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Detecting ecosystem service trade-offs and synergies: A practice-oriented application in four industrialized estuaries

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ABSTRACT

Estuaries connect terrestrial and marine biomes. Their ecological functioning is essential for marine matter fluxes, while their central economic role as transport hubs persists throughout history and has become ever more pronounced. Managing complex socio-ecological systems such as estuaries can benefit from an ecosystem service approach. The challenge is to combine highly complex knowledge, prone to uncertainties, to policy relevant information. This paper introduces a knowledge-based ecosystem service screening, applied in a participatory manner by including different stakeholders from four industrialized NW-European estuaries.

The approach allowed to efficiently engage stakeholders from different, often opposing sectors, in order to derive a set of ecosystem services of high societal importance, link them to supply by habitats, and explore inter- and intra-estuarine variability. By introducing the notion of trade-offs and synergies and assessing these for estuaries, the interconnectedness and mutual interests for estuarine management measures were indicated. The screening is based on knowledge surveys among experts. Statistical reliability was acceptable, but to complement the assessment, quantitative validation on a local scale would be useful.

Ecosystem service assessments, especially when engaging stakeholders, can inform policy on strategies for the sustainable use of ecosystem services in intensively used and ecologically fragile estuarine zones.

1. Introduction

Ecosystem services (ES) are *the aspects of ecosystems, utilized actively or passively, to produce human well-being* (Fisher et al., 2009). The science of ecosystem services aims to classify, describe and assess these natural assets, their demand and supply functions, quantification, valuation and management. ecosystem services are currently categorized in provisioning, regulating, and cultural services. All of those are eventually generated, supported and ensured by ecosystems in all their diversity (MA, 2005; TEEB, 2010).

Estuaries and coastal marine ecosystems – as the transitional zone between land-based ecosystems and the world ocean – are among the most productive biomes of the world, serving important life-support systems for human beings (Day et al., 1989). A distinctive feature contrasting estuaries from other biomes is the nature and variability of the physicochemical forces that influence these ecosystems. Within small geographic regions, many estuaries experience widely varying conditions of temperature, salinity, concentrations of a wide variety of chemicals, and plant and animal densities, many of whose are mediated by water movement over relatively short timescales (Jacobs, 2009; Elliot and McLusky, 2002). Estuarine biotas are therefore geomorphologically very dynamic and ephemeral systems, influenced by both sea and land changes, resulting in a complex mixture of many different habitat types. Natural processes and structures provide intermediate services (also called functions) which lead to final services, directly linked to benefits. Supporting functions include biogeochemical cycling and movement of nutrients, purification of water,

