

# ADAPTATION PATHWAYS FOR SANDY COASTS UNDER EXTREME ACCELERATED SEA LEVEL RISE

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## 1. Introduction

To prevent coastal flooding, compensate for erosion and sea level rise (SLR) sand nourishments are frequently applied at the sandy coast of the Netherlands. Recent studies project the bandwidth of future SLR to be in the range of 0.35 to 2.46 m by 2100, if rapid ice sheet mass loss of Antarctica is included [1]. Under those, potentially high, rates of SLR it is unclear how a sandy coast will respond, and which type of nourishment can optimally support both safety and other coastal functions such as recreation and nature.

In this study we explore which nourishment strategies are effective, feasible and desirable for the Dutch sandy coast under (extreme) accelerated SLR. We evaluate alternative sequence (pathways) of nourishment strategies from an integrated perspective (including morphology, ecology, socioeconomic) and connect present-day action with future action perspectives.

## 2. Methods

We use the Dynamic Adaptive Policy Pathways method (DAPP) [2] to explore pathways for coastline management. As a first step, adaptation strategies are identified, and their effectiveness under accelerated SLR is evaluated along a range of reasons to adapt: technical feasibility, availability of space and material, ecological feasibility, cost-benefit conditions, social (un)acceptability and economic productivity [2], followed by the design of adaptation pathways. Adaptation pathways are sequences of linked (portfolios of) actions that can be implemented as conditions change. Typically, they start with low-regret actions that maintain future options when uncertainty is high. As time progresses and conditions change, this initial low-regret adaptation action may reach a threshold when it no longer performs acceptably, i.e., an adaptation tipping point occurs. Subsequently, a switch to another action is needed to continue to achieve objectives and a pathway of adaptation decision emerges.

Results in this abstract are based on 8 narratives obtained from the project-consortium workshop, where consortium members described a possible future of a sandy coast. With the provided narratives, measures are identified, adaptation tipping points of those measurements under SLR are identified and pathways are constructed. These narrative-based pathways will illuminate the need for knowledge and model development. Additionally, they will be proposed to stakeholders (spring 2021) to derive feedback.

## 3. Results

The morphological response of a sandy coast to SLR makes that hard ('unsurpassable') adaptation tipping points (e.g. not enough sand available) might be absent or only occur under extreme changes. Nonetheless, the system could experience soft ('surpassable') tipping point (e.g. nourishments might become too frequent for ecology to restore or wind-driven sediment transport to the dunes starts lagging behind with storm-driven erosion rates). This is specifically the case for the Dutch sandy coast with wide, high dunes and a maintenance strategy that resulted in a seaward migration of the coast over the last 20 years. Nonetheless, exploring the solution space of different nourishment strategies might be beneficial to identify long-term consequences (impact on ecology, recreation) and limitations (sand availability, sand redistribution cross- and alongshore direction) and what those long-term consequences mean for short-term actions to prepare and keep options open (e.g. spatial reservations, experiments).

The narratives of pathways identified three sandy-strategies: 1. the present-day approach with regular small-scale nourishments, 2. mega-nourishments (e.g. the Sand Motor) and 3. no

nourishments. A preliminary adaptation pathways map indicates that combinations of all measures are possible (Figure 1). However, half of the narratives indicated that societal support for larger measures could be a deal-breaker and might be dominant over safety-driven adaptation tipping points. Although narrative based, the provided reasons to adapt indicate that an integrate approach should be used to evaluate future maintenance strategies. At the conference, adaptation pathways and reasons to switch between coastal maintenance strategies will be presented, including insights from the stakeholder workshop scheduled spring 2021.

