



WORKSHOP REPORT

Stakeholder Workshop – Project *adjust*
Research on Coastal Vulnerability to Sea-Level Rise in Seychelles
March 30-31, 2022

BACKGROUND

With this on-site stakeholder workshop, the 5-year research project *adjust* followed up on a kick-off meeting held virtually in May 2021. The project investigates how global adaptation finance can be distributed more fairly, considering the diversity of climate hazards and uneven vulnerability of countries around the globe. In addition to a study on national adaptation finance allocation in Seychelles, which will be conducted at a later stage, the *adjust* project conducts an analysis of Seychelles' vulnerability to sea-level rise. To ensure that this research meets the needs of local stakeholders, the workshop set out to gather local perspectives on vulnerability to sea-level rise and feedback on research priorities and needs.

OBJECTIVES AND PARTICIPANTS

At the workshop, the *adjust* team sought a deeper understanding of the stakeholders' views and local knowledge on Seychelles' vulnerability to sea-level rise and adaptation priorities. Hence, receiving input from participants on those matters was a key aim. A further objective was to present modelling options for coastal flooding and to provide some background on sea-level rise in Seychelles and general adaptation options. Rather than presenting and discussing new research findings, the overall aim of the workshop was specifying research priorities for the assessment of coastal vulnerabilities. 47 participants attended the two-day workshop, mainly representing governmental bodies and civil society (see Annex A). The second on-site workshop scheduled for 2024 will then focus on presenting modelling results and discussing possible adaptation pathways.

ACTIVITIES AND OUTCOMES

Introductory presentations of the project and the case study

The workshop was opened by Tony Imaduwa, the acting Principal Secretary of the Ministry of Agriculture, Climate Change and Environment. Next, Christian Baatz and Nassos Vafeidis from the *adjust* team introduced the project and the case study on vulnerability to sea-level rise respectively ([see presentation here](#)). Nassos Vafeidis presented the current knowledge on global sea-level rise (SLR) and showed projections of future SLR for the Seychelles. He explained, among others, that the case study considers a combination of different climate change and socioeconomic scenarios, the so-called Representative Concentration Pathways (RCPs) and Shared Socioeconomic Pathways (SSPs), which describe future atmospheric greenhouse gas concentrations and different plausible socioeconomic developments (O'Neill 2014, van Vuuren 2011). He also emphasized that sea-level rise is an issue that we have to face inevitably, regardless of progress in emission reductions, and that immediate adaptation action is crucial for our ability to cope (IPCC 2022). At the same time, he emphasised the need for flexible long-term planning, using combinations of adaptation measures, to address deep uncertainty related to the total amount and rate of sea-level rise that we will face in the future.

During the discussion that followed the presentations, Christian Baatz and Nassos Vafeidis clarified how the cooperation with the Seychelles emerged. From their perspective, existing studies, data and adaptation experience in combination with persisting knowledge gaps provide an interesting but challenging research

environment and the open-minded attitudes of potential local research partners allow for fruitful collaboration. Moreover, the potential involvement of students was discussed. In cooperation with the University of Seychelles, the *adjust* team plans to offer training in modelling for both local students and administrative staff. They will also seek to realise some co-teaching and may be able to offer selected students the opportunity to come to Kiel University, e.g. in order to carry out parts of their Master theses there. Following on the point of compound flooding that was raised during the discussion, the *adjust* team agreed that this is an important aspect in the risk assessment and will consider accounting for rainfall and flash floods in the analysis, depending on resources and data availability. Nassos Vafeidis also highlighted that land subsidence can be an important factor influencing regional sea level rise. This may be due to different factors, although strong horizontal land movement is commonly a result of human activity. If there are any data on land subsidence for the Seychelles, it will be considered in the analysis.

Group work on vulnerability to sea-level rise and coastal adaptation

The introductory session was followed by group work that aimed at understanding the stakeholders' perceptions of Seychelles' vulnerability to sea-level rise and coastal adaptation. Following some brief input on scenario development and different commonly used coastal adaptation measures, participants were asked to discuss two guiding questions regarding future development pathways and adaptation practices in the Seychelles. The following summarizes their answers and highlights selected key issues.

