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What makes long-term investment decisions forward looking: A framework applied to the case of Amsterdam's new sea lock

W.D. Pot[a,*], A. Dewulf[a], G.R. Biesbroek[a], M.J. van der Vlist[b,c], C.J.A.M. Termeer[a]

[a] Wageningen University and Research, Public Administration and Policy Group, Hollandseweg 1, 6706 KN, P.O. box 47, Wageningen, The Netherlands
[b] Wageningen University and Research, Landscape Architecture Group, Droevendaalsesteeg 3, 6708 PB Wageningen, The Netherlands
[c] Rijkswaterstaat, Griffioenlaan 2, 3526 LA Utrecht, The Netherlands

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ABSTRACT

Long-term investments challenge decision makers to look into the far future. Existing future studies often build upon a rational idea of decision making that does not help to explain why decision makers anticipate the future. In addition, existing studies do not provide a clear definition of what is considered as "forward looking". This article proposes a framework that can be used to evaluate and explain for what reasons and based on what criteria decision makers take forward-looking investment decisions. We apply this framework to a specific decision-making case about a Dutch sea lock, making use of interviews (n = 16) and a content analysis of primary documents (n = 430). We find that not all investment decisions are necessarily forward looking. Secondly, we conclude from our case that decisions became forward looking because administrators used scenarios, visions, and flexible solutions to build support, avoid political risks and comply to formal rules. Scenario developers and urban planners could therefore involve administrators in early stages of the decision-making process to increase their awareness of the future towards which they are steering and provide them with alternative future paths. Furthermore, they could identify and use relevant institutional rules with forward-looking features to stimulate forward-looking decisions.

1. Introduction

A current challenge in the developed parts of the world is that an increasing number of water management structures are approaching their end-of-lifetime consequent to technical aging or changing functional demands (Díaz et al., 2016; Grigg, 2017; Hijdra et al., 2014; Van Vuren et al., 2015). This challenge of end-of-lifetime infrastructure puts long-term investment decisions on the agenda of many public sector organizations. The long infrastructure lifetime of up to 100 years may require decision makers to look into the far future to anticipate future challenges and to decide on technical solutions that can cope with deep uncertainty (Nair and Howlett, 2014). Various institutional barriers, including political myopia, can make it difficult for decision makers to take decisions that anticipate the future (Bonfiglioli and Gancia, 2013). Furthermore, decision makers are faced with large uncertainties when they need to invest in infrastructure that will remain for 100 years. Uncertainties can arise because new technical solutions will become available during the lifespan of an infrastructure, climate change will impact the effectiveness of infrastructure, and user demands may change severely.

A growing body of literature supports decision making under deep uncertainty by providing a range of scenario and decision support methods (see Haasnoot et al., 2013). Scenario planning and deep uncertainty approaches often assume a rational decision-making process in which a decision maker formulates long-term goals, explores as many alternatives as possible, weighs future consequences, and chooses the solution that can withstand long-term change (Kwakkel et al., 2010; Restemeyer et al., 2016; Wise et al., 2014). This dominant perspective of decision making as an orderly process is more prescriptive than descriptive, being more concerned with how alternative solutions and futures *should* be explored than with how specific solutions are chosen (Mintzberg et al., 1998, p. 3; Stone, 2002, p. 184). Such a perspective therefore does not help to elucidate the complex processes that cause decision makers to consider the future when deciding to invest in end-of-lifetime infrastructure. Furthermore, the literature does not provide a clear definition of a "forward-looking decision" or equates forward looking to the application of foresight and scenario methods (Havas and Weber, 2017; Iden et al., 2016). Without a clear definition of what constitutes a forward-looking decision, it is difficult to judge whether

* Corresponding author.
E-mail addresses: wieke.pot@wur.nl (W.D. Pot), art.dewulf@wur.nl (A. Dewulf), robbert.biesbroek@wur.nl (G.R. Biesbroek), maarten.vandervlist@wur.nl (M.J.v.d. Vlist).

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and how scenario methods influence public sector investment decisions (Rickards et al., 2014; Volkery and Ribeiro, 2009).

This article aims to evaluate and explain for what reasons and based on what criteria decision makers take forward-looking investment decisions. The main question that guides this paper is: What makes long-term investment decisions forward looking? In answering this question, we aim to make two theoretical contributions. First, we develop a decision-making framework to explain how decision processes evolve and why decisions become forward looking. Our framework provides an alternative to the burgeoning literature about scenario studies, strategic planning and deep uncertainty that has a more normative view on decision making and the role of future aspects therein. The decision-making framework that we develop builds on the Multiple Streams Framework (MSF) developed by Kingdon (2003) and advanced by Zahariadis (2007) and Howlett et al. (2016, 2014). The MSF is especially suited to explain decisions in situations of deep uncertainty and high ambiguity (March, 1991; Zahariadis, 2007). Our alternative framework is therefore particularly useful to explain how decision makers use scenarios, visions, strategies, and flexible solutions in practice and with that, produce forward-looking decisions. Second, we introduce a comprehensive definition of "forward looking", to specify on the basis of what criteria an investment decision can be characterized as forward looking. The definition consists of three evaluative criteria: a problem definition that includes a long time horizon and future developments, a solution that is adaptive or robust to account for uncertainty, and a justification that relies on long-term goals or future scenarios. To illustrate the value of our framework and to provide explanations for why decisions become forward looking, we selected the case of the investment decisions in the IJmuiden sea lock in The Netherlands.

This article is structured as follows. Section 2 presents the MSF and defines the criteria for forward-looking decisions based on a review of different strands of literature. Section 3 describes the research approach and methods of data collection and analysis. Section 4 presents the case findings. Section 5 reflects on the key insights about forward-looking decisions gained from the application of our framework to our case and provides some directions for future research. We end this article with conclusions.

2. Conceptual framework for analyzing and explaining forward-looking decisions

2.1. Framework to understand the process of forward-looking decision making

There are different frameworks to analyze decision making and each framework has its own assumptions about how decision making evolves. Scholars in the field of strategic planning, deep uncertainty, transition theory and forecasting tend to align to rational and linear notions of decision making: they tend to assume or prescribe a decision-making process that evolves according to successive stages and in which a single actor aims at finding the most optimal policy (Albrechts, 2004; Kemp and Loorbach, 2007; Kwakkel et al., 2010; Restemeyer et al., 2016; Wise et al., 2014). However, rational and linear models have mainly prescriptive and descriptive power and are not well suited to explain complex decision making in situations of deep uncertainty and high ambiguity (March, 1991; Zahariadis, 2007). For the purpose of explaining decisions that consider uncertain future developments we need a different perspective to decision making than the rational view.

In this article we propose an alternative model to explain why decisions become forward looking. This model is based on a group of process-oriented decision theories that build on each other, namely the Garbage Can Model (Cohen et al., 1972), Kingdon's Multiple Streams Framework (Kingdon, 1984) including recent advancements by Howlett and colleagues (Howlett et al., 2016, 2014), and the Rounds Model (Teisman, 2000). This group of theories assumes that decision making evolves through more evolutionary and chaotic processes that are characterized by amongst others political conflicts, power struggles and framing contests. The Garbage Can Model portrays the opportunity for a decision as a garbage can into which different problems and solutions are dumped by participants, and where a problems sticks to a solution from time to time (Cohen et al., 1972, p. 2). Kingdon (2003, 1984) modifies this Garbage Can theory to explain why certain problems receive the attention of policy makers and other problems do not. He uses 'streams' to refer to the horizontal and parallel processes of 1) framing problems, 2) developing solution alternatives, and 3) politics. Each stream is characterized with its own specific participants and rules. Kingdon refers to the revised version of the Garbage Can Model as the 'Multiple Streams Framework' (MSF). The metaphor of a stream has been further developed and used to understand decision making and describe the independent and parallel flow of solutions, problems, politics and decision-making processes that develop and change over time (Howlett et al., 2016, 2014). When the streams come together at critical junctures, decisions can be made. Several decisions, and therefore several rounds of decision making, may be needed before a 'definite' solution is chosen (Teisman, 2000). We will briefly explain the key concepts of the MSF that we will rely upon in this study.

The first stream that we distinguish is the *problem stream*. The problem stream consists of different problem definitions, and these definitions can evolve over the course of the decision-making process (Stone, 2002, pp. 242–245). A situation is framed as a problem because certain actors feel something needs to be done to change that situation (Jones and Baumgartner, 2005; Kingdon, 2003). For example, some argue that an urban water system needs to be renewed to use new technologies, whereas others may argue that renewal is needed because urban water systems are unsustainable (de Graaf and van der Brugge, 2010).

The *solution stream* consists of the technical solutions developed by experts and highlighted by specific actors during decision making (Kingdon, 2003; Stone, 2002, pp. 246–247). Solutions for flooding, for example, can include strengthening dykes to prevent flooding or the creation of room for the river through land-use planning (Van Staveren and Van Tatenhove, 2016). Certain actors bring pet solutions to the decision-making process, in search of a suitable problem frame. The solution stream is typically dominated by technical experts and planners that are often strongly guided by their specific disciplinary practice and background (Lawrence et al., 2013).

The *political stream* consists of the political processes of party ideology, elections, coalition changes, and pressure from groups outside of government that cooperate on a certain topic (Kingdon, 2003). A new political administration may not want to increase taxes to renovate urban water systems. Without sufficient political will it is unlikely that investment decisions will be made (DeLeo, 2016; Volkery and Ribeiro, 2009).

