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Publication date

2021

Document Version

Final published version

Citation (APA)

de Jong, A. M. P. (Author), de Vries, G. (Author), & Timmermans, J. (Author). (2021). The practice of Adaptive Delta Management in the Netherlands. Web publication/site, Flow Platform.
<https://flowsplatform.nl/#/the-practice-of-adaptive-delta-management-in-the-netherlands-1639951476255>

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Anne-Marie de Jong, Gerdien de Vries, Jos Timmermans | December 2021

The practice of Adaptive Delta Management in the Netherlands

In 2011, Adaptive Delta Management (ADM) was introduced in the Dutch Delta Program as a policy development method that incorporates uncertainty in decision-making. At this moment, little is known about the functioning of ADM in practice, while this is key for successful adaptation. This paper presents the results of research into the implementation of ADM in The Netherlands. We focus especially on the efficacy of ADM in dealing with uncertain sea-level rise.

This research concludes that to enhance adaptation to sea-level rise to keep the Netherlands safe, policymakers at all levels must gain an overview of the entire solution space over time. Furthermore, actors implementing adaptation plans, like water boards and municipalities, require more insight into the combined consequences of sea-level rise and national adaptation strategies for their area. Here we propose the development of regional consequence scenarios as a promising way forward. In addition, implementing actors need to be enabled to incorporate uncertainties in their decision-making processes. Especially they need support in using the sometimes complicated instruments of ADM.

Introduction

The most recent IPCC projections (Oppenheimer et al., 2019) estimate a sea-level rise in 2300 between 2.3 and 5.4 meters in the highest scenario and a sea-level rise of 1 meter in the lowest scenario (figure 1). The high level of uncertainty makes it hard to evaluate the risk, leading to a possible outcome that insufficient measures are taken or measures are implemented too late to protect urbanized deltas against sea-level rise. Simultaneously, the possibility exists that the measures taken are over-dimensioned, which leads to unnecessary expenses for society. Adaptive Delta Management (ADM) was introduced in the Dutch Delta Program in 2011 to incorporate uncertainty about future conditions transparently in policy development and decision-making (DP2012, 2011). In ADM, adaptive is defined as the ability to speed up or temporize efforts or to change strategy when the actual or expected rate of

climatic change and/or socio-economic developments indicate this might be necessary (Bloemen et al., 2019).

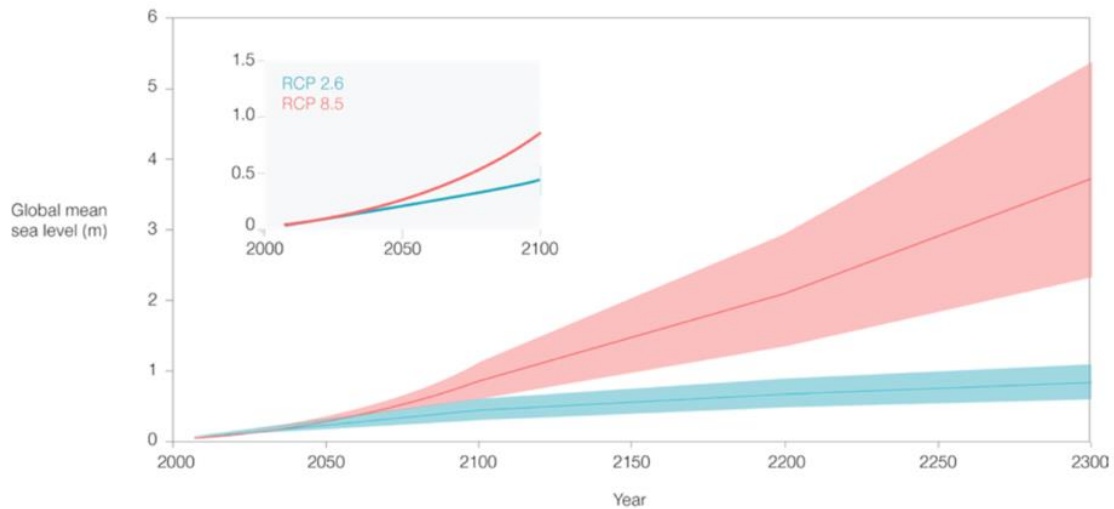


Figure 1 - IPCC's projections of global sea level rise (Opperheim et al., 2019). Visualization retrieved from Swinkels (2020).