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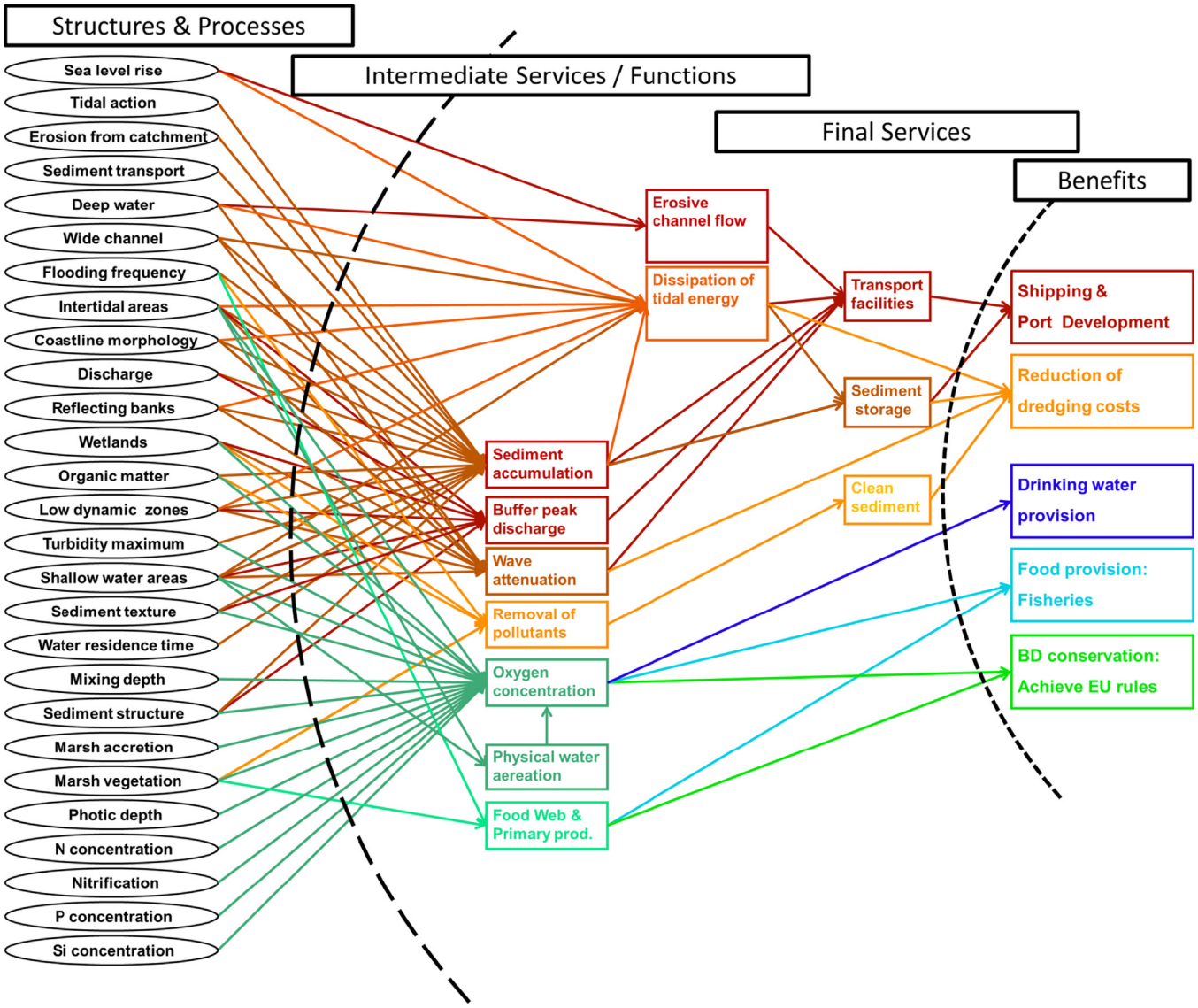

Fig. 1. Links from supporting structures and processes, through functions and ecosystem services, to benefits, illustrated for a set of typical estuarine ecosystem services.

mitigation of floods, maintenance of biodiversity, and biological production (Jacobs et al. 2009; Daily et al., 1997, see Fig. 1). Moreover, many estuaries are economically and socially important, and they are among most heavily used and threatened natural systems globally (Lotze, 2006; Worm et al., 2006; Halpern et al., 2008). Human activities provoke an intense and increasing deterioration, and this has a direct impact on the services delivered by estuaries.

Assessing ecosystem services is critically important for improving estuarine management and designing better integrated policies (Barbier et al., 2011). Particularly in estuaries, where ecological as well as social system functioning is inherently complex, many uncertainties persist, while decisions affect a multitude of societal groups (Granek et al., 2010). Many benefits have not been estimated reliably, and even for those services that have been valued, only few dependable studies have been conducted (Barbier et al., 2011). Interactions between different services generate trade-offs and synergies between services, and between current and future delivery.

In this paper, we address the following research questions:

- What are key ecosystem services for industrialized estuaries?
- How does ES-demand and supply vary between estuaries and along the salinity gradient, and supply between habitats?
- What are potential trade-offs or synergies in supply of ecosystem services?
- How were findings applied in estuarine management during and after the project?

In this paper presents the results of a participative ecosystem service screening for four North-West EU estuaries, with the objective to inform estuarine management in practice. The research was performed within the TIDE project[1] and focused on estuaries with important port and industrial activities on the one hand, but a full tidal influence over their salinity gradient on the other hand. The screening was performed to generate a complete spatial inventory of demand, supply and interdependences of ecosystem services. The objective was to raise awareness on ecological and socio-economic complexity of estuarine systems

[1] TIDE (tidal river development) project, funded by the Interreg IVB North Sea Region Program, ccordinated by the Hamburg Port Authority. http://www.tide-project.eu/, http://www.tide-toolbox.eu/.

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