The last stream that we distinguish is *the choice opportunity stream*, which consists of the occasions when organizations are expected to produce decisions. The choice opportunity stream includes the rules, procedures, and norms that guide decisions and that determine who is involved and on what basis solutions are examined (Cohen et al., 1972; Howlett et al., 2016, pp. 280–281). Examples are the annual budget cycle, delegations of authority, rules for cost benefit analyses to evaluate possible solutions, and information that needs to be sent to the parliament.

When these four streams meet at a certain juncture, decisions can be made (Howlett et al., 2016, p. 481; Kingdon, 2003, p. 87). The decision that emanates from the joining of the four streams does not necessarily have to be composed of content from all four streams. Also, any of the streams can be the main driver behind reaching a decision; for example, a new government can reframe the problem definition, or technological advancements can create new solutions (Howlett et al., 2014). Multiple decisions may be needed to invest in a new infrastructure. Therefore, following Teisman (2000), we portray the decision-making process in terms of rounds rather than phases. After each decision, the multiple

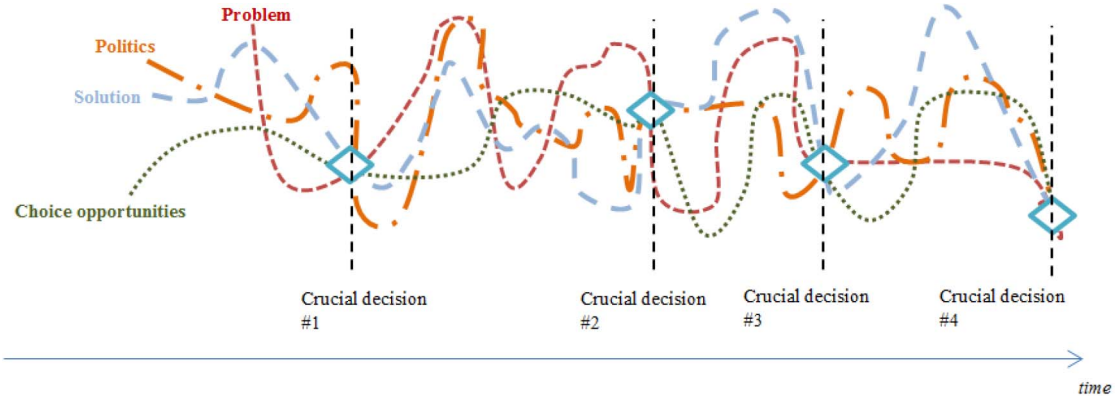

Fig. 1. Multiple stream model of decision making modified from Howlett et al. (2016).
Each thread represents one stream that evolves over time. The symbol ◇ refers to the crucial investment decisions taken at critical junctures in the four streams.

streams start to flow independently until certain participants in the process connect the four streams to reach another decision about the same object. In the rounds model, decisions are then called *crucial decisions* because the decisions that are made change the circumstances in which future decisions will be made (see also Derbyshire, 2016, p. 3). This multi-faceted process is illustrated in Fig. 1.

2.2. Framework to analyze whether an infrastructure investment decision is forward looking

Arguably, investment decisions are specific types of crucial decisions, as they set the stage for later events in the different streams. Investment decisions are usually taken in the political arena and have a specific problem definition, solution, and justification derived from the four streams. To understand whether investment decisions about end-of-lifetime infrastructure anticipate the future, we need a definition of what constitutes "forward looking". This definition is currently lacking. Several strands in the scholarly literature have looked at various aspects of forward-looking decisions, but what constitutes forward looking remains unspecified or narrowly defined, often referring only to foresight (e.g. Dahlberg and Lindström, 1998; Gavetti and Levinthal, 2000; Havas and Weber, 2017). A forward-looking decision is however not the same as a decision that relies on foresight, nor entails the opposite of backward looking (i.e. experience based) (Gavetti and Levinthal, 2000). Instead, we position forward-looking decisions as the opposite of myopic decisions, decisions that do not take into account long-term future developments or consequences (Bonfiglioli and Gancia, 2013). To understand what forward looking as opposed to myopic means, we need to take into account a broad range of academic disciplines that aim to deal with 'the future' and with that develop a broader definition than currently exists. Also, this definition needs to be very specific to be useful for the analysis of infrastructure related investment decisions.

To conceptualize forward looking, we conducted a literature review in the fields of decision making under deep uncertainty, transition management, scenario planning, strategic management, and long-term policy making. Combining the key elements of these different strands of literature introduces an elaborate definition of a forward-looking investment decision that consists of three criteria: a problem definition that includes a long time horizon and future developments (Segrave et al., 2014), a solution that is robust or flexible to cope with uncertainty (Nair and Howlett, 2014), and a justification that relies on desired long-term goals (Jacobs, 2011; Meuleman and in 't Veld, 2010) or possible future scenarios (Rickards et al., 2014). The criteria for forward-looking investment decisions are summarized in Table 1.

We briefly describe each of the forward-looking criteria for investment decisions about end-of-lifetime infrastructure.

First, the problem definition of a decision is forward looking when it includes anticipated *future developments or future needs*. To define a situation as a problem, actors in the streams may frame technical disturbances, user complaints, and indicators of change to strive for recognition of the end-of-lifetime of an infrastructure. However, only when the problem definition in the investment decision includes a reference to uncertain future developments do we consider the problem definition to be forward looking (Albrechts, 2004; Dominguez et al., 2011). Such future developments could potentially impact the core functionalities of the infrastructure but can also be highly unknown (Abbott, 2005; Termeer and van den Brink, 2012).

Forward looking also means that decision makers adopt a *long-term time horizon* to understand and frame the problem (Segrave et al., 2014). What constitutes the 'long-term' can strongly differ per actor and depends on the problem at hand (Bressers and Deelstra, 2013; Wolf and Van Dooren, 2017). A infrastructural *solution* can have a lifetime of up to 100 years but that does not necessarily imply that decision makers will define the *problem* that a new infrastructure needs to solve in terms of 100 years. Maybe the infrastructure needs to solve an urgent water safety issue. The most important actor for investment decisions is the decision maker that usually resides at the highest organizational level. Decision makers at the highest organizational level typically are suspected of short-termism, myopia, or short sightedness, which means that they only pay attention to what is within their board terms of four to eight years (Bonfiglioli and Gancia, 2013; Boston, 2017; Nair and Howlett, 2017). Therefore, we argue that the *minimum* time horizon of a forward-looking decision problem should be 10 years (Boston, 2017; Meuleman and in 't Veld, 2010). A minimum of 10 years means that political decision makers are requested to look beyond the two political cycles during which they are allowed to hold office in most Western democracies. This time horizon to understand long-term problems serves explicitly as a minimum since challenges such as climate change may require a much longer outlook.

Second, the chosen technical solution of a decision is forward looking when it aims to be robust, flexible, or both. *Robustness* refers to the capacity of a solution to remain functionally effective during its technical lifetime, even in extreme case scenarios (Ben-Haim et al., 2015; Halim et al., 2015). To assess the robustness of a decision, different future tests can be performed such as scenario analysis (Haasnoot and Middelkoop, 2012) and pilots (Loorbach, 2010; Nair and Howlett, 2016). *Flexibility* means that a chosen solution can be adapted to changed circumstances and insights to secure long-term effectiveness (Dewulf and Termeer, 2015; Hargadon and Douglas, 2001; Van Der Brugge and Roosjen, 2015). This implies that decision makers do not set up path dependencies that make adjustments difficult or expensive in the future. Actions that can be mentioned in decision(s) to ensure flexibility include actions to monitor future challenges and actions to take future decisions to adjust a chosen solution (Albrechts, 2004; Boyd et al., 2015; Haasnoot et al., 2013; Hill Clarvis et al., 2013). Ideally, solutions are both flexible and robust (Hargadon and Douglas, 2001).

Table 1
Criteria for forward-looking investment decisions.

Criterion	Elements	Description
1. Forward-looking problem	Future orientation and long time horizon	○ The problem definition includes future challenges and/or future needs. ○ The time horizon of the problem definition is minimum 10 years.
2. Forward-looking solution	Robustness and/or flexibility	Robustness: ○ The solution remains functionally effective during its technical lifetime when tested against an extreme case scenario. ○ Pilots or experiments of one or more solutions were executed to test robustness. Flexibility: ○ The solution can be adapted to changed circumstances and insights during its lifetime, or supplemented by other measures to secure long-term effectiveness. ○ There is an agreement to establish a monitoring process to secure the effectiveness of the chosen solution. ○ There is an agreement to establish an iterative decision process for adaptation of the solution.
3. Forward-looking justification	Long-term goals/visions and/or future scenario	Long-term goals/visions: ○ The decision is connected to future goals or a future vision. Future scenarios: ○ The decision relies on multiple scenarios for one future development. ○ The decision relies on scenarios to understand multiple future developments.

Third, the justification for a decision is forward looking when the decision is based either on foresight methods to understand plausible futures or on future goals and visions to formulate desired futures. Forward-looking decisions may use scenarios to explore future trends or use specific intuitive scenario exercises to understand plausible futures (Halim et al., 2015; Hamarat et al., 2013; McKiernan, 2016). To be called forward looking, decisions – our review suggests – would need to rely on *multiple scenarios* to cover different plausible or imagined futures (Soetanto et al., 2011; Van't Klooster and Van Asselt, 2006). Furthermore, decisions should build on a combination of scenarios that includes a *range of future developments* such as economic and market developments, spatial-demographic futures, climate change, socio-political trends and possible technological developments (Haasnoot and Middelkoop, 2012; Mintzberg et al., 1998; OECD, 2014; Rowland and Spaniol, 2017). Forward-looking decisions can, however, also be based on *desired long-term goals and strategic visions* to establish desired change (Hansson et al., 2015; Meuleman and in 't Veld, 2010). To reach long-term goals, for example by aiming at a transition to renewable energy, visions may be developed by one or a combination of actors (Albrechts, 2004; Kemp and Loorbach, 2007; Mintzberg et al., 1998).

