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Welfare effects of protecting the Volta delta against erosion

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This policy brief is the result of a collaboration between the Institute for Environmental Studies at Vrije Universiteit Amsterdam (IVM-VU), the Institute for Environment and Sanitation Studies at University of Ghana (IESS-UG), The Development Institute (TDI) and IUCN-NL. The project targeted to value ecosystem services in both urban and rural areas along the Ghanaian coast, thereby providing insights for future coastal zone management including sustainable port design and nature-based solutions. Funding was received from IUCN-NL and NWO-WOTRO through the Urbanising Deltas of the World programme, project number W07.69.206.

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Introduction

Coastal areas are very sensitive to climate change due to sea-level rise leading to negative impacts such as coastal erosion[1]. The impact of sea-level rise is increased by coastal developments, land use change and population growth, and causes societal problems such as increased salinity of groundwater and soils, the necessity to migrate and loss of infrastructure[1,2,3]. Developing countries are generally more vulnerable to coastal changes due to their limited capacity to prevent and absorb the related effects[1,4,5]. While ongoing coastal changes could furthermore lead to reversed or reduced economic growth, coastal adaptation towards climate-proof coasts has progressed less in developing countries than in the developed world[1,3].

To stimulate coastal adaptation in developing countries it is important to evaluate different adaptation strategies and identify opportunities. Potential adaptation strategies in coastal areas include hard structures, beach nourishment, ecosystem restoration, retreat, zoning and building codes[3,6,7]. The adaptation options that aim to provide coastal protection can be separated into engineering and nature-based solutions. Engineering solutions are the conventional adaptation measures such as groynes and revetments, which are increasingly criticized due to down-drift effects and high costs related to investment and maintenance[8,9,10,11]. Alternatively, nature-based solutions are increasingly being studied and implemented, and are often cost-effective, low maintenance, and preferable due to the provision of diverse and abundant co-benefits[11,12,13].

Coastal erosion in the Volta delta

Coastal erosion is a major environmental problem in the Volta delta. Much needed sediment is trapped behind the Akosombo dam and sea-level rise is expected to increase current erosion rates[14,15,16,17]. Since the 1960s coastal erosion is estimated to have destroyed about 5,000 houses, displaced households, destroyed sources of livelihoods and forced migration[18,19,20,21,22]. Sea-level rise could lead to an additional 20 meters of erosion in the low-lying Volta delta by 2050[17]. This threat posed by coastal erosion makes protecting the coastline in this area a highly urgent matter.

The area down-drift of the Volta estuary is especially vulnerable and stretches along the communities of Fuveme, Atiteti, Anyanui, Agbledomi, Dzita, Atorkor, Srogboe, Whuti and Anloga. Along this coastal stretch historical erosion rates differ between 2.8 and 0.2 meters per year[23]. In total around 5,000 households currently inhabit this area. The majority of these households depend to a large extent on fishing and farming for their livelihoods. Currently Ghana mostly invests in engineering approaches to prevent coastal erosion, such as groynes in Ada and Keta. However, beach nourishment could potentially serve as a nature-based and more sustainable alternative. Here we will provide the results of a cost-benefit analysis of these two coastal adaptation measures[24].

Figure 1: Coastal communities (left) and infrastructure (center) in the Volta delta are threatened by increasingly smaller beaches (right) due to coastal erosion. Source: author's private collection.

Approach

For the estimation of the costs of the adaptation measures we used information on the costs of groynes and beach nourishment from reports and scientific studies concerning previous projects in the region[8,25,26,27,28,29]. For the estimation of the benefits of the adaptation measures we conducted 250 household surveys across the communities between Fuveme and Anloga. This survey included a discrete choice experiment (DCE). A DCE is a valuation method that is widely used to value goods that are not sold on the market, like erosion prevention, and is commonly applied in similar situations. A DCE involves making choices between different packages that consist of changes in the coastal zone and a payment for these changes. In our case the payment is defined as time contributions instead of the commonly applied money contributions to avoid financial constraints faced by the households[30]. Time contributions are later translated into monetary values by applying the average earnings of the respondents in this study[31]. By observing the trade-offs that respondents make it is possible to estimate relative values of the goods. This reveals the willingness-to-pay (WTP) of the local households for erosion prevention. In the cost-benefit analyses we include a range of sensitivity analyses to test the robustness of our results. These sensitivity analyses include differences in cost estimates, population growth rates, erosion rates, WTP estimates, discount rates and the effectiveness of the measures. The time span of the cost-benefit analysis is set at 30 years, ranging between 2020 and 2050.

Findings

The cost-benefit analyses result in positive net present values (NPV) for both groynes and beach nourishment along the coastal stretch between Fuveme and Anloga. The NPVs are larger for beach nourishment than for groynes. The most conservative NPV estimates equal $457 million for beach nourishment and $285 million for groynes. These numbers are based on a low population growth rate, decreasing erosion rates over time, lower bound estimates of the WTP values, high cost estimates and a high discount rate. The welfare estimates based on different assumptions in the analysis can range up to $8,231 million for beach nourishment and $6,892 million for groynes. For the most conservative estimates, nourishment remains economically viable also if it only reduces erosion by 48%. Groynes need to reduce erosion by at least 68% before being economically viable.