Currently, little is known about the functioning of ADM in the Netherlands in practice, while this is key to its success. Evaluations of the Delta Program focus on the organization and less on the methodologies, ADM, used. This research is further motivated by the conclusion of Timmermans et al. (2015), who found that the link between ADM in practice and ongoing development in science has weakened. Bloemen et al. (2019), emphasizing the relevance of science receiving feedback from practice, come to a similar conclusion. Van der Brugge and Roosjen (2015), further stress that ADM's governance challenges are considerable, but receive limited attention. This paper takes up these challenges and specifically aims to contribute to the knowledge on the functioning of ADM in Dutch practice.

Methodology

This research aims to explore whether ADM in practice enhances adaptation to sea-level rise. It explores the similarities and differences between the theory of ADM and its current practice in the Netherlands. With this research, we aim to learn and further develop ADM as a policy development method. To do so, first, a literature review is performed to explore how the governance of ADM should be shaped according to its scientific roots. The review resulted in a governance framework that can be used to structure the research, data collection and analysis. The framework incorporates the relevant institutional and instrumental governance elements of ADM found in the scientific literature that should inform the practice of ADM.

Next, using this framework, empirical research is performed to explore how the institutional and instrumental governance of ADM are shaped in Dutch practice and how they fit ADM

theory. The similarities and differences between the institutional and instrumental governance of ADM in practice and theory are analyzed. Based on this analysis the efficacy of the governance of ADM in adapting the Netherlands to sea-level rise is evaluated. Finally, we provide recommendations to further enhance the efficacy of the Dutch ADM practice.

The information sources used for this research are scientific publications, interviews, policy documents, and advisory reports. In total 14 interviews were performed with representatives from the Signal Group, the Knowledge Network, Research Program Sea-Level Rise, (Staff) Delta Commissioner, the Delta Program Sub-Programs, various knowledge institutions, regional water authorities, and municipalities.

ADM in theory

Theoretical governance framework of ADM

The findings of the literature review show that several institutional and instrumental governance elements are essential for ADM. Institutional governance describes how the organizational structure of the actors involved in ADM is shaped. Instrumental governance describes the methods and tools (instruments), like scenarios and pathways, used in ADM. Together the institutional and instrumental governance form the theoretical governance framework of ADM. The framework is presented Table 1.

The literature review resulted in five elements of the institutional governance of ADM, explaining how the organizational structure of the actors should be shaped according to theory. First, the actors that play a role in ADM must understand their own and each other's responsibilities and tasks; this increases mutual trust and stimulates collaboration (Hermans et al., 2016). In addition, transparency in information management is critical for applying ADM (Hermans et al., 2016). ADM is a data-driven policy method in which new information on developments determines the course of the strategy. Furthermore, involving multiple levels helps to improve information flows and knowledge exchange between these levels (Restemeyer et al., 2017). Involving multiple actors in the monitoring process of the external developments relevant to delta management also contributes to the reliability of the knowledge obtained (Bloemen et al., 2018) and will support the timely realization of measures (Hermans et al., 2017). In addition, the engagement of local stakeholders is vital for the support of the plans (Bloemen et al., 2018). Finally, ADM strategies should be coordinated at a higher level than the level where they are implemented to increase consistency (Bloemen et al., 2018; Dewulf & Termeer, 2015; Rosenzweig & Solecki, 2014).

Table 1 - Theoretical governance framework of ADM.

Institutional governance elements	Instrumental governance elements
Clear agreements on roles and responsibilities	Scenarios – Static scenarios or transient scenarios outline the major uncertainties that play a role in decision making
Transparent information management	Adaptation pathways – Outline the possible strategies, the signposts that should be monitored and the transfer stations on which can be switched to another strategy
Engagement of multiple actors at various levels in monitoring	Adaptation tipping points – Indicate the endpoint of a strategy, which is when a strategy no longer meets the predefined objectives
Engagement of multiple actors at various levels in evaluation	Monitoring system – Keep track of the external developments that may lead to adjusting choices and strategies continuously
Coordination at a higher level than implementation	Evaluation system – Evaluate if pursuing current strategies will lead to reaching the predefined objectives in time considering the external developments and recalibrating strategies whenever new monitoring information comes available