This framework to analyze forward-looking decisions can be used to analyze whether decisions are forward looking, i.e. decisions that meet all three forward-looking criteria. It can also be used to assess the extent to which decisions are forward looking, i.e. the number of (sub) criteria that decisions meet. We will use this framework to evaluate decisions about infrastructure with a long lifespan, hence decisions that could be called 'long-term investment decisions'. This is because we expect that if anywhere, forward-looking decisions can be found in the field of infrastructure because of the long technical lifespan of infrastructure. But in theory, the framework could also be applied to short-term decisions. Decisions with a short decision lead time or short solution lead time can meet the criteria of a forward-looking decision whenever they aim to deal with long-term future developments (Meuleman and in 't Veld, 2010). An example of a short-term but forward-looking decision could be a decision to earmark an existing green area for water storage to be able to cope with extreme precipitation that may occur more often because of projected climate change.

3. Methods and case

We selected the case of the IJmuiden sea lock in the Netherlands to illustrate the value of our framework and to elucidate the processes that explain forward-looking investment decisions. The case was selected because the final crucial decision to realize the new sea lock was made recently (2016). The decision was preceded by a long history of events (1996–2016), and this enables a detailed reconstruction of the decision-making process and analysis of multiple crucial decisions. This article adopts a process-tracing approach to identify crucial investment decisions between 1996 and 2016; analyze the extent to which these decisions are forward looking; and find diagnostic evidence for how forward-looking decisions are made (Bennett and Checkel, 2015, p. 7; 18).

3.1. Data collection

Data were collected from multiple sources to seek diverse evidence and cross-check causal inferences derived from process tracing (Bennett and Checkel, 2015, p. 28). Primary documents were collected through a systematic search of policy databases of the national parliament, Province of North-Holland, and the Municipality of Amsterdam by using three different search queries for the years 1996–2016 (see Appendix A). We excluded duplicates, audio files, and documents that only mentioned the IJmuiden sea lock as an example without providing any context. In addition, we conducted two rounds of interviews with key actors that were recorded and transcribed. For the interviews, a semi-structured interview guide was designed to cover pre-defined topics while being open to other relevant information. Interviewees were identified through decision documents and snowball sampling. Interviewees were associated with the Municipality of Amsterdam and Port of Amsterdam ($n = 6$), with the Province of North-Holland ($n = 3$), and with the Ministry of Infrastructure and Environment and Rijkswaterstaat (RWS)[1] ($n = 7$). Three of the interviewees were political administrators (see Appendix B for an overview of interviewees). During the interviews, several recurring topics were discussed: the evolution of problem definitions; the impact of political processes and decision procedures; the way solutions were selected; actors' time horizon and the role of visions and scenarios.

Interviews and primary documents were used to identify the crucial investment decisions. The documents that marked these crucial investment decisions were collected to analyze the extent to which these investment decisions are forward looking. The decisions in this study consist of the formally (i.e. politically) approved documents that formulate the decision to invest or not invest in the IJmuiden sea lock, as well as the underlying documents and reports to which these decisions refer. An overview of all decision documents can be found in Appendix C.

To improve our theoretical framework and validate the research findings presented in this paper, we organized two symposia with

[1] Before 2010, the responsible ministry was called Ministry of Transport, Public Works, and Water Management. Rijkswaterstaat is the executive agency for Public Works and Water Management, part of the Ministry of Infrastructure and the Environment.

scientists and practitioners working in the domain of water infrastructure. These symposia took place in April 2016 and May 2017.

3.2. Data analysis

We developed a rough storyline from the collection of primary documents and interviews. We inputted the transcriptions of interview records together with the collected primary documents into the qualitative data analysis program Atlas.ti. We developed a code network to code the relevant paragraphs of parliamentary documents, ministerial speeches, and decision documents (see Appendix D).

To analyze the extent to which the investment decisions were forward looking, the coded decision documents were analyzed in two rounds. First, we scored the coded paragraphs of the documents in terms of yes or no for the absence or presence of forward-looking criteria in each decision. Second, we described the forward-looking elements of each investment decision in words to account for their specific formulation and evolution.

To explain which processes led to the presence of forward-looking criteria in the investment decisions in our case, we first developed a detailed and chronological story line of the case events to reconstruct causal chains of events. Second, analysis of the interviews and primary documents enabled us to trace back the processes within streams that could explain the presence of each specific forward-looking criterion. Words in interviews that implicitly or explicitly referred to forward-looking criteria were used to find explanations for the presence of forward-looking criteria both during the interview and during transcript analysis. We iterated between empirical findings and theoretical concepts to identify causal mechanisms that explain how, in each stream, specific processes causally contributed to the forward-looking characteristics of the crucial investment decisions. This data analysis approach relates to what Beach and Pedersen (2016) call *theory-building process tracing*.

Appendix A summarizes how we collected, analyzed, and used the data in this study.

4. Results

We start the results section with a description of case events and crucial investment decisions. Second, we analyze the crucial investment decisions and show how forward looking they are. Last, we present the causal mechanisms that explain the forward-looking elements of these decisions.

4.1. Crucial investment decisions about IJmuiden sea lock

The IJmuiden lock in the Netherlands forms the access for vessels from the sea to the North Sea Canal area and the seaports of Amsterdam, Zaanstad, Beverwijk, and Velsen. The North Sea Canal was created between 1865 and 1876 to facilitate the growing number of vessels on the route from the sea to Amsterdam. The IJmuiden lock in fact consists of four locks, of which the North lock was the largest in the world until 1967 (Appendix C; document #34, 35). The North lock – which can accommodate vessels 320 m long, 45 m wide, and 14 m deep – dates from 1929. The four locks together can process up to 95 million metric tons of goods per year. The locks have three functionalities: providing access from the sea, protecting the Netherlands against the sea as a primary flood defense structure, and safeguarding water quality behind the locks (Appendix C; document #23).

As a primary flood defense structure, the IJmuiden locks not only grant but also block access to the North Sea Canal area. In our case, the Province of North-Holland and the Municipality of Amsterdam argued that the locks are a bottleneck to reaching the North Sea Canal area and started lobbying for an additional large lock as far back as the 1960s (interviewees #5 and #15). From the early 1990s, the province and municipality emphasized that a growing number of large vessels were using the North lock, leading to capacity issues. The national government owns and maintains the IJmuiden locks and was at first not convinced of these capacity issues. The national government's attitude changed when a change in the problem stream and in the political stream successfully coincided: a new minister and parliament were receptive to the demonstrated growth in transshipment at the end of 2006. In 2009, the minister, province, and municipality agreed to invest in a new lock. In this agreement, the government invested the money that it otherwise would have paid at the end of the technical end-of-lifetime of the North lock in 2029.[2] From our analysis, we identified six crucial investment decisions. In the years 2002, 2009–10, 2012, and 2014–15, the crucial investment decisions consisted of a cluster of separate political decisions of the ministry, the province, and the municipality, and multiparty agreements. Table 2 provides a detailed chronological overview of events and crucial investment decisions.

4.2. Forward-looking decisions about IJmuiden sea lock

We analyzed the crucial investment decisions identified in our case with the framework introduced in Section 2.2. Table 3 synthesizes the extent to which the six crucial investment decisions are forward looking. Regarding the *problem definition*, our data suggest that the problem definition is forward looking in investment decisions 3 to 6. When we look at decision 3, the Ministerial decision states that “with a favorable development of flows of goods […] it is expected that congestion will occur in the period 2010–2020” (Appendix C: document #12). In decisions 4 to 6, the problem definition can be considered forward looking because, once the link to the technical end-of-lifetime of the North lock was established in 2008 (see Table 2), the decision documents after 2008 all include the problem frame of the anticipated need to replace the North lock in 2029 to secure the primary functionalities of this lock for the future (see for example the covenant, Appendix C: document #15).

Given our criteria, the solution in decisions 2 and 5 could be characterized as a flexible *forward-looking solution* because the decisions mention future additional solutions that can supplement the chosen solution at a later stage and take action to monitor the impact of the chosen solutions. With decision 2, the minister decided not to invest in a new lock and instead to invest in capacity management measures. The impact of these measures would be monitored. In the decision, the minister recognizes that “in the long run a new sea lock will be needed” and states that she would discuss the development of transshipment with governments in the North Sea Canal area again in 2008 to “determine which measures are needed” (Appendix C: document #9). With decision 5, it was decided to build a new lock to replace the North lock. With the new lock, the IJmuiden lock system could facilitate growth of transshipment to 125 million metric tons per year. To grow beyond this point, the decision mentions the option of maintaining the North lock next to the new lock. One of the attachments of the decision is a roadmap that compares different scenarios with future decisions and interventions that could be taken at certain points in time to enable future growth (Appendix C: document #42, p. 14). Decision 5 also proposes a future decision about the future functionality of the North lock “two years before realization of the new lock” (Appendix C: document #28–29); and an action to monitor the technical end-of-lifetime of the North lock because the exact lifetime was uncertain (Appendix C: documents #34–35). Last, the solution chosen with decision 6 meets one criterion of flexibility, as the decision mentions different monitoring agreements, of which one tracks the effectiveness of one of the primary functionalities of the new lock: a monitoring

[2] This is not money that the government reserved, but money the government was expecting to spend: in the Netherlands, the national government uses cash basis accounting, meaning that expenses are only reported in the year that cash payments occur. In terms of infrastructure investments, this means that the government raises money in the market just before it needs to spend it.

