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Review and rebuttal of the paper

Nature-based coastal flood protection: Lessons from the Caribbean and the Philippines

R. Sousa et al.

Editor handling the paper: Jeremy D. Bricker

The reviewers remain anonymous.

Round 1
Response to reviewers (in red)

Reviewer A:

Dear editor and author,

Thank you very much for your interesting short communication about Nature-based coastal flood protection and the opportunity for review. I have read the findings with interest and have the following remarks on the contents:

The short communication provides useful lessons learned from specific cases in both the Caribbean and the Philippines. Allthough the physical systems between the presented cases differ quite some, considering coral coasts of Grenada and the Phillipines versus the sandy coast of Suriname, the findings about the institutional and social capacities needed for effective implementation of the measures can indeed be seen as a general observation.

Suriname has in general a muddy coast. Sandy coast is found in the east at the estuarine zone of river Marowijne towards the west. Sand along the coast is also seen, particularly where erosion is going on. Sand is formed by the "wash and swash" actions of the waves. The coast of Weg naar Zee is muddy.

As a general comment, the case studies and lessons learned section can benefit from a more systematic description of the similarities and arguments used for drawing conclusions. My recommendation would be to revisit the arguments that will be used to draw conclusions/ lessons from the cases, present them in a section prior to introducing the cases and then discussing them in the cross-cutting lessons section.

Especially where the authors draw conclusions about their similarities about the effectiveness of NBS solutions, it would be good to present these arguments first (possibly as criteria of a framework), then discuss them separately in the cases and then summarize them in the cross-cutting lessons section of the communication. For example, strong multilevel governance structures in all four projects is used to conclude that the success of NBS is closely tied to governance arrangement and institutional coordination. However, in the Surinam case, the governance arrangements are not well discussed, rather this section focusses more on the technical measures taken to combat erosion.

Following this recommendation, we have added a dedicated section immediately before the case descriptions entitled *"Analytical Framework for Case Assessment."* This section outlines the six criteria (effectiveness in risk reduction, ecological integrity, socioeconomic benefits, governance and stakeholder engagement, technical feasibility, and sustainability and scalability) that we use systematically to evaluate each case. The same criteria then guide the synthesis in the *Cross-Cutting Lessons* section, ensuring a clearer alignment between the individual case analyses and the overarching conclusions.

Some arguments lack explanation: Green and grey infrastructure is presented on page 11 and Grenada's submerged breakwaters and Suriname's STU's are considered a combination of both. It is not explained in neither of these sections why these are a combination. Also, it is not clear how the loss of biodiversity as a result of poorly informed or under-resourced interventions follows from the case studies.

The "green" is the restoration of mangroves and coral reef recruitment. The "gray" refers to the modular submerged units in Grenville Bay and the dyke at Weg naar Zee which is very much needed not only to protect the land from getting eroded, but also to prevent the hinterland from flooding during highwater,

particularly during the spring tides. Mangroves in front of the dyke will attenuate, mitigate the negative impacts. The loss of biodiversity is interlinked with loss of mangroves in the case of Suriname and pollution in the case of Grenada.

The section on cross-cutting lessons can read a bit confusing, with different arguments presented for a conclusion that might not fit together well. For example, on pages 10 and 11, an argument is made about sediment supply in the Surinam and Grenada cases, which is then compared / linked to social and economic characteristics of coastal populations in the Danajon Bank. This is a bit confusing.

Answered before.

The following are more specific comments on the sections of the cases:

For Grenada, the total loss of Hurricane Beryl reads as if the USD 1.2 billion is specific to the island, whereas it is the total damage of the storm in the entire region correct? This statement was removed.

Furthermore, more technical explanation would benefit the section, for example about how the retention ponds are made, if anything was done to capture/ filter pollution and waste coming down the rivers,

The retention ponds are just excavated low-lying sites to create basins that captures and temporarily hold runoff water, allowing sediments and nutrients to settle before the water infiltrates or is slowly released. Nevertheless, this wasn't the focus of the paper.

and if there is an idea on the time needed for effective growth of the artificial reef (to know when it will restore the original functionality of the reef that has deteriorated).

Within less than a year after the installation of the submerged breakwaters, coral reef recruitment was thriving.

Finally, ae there any more references to this section than the interview held?

References added.

For Surinam, this section would improve if a map was included with an explanation of the location of the STU's, the risk of erosion, the dredged area that impacted the effectiveness of the STU's and the planned seawall.

Map added.