The literature review resulted in five instrumental governance elements that describe the methods and tools that can be used for applying ADM. Firstly, scenarios, static or time-dependent, should be used to outline the major uncertainties that play a role in decision making (Haasnoot et al., 2015; Bloemen et al., 2019). Second, adaptation pathways (Figure 2) that outline the possible strategies, the signposts that should be monitored and the transfer stations on which can be switched to another strategy (Haasnoot et al., 2013) are a core instrument. Adaptation tipping points are relevant, because they indicate the endpoint of a strategy, which is when a strategy no longer meets the predefined objectives (Haasnoot et al., 2013; Dewulf & Termeer, 2015; Kwadijk et al., 2010), and additional decisions and actions are required. The monitoring system keeps track of the external developments that

may lead to adjusting choices and strategies continuously (Zevenbergen et al., 2018; Dewulf & Termeer, 2015). The evaluation system evaluates if pursuing current strategies will lead to reaching the predefined objectives in time while considering external developments and recalibration of strategies (Bloemen et al., 2019).

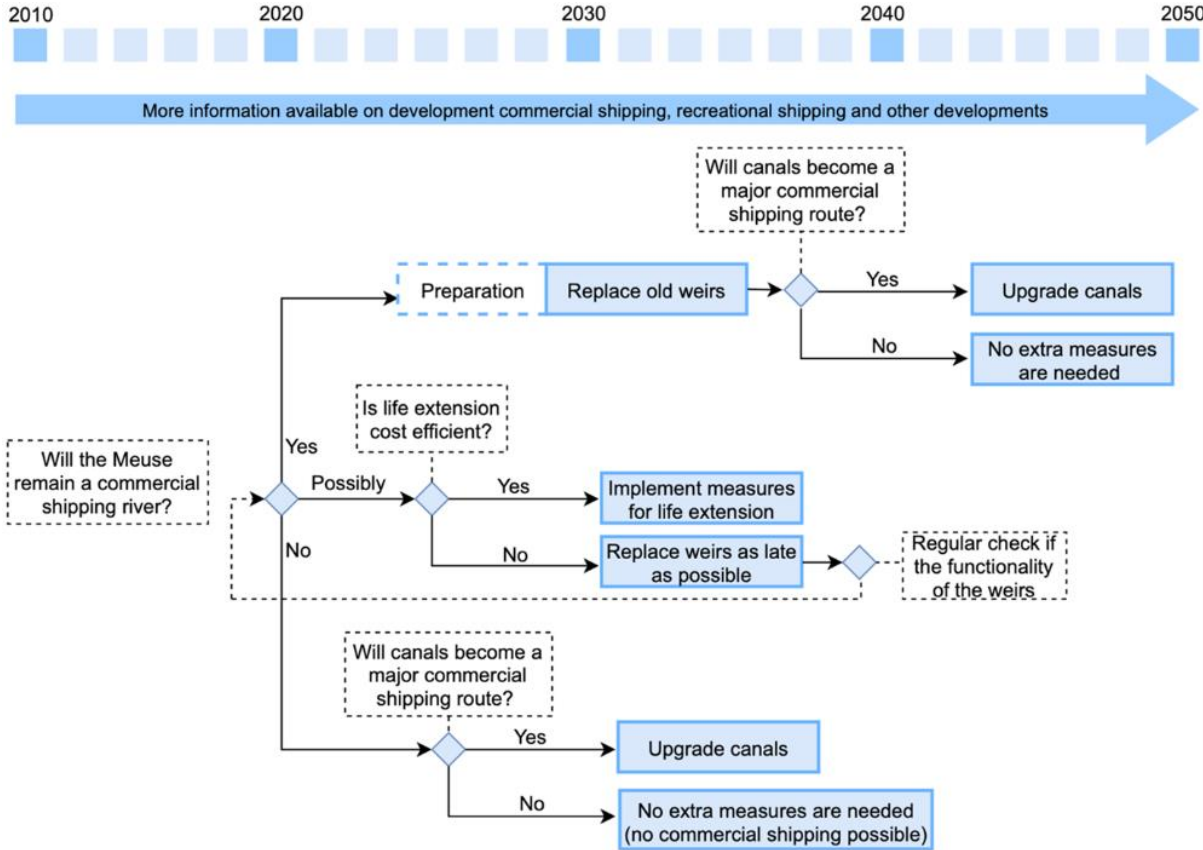


Figure 2 - Adaptation pathway map designed for the Delta Program, adapted from DP2012 (2011).

ADM in practice: observations

The empirical research aims to reveal the institutional governance of ADM in Dutch practice. For both institutional and instrumental governance, interviews, policy documents, and advisory reports are used for the analysis.