1. Are impacts of sea-level rise already visible in Seychelles?

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| <ul style="list-style-type: none"> - Loss of critical infrastructure, properties and biodiversity - Erosion is getting worse - Wave overtopping of roads - Collapse of roads and seawalls - Saltwater intrusion and soil infertility - Flooding of roads happens more often (overflow of drains) | <ul style="list-style-type: none"> - Storm surges - Blockage of drainage at estuaries - Mangroves die off - Marsh enlargement - Habitat alteration - Borehole extraction - Failure of hard engineering measures |
|--|--|

2. What adaptation measures are already being implemented and what measures do you consider relevant in the future?

Implemented measures:

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|---|---|
| <ul style="list-style-type: none"> - Setbacks - Rise in building levels - Rock armoring, dumping - Timber pillars (not working) - Restoration of corals, dune land, coastal vegetation - Seawalls, Non-return dikes, sea gates (not working because of too much rain) - Groynes (aesthetic issue for tourism and prevent turtles from nesting) - Bollards | <ul style="list-style-type: none"> - Rainwater harvesting (La Digue) - Beach nourishment (no longer sustainable or effective) - Temporary barriers stopping sand from migration - Gabions (40 years ago) - Breakwaters - Bridge- and drain enlargement - Geo-textile cloth - Retention ponds - road relocation |
|---|---|

Relevant measures:

- Blue Barrier
- Setback: Building away from the coast (lateral), building above the surge area (vertical)
- Development buffer zone
- Mangrove, seagrass and coral reef protection
- Reef creation and other NbS
- Infrastructure relocation, e.g. raising and moving roads
- Seawalls and sea dikes for significant sediment accretion
- Houses on stilts
- House building design for uphill
- Geo-textile sandbags
- Submerged or emerged breakwaters
- Rainwater harvesting
- Floodways
- Mobile barriers

Overarching points from the group discussions:

Participants highlighted that coastal protection measures are mostly implemented as a reaction to flood events and erosion that require quick action with preferably low expenses. This often results in measures such as rock armouring or other hard engineering solutions. Measures are usually undertaken at erosion hotspots possibly causing problems or hotspots in other locations. Participants thus emphasized the need for a more proactive and holistic approach. They also said that many past and present coastal adaptation measures do not work because they were of suboptimal quality or not implemented properly. Of course, it also depends on the local conditions whether certain measures are appropriate and effective. In addition, factors such as road construction near a high-water line, beach cleaning, vehicles parking near the beach, marsh and beach fill make it difficult to prevent erosion or successfully implement protection measures. Participants also stressed that soft engineering and policy measures are not widely implemented and called for hybrid solutions combining soft and hard engineering measures and, more generally, for a mixed approach where drawbacks of some measures are mitigated by others.

Open discussion on present and future coastal development

To gather the stakeholders' perspectives on plausible coastal development pathways in the Seychelles there was an open discussion guided by two questions:

1. How do you feel about current coastal development in Seychelles?

Participants started the discussion with concerns regarding some trends in coastal development. Hard protection measures such as seawalls and rock armouring make the coastline appear increasingly artificial. While Nature-based Solutions avoid this pitfall, they take time to plan and implement. "Hard" emergency measures are thus often needed. The Seychelles are also facing considerable population growth, but further development of physical infrastructure, housing etc. is increasingly difficult due to the narrow and low-lying coastal plain. Since building uphill is complicated and can cause erosion during rainfalls, land is being reclaimed. This is associated with potential risks, as artificial islands strongly interfere with the coastal sediment system and may cause erosion in other coastal strips. However, artificial barrier islands may also serve as coastal protection since they are higher than the natural coast line (e.g. Eden Island during the 2004 Tsunami). Setback zones are regarded as a solution, but they are difficult to implement given limited available space and because a lot of the coastal land is private property that cannot be accessed. Anse A La Mouche and Baie Lazare were reported as positive examples of coastal development. Further discussion points included "climate-proofing" of new development projects, for which participants mentioned that the challenge is not so much implementing further environmental regulations but rather properly enforcing already existing ones.