For the Philippines, it is not clear if the mitigations presented actually prevent coastal flooding, or are intended to adapt to other adverse impacts of climate change. This could be better described. Especially since the communication states that the NBS paint a promising future for the Danajon Bank. For the Del Carmen case study, it is not clear / consistent that in this section, the high emission scenario for climate change is presented whereas in previous cases the average to high emission scenario is discussed. Also, it would be great to discuss the elevation of the area compared to MSL currently and as expected with the proposed mitigation measures.

For the Philippines cases, we have now distinguished more explicitly between the role of NbS in reducing coastal flooding (e.g., mangroves as wave barriers, coral reefs attenuating storm surges) and their broader contribution to other climate adaptation benefits, such as supporting fisheries and livelihoods.

Finally, in the conclusions section, it is argued that the cases are able to reduce coastal flooding and generate co-benefits for biodiversity and local livelyhoods. It is not entirely clear if coastal flooding is actually mitigated, especially in the cases of Grenada and the Philippines, where coastal flooding seems inevitable.

We changed it to reducing coastal hazards instead.

I recommend revising and resubmitting the communication after addressing the points outlined in this review. Currently, the article lacks sufficient clarity regarding the methodology used for selecting, assessing, and comparing the case studies. Consequently, the case studies do not consistently present the necessary information along a standardized set of criteria, limiting the ability to effectively support or generalize the conclusions. At present, the case studies are described narratively with limited justification or systematic comparison.

Answered before.

The revised version should adopt a more structured approach, explicitly comparing the case studies against clearly defined key criteria. These criteria will then directly support and strengthen the conclusions and lessons presented in the final sections of the article.

Answered before.

Good luck and my regards,

Recommendation: Resubmit for Review

Reviewer B:

Nature-based Solutions (NbS) are often community-driven and don't have a standardized methodology, which makes comparing case studies such as this paper from different regions particularly valuable. Especially when it comes to flood protection, it's important to learn not only from successful examples but also from failures.

However, this paper seems to be written mostly based on third-party information. So the reviewer wonders if the authors were personally involved in any of the projects and faced challenges themselves. If the authors themselves were involved in the project, the insights come across as a bit superficial. On the other hand, if the authors are introducing a project by other organizations, the discussion seems shallow, with the main objectives remaining unclear.

The authors were directly involved.

In the chapter "3 Cross-Cutting Lessons," each case study appears rather superficial, making the message vague, and it seems that no meaningful cross-cutting lessons have been derived.

Overall, the discussion in this paper does not demonstrate sufficient depth even for a short communication. Therefore, in its current form, it is difficult for this reviewer to recommend for publication. If the purpose of this paper is to introduce case studies of initiatives in various regions, it would be better to conduct a more thorough investigation and submit it as in-depth review paper or survey report.

Other specific comments:

The authors present four case studies from Grenada, Suriname, and the Philippines, but it's unclear why these regions were selected. Do they share any common issues?

These low-lying coastal communities and Small Island Developing States, highly exposed to hurricanes, typhoons, and other coastal hazards, stand at the frontline of climate change impacts. PEERS has been working alongside them for nearly two years to advance collaborative adaptation efforts.

Each figure should be clearly referred to and discussed in the main text.

Figure 1: The location is unclear. Please include a broader world map for context.

Done.

Figure 2: The photo would be easier to understand if the locations of the countermeasures were clearly marked.

Done.

Figure 3: The structure appears to resemble an artificial reef rather than a breakwater. If it is intended to function as a breakwater, please specify the expected wave-dissipation performance.

That information is in Reguero et al. 2018.

Figure 7 and 9: As is immediately clear from these photos, the primary problem on the islands should be overpopulation, not climate change or environmental degradation. Discussing NbS without addressing the root issue seems meaningless.

Wrong. The problem is not overpopulation, but climate change or environmental degradation.

Figure 8: NbS alone is not likely to be effective for high-tide flooding, as shown in this photo.

That may be true, but NbS extend well beyond flood protection. As highlighted in our paper, in addition to mitigating flooding, the case studies demonstrate a wide range of co-benefits generated by these interventions.

Recommendation: Resubmit Elsewhere

Round 2

Response to reviewers (in red)

Reviewer A:

Dear Editor,

The authors have addressed all comments that I had raised in my first review. More specifically:

- A clear framework was added that provides structure and consistency across the case studies and in the final “Cross Cutting Lessons” section;
- Differences between green and grey infrastructure and additional technical information was provided in the case studies;

- Requested figures were attached.
- The conclusion was amended to better reflect the results of the case studies as presented in the new analytical framework.

Overall, the paper now reads as a coherent and well-structured short communication that provides valuable insights into the implementation of nature-based solutions in small island and coastal settings.