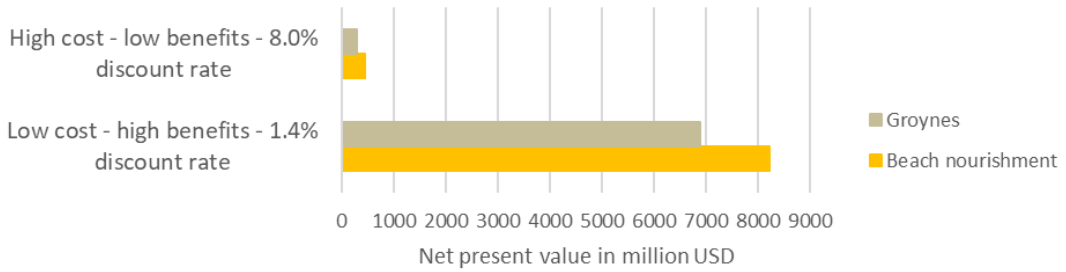

Figure 2: Net present value (NPV) for groynes and beach nourishment, based on different assumptions made in the analysis regarding population growth rates, erosion rates, WTP estimates, cost estimates and discount rates.

Implications

Nature-based solutions provide a possible means to protect coastlines suffering from coastal erosion and sea-level rise more generally. The cost-benefit analyses of both beach nourishment (nature-based solution) and groynes (engineering solution) reveal that beach nourishment results in higher welfare effects. Beach nourishment is furthermore more compatible with local lifestyles, provides potential future economic opportunities in terms of tourism, and supports biodiversity by providing nesting area for sea turtles (see Figure 3). Moreover, it is a flexible adaptation solution that is reversible, keeping all coastal adaptation options open for future generations.

It is therefore recommended to invest in a pilot beach nourishment project along the studied coastal stretch, accompanied by the advice to complement our economic analysis with a more detailed study on coastal geomorphology in the study area to verify the assumptions made in our study. This pilot could potentially identify beach nourishment as an effective solution to erosion problems all over Ghana. For the implementation of beach nourishment, it would be of high importance to monitor the effectiveness of nourishment, enforce existing sand mining regulations, implement zoning and building codes, and ensure long-term political support. Overall, beach nourishment has the potential to serve as a more sustainable coastal protection measure for Ghana and other countries in West Africa.

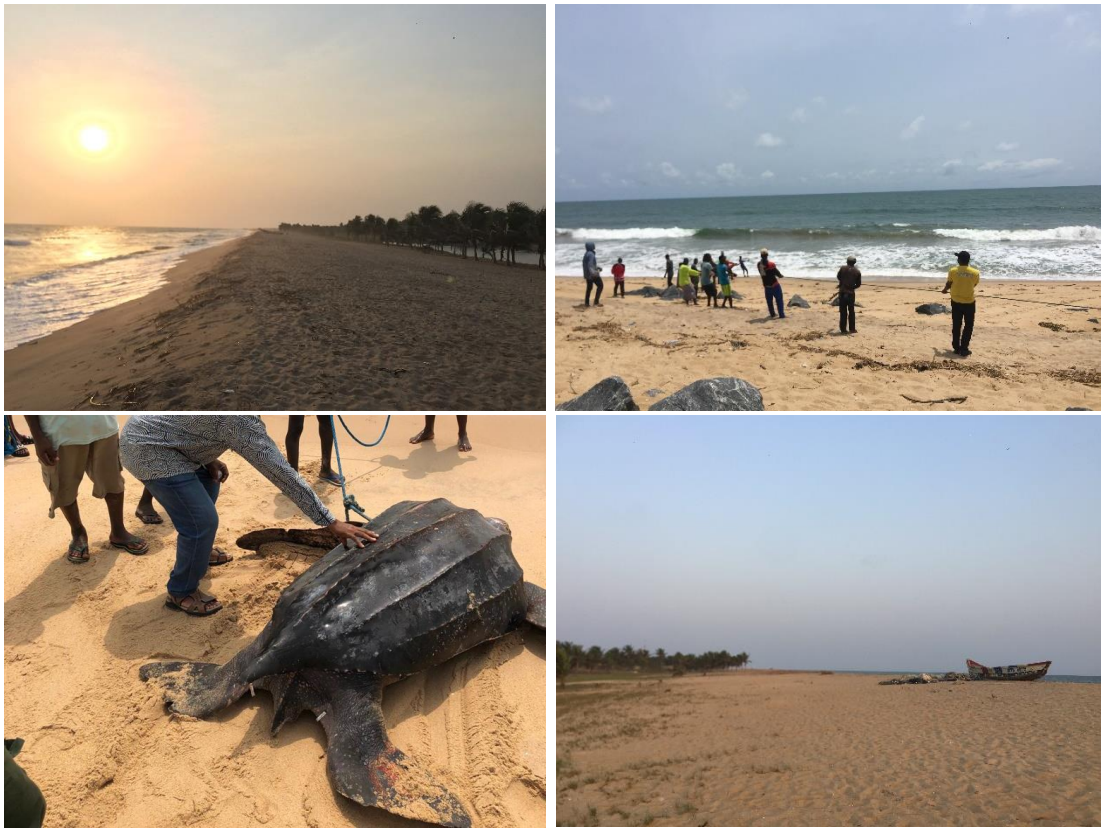

Figure 3: Examples of beaches and beach uses in the Volta delta. Upper left and bottom right: currently still wider beaches along the Volta delta coastline. Upper right: traditional fishing practice in which a large net is dragged along the beach during a few hours. Bottom left: sea turtle that uses the beach for nesting. Source: author's private collection.

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