2. What positive and negative future developments can you envision for the Seychelles?

Participants agreed that a highly developed coastline dominated by concrete represents a worst-case scenario. It was suggested that a "business as usual" pathway may lead to such a future. The stakeholders

strongly advocated the need for nature conservation and voiced a dislike for mega-hotels on private islands, the privatisation of beaches and a further increase in motorised private transport.

Participants suggested more efficient public transport and a partial replacement of land transportation by jetties to prevent traffic jams and reduce pollution as an alternative to “business as usual”. They also proposed decentralization of services, which would reduce traffic and developmental pressure on the coastline. At the same time, further developing the infrastructure for working remotely is required. Another suggestion was to construct buildings with more storeys to accommodate more people, to build houses on pillars to avoid issues with flooding, or to start elevating certain infrastructures by about 1.5 m. In more general terms, some participants called for an economic diversification and a controlled development that is not driven by economic growth. As an alternative, they envisioned a low-tech society with a circular economy in which the Seychelles would be less dependent on tourism and imports. In contrast, it was also suggested to develop a high-tech economy in the Seychelles to reduce its carbon footprint. Overall, participants wished for more nature preservation that will also support adaptation. Asked how they see land reclamations, some participants expressed reservations, others famed it as a needed compromise. And it was mentioned that while there might not be sufficient space for further big public reclamations, a lot of private, small-scale and low elevation reclamation is happening.

Presentation of modelling tools and exemplary results

The second workshop day started with a presentation by Dorothee Fehling who is conducting the case study on vulnerability to sea-level rise in the Seychelles as part of her Ph.D. project. By downscaling the DIVA (Dynamic Interactive Vulnerability Assessment) modelling framework from a global to a regional scale, she plans to produce quantitative indicators, such as number of people flooded annually or annual flood damage, in order to identify vulnerability hotspots in Seychelles. These hotspots can then be analysed in higher detail using hydrodynamic modelling. Dorothee Fehling explained how a hydrodynamic model allows for simulations of actual coastal flood events and showed exemplary results from modelling a past flood event for the port of Victoria, also under different scenarios of future sea-level rise ([see presentation here](#)). It is very important to note that the model output shown during the workshop is only a figurative example and has no scientific relevance so far. Due to the technical infrastructure available at Kiel University, Dorothee Fehling will be able to conduct a large number of detailed model runs, which will allow us to comprehensively analyse flood risk in a fully probabilistic manner. An important issue during the discussion that followed the presentation was the ability of DIVA to represent processes at the scale required for the regional analysis. This remains to be explored in the context of *adjust*. In case downscaling DIVA is not possible for the Seychelles, e.g. due to data or model limitations, alternative modelling solutions, such as simplified hydrodynamic models (e.g. LISFLOOD), will be used to conduct the regional assessment.

Discussion of research priorities

Participants suggested to not only model Mahé, Praslin and La Digue but to also cover other inner and outer islands that are envisaged for future development and/or have a high value for biodiversity (e.g. Aldabra, Cousin Island, Coëtivy). As for sea-level rise, both low impact/high probability and high impact/low probability scenarios are relevant. The commercial port in Victoria and the airports on Mahé and Praslin are of particular importance.

Stakeholder analysis and port tour

Towards the end of the workshop the participants were split into two groups. While one group worked on a stakeholder analysis the other went on a guided tour of the port of Victoria.

Stakeholder analysis: In the beginning of the project, the *adjust* team created a list of Seychellois stakeholders that are relevant for the analysis of vulnerability to sea-level rise and placed them within a so-called Influence Interest Matrix according to their estimated influence on and interest in adaptation to sea-level rise in Seychelles (see annex B). Since the *adjust* team is not from Seychelles, they have a limited understanding of the interests and influence of the various stakeholders. To complement the work of the team, the workshop

participants were asked to organise and discuss the matrix themselves. During this process, they also had the opportunity to add missing stakeholders. There was substantial diversity of opinions both between and within the groups regarding the interest and influence of several stakeholders (for the detailed results see annex B).