Table 2
Analysis of case events and decisions about IJmuiden sea lock.

Rounds preceding crucial decisions	Summary of events
1. The province and municipality show willingness to invest at an early stage *1997–2002*	The project Quality of Sea Access North Sea Canal became part of a planning study program of the Dutch Ministry of Transport, Public Works, and Water Management in 1998, with an estimated budget of 800 million to 1.3 billion Dutch Florins (approximately 500 to 790 million Euros). In this round, three alternative **solutions** were explored: a zero plus alternative with measures to improve access to the North Sea Canal; an additional and larger new lock; and an additional lock with the same parameters as the North lock. The alternative of a larger new lock was the one actively lobbied for by **politicians** from the Municipality of Amsterdam and the Province of North-Holland, although the **problem** that it should solve was contested. **Crucial investment decision 1:** In 2001, the municipality **decided** it was willing to co-finance a new lock; and the province reserved €34 million for a new lock; the money was realized from energy shares sold. Not all provincial **politicians** agreed to such a long-term reservation. The **Minister** decided to postpone a decision about the project after negative cost benefit analyses in April 2002.
2. More knowledge cannot support the desired solution *2003–2005*	Between 2002 and 2003, the province and municipality gathered more knowledge and financial investment alternatives to prepare for decision making. At the beginning of 2004, **Minister Peijs** asked the province and municipality to develop a regional vision for the North Sea Canal area and to explore alternative solutions instead of focusing solely on a new lock as part of the project, IJmuiden Approach. The Minister informed **parliament** that a decision about the project was postponed until completion of the continuing exploration of alternatives by the regional governments. **Solutions** explored in this period were an additional and larger new lock; a larger lock to replace one of the existing locks; an enlarged North lock; a semi-open flood defense; coastal expansion; and lightening of vessels from the sea. **Crucial investment decision 2:** On the basis of negative cost benefit analyses, **the Minister** concluded that there was not enough support for a large infrastructural investment in the lock complex and **decided to stop** the existing national government procedure. Instead, the minister offered to **invest in the alternative** of deepening the IJ gutter.
3. Demonstrated growth and a resolution of parliament create an opportunity for change *2006–2007*	Between 2005 and 2007, the **lobby of provincial and municipal politicians** continued despite the negative decision of Minister Peijs. The lobby became successful when the province and the municipality found the previous member of the Amsterdam municipal council and then **Member of Parliament** (MP) Van Oudenallen prepared to file a resolution. Van Oudenallen asked for the exploration of **solutions** for access to the North Sea Canal to be restarted, because of demonstrated growth figures as well as expected future economic development of the ports behind the locks. The resolution was adopted in parliament and Minister Eurlings asked the Netherlands Bureau for Economic Policy Analysis (CPB) to analyze the growth trend. The CPB concluded that based on **continuous growth**, **congestion** might occur between the years 2010 and 2020 but that this growth was very uncertain. Because of the long lead-time of realizing a new infrastructure, the CPB recommended starting an exploration of alternatives. **Crucial investment decision 3:** On the basis of the CPB recommendation, Minister Eurlings decided to start exploring technical and financial solutions for the IJmuiden lock complex in September 2007.
4. The end-of-lifetime of the North lock is connected to the problem of allocating national budget *2007–2009*	During the 2007–2009 round, three alternative **solutions** were explored: 'maintain' the current locks; 'facilitate' by building a new lock; and 'selectivity' by decreasing the inflow of vessels. To open up possibilities for the ministry to invest in a solution, public officials linked new lock solutions to the **expected technical end-of-lifetime of the North lock** in 2029. The extension of the multi-annual plan for infrastructure (MIRT) by eight years created the possibility to plan infrastructure investments beyond 2020. The orientation study report was finalized in November 2008, and Minister Eurlings asked the CPB to provide a second opinion on the cost benefit analysis. The cost benefit analysis showed negative to almost neutral results except when the most optimistic macroeconomic scenario was applied to the solution of 'facilitate'. The CPB also concluded that the North lock could not be replaced at its current location when it reached its technical end-of-lifetime, because this would mean the lock would be out of order for minimum three years. This implied that building a new lock sometime in the future would necessitate maintaining the existing complex. This opened the opportunity to invest in a new lock despite the negative cost benefit analysis. The link to the end-of-lifetime of the North lock altered the **political discussion** from why to when and what. The province and the municipality wanted to realize a larger lock at an earlier stage than the foreseen end-of-technical lifetime of the North lock. **Crucial investment decision 4:** As a result of this political negotiation, the province, the municipality, and the minister **signed a covenant in 2009** to build a larger new lock that would be financed with the replacement budget for the North lock and co-financing by the municipality and the province.
5. Political negotiations follow to find the feasible solution for the available budget *2010–2012*	The signing of the covenant marked the start of a round to explore whether a new sea lock was technically and financially feasible. During this round, **four lock widths** were explored: one with the same parameters as the North lock; and the others with a width of 60, 65, and 70 m. In the MIRT plans of 2010 and 2011, the **problem** was defined as accessibility to the North Sea Canal area and expected congestion between 2010 and 2020. **MPs** discussed the need and lead-time of the new lock, and connected this need to a vision about the future. To ensure national government funding, involve governments emphasized that the lock was an existing asset that needed to be maintained for its functionalities of sea transport and water safety. **Minister Eurlings** connected the state's responsibility to the international position of the Port of Amsterdam. **Crucial investment decision 5:** At the end of 2012, parties decided on a 65-m-wide lock and challenged the market to propose a 70-m-wide lock that required the same budget. The lock was to have **rail doors**, because they fitted the design, were cheaper than other types, and were 'proven technology'. One of the novelties was that the lock was the first known wet infrastructure to be realized with a Design-Build-Finance-Maintain **tender contract**.

(*continued on next page*)

Table 2 (*continued*)

Rounds preceding crucial decisions	Summary of events
6. Politicians discuss and decide about financial agreements and environmental impacts *2012–2015*	The Municipality and the Port of Amsterdam found the IJmuiden lock system to be a **growing bottleneck especially due to the larger parameters of vessels, including cruise boats**. The province took the lead in the environmental assessment and spatial integration of the **new lock**. The governments in the North Sea Canal area co-developed a long-term vision to agree to facilitate future growth of the ports. **Politicians** became interested in the environmental consequences of the lock. Municipal politicians became aware of the need to transition to renewable energy resources. This desired transition was reflected in the resolutions that they filed when the final go-decision about the new lock was discussed. **Crucial investment decision 6:** At the end of 2014, the Ministry of Infrastructure and the Environment, the Province of North-Holland, and the Municipality of Amsterdam signed the final **financial agreement**. The building of the new lock started at the beginning of 2016.

Table 3
Evaluation of crucial investment decisions about IJmuiden sea lock based on forward-looking criteria. Y means the criterion is met. N means the criterion is not met. N/E means that we could not find evidence for the presence or absence of this criterion. A forward-looking problem needs to include both a long time horizon and future challenges. A forward-looking solution can be either robust (meeting the criteria of ROB 2.1.1 and ROB 2.1.2), flexible (meeting the criteria of FLEX 2.2.1, FLEX 2.2.2, and FLEX 2.2.3), or both. A forward-looking justification can rely on long-term goals or visions (meeting criterion VIS 3.1.1) or on scenarios (meeting criteria SCEN 3.2.1 and SCEN 3.2.2), or on both.

Criterion	Description	Decision 1 2002	Decision 2 2005	Decision 3 2007	Decision 4 2009–10	Decision 5 2012	Decision 6 2014–15
1. Forward-looking problem		**N**	**N**	**Y**	**Y**	**Y**	**Y**
	1.1 The problem definition includes future challenges and/or future needs.	N	Y	Y	Y	Y	Y
	1.2 The time horizon of the problem definition is minimum 10 years.	N	N	Y	Y	Y	Y
2. Forward-looking solution		**N**	**Y**	**N**	**N**	**Y**	**N**
	2.1.1 ROB: The solution remains functionally effective during its technical lifetime when tested against an extreme case scenario.	N	N	N	N	N	N
	2.1.2 ROB: Pilots or experiments of one or more solutions were executed to test robustness.	N/E	N/E	N/E	N/E	N/E	N/E
	2.2.1 FLEX: The solution can be adapted to changed circumstances and insights during its lifetime, or supplemented by other measures to secure long-term effectiveness.	N	Y	N	N	Y	N
	2.2.2 FLEX: There is an agreement to establish a monitoring process to secure the effectiveness of the chosen solution.	N	Y	N	N	Y	Y
	2.2.3 FLEX: There is an agreement to establish an iterative decision process for adaptation of the solution.	N	Y	N	N	Y	N
3. Forward-looking justification		**Y**	**N**	**N**	**Y**	**Y**	**Y**
	3.1 VIS: The decision is connected to long-term goals or a future vision.	Y	N	N	Y	Y	Y
	3.2.1 SCEN: The decision relies on multiple scenarios for one future development.	Y	N	Y	Y	Y	Y
	3.2.2 SCEN: The decision relies on scenarios to understand multiple future developments.	N	N	N	N	N	Y
Forward-looking decision		**N**	**N**	**N**	**N**	**Y**	**N**

agreement focused on salt intrusion to safeguard the water quality functionality. However to be considered as a flexible solution, a decision needs to meet all three criteria of flexibility.