Institutional governance of ADM

The actors responsible for ADM are all the actors that play a role in the six-yearly recalibration of the Delta Program (Delta Commissioner, 2018). These actors are referred to as the actors on the strategy level and are the Signal Group, the Knowledge Network, Research Program Sea-Level Rise, (Staff) Delta Commissioner, the Delta Program Sub-

Programs, and various knowledge institutions. The actors responsible for the adaptive implementation of the strategies considered in this research are regional water authorities, municipalities, and drinking water utilities. These actors are referred to as the actors on the implementation level. Except for the drinking water utilities all these actors were interviewed.

Table 2 - The actors of ADM.

Actor	Level
The Signal Group	Strategy
The Knowledge Network	Strategy
Research Program Sea-Level Rise	Strategy
(Staff) Delta Commissioner	Strategy
Knowledge Institutions	Strategy
DP Sub-Programs	Strategy
Regional Water Authorities	Implementation
Municipalities	Implementation
Drinking Water Authorities	Implementation

Figure 3 summarises the results of the research in a schematic representation of the interactions between the actors in Table 2. The figure shows who reports to whom and what information is shared between actors. The actors and the interactions between them are based on a combination of desk research and information obtained in the interviews conducted with the actors of ADM. This empirical research found that all theoretic institutional governance elements are present in practice. First of all, Figure 3 shows that roles and responsibilities are clear. Also the other elements, like information management, engagements of actors at various levels and the coordination by the Delta program clearly show up. Next to the formal interactions visible in Figure 3, informal interactions occur, and overlap exists between the actors of ADM. The delta management sector in the Netherlands is a close-knit sector in which many actors know each other personally.

