

Streszczenie w języku angielskim

In many regions of the world, the environmental resistance threshold has been exceeded, which has led to an irreversible reduction of the array of options for using the environment and a reduction in its ability to self-regulate. As a result, its parameters, processes and functions deteriorate, which in the case of aquatic ecosystems means, among others, the increased water turbidity, cyanobacterial blooms and the occurrence of hypoxic or anoxic near-bottom conditions. Consequently, the poorer the environment is, the weaker flow of benefits to the users is being observed (TEEB 2010). In order to assess the value of such benefits or losses, the term 'ecosystem services' has been introduced, as the issue of natural resources, widely discussed and analyzed so far in the economic theory, due to the lack of interdisciplinary arrangements of its theoretical essence with ecology and biology, has become insufficient for the demanding process of estimating the economic value of the environment.

According to the Helsinki Commission (2010), amongst the twenty-four identified ecosystem services provided by the Baltic Sea, only ten function well, while seven are severely threatened, including the ability of the ecosystem to regenerate and buffer anthropogenic waste input, which results in the increased eutrophication (HELCOM 2010).

Every year, the excessive amounts of pollution are discharged to the ecosystem of the Gulf of Gdansk. These can be from either (i) point sources such as municipal and industrial sewage treatment plants or, (ii) area sources such as the surface runoff or atmospheric deposition. They contain, among others, nutrients, mainly nitrogen and phosphorus, which cause over-fertilization of water – a phenomenon called eutrophication. The concentrations of nitrogen and phosphorus in estuaries are shaped by their external inflow, exchange with marine waters and the processes that these components undergo in the water column and sediments. Usually, the bottom sediments are the final recipients of nitrogen and phosphorus from the water column, which means that in the long term some of the nitrogen and phosphorus reaching the sediments accumulate in them, and in the case of nitrogen also denitrify, which results in the exclusion from circulation in the aquatic environment of this part of nitrogen (Graca 2009). The load of nitrogen removed from the water column as an effect of denitrification in sediments has reached the maximum amount of $20.41 \cdot 10^3 \text{ t N} \cdot \text{y}^{-1}$, which corresponds to 15% of the external nitrogen supply to the gulf. These data testify to the relatively high potential of sediments to immobilize nitrogen in hardly bio-available forms (Graca 2009).

The dissertation attempted to assess the economic value of one of the regulatory services provided by the Gulf of Gdansk ecosystem – a service of balancing the effects of eutrophication – understood as regulating the amount of nitrogen compounds by bacterial denitrification in sediments. The Replacement Cost Method (RCM) belonging to the group of methods based on revealed preferences and the Contingent Valuation Method (CVM) from the group of methods of declared preferences were used. The choice of the valuation method by estimating the replacement costs forced the selection of such components of the analyzed ecosystem regulatory service that allowed its reliable use. As a result, the denitrification process occurring in the Gulf of Gdansk sediments was valued.

The research hypothesis of the dissertation is: **the value of the service of balancing the effects of eutrophication estimated on the basis of the costs of replacing the ecosystem function is higher than the value expressed by social preferences.**

The environmental and social problem, which is the eutrophication of the Baltic Sea and the Gulf of Gdansk, as well as the identified gaps and needs in the implementation of maritime, environmental and spatial planning policies in marine areas have allowed identifying the following main aim of this work, i.e.:

- **estimation of the economic value of the regulatory service of natural processes balancing the effects of eutrophication in the Gulf of Gdansk.**

The specific aims of the work reflect the logic applied, as well as the procedure of research methods used and stages completed. These are the following:

- **identification and quantification of the ecosystem service under study,**
- **presenting a technical substitute for the service provided by the environment,**
- **estimating the cost of replacing the ecosystem service,**
- **performing a direct valuation using contingent valuation.**

The economic value of the regulatory ecosystem service of the Gulf of Gdansk was estimated, which is balancing the effects of eutrophication using a combination of two methods: the replacement cost method and the contingent valuation method. This is the first such assessment in Poland and in the Baltic Sea region.

The value of the service of balancing the effects of eutrophication responsible for the removal of 20,410 tons of nitrogen through denitrification in sediments estimated using the

replacement cost method is about 1.6 billion PLN per year (2014). The total value of this regulatory ecosystem service is certainly greater, as in fact the role of the ecosystem in removing nitrogen was estimated. The methodological limitations of the replacement cost method did not allow capturing its full value. The results obtained by this method are a reliable indicator of the economic value of the regulatory service of the Gulf of Gdansk ecosystem.

Not only the costs of the substitute were determined, but also the benefits perceived by society expressed in money, captured in the results obtained by the contingent valuation method. The average WTP value declared by the so-called non-protesting respondents in the amount of 21.14 PLN per person was determined. This indicates the willingness (WTP) of the society to participate in the financing of programs aimed at combating the causes of eutrophication.

As a result of aggregation of the average willingness to pay (WTP) for financing technological solutions replacing the lost natural self-cleaning functions of the Gulf of Gdansk, the value of benefits resulting from this regulatory service was estimated at 0.508 billion PLN. The first in Poland valuation of the array of economic benefits resulting from denitrification in this basin was performed.

The veracity of the research hypothesis has been verified. Considering the valuation scenario, the social preferences (WTP) after aggregation are many times smaller than the value estimated on the basis of the replacement cost method. The conducted research shows that the society, despite the willingness to pay, underestimates the importance of regulatory services and may not understand their actual value, hence it cannot be expected that this issue will be properly recognized in the course of political dialogue regarding the maritime spatial development. Some services provided by marine sediments may be irretrievably lost e.g. through the development of offshore wind energy. Therefore, there is a need to change both the environmental policy and the content of other strategic documents. Underestimation by the society of the values that are brought by marine ecosystems (the Gulf of Gdansk is just an example here) indicates the need for educational actions.

An independent added value of the work is the performance of the first economic valuation of the regulatory ecosystem service by the method of replacement cost, meeting all the recommended conditions necessary to obtain reliable value results. The first in Poland valuation of the array of economic benefits from denitrification occurring in the sediments of

the Gulf of Gdansk was made. The effectiveness of the applied research techniques was verified. The study has enriched science with new knowledge about the perception of the issue of protecting the marine environment by the Polish society and the ways in which this knowledge influences people's decisions.