None of the crucial decisions meets the criterion of a robust solution. Although the 2014 solution passes the test of an extreme climate scenario, the solution does not pass the robustness test of high growth scenarios. In fact, according to a high growth scenario, the maximum capacity level of the IJmuiden lock system with the new lock will be reached around 2026; hence within 10 years of realization (Appendix C: document #47, p. 25). No separate pilots or experiments were mentioned in the decisions to assess robustness. This may be because the Ministry of Infrastructure and the Environment and RWS have a strong focus on proven technology (interviewee #8).

Four out of the six decisions have *justifications* that can be considered forward looking. Decisions 1, 4, 5, and 6 discuss efforts to realize visions for regional economic and/or port development. For example, the municipal decision that is part of crucial decision 1 refers to the Port Vision 2001–2010, in which the expansion of the IJmuiden lock system is connected to transshipment growth (Appendix C: document #5). For crucial decision 3, the most important justification came from a CPB report that analyzed capacity issues at the locks. This report uses six macroeconomic scenarios, and the minister used the main conclusion to start exploring the possibilities of a new sea lock for IJmuiden (Appendix C: documents #12, 14). Decision 6 relies not only on scenarios to understand macroeconomic futures but also on a scenario for climate change, i.e. scenario Veerman: “the height of the IJmuiden locks needs to be 8.25 m above sea level. This is based on a sea level rise of 1.20 m to 2100 (scenario Veerman)” (Appendix C: document #63).

Our results therefore show that, when our criteria are applied to analyze investment decisions, one crucial decision meets all criteria and can be considered as forward looking: decision 5 (see Table 3). First, this decision has a problem definition that includes future challenges and a long time horizon: the decisions refer to capacity restrictions of the current locks, the current and future growth of transshipment, the increasing parameters of vessels, and the technical end-of-lifetime of the North lock in 2029 (Appendix C: documents #28–30, 35–35). Second, the municipal decision that is part of crucial decision 5 is based, amongst other things, upon a long-term goal in the Port Vision: Amsterdam aims to increase transshipment to twice the current volume between 2005 and 2020 (Appendix C: documents #34–35 pp. 7–8). Last, the decision proposes a solution that is flexible because it is anticipated that the new lock can be supplemented by another solution of maintaining the former lock to facilitate future growth (Appendix C: documents #28, 34–35, 42).

Table 4
Causal mechanisms of forward-looking decisions. The first column presents the causal mechanisms that we found. These mechanisms are based on the combination of empirical evidence described in the second column with existing theoretical concepts. The third column links the decision and criterion numbers, referring back to Table 3.

Mechanism	Empirical manifestations in the IJmuiden sea lock case	Forward-looking criterion and decision
Strategic reframing using forward-looking argumentation	Politicians used information from cost benefit analyses that rely on scenarios to strengthen the problem definition that supported their pet solution.	Criterion 3.2.1 Decision 3
	The Minister expressed a long-term goal in which he emphasized the national political stake in investing in a new sea lock.	Criterion 3.1 Decision 4
	Civil servants of the Ministry added the long-term time horizon and foreseen replacement challenge to the problem definition to allocate national budget.	Criteria 1.1 and 1.2 Decisions 4, 5, 6
Avoiding political risks by relying on visions, scenarios, and flexible solutions	The Minister proposed a flexible no regret alternative to compensate her decision to not invest in the pet solution.	Criterion 2.2 Decision 2
	RWS created a flexible pathway solution to solve a political disagreement by separating the optional long-term maintenance of the existing lock as an additional future measure.	Criterion 2.2 Decision 5
	The investing governments sought political alignment together by using visions to remove political bottlenecks before crucial decisions.	Criterion 3.1 Decisions 1, 4, 5
	Civil servants of the Municipality of Amsterdam used multiple scenarios to mitigate financial and political risks.	Criterion 3.2.1 Decision 6
Compliance with rules that have forward-looking features	Governments used acknowledged scenarios and standards for cost benefit analyses in response to existing regulation, and to positively impact decisions.	Criterion 3.2.1 Decisions 1, 3
	The Municipality of Amsterdam formulated a long-term goal that complied with the boundaries of growth according to the environmental assessment procedure.	Criterion 3.1 Decision 6
	RWS ensured that the technical design of the new lock complied with institutionalized standards including water safety standards that rely on climate scenarios.	Criteria 2.2.2, 3.2.1, 3.2.2 Decision 6

4.3. Causal mechanisms behind forward-looking decisions

Now that we showed how to apply our criteria of a forward-looking decision to a specific case and analyzed multiple investment decisions, we will look for explanations of why long-term investment decisions become forward looking. To do this we included all of the crucial decisions about the IJmuiden sea lock in our analysis and used our MSF lens to understand decision making. For each of the criteria that were present in these decisions, i.e. the criteria that scored a 'yes' in Table 3, we identified explanations of why decisions became – partially – forward looking. We iterated between the empirical explanations that we retrieved and existing theoretical abstractions to identify the causal mechanisms. Mechanisms are the recurring, generalizable processes responsible for producing an observed outcome within interactive processes (Biesbroek et al., 2014). In this study, we consider mechanisms to be actors' responses within a certain context that result in forward-looking elements of investment decisions. Table 4 presents an overview of the three causal mechanisms that we found and that we discuss in more detail below.

4.3.1. Mechanism 1: strategic reframing using forward-looking argumentation

First, we recognize the general theoretical mechanism of political manipulation of ambiguity through strategic reframing (Zahariadis, 2007, pp. 69–70). Politicians try to formulate interests that appeal to a larger audience and thereby increase support for pet solutions (Kingdon, 2003, p. 78). To win support, they strategically use new information to influence the decision-making process. This mechanism of strategic reframing can alter the problem conception by highlighting certain arguments over others. If certain forward-looking arguments emerge from the problem or political stream and such arguments help to build support for a certain solution, the decision may also become forward looking.

In our case, decision makers did not aim for a forward-looking problem definition but used forward-looking arguments that helped to gain support for the preferred solution. We found that political administrators indeed *manipulated information from cost benefit analyses to invest in a pet solution*, a new lock, and that this led to a forward-looking problem definition in 2007. The cost benefit analyses themselves are quite forward looking: they use multiple scenarios and time horizons until 2040 to assess costs and benefits over time. On the basis of the 2007 cost benefit analysis, the CPB concluded that, in a situation of continuous growth, congestion might occur between the years 2010 and 2020 but that this growth was very uncertain (Appendix C: document #14). The then minister responsible for infrastructure, Mr. Eurlings, used part of the CPB conclusion in his problem definition, which was stated in the decision: "with a favorable development of inflow of goods in Amsterdam port it can be expected that congestion will occur in the period 2010–2020" (Appendix C: document #12).

The minister himself connected the foreseen congestion issue to the position of the Port of Amsterdam as a "port of international standing" (Port dinner speech 2008). We coded this as a forward-looking long-term aim. He adopted this long-term aim *to rescale the issue of investing in a new lock and justify the national level stake in investing in a new lock*.

Both the forward-looking problem definition and the future aim enabled the ministry to look for state funding to finance a new lock. *To allocate state funding*, the ministry connected the capacity issues of the lock to the expected technical end-of-lifetime of the North lock in 2029 (interviewee #5). The ministry had allocated funds to replace the North lock at the end-of-the-technical lifetime. This money was transferred to the new lock by linking the technical end-of-lifetime of the North lock to the problem definition of congestion. This added another forward-looking problem definition.

Our case demonstrates that strategic political administrators used forward-looking argumentation to reframe a problem definition such that it fitted and supported the pet solution: a new sea lock. This mechanism of strategic reframing impacted forward-lookingness when future-oriented information and arguments were adopted to reach the goal of finding support for a specific solution. Therefore, the presence of strategic leadership enabled the use of forward-looking arguments.

4.3.2. Mechanism 2: avoiding political risks by relying on visions, scenarios, and flexible measures

Second, we found a mechanism of political risk avoidance behind forward-looking decisions. The general mechanism tells us that politicians are highly risk averse (Howlett, 2014). Because of this risk aversion, Jacobs (2011) argues that politicians will take long-term investment decisions only when they feel safe electorally. The large body of literature on evidence-based decision making and knowledge in the policy process reveals the tendency of public sector organizations to fight uncertainty and risk by introducing more knowledge. Another strategy to be electorally safe is to build coalitions. By working together before crucial decisions need to be reached, politicians build shared commitment to facilitate desired outcomes (Swanson et al., 2010).

In our case, forward-looking solutions arose in an effort to avoid

political risks. In decision 2, Minister Peijs proposed a flexible "no regret measure" (interviewee #12) because cost benefit analyses did not support investing in a new sea lock (Appendix C: document #9). The minister was risk averse in the sense that she did not want to defend a negative cost benefit analysis in parliament but also wanted to avoid political opposition from the regional governments. To avoid conflict, the minister proposed the alternative of deepening the IJ gutter *to compensate the province and municipality* for the decision not to invest in a new sea lock, saying "I can give you this instead" (interviewee #7). In the decision, the minister proposes to re-evaluate her decision in 2008, conveniently after the next elections. The suggestion of a no regret alternative together with a specific proposal to re-evaluate the decision made the solution of decision 2 forward looking.

Before decision 5 was reached, actors did agree on the need for a new sea lock, but the national government, province, and municipality could not agree about what to do with the North lock once the new sea lock was realized (interviewees #5, #8). The conflict was settled, and the political risk therefore reduced, when RWS showed the municipality and the province that the decision about the North lock could be *separated from the decision as a future additional measure to enable political agreement*. RWS introduced a solution map that compares well with a simplified version of an adaptation pathways map (Haasnoot et al., 2013) to demonstrate how the decision about the future destination of the current lock could be an additional future measure for which decisions could be postponed until a later stage (interviewee #8).

