Developing a global economic valuation function for nitrogen impacts on coastal and marine ecosystem services

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Abstract

The ecological and economic importance of coastal and marine systems is widely recognised. Yet, excessive nutrient loads can lead to eutrophication, impair ecosystem services (ES), and cause significant economic costs. This work reviews existing studies to develop a spatial valuation function for nitrogen (N) impacts on ES provision, using the Baltic Sea as an initial example. Recreation and water quality improvements are the most frequently valued ES in the Baltic Sea. However, the use of different N-related indicators and unit values proves to be challenging. Future work will standardise N-indicators to develop a global valuation function for marine ES.

Keywords: nitrogen loads, marine water quality, ecosystem services, economic valuation

1. Nitrogen impacts on coastal and marine ecosystem services (ES)

Water pollution from excessive nutrient loads is often considered one of the main causes for coastal and marine environmental deterioration, with implications for ES provision. This has led to attempts to estimate critical N-load thresholds (Smith et al. 1999) and assess their impacts on ES (Compton et al. 2011). Our work aims to develop a global valuation function that incorporates the impacts of N-loads on marine ES, using the Baltic Sea as a case study.

2. Methodology

The Baltic Sea is particularly vulnerable to N-loading. N-load contributions vary considerably among the 9 Baltic Sea countries (Fig. 1). To mitigate these effects, several policies have been implemented, most importantly the HELCOM TN load targets (Fig. 1).

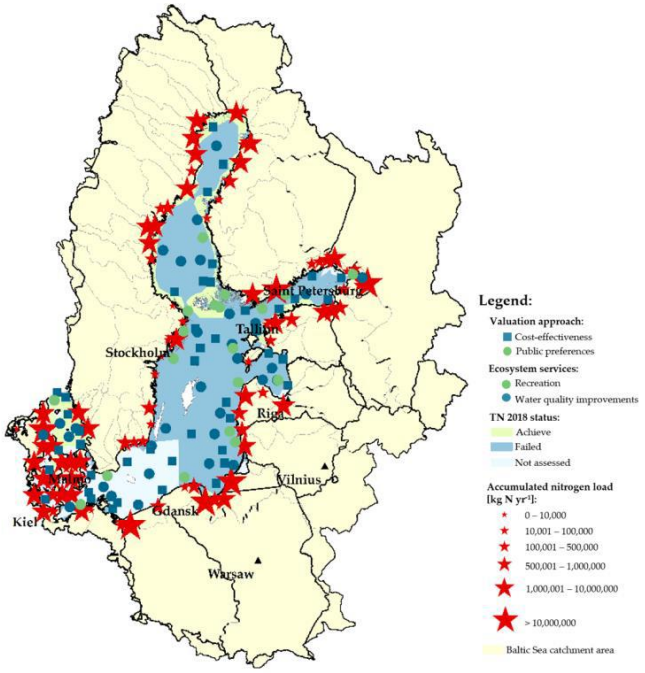

Fig. 1: Baltic Sea valuation studies and N-related ecosystem services. The accumulated N-loads at river mouths (Beusen et al. 2016, 2000 data) affect the achievement of TN targets.

Establishing dose-response relationships between N-loads and ES is challenging. Thirty valuation studies identified from scientific databases were reviewed in terms of study design (e.g. valuation methods), characteristics (e.g. ecosystem services) and context (e.g. policy targets).

3. Results

Valuation studies assess either the cost-effectiveness of nutrient abatement measures (47%) or public preferences for water quality improvements (53%), and focus mainly on recreation (30%) and general water quality improvements (70%). The indicators describing dose-response relationships vary considerably. Half of the studies used N-loads (kgN yr^{-1}) to infer its effects on water quality improvements, 40% eutrophication, 7% water clarity and 3% a combination of the latter two (3%). N-abatement measures include nature-based solutions (16%), and mainly target agriculture (30%) and wastewater treatment (8%).

Values for water quality improvements vary significantly between valuation methods and countries (Fig. 2), and range between 8-440 US$/person/year in public preference studies and 0.3-600 US$/kgN in cost-effectiveness studies. Recreation has the lowest values (14-90 US$/person/year).

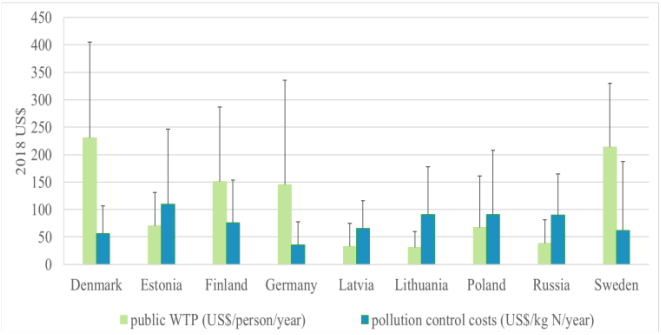

Fig. 2: Average economic values across Baltic Sea countries for water quality improvements in 2018 prices, based on studies estimating willingness to pay (WTP) and pollution abatement cost.

4. Gaps and challenges

The Baltic Sea is among the most frequently valued marine ecosystem in the world. However, only a limited number of valuation studies link N-loads to their impacts. Our next step in developing a global valuation function is to standardize the methods and N-indicators among studies.

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