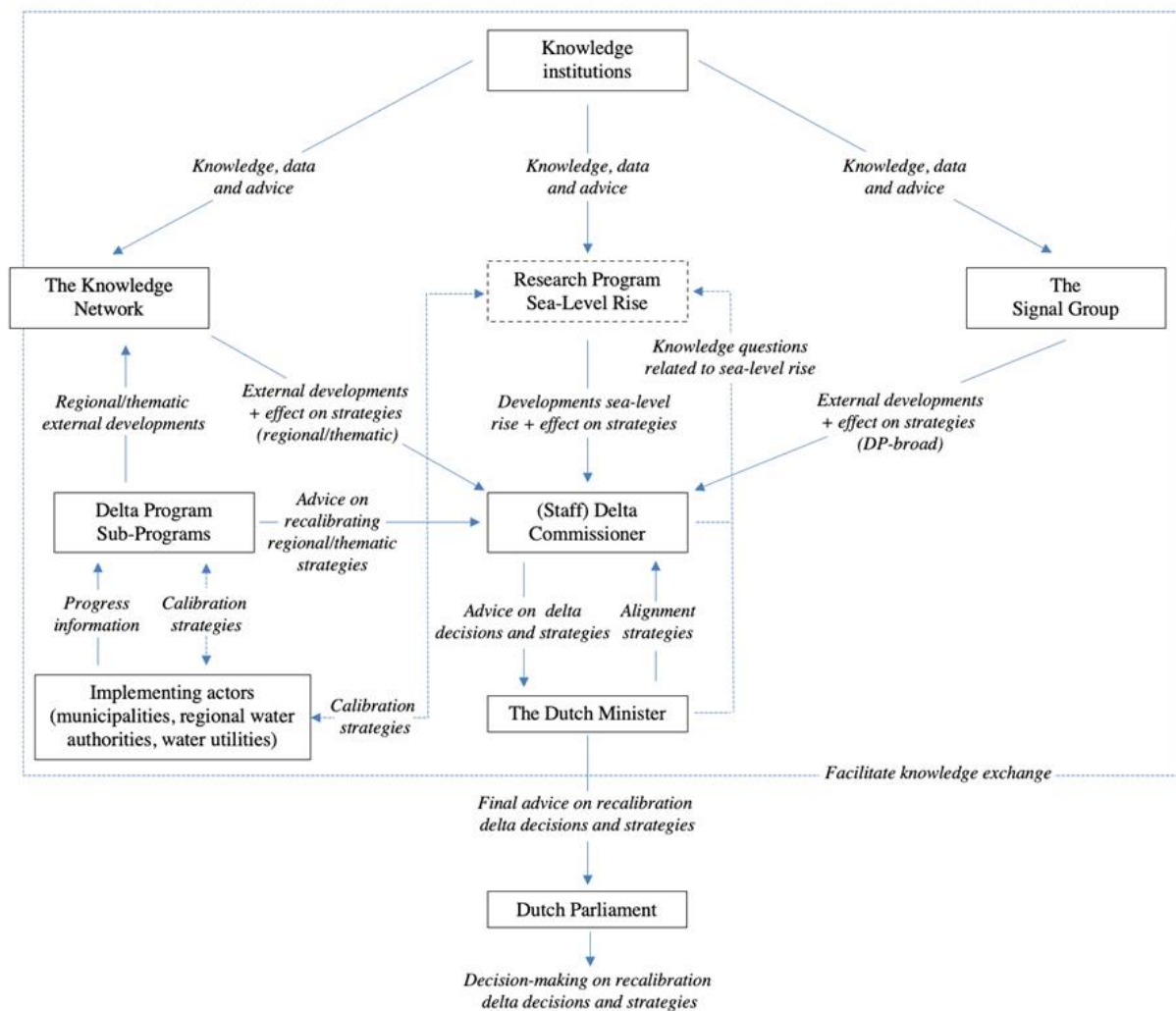


Figure 3 - Interactions between the actors of ADM.

Instrumental governance of ADM

The results of the empirical research into the instrumental governance of ADM in practice show differences between practice and theory, and between the strategic level and the implementation level. On the strategy level, the application of scenarios and the monitoring system aligns with how they should be shaped according to theory. For adaptation pathways, differences between theory and practice were observed; the adaptation pathway maps used in practice only contain the preferential strategy instead of multiple strategies, and no signposts and transfer stations are defined. Also, the research found that adaptation-tipping points in practice are more flexible than in theory (Table 3). Furthermore, evaluation and adjustment of strategies do not happen as soon as new information comes available, as proposed in the scientific literature, but has in practice a fixed rhythm. The main implication of these differences is that ADM in practice provides less guidance to policymakers on when and which adjustments of strategies are needed.

Table 3 - Instrumental governance elements at the strategy level.

Instrumental governance elements	Incorporation on the strategy level	Application in practice
Scenarios	+	+
Adaptation pathways	+/-	-
Adaptation tipping points	-	-
Monitoring system	+	+
Evaluation system	+	+/-

On the implementation level, the majority of instrumental governance elements are not applied. Scenarios and adaptation pathways are hardly ever used by the actors at the implementation level. Also, no concrete adaptation tipping points have been identified at the implementation level. Finally, it was not possible to generalize the findings on the monitoring and the evaluation system on the implementation level, because no rules or arrangements are in place on how monitoring and evaluation should be shaped in practice (Table 4). Therefore, the monitoring and evaluation system is different for every implementing actor.

Table 4 - Instrumental governance elements at the implementation level.

Instrumental governance elements	Incorporation on the implementation level
Scenarios	<i>absent</i>
Adaptation pathways	<i>absent</i>
Adaptation tipping points	<i>absent</i>
Monitoring system	<i>findings cannot be generalized</i>
Evaluation system	<i>findings cannot be generalized</i>

ADM in practice: consequences for adaptation to sea-level rise

Enhancing adaptation to sea-level rise

At the strategy level, the use of scenarios, the monitoring system, and the evaluation system enhance adaptation to sea-level rise. However, adaptation pathways towards the national LT-coastal adaptation strategies to cope with sea-level rise have not been defined. The result

is that it is more challenging for policymakers to identify the short-term actions needed to keep the LT-coastal adaptation strategies open. Also, the absence of adaptation pathways could reinforce path-dependency and lock-in. Furthermore, defining concrete adaptation tipping points is challenging in the absence of LT-coastal adaptation strategies, which makes it more difficult to determine when a strategy should be adjusted.

The absence of the national LT-coastal adaptation strategies also limits adaptive capacity at the implementation level. On the implementation level, most instruments of ADM are not applied in practice, which further inhibits adaptive capacity. Because scenarios are absent on the implementation level, uncertainty is currently hardly incorporated in decision-making. The actors on the implementation level mostly use mean values for expected sea-level rise instead of scenarios covering the full range of plausible futures. Furthermore, the lack of adaptation pathways and adaptation tipping points coordinated with an LT-coastal adaptation strategy at the national level, makes it difficult for regional to local policymakers to gain insight into the measures that need to be taken to protect a specific area against sea-level rise. Based on these findings, the conclusion is drawn that adaptation to sea-level rise is not enhanced by current ADM practice at the implementation level.