Furthermore, decisions 1, 4, and 5 mentioned long-term visions that could also be explained by the mechanism of risk avoidance. First, the Municipality and the Port of Amsterdam developed a long-term Port Vision to inform the municipal council and to stipulate that a new sea lock was a precondition of future port development (interview #15; Appendix C, document nos. 66, 18, 19). The interviewees found the Amsterdam municipal council to be a highly uncertain actor in the case of the IJmuiden sea lock (interviewee #3, 4, 9). Therefore, the Port Vision was one of the instruments whereby the Municipality and the Port of Amsterdam positively influenced internal political consent to *avoid internal politics becoming a bottleneck* for future multiparty decisions. Second, the municipalities and province in the North Sea Canal area developed a North Sea Canal Vision. This vision was emphasized by the national government to assure that regional governments would facilitate the future growth of transshipment in the North Sea Canal area, before signing the final administrative agreement for the new sea lock in 2014 (interviewee #5). As one interviewee stated, the vision for the North Sea Canal area provided "political comfort" about the new sea lock by reducing the risk of disapproval of future spatial and environmental permits that would be needed to facilitate this growth (interviewee #1). Therefore, we can conclude that these visions were used *to avoid the political risk of future political conflict* when crucial decisions needed to be made.

Finally, the risk avoidance mechanism explains why, in 2014, the Municipality of Amsterdam used a relatively large number of scenarios to understand future economic and market growth. The municipality found itself confronted with a different political situation with a new municipal council and a changed national mood consequent to the economic crisis. Because of this changed situation, the municipality was urged to negotiate a better deal, i.e. a specified investment sum, with the national government compared to 2009 (interviewee #1). The number of scenarios supported a second negotiation round in which the municipality aimed to *mitigate financial and thus political risks*, and thereby lower the threshold for political agreement within a new municipal council (interviewee #4).

Our case demonstrates that forward-looking decisions result from a mechanism in which actors seek to avoid political risks by co-developing visions, proposing flexible solutions, and applying scenarios. Negative cost benefit analyses, environmental impacts, and political dissent can constitute perceived political risks. In this mechanism, perceived political risk forms a condition for the application of forward-looking activities such as visions.

4.3.3. Mechanism 3: compliance with rules that have forward-looking features

The last mechanism that we revealed is rule compliance; this triggers the forward-looking criteria of scenario usage, long-term objectives, and monitoring agreements. This mechanism relates to notions of rule-following in which actors are inclined to act in accordance to certain rules (Hodgson, 1997). As March (1991) argued, decision-making behavior often involves finding the appropriate rules to follow.

The rule compliance mechanism was activated in different rounds in our case. In 2002, the national government decided to *apply official guidelines for cost benefit analyses* to guide investment decisions. These official – so-called OEI – guidelines also prescribed the use of scenarios. This application of official guidelines arose because the CPB questioned the way that a consultancy had executed the cost benefit analysis in an earlier decision round (Appendix C, document #67). In 2007, the municipality and the province *used multiple well-established scenarios* to positively impact a decision by Minister Eurlings to restart the exploration of solutions for the lock. Only well established and therefore standard macro-economic scenarios were perceived as acceptable (interviewee #5).

In decision 5, the municipality formulated a future aim to grow transshipment to 125 million metric tons. This future aim confirmed the maximum growth allowed according to the environmental assessment procedure (Appendix C, document #68). This *future aim therefore complied with the boundaries of growth according to institutionalized procedures*.

In 2014, the EU Water Framework Directive (WFD) and the Dutch Delta Freshwater Program were applied to comply with water quality standards. The effort to monitor water quality was part of the WFD. The monitoring arrangement in decision 6 arose from concerns of the province and water boards about salt intrusion (interviewee #2). This monitoring agreement meets one of the flexibility criteria in our framework. Also in 2014, the height of the new lock needed to be determined. The prescribed height for primary flood defenses is derived from *existing water norms mentioned in the Dutch Water Law* (interviewee #8; Appendix C, document #63). The norms include application of the most extreme climate change scenario of the Royal Netherlands Meteorological Institute (KNMI).

In our case, we can see that forward-looking decisions resulted from a mechanism to follow appropriate rules that possess certain forward-looking features. Such forward-looking features could include: monitoring arrangements, specific scenarios, and scoping conditions that trigger future aims. This mechanism was activated when the justification for specific investment decisions was prepared and when the design and (environmental) consequences of a chosen solution were detailed. Therefore, the context condition of this mechanism to lead to forward-lookingness is the presence and perceived appropriateness of rules that have forward-looking features.

5. Discussion

In this article we developed a framework to evaluate and explain for what reasons and based on what criteria decision makers take forward-looking investment decisions. Building on a combination of different theoretical strands, our framework offers a rich analysis to assess whether, how and why the long term plays a role in real-life investment decisions. Applying it to a specific case allows us to reflect on the value of the framework for the evaluation of investment decisions about end-of-lifetime infrastructure.

The application of our framework to a specific case provides three key insights about the value of our framework for decision makers, urban planners, and developers of decision support tools.

First and perhaps surprisingly, we find that huge investment decisions that involve up to hundreds of million euros are not necessarily forward looking. Just one investment decision in our case was forward looking, and this decision still only met the minimum criteria. None of the decisions in our case met all sub criteria of a forward-looking decision: none of the decisions anticipated multiple future challenges, adopted a long time horizon, and proposed both a robust and a flexible solution, and was justified both with multiple scenarios for multiple future developments and with long-term visions. The forward-lookingness of decisions was more a side effect – an effect of which the involved actors were not even conscious – than an explicit aim of decision makers, despite the long time horizon involved in dealing with a sea lock with a lifespan of 100 years. Of course, we also need to add here that forward-lookingness is only one criterion to assess the quality of decisions and that the framework is not suited to answering, nor does it aim to answer, the question of whether a decision adequately and efficiently solves a problem. In conversation with decision makers and urban planners the framework could be helpful to reflect how their investment decision-making processes deal with the long term.

Second, with the application of the MSF to our case we revealed the causal processes behind forward-looking decisions. The causal mechanisms we found show that the forward-lookingness of decisions results strongly from political processes and institutionalized rules. This finding proves the importance of adopting non rational frameworks of decision making to understand the use of scenarios, visions, flexible and robust solutions in practice. Often, rational problem-oriented decision frameworks form the start in much of the literature on scenario planning and adaptive decision making. Here, forward-looking behavior is equated with acting rationally (Dahlberg and Lindström, 1998; Keane and Wolpin, 2002). Our findings show, however, that, although the criteria for forward-looking investment decisions seem to fit well with a rational understanding of decision making, rational decision making alone does not help to explain forward-looking decisions. Our findings underline the importance of including the political and the institutional dimensions in studies that develop methods for decision making under deep uncertainty, such as adaptation pathway and scenario planning approaches (Orach and Schlüter, 2016; Van Der Brugge and Roosjen, 2015; Volkery and Ribeiro, 2009; Wise et al., 2014). The MSF can help to include the institutional and political dimension of decision making.

Third and last, our article contributes to the understanding of how scenarios and other types of decision support methods actually impact public sector organizations' investment decisions (Volkery and Ribeiro, 2009). Our case demonstrates that scenarios are important tools because political administrators rely heavily on cost benefit analyses that apply established scenarios to calculate returns. As Anderson (2010) states, calculation makes the future present and is a dominant mode of practice for governments to decide about futures; but, in a way, this reduces the potential of scenarios to a product that predicts rather than explores futures. Scenarios are also valuable to make sense of possible futures, thereby possibly stimulating our mechanism of political reframing (see for example Patel, 2016). However, when the problem is framed mainly to build support for the political pet solutions, there is little opportunity to gain a broad understanding of long-term problems through scenarios or visions. Another illustration of the limited use of future-oriented decision support methods is that, as we saw in our case, an adaptation pathway map can be used merely as an instrument to exit stagnated discussions and pave the way for political agreement (Haasnoot et al., 2013). Scenario developers and urban planners could start involving administrators to make them aware of the future towards which they are steering, provide them with alternative future paths, and help them to overcome myopic thinking. Furthermore, they could map the relevant institutional rules with forward-looking features so that those rules may be consciously applied to influence forward-lookingness.

While this framework has examined forward-looking decision making because it is often overlooked and has potential for investment consequences, the framework also enables that short-term needs will still be addressed (Burt et al., 2015). This is consistent with Goetz (2014) who stresses in the context of governments that it is vital for organizations to be both responsive and responsible, fostering attention to the needs of both current and future generations.

The development of our framework offers several avenues for answering new research questions. First, we used the framework to evaluate decisions about infrastructure with a long lifespan, but given the scope of our literature review, it has potential to be applied to decisions within other sectors such as healthcare, energy grids, and information technology. It would be valuable to see how our criteria, such as flexibility, are applied in a very different domain. See for example Hargadon and Douglas (2001) who discuss robustness and flexibility in the context of product innovation. Second, we used a process tracing-research design to analyze and compare multiple investment decisions within one case. The framework could also be applied to compare the investment decisions of multiple organizations within a sector and evaluate how organizations score compared to each other. Increasing the number of cases could also be valuable to find configurations of mechanisms or context conditions that enable forward-looking decisions. Third, it would be valuable to apply the framework to a different institutional context to better understand the generalizability of the causal mechanisms that we found.

6. Conclusions

This article aimed to answer the question of what makes long-term investment decisions forward looking.