Port tour: Rodney Quatre from the Seychelles Port Authority kindly organised and guided a tour through the commercial Port of Victoria. He explained the importance of the port for Seychelles' economy, given that most imports on which the Seychelles depend (e.g. fuel) go through the port. At the same time, the port is highly exposed to sea-level rise. Already today the port cannot work continuously during extreme high tides. Furthermore, the equipment that is used to transfer the imported fuel through is very costly and at risk of degrading if it is flooded by sea-water. The port will be expanded soon, and in order to be considered "climate-proof" the newly developed part needs to be elevated by 65 cm compared to existing parts. However, funding only suffices for an elevation of 45 cm.

KEY MESSAGES AND PARTICIPANTS' FEEDBACK

The *adjust* team is looking back on a fruitful workshop that advanced the project and provided the team with a better understanding of current challenges, research needs and important perspectives on possible future developments. For the team, key messages are that finding space for development is a big challenge, so as to consider vertical expansion in specific urban locations and land reclamation under specific conditions. Participants perceive business-as-usual development as a non-desirable future. Decentralization, innovative development planning and an enforcement of existing laws and regulations are seen as a desirable scenario. Soft adaptation, relying on e.g. Nature-based Solutions or hybrid solutions combining soft and hard measures, would be the preferred adaptation pathway. Not only the main islands but also some inner and outer islands are interesting for the study due to high biodiversity or development plans. Participants are worried that sea-level rise and adaptation will negatively affect tourism. They thus agreed that rigorous, long-term adaptation planning should be initiated now and that further external funding needs to be sought out.

Based on input from the workshop and several bilateral stakeholder meetings, the *adjust* team has started their modelling work and will seek feedback on preliminary result in about twelve months from now. In the second half of 2024, the team will return to Seychelles in order to present findings from DIVA and hydrodynamic modelling and discuss adaptation pathways for Seychelles in a second stakeholder workshop. Regarding the case study on the distribution of funding for adaptation to climate change in Seychelles, stakeholder interviews are schedule for early 2023 ([see presentation here](#)).

Overall, the workshop was perceived as "very knowledgeable and very fruitful" by the participants. They particularly enjoyed "[learning] about the DIVA model, what kind of tool it is, the aims and the limitations of this model" and "the different adaptation methods that can be considered to combat sea-level rise". Many of the attendees appreciated the "interactive" and "lively" workshop style with group discussions, gaining insights from "different stakeholders and their interpretation on the impact of the sea level rising" as well as the possibility to thereby "develop networks for future projects". Also, the "organising (not overloaded programme), including the very well conversed field trip" was emphasized. Acknowledging that "informed decision-making would need inputs from different stakeholders", participants also wished for a more selected but at the same time extended range of attendees in the future to get "more stakeholders on board" "that are involved in decision making". In terms of un-addressed but relevant aspects regarding sea-level rise and coastal adaptation it was stated that "scenarios should reflect Seychelles' reliance on biodiversity and include it as an important criterion for vulnerability to sea level rise". Different specifics of local conditions have been identified as possible research topics, e. g. "exploring risk areas & infrastructures on the island & existing policies/laws on the matter" and "a detailed study on the Seychelles Port Authority as it has a huge impact on the industry". Participants are positive that the workshop "will influence the planning of new infrastructure in the long-term", e. g. through "soft engineering methods that will mitigate coastal erosion", and can "help to guide and advise developers on what to consider during implementation of their projects/developments" (see Annex C for a structured overview of participants' feedback).

