONCLUSION

The seas and the coasts are drivers of Europe's economy (European Commission, 2012). To meet the goal of sustainable growth it is necessary that consideration of human health impacts be taken into account in the process of implementing the Blue Growth strategy. As coastal populations continue to increase and as sectors such as tourism, aquaculture and blue biotechnology expand as part of Europe's Blue Growth strategy, the public health and economic repercussions emanating from the interactions between oceans and human health will become increasingly prominent, requiring effective and integrated public health solutions to be developed through the formulation of politically and environmentally meaningful policies (Moore *et al.*, 2013). However, as yet, Europe has largely failed to promote an integrated interdisciplinary and collaborative research effort in the area of oceans and human health on a scale necessary to address the public health implications of rapidly increasing human activity in European seas and oceans, especially in the coastal zones (Fleming *et al.*, 2014). Quantifying the economic implications of oceans and human health in Europe will contribute to achieving sustainable development through providing information that can influence evidence-based environmental and public health policies, which recognize and address the positive and negative impacts of oceans on human health. Boyes & Elliott (2014) recognize the European Union as a preeminent player in sustainable development through its adoption of over 200 pieces of legislation underpinning marine environmental policy and management. Accounting for the economic implications of oceans and human health can only serve to maintain and enhance Europe's reputation for supporting sustainable development.

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