We started this article with the assumption that decisions about infrastructure with a long lifespan may require decision makers to look into the far and uncertain future; but also that it may be difficult for political decision makers to do so because of various institutional barriers such as political myopia. We developed a framework to evaluate and explain for what reasons and based on what criteria decision makers take forward-looking investment decisions. We argue that forward-looking decisions are decisions that meet three criteria: a problem definition that includes a long time horizon and future developments; a solution that is robust or flexible to cope with uncertainty, and a justification that relies on desired long-term goals or possible future scenarios. Applying our forward-looking decision framework to the case of the IJmuiden sea lock, learns us that decision makers may not necessarily aim to anticipate the future with their long-term investment decisions and that therefore not all investment decisions are forward looking. Secondly, we revealed three causal mechanisms that drive forward-looking decisions: strategic reframing using forward-looking argumentation; avoiding political risks by relying on visions, scenarios, and flexible solutions; and compliance with rules that have forward-looking features. This shows that the decision makers in our case anticipated the future because it helped them to build support for their pet solution, to avoid political risks and because it was in compliance to rules to do so.

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Appendix A. Overview of data collection and analysis

Type of data	# relevant and unique	Collection	Analysis	Used for
Interviews	16	Interviewees were identified through decision documents and peer recommendation.	Keyword search related to forward looking, manual analysis	RQ 1 + 2 Identify investment decisions
Parliamentary documents 1996–2016	177 (of 360) 7 part of decision documents	Database: https://zoek.officielebekendmakingen.nl/ Search terms: zeesluis ijmuiden/zeetoegang ijmond/ zeepoort ijmond Additional check with broad term 'ijmuiden' did not add any documents.	Coded paragraphs about sea lock with Atlas.ti	RQ 2 Events in streams
Provincial documents 1996–2016	107 (of 239) 1 part of decision documents	Databases: https://zoek.officielebekendmakingen.nl/ http://bit.ly/Provincedatabase Search terms: zeesluis ijmuiden/zeetoegang ijmond/ zeepoort ijmond	Manual analysis of documents to fill "black boxes"	RQ 2 Events in streams
Municipal documents 1996–2016	99 (of 395) 10 part of decision documents	Database: http://bit.ly/CouncilinfoAdam Search terms: zeesluis ijmuiden/zeetoegang ijmond/ zeepoort ijmond	Manual analysis of documents to fill 'black boxes'	RQ 2 Events in streams
Decision documents	64	Databases: Municipality: http://bit.ly/CouncilinfoAdam Province: http://bit.ly/CouncilinfoProvinceNH http://bestanden.noord-holland.nl/internet/ Latter only needed for budget change 2010. Search within specific meeting dates Parliament: through abovementioned search and database.	Coded forward-looking characteristics with Atlas.ti	RQ 1 Forward-looking characteristics
Additional documents	9 MIRT (4 also part of parl. Doc.) 5 CPB (all part of decision doc.)	Multi-annual infrastructural plans: http://bit.ly/MIRT07-15 CPB Netherlands Bureau for Economic Policy Analysis (CPB): CPB reports https://www.cpb.nl/publications?type=	Coded lock sections and decision characteristics with Atlas.ti	RQ 2 Events in streams
Speeches 2000–2003; 2008–2014	11	Identification of importance through interviewees; collection through speech writers ministries (years 2004–2007 not in archive)	Coded paragraphs about sea sluice with Atlas.ti	RQ 2 Events in streams

Appendix B. List of interviewees

Nr.	Interviewee	Case involvement	Type	Interview date
1	Policy advisor Spatial Planning Municipality of Amsterdam	2012–2014	Face-to-face, written record checked by interviewee	9/5/2016
2	Project manager Planning Study Sea Access IJmond, Rijkswaterstaat	2010–2014	Face-to-face, audio record, and transcript	9/26/2016
3	Project director Sea Access IJmond, Port of Amsterdam	2013–2016	Face-to-face, audio record, and transcript	10/7/2016
4	CFO Municipality of Amsterdam	2011–2014	Face-to-face, audio record, and transcript	10/6/2016
5	Program director North Sea Canal area, Province of North-Holland	2005–2016	Face-to-face, audio record, and transcript	10/4/2016
6	Project director Sea Access IJmond, Rijkswaterstaat	2014–2016	Face-to-face, audio record, and transcript	10/10/2016
7	Team lead waterways and Project lead Sea port/Access IJmond	2004–2014	Face-to-face, audio record, and transcript	10/14/2016
8	Project director Sea Access IJmond, Rijkswaterstaat	2009–2012	Face-to-face, audio record, and transcript	10/18/2016
9	Member of Provincial Executive, Province of North-Holland	2003–2009	Face-to-face, audio record, and transcript	10/20/2016

10	Member of Provincial Executive, Province of North-Holland	2009–2016	Face-to-face, audio record, and transcript	10/27/2016
11	Alderman, Municipality of Amsterdam	2008–2014	Face-to-face, audio record, and transcript	10/31/2016
12	Project manager, Ministry of Infrastructure and Environment	2008–2014	Face-to-face, audio record, and transcript	10/20/2016
Second round				
13	Program director Sluices, Rijkswaterstaat	2013–2016	Phone, audio record, and transcript	11/25/2016
14	CEO Port of Amsterdam	2000–2009	Face-to-face, audio record, and transcript	1/6/2017
15	CEO Port of Amsterdam	2009–2016	Face-to-face, audio record, and transcript	1/10/2017
16	Director General Aviation and Maritime Affairs, Ministry of Infrastructure and Environment	2008–2011	Face-to-face, audio record, and transcript	1/12/2017

Appendix C. Overview and numbering of decision documents

Year	Multi-party agreements	National level	Provincial level	Municipal level	Study reports	Cost benefit analyses
2002		1. National Parliament, 2003–2004, 29,200 A, no. 24. 2. National Parliament, 2002–2003, 28,600 A, no. 43.	3. Province of North-Holland (2001) Nota PS Commissie Plannen van aanpak Prioritaire UNA-Projecten. 29 November. 4. Province of North-Holland (2001) Plannen van Aanpak Prioritaire UNA-projecten, 28 November, Diction no. 89.	5. Municipality of Amsterdam (2001) Variantkeuze in het kader van Trajectnota/MER voor de Grote Sluis, gelegen ten zuiden van de huidige Noordersluis. 11 December. Diction no. 000008915. 6. Municipality of Amsterdam (2001) Raadsvergadering 14 November. Minutes no. 000008713.	7. RWS (2001). Trajectnota/MER Zeepoort IJmond. Den Haag: Opmeer Drukkerij bv.	8. CPB (2001) Analyze zeetoegang Noordzeekanaalgebied: een second opinion.
2005		9. National Parliament, 2005–2006, 30,300 A, no. 17.				10. CPB (2005) Kosten-batenanalyse Zeetoegang IJmuiden, een second opinion. 11. SEO (2004) Kosten-batenanalyse Zeetoegang IJmuiden.
2007		12. National Parliament, 2006–2007, 29,862, no. 8. 13. National Parliament, 2006–2007, 29,644, no. 74, appendix 2.				14. CPB (2007). Zeetoegang IJmuiden, tussentijdse visie. Den Haag: Centraal Planbureau.
2009–10	15. Covenant Ministry of Transport and Water, Province of North-Holland, Municipality of	16. National Parliament, 2009–2010, 32,123 A, no. 80. 17. Rijkswaterstaat		18 + 19. Municipality of Amsterdam (2010) Instemmen met het convenant planstudiefase	23. RWS and Witteveen + Bos (2008) MIRT-Verkenning Zeetoegang IJmond. Main	24. CPB (2008) Second opinion kKBA rapportage in de MIRT-Verkenning Zeetoegang IJmond, 28 November. 25. Rijkswaterstaat North-

	Amsterdam (2009) "Planstudie fase Zeetoegang IJmond", 24 November.	(2010) Letter of assignment MIRT Planning study Sea Access IJmond, 26 May.		Zeetoegang IJmond en beschikbaar stellen van een bedrag voor de realisatie van de Nieuwe Zeesluis; Council decision and council diction no. 76, 2010: and appendices: 20. Municipality of Amsterdam (2010) letter of alderman Ossel to the city council (2010) 'Covenant planning study Seaport IJmond', 22 January. 21 + 22. Municipality of Amsterdam (2010) letter of Mr. Jacobs (2009) "Discussion sea sluice IJmuiden", 12 January; and response Deloitte to letter Mr. Jacobs (2010) 'discussion sea sluice IJmuiden', 15 January.	report. Document ref.: RW1664–10/dijw/084.	Holland and Witteveen +Bos (2008) MIRT-Verkenning Zeetoegang IJmond. Achtergrond report kKBA. Document ref.: RW1664–10/dijw/078.
2012		26 + 27. Ministry of Infrastructure and Environment (2012) Letter to Province of North-Holland 'agreements between national government and province for the spatial integration of a new sea sluice in the sea access of Ijmond', 7 June. Document Feature 2012/108924; and response of Province of North-Holland (2012), letter with feature 59,909. 28 + 29. Ministry of Infrastructure and Environment (2012) Letter to Municipality of Amsterdam 'preference decision Sea Access IJmond',	30. Council diction no. 68. Province of North-Holland (2012) 'vaststellen startnotitie Provinciaal Inpassingsplan (PIP) Zeetoegang IJmond, August 6. 31 + 32. Province of North-Holland (2012) Decision list and Minutes of Provincial Council Meeting 24 September. 33. Province of North-Holland (2012) Startnotitie PIP Zeetoegang IJmond, August.	34 + 35. Municipality of Amsterdam (2012) Instemmen met het eerste 'go/no go'-besluit over de voorkeursvariant en het ingaan van fase 2 van de planstudie inzake het Project Zeetoegang IJmond, 11 and 12 July. Council diction and decision no. 533.	36. Rijkswaterstaat (2012) Notitie Reikwijdte en Detailniveau MER Inpassingsplan Zeetoegang IJmond, document no. MD-AF20121208/MR, 5 July. 37. Rijkswaterstaat (2012) Milieutoets Planstudie Nieuwe Zeesluis IJmuiden – fase 1, April, Document no. WPMIL-20111128-CME-01. 38. Rijkswaterstaat (2012) Proof of concept. Planstudie Nieuwe Zeesluis IJmuiden – fase 1, 12 March, Document no. WPPoC-20,111,215-EBR-01. 39. Rijkswaterstaat (2012) Final report. Planstudie Nieuwe	43. CPB opinion report: CPB (2012). Second opinion KBA Zeetoegang IJmond, 28 March, Den Haag: Centraal Planbureau. 44. Rijkswaterstaat (2012) Maatschappelijke Kosten Batenanalyse Zeetoegang IJmond. Planstudie fase 1 Zeetoegang IJmond. Document no.: WPMKBA-20120216-SRI-02, 16 February. 45. S. Newton, Y. Kawabata, R. Smith, N. in 't Veld (2012) Netherlands Port Traffic Forecasts and Capacity Planning. Zoe Termeer: NEA. 46. Commissie voor de Milieueffectrapportage (2012) Zeetoegang IJmond Toetsingsadvies over de Milieutoets, 20 March, Document no. 2525–138. 47. Dynamar B.V. (2011) Toetsing Goederenstroomprognose