My recommendation is to accept with minor editorial revisions.

Done

Regards,

Recommendation: Accept Submission

Reviewer B:

After carefully re-examining the revised manuscript, this reviewer has identified a serious issue. As detailed below, the authors appear to have misrepresented the content of certain cited important references to emphasize the effectiveness of NbS. From the standpoint of research ethics, such conduct is clearly unacceptable. For the future wider adoption of NbS, its effectiveness must be evaluated carefully and scientifically; otherwise, it risks losing credibility. Also, even if this manuscript was submitted as a communication letter, the research question remains ambiguous, the novelty is unclear, and it is difficult to understand what lessons or insights have ultimately been gained from the study. Therefore, this reviewer's recommendation is Reject.

Page 5 L17 to 21:

Effectiveness in Risk Reduction: The project built submerged hybrid breakwaters designed to reduce wave energy and facilitate coral recruitment. Modelling results showed a 50-70% wave attenuation behind the breakwaters and reduced shoreline retreat (Reguero et al., 2018). The intervention was conceived to

function under projected sea level rise scenarios, with reef crest heights and planting zones adapted to anticipated tidal changes.

Reguero, B. G., Beck, M., Agostini, V., Kramer, P., & Hancock, B. (2018). Coral reefs for coastal protection: A new methodological approach and engineering case study in Grenada. Journal of Environmental Management, 210, 146–161. https://doi.org/10.1016/j.jenvman.2018.01.024

Corrected

Reguero et al. (2018) investigated the wave attenuation effects of natural reefs and did NOT consider the effects of breakwaters. Claiming that there was 50–70% attenuation behind breakwaters and that shoreline retreat was prevented is clearly misleading.

This is true. While the co-author noted that numerical modeling was conducted to evaluate the attenuation potential of the hybrid system, the results of Reguero (2018) describe the protective influence of existing reefs rather than the performance of the installed breakwaters.

Page 14 L 39 to 43:

Effectiveness in Risk Reduction: The citizens of Del Carmen understand that the co-benefits of protecting their mangrove forests do not only extend to improving their livelihoods alone, but also to protecting their homes from the worst impacts of typhoons and storm surges. Indeed, the mangrove forests played a crucial role in preventing the worst damages and casualties suffered by coastal settlements in Del Carmen in December 2021 during Typhoon Odette (Segales et al, 2024).

Segales, J.M., Paz, E.M. and Cauba Jr, A.G., 2024. A-PoRM SIPLAS: Assessing The Post-Disaster Recovery Of Mangrove Forest In Siargao Island Protected Landscape And Seascape (SIPLAS) Area Using Sentinel-1 SAR Data. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 48, pp.105-116.

Corrected

Similarly, Segales et al. (2024) analyzed post-typhoon forest recovery using Sentinel-1 satellite data and did NOT provide any quantitative assessment of the mangrove forests' effectiveness against coastal flooding. Describing the effectiveness of NbS in this way is terribly misleading.

Also true. The co-authors qualitatively noted the protective role of mangroves in Del Carmen, citing secondary sources, but no empirical assessment of flood mitigation or damage reduction was performed in their analysis.

Recommendation: Decline submission

Round 3

Response to reviewer (in red)

Reviewer C:

The paper provides a valuable synthesis of nature-based solution case studies, considering not just risk reduction of ecological and social implications. Overall, the paper is clear and concise. Below are some specific comments:

1) On page 2 line 19, the reference to Hurricane Katrina is overly simplified. Marshes played a key role in risk reduction for SE Louisiana when protection measures where designed, but marsh degradation, issues with maintenance, and construction as individual projects instead of a single system contributed to failure. It isn't clear what is mean by "top-down" ... protection.

The sentence has been revised to reflect the established findings of Daniels et al. (2006) and Delisi (2006), who argue that the catastrophic flooding during Hurricane Katrina was not the result of the storm itself but of the failure of a large-scale, federal protection system. These studies also corroborate that extensive marsh degradation, weak maintenance regimes, and the Corps' construction of levee and floodwall segments as isolated projects, were central contributors to the disaster.

2) Super typhoon on page 11 should be two words

Corrected.

3) On page 12, describe what the Ramsar List is or provide a reference.

Description included.

4) Last paragraph on page 12, LGU is not defined. Plus a number of acronyms are introduced, but are not used again, so can be el

Corrected.

5) Page 13, you state that the reefs in the Philippines are ecologically crucial, but suggest your state that reefs are "crucial ecologically and for wave attenuation". So, not only are the protective, but they are crucial for protection.

Corrected.

Recommendation: Accept Submission