Finally, two newspaper articles were published on the workshop and one is publicly accessible:
<https://nation.sc/articles/13041/research-project-highlights-seyelles-vulnerability-to-sea-level-rise>

LAST BUT NOT LEAST: SUPPORT THE RESEARCH WITH PICTURES AND VIDEOS

To support the modelling work, pictures or even videos of flood events at the coast would be of great help. These items would be most useful if they included flooded items helping to approximate water depth (e.g. stairs, cars). If you are able to help, please upload pictures/videos here: <https://cloud.rz.uni-kiel.de/index.php/s/Qffb2KmSdkQgZ5n>.

Please include your names in the name of the file and add the exact time and date of when they were taken, if possible, or attach a document containing that information.

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ANNEX A: WORKSHOP PARTICIPANTS

NAME	ORGANISATION
Tony Imaduwa	MACCE/SEC
Jeanette Larue	MACCE - PECO
Sophie Morgan	MACCE - CCD
Elissa Lalande	MACCE - CCD
Kai Kim Chiang	MACCE/ Commonwealth (climate finance)
Veronique Bonnelame	community organiser
Roland Alcindor	fisher/farmer (former UNDP manager for Seychelles)
Annie Simeon	MACCE - CCD
Cynthia Peton	MACCE - CCD
Nigel Simeon	MACCE - CCD
Sharifah Arissol	MACCE - CCD
Stephen Bonne	MACCE - CCD
Noah Dine	MACCE - CCD
Jemima Doudee	MACCE - CCD
Amanda Port- Louis	MACCE - CCD
Jade Landry	Agriculture Dept
Philomena Hollanda	Department of Tourism
Sanjeev Pugazhendhi	Ministry of Health
Cliff Alissop	DRMD
Andre Gabriel	District Administrator AAP
Michael Jean Louis	DA Grand Anse Praslin
Denis Antat	DA Baie Ste Anne Praslin
Peter Estico	Department of Community Devt
Sylvanna Antat	UniSey
Amelie Desaubin	Central Bank of Seychelles
Rodney Quatre	Seychelles Port Authority
Laurent Sam	PUC - Electricity
Dorayne Calderin	Seychelles Infrastructure Agency
Rachel Ernesta	SIA
Chudar Pillay	SIA
Jordan Simara	SIA
Michelle Pool	SIA
Maria Madeleine	Seychelles Planning Authority
Magali Rocamora	Climate Resilience consultant
Daniel Siegburg	Blue Economy Dept
Veronique Banane	Seychelles Island Foundation
Janice Ladouceur	Seychelles Land Transport Authority
Christian Baatz	Kiel University
Nassos Vafeidis	Kiel University
Doro Fehling	Kiel University
Clara Gurreso	Kiel University
Michele Martin	S4S
Maureen Hoareau	MACCE
Ronny Jumeau	Consultant
Daniel Etongo	UniSey
Mathew Macgaw	SMSA
Theodore Marguerite	CC ² Consulting
Alvin Laurence	CEPS
Lynndine Essack	MOE
Lyndy Bastienne	SEP-UNDP/GEF
Mamy Razanajatovo	SEC
Aneil Tripathy	University of Bologna

- Content: lack of a) attention on biodiversity, b) accurate/reliable data, c) new insights on adaptation methods
- Organisation: a) workshop could have been longer; b) use of non-local fruit for the snack

4. How can you apply what you learned in your work?

- Using the inputs, models and data for further research or communicating SLR (6)
- Taking the learnings into consideration for the infrastructure planning (6), e. g. soft engineering methods
- Identifying needs and possible solutions (3), e. g. in agricultural or communal work, coastal protection
- Raised overall awareness which will be carried further, influence day-to-day activities, e. g. through a closer assessment of their impact, and serve as guidance for developers (5)
- Useful contacts to other stakeholder, e. g. planning authorities (3)

5. What issues regarding sea-level rise and coastal vulnerability were not (sufficiently) considered?

- Biodiversity (3): how SLR will affect it, e. g. through saltwater intrusion; should be included as a criterion of vulnerability
- Local conditions (4): give more consideration to local policies, and the infrastructure and economic situation which is different in the various coastal districts (2); closer assessment of Victoria Port (2)
- Possible preventive measures