ADM in practice: recommendations for policy-makers

Based on the conclusion from our research we formulated the following recommendations for policymakers to improve adaptation to sea-level rise:

- *Develop adaptation pathways for the LT-coastal adaptation strategies* currently considered in the Netherlands (Protect-Open, Protect-Closed, Seaward, and Accommodate). This will provide policymakers with insight into the possible adaptation options, lock-ins, and path dependencies. Furthermore, it will help them to identify short-term measures that keep the LT strategies open.
- *Develop area-specific consequence scenarios.* Consequence scenarios translate the plausible consequences of sea-level rise and the LT-coastal adaptation strategies considered to a specific region, for example, a municipality or water board. Insights into the possible consequences of sea-level rise are crucial for implementing actors to make informed decisions on appropriate measures and actions. Furthermore, such scenarios are required for applying other instruments of ADM on the implementation level.
- *Formulate policy objectives more precisely.* Policy objectives should be defined as clear and explicit as possible, preferably with measurable indicators. Clearly defined goals make it easier to determine if a strategy is successful or not (and an adaptation tipping point occurs). Resulting in policymakers having insight into when adjustment of a strategy is needed.
- *Provide workshops and training on the application of the instruments of ADM.* Workshops and training can enable actors of ADM to apply these instruments since using the instruments of ADM in the prescribed manner is challenging.

Discussion

Reflecting on the overall results of this research, one could wonder if the ADM approach will be successful in coping with sea-level rise in the future or if the method is too complex to be successful in practice. Although the method is complex to apply in practice, we think that the instruments of ADM (such as scenarios and adaptation pathways) can be very helpful in dealing with the uncertainty of sea-level rise. Nonetheless, future research into how to make the ADM method easier to apply for policymakers is recommended.

Based on our research, more in general, we observe three implications for policymakers. Firstly, a more future-oriented mindset is required for policymakers. Policymakers need to explore the long-term strategies to cope with sea-level rise and to connect their explorations to short-term decisions with long-term objectives. Secondly, better alignment between the actors at different levels is needed. Thirdly, policymaking at the implementation level will become more complex and time-consuming than it is today.

Accelerating climate change might require more rapid and more extreme adaptations action. The implementation of such transformative adaptations needs further development of ADM's institutional and instrumental governance elements. The extensive policy literature on transformative change (Jones and Baumgartner 2005; Loorbach 2010) might form a fertile start, but needs to be adapted to the Dutch ADM context and equipped with additional instruments.

Although the primary focus of the research was to investigate whether the current governance of ADM enhances adaptation to sea-level rise, two other implications of this research were detected that are valuable for further developing the ADM method. Firstly, adaptation-tipping points are more flexible in practice than in theory. Further research is suggested on how adaptation tipping points can be defined when precise policy objectives are absent. Secondly, the pace at which the evaluation of strategies in practice has a fixed rhythm, while theory recommends re-evaluation whenever new information comes available. The fixed rhythm is expected to be positive for the application of the ADM method in practice. Therefore, further research is suggested into the effectiveness and the implications of a fixed rhythm for evaluation in the ADM method.

Conclusion

The research of our research shows that the application of the greater part of the instruments of ADM is not coherent with how they should be applied according to theory. Based on the analysis of the similarities and differences between the theory and practice of ADM, the research found that currently, the governance of ADM in practice in the Netherlands does not sufficiently enhance adaptation to sea-level rise. Several recommendations inspired by the theoretical foundation of ADM are proposed to further enhance the practice of ADM for adaptation to sea-level rise in The Netherlands. The first recommendation aims to ensure that policymakers get insight into the solution space to cope with sea-level rise. They should understand what short-term measures are needed to keep all the long-term strategies to cope with sea-level rise open. Also, they need to better

understand how, and which strategies can be combined, or which ones are mutually exclusive. Furthermore, actors involved in the implementation of strategies should obtain more insight into the possible consequences of sea-level rise and LT-coastal adaptation strategy at the national level for their region and know how to incorporate these in their decision-making. Here we propose regional consequence scenarios as a viable way forward.

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With special thanks to Annick de Vries (Wetenschappelijke Raad voor het Regeringsbeleid), and Hans de Bruijn (TU Delft) who guided the research and provided valuable feedback.

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