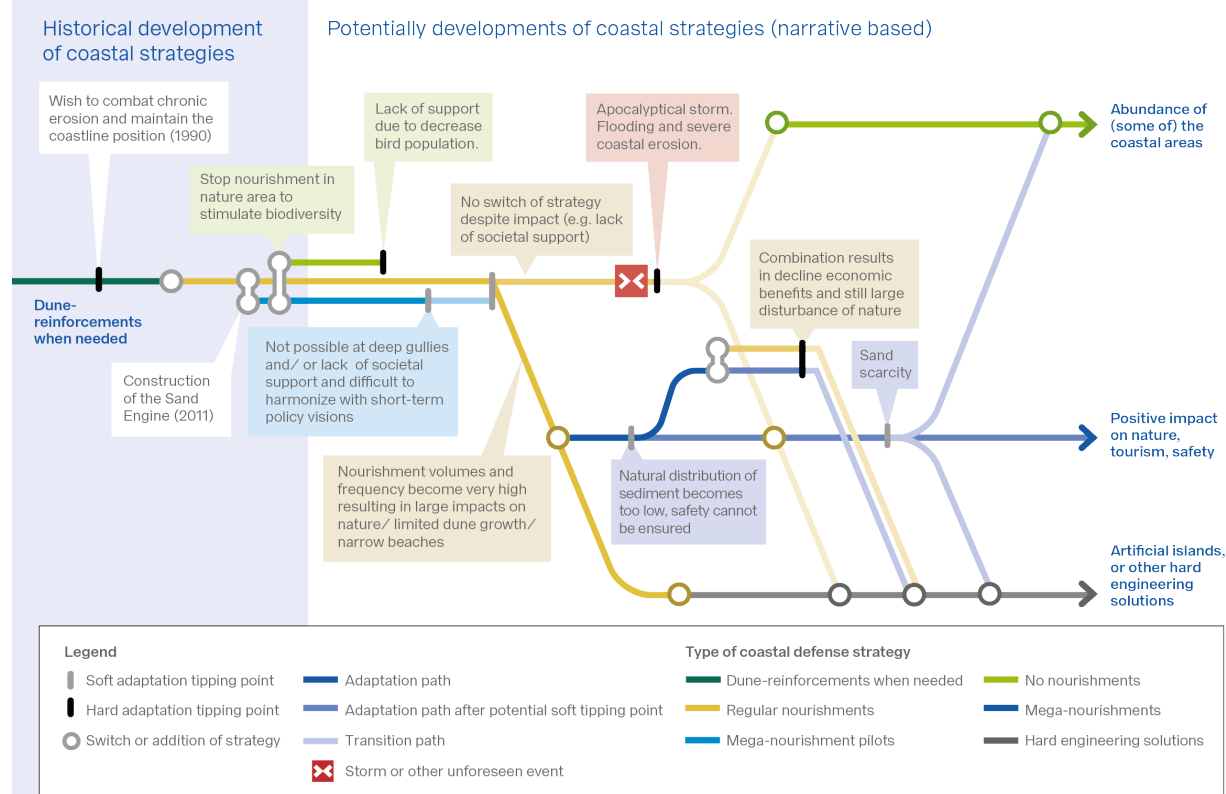


Figure 1. History (blue) and exploratory, narrative-based (white) adaptation pathways for different nourishment strategies under SLR, including potential adaptation tipping points.

#### 4. Discussion and conclusions

The sandy system will adjust under SLR, adaptation tipping points are therefore not exact, but rather a gradual scale (e.g. too ecologically disturbing or loss of efficiency). Given the wide range of sandy solutions, this implies that a drastic shift of strategy is potentially not needed. Nonetheless, having insight when, why and under which conditions those soft adaptation tipping points are met, might help in defining a robust sequence of solutions and identify opportunities that solutions might have under SLR.

The DAPP-method facilitates linking different disciplines and identifying knowledge gaps needed to explore coastal maintenance options under an uncertain future. The DAPP-method and the stakeholder engagement connect visions of future maintenance to present-day/ near-future actions and helps with identifying adaptation tipping points and adaptation opportunities.

#### References

- [1] SROCC, IPCC SR Ocean and Cryosphere (2019) *Chapter 4 IPCC Special Report on the Ocean and Cryosphere in a Changing Climate.*
- [2] Haasnoot, M, S. Brown, P. Scussolini, J. Jimenez, A. Vafeidis and R. Nicholls 2019 “Generic adaptation pathways for coastal archetypes under uncertain sea-level rise” *Environ. Res. Comm.*