		13 June. Document feature 2012/112984; and response of Municipality of Amsterdam (2012), letter with feature ZD2012–002959.			Zeesluis IJmuiden – fase 1, 21 May, Document no. WPEI-20120103-MVB-01. 40. DHV/Province of North-Holland (2011) Optimale benutting bestaand havengebied Noordzeekanaal. December. 41. Municipality of Amsterdam (2008) Slimme Haven. Port Vision 2008–2020, 19 November. 42. Ministry of Infrastructure and Environment/ Policy Research Corporation (2012) Roadmap Noordersluis.	2020–2040. Noordzeekanaalgebied achter de zeesluis, April.
2014–15	48. Administrative agreement: Ministry of Infrastructure and Environment, National Government, Province of North-Holland, Municipality of Amsterdam (2014). Bestuurlijke overeenkomst zeetoegang IJmond, 11 December	49. National Parliament, 2014–2015, 34,000 A, nr. 49. 50. Rijkswaterstaat (2014) Letter Opdracht realisatie Zeetoegang IJmond, 4 September.	51. Council diction no. 69. Province of North-Holland (2014) Zeetoegang IJmond, 22 September. 52 + 53. Province of North-Holland (2014) Decision list and Minutes Provincial Council 22 September 2014.	54–61. Municipality of Amsterdam (2014). Instemmen met een definitief go-besluit tbv het rijksproject Zeetoegang IJmond, 26 November. Council diction and decision no. 302/1117. Including council motions no. 1156–1161.	62. Rijkswaterstaat (2014) Milieueffectrapport Zeetoegang IJmond, 17 January, document no. MD-AF20140072/PO. 63. Rijkswaterstaat (2014) Bijlage Provinciaal Inpassingsplan Waterkering Zeetoegang IJmond, 18 July. 64. Royal Haskoning (2014) Inpassingsplan Zeetoegang IJmond planstudie Zeetoegang fase 2 - ter vaststelling. 20 August, Document no.: BB1189104115.	Part of Municipal decision 2014 (business case)
Additional documents referred to in manuscript		65. National parliament 2006–2007, h.tk. 233–268 and 294–351. 67. National parliament, 2000–2001, 27,408, no. 2. 68. National parliament, 2011–2012, appendix no. 3243.		66. Municipality of Amsterdam, 2001, document no. 00000110		

Appendix D. Code book Atlas.ti

Case IJmuiden
1. Actors
European Union
Municipality of Amsterdam
National government/Ministry
National Water Authority (Rijkswaterstaat)
Port of Amsterdam
Province of North-Holland
Document or interview of actor
Document / interview of Municipality of Amsterdam
Document / interview of national government/Ministry
Document / interview of National Water Authority
Document / interview of Port of Amsterdam
Document / interview of Province of North-Holland
2. Multiple streams
Stream problems
Problem St: Cope with climate change
Problem St: Cope with disrupting events
Problem St: Problem of multiple future challenges
Problem St: Functional end-of-lifetime challenge due to changed or already changing functional demands
Problem St: Technical end-of-lifetime and replacement task
Problem St: Technical future developments, growth of sea ships
Problem St: Economic future developments, market growth
Problem St: Spatial future developments: development of North Sea Canal area
Problem St: Focusing event
Problem St: Sustainability transitions
Stream politics
Politics St: Focus on current national mood
Politics St: Focus on current or currently changing situation
Politics St: Focus on immediate impact or short-term need
Politics St: Focus on long-term developments and needs
Politics St: Willingness to take decisions despite incomplete information and/or uncertainties
Politics St: Focus on < 10 years
Politics St: Focus on long-term vision and goals
Stream solutions
Solution St: 0-alternative maintain existing lock
Solution St: 0 + alternative capacity management
Solution St: 1-alternative lightening, deepening gutter
Solution St: Replacing lock for Middle or North lock
Solution St: Short-term measures decrease certain sea transport types
Solution St: 60m lock
Solution St: 65m lock
Solution St: 70m lock
Solution St: Large new lock
Solution St: Climate change is part of solution
Choice opportunity stream
C.O. stream: Assessment framework Nat Government for large investments in sea ports
C.O. Stream: Long-term orientation in Multi-Annual Infrastructure Plan or yearly budget round
C.O. Stream: Mildly positive support for decision based on expert opinion, cost benefit analysis
C.O. Stream: Negative support for decision based on expert opinion, cost benefit analysis
C.O. Stream: Neutral support for decision based on expert opinion, cost benefit analysis
C.O. Stream: Positive support for decision based on expert opinion, cost benefit analysis
C.O. stream: Process innovations
C.O. Stream: Positive cooperation between actors
Crucial decisions
Decision 2002 delay and co-financing
Decision 2005 end of planning phase
Decision 2007 start of exploration phase
Decision 2009–2010 Proof of Concept and covenant
Decision 2012 market orientation and detailed study
Decision 2014–2015 administrative agreement and spatial integration
3. Forward looking (FWL)
FWL problem definition
FWL Future developments

FWL FD Climate Change
FWL FD Economy and Market develop
FWL FD Spatial-Demographic trends
FWL FD Technology
FWL Time horizon
FWL Time horizon of < 10 years
FWL Time horizon of > 10– < 25 years
FWL Time horizon of > 25– < 50 years
FWL Time horizon of > 50 years
FWL robustness of solution
FWL Rob Experiments and pilots
FWL Rob Solution tested with scenarios
FWL flexibility of solution
FWL Adaptive iterative decision-making process
FWL Adaptive Monitoring
FWL Adaptive Solution can be adapted
FWL backcasting
FWL Future Goals
FWL Vision connected to
FWL Vision developed for
FWL forecasting
FWL Scenario & Prognoses
1 scenario
2 scenarios
3 scenarios
_ > 4 scenarios
`Extrapolation historic data
4. Short term
Short-term economic reasoning
Short-term process (c.o.) focus
Short-term technological reasoning
Short-term time horizon 0–5 years

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W.D. (Wieke) Pot, MSc. is a PhD Candidate at the Public Administration and Policy group at Wageningen University, the Netherlands. Her research addresses long-term decision making in public sector organizations, climate change adaptation, and investment decisions in end-of-lifetime infrastructure. After finishing her Master’s in Public Administration, she worked as a researcher at Wageningen University & Research and as a strategy consultant and manager, amongst others via Boer & Croon.

A. (Art) Dewulf is Associate Professor at the Public Administration and Policy group, Wageningen University & Research, the Netherlands. He studies complex problems of natural resource governance with a focus on the interactive processes of sensemaking and decision making in water and climate governance. He has published extensively on issue framing, decision making under uncertainty, governance of climate adaptation, the role of knowledge in decision making, and the governance of wicked problems.

G.R. (Robbert) Biesbroek is Assistant Professor at the Public Administration and Policy group, Wageningen University & Research, the Netherlands. His research includes causal mechanisms of complex decision making, dynamics of policy (dis)integration of cross-cutting societal issues, tracking policy change using big data tools and methods, and the political and bureaucratic responses to climate change adaptation. He has (co)authored over twenty scientific papers and currently serves as Editor for Regional Environmental Change.

M.J. (Maarten) van der Vlist has a joint appointment as special associate professor adaptive water management at Wageningen University, The Netherlands, and as a principle expert in adaptive water management at Rijkswaterstaat, The Netherlands. Rijkswaterstaat is currently the executive branch of the Ministry of Infrastructure and Environment. His research addresses adaptation to climate change of the spatial layout of areas, with special attention on the replacement of aging water management infrastructure.

C.J.A.M. (Catrien) Termeer is Chair of the Public Administration and Policy group at Wageningen University & Research, the Netherlands. Her research addresses the governance of wicked problems in the policy domains of sustainable agri-food systems, adaptation to climate change, and vital rural areas. Before, she worked at the Erasmus University of Rotterdam; Technical University of Delft; the Ministry of Agriculture, Nature, and Food; and Sioo, a Centre for Organizational Change and Learning. She has also served on the Advisory Council of Rijkswaterstaat.