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# Oxford Research Encyclopedia of Climate Science

## Governance Arrangements for the Adaptation to Climate Change

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### Summary and Keywords

Adaptation to climate change is not only a technical issue; above all, it is a matter of governance. Governance is more than government and includes the totality of interactions in which public as well as private actors participate, aiming to solve societal problems. Adaptation governance poses some specific, demanding challenges, such as the context of institutional fragmentation, as climate change involves almost all policy domains and governance levels; the persistent uncertainties about the nature and scale of risks and proposed solutions; and the need to make short-term policies based on long-term projections. Furthermore, adaptation is an emerging policy field with, at least for the time being, only weakly defined ambitions, responsibilities, procedures, routines, and solutions. Many scholars have already shown that complex problems, such as adaptation to climate change, cannot be solved in a straightforward way with actions taken by a hierarchic or monocentric form of governance. This raises the question of how to develop governance arrangements that contribute to realizing adaptation options and increasing the adaptive capacity of society. A series of seven basic elements have to be addressed in designing climate adaptation governance arrangements: the framing of the problem, the level(s) at which to act, the alignment across sectoral boundaries, the timing of the policies, the selection of policy instruments, the organization of the science-policy interface, and the most appropriate form of leadership. For each of these elements, this chapter suggests some tentative design principles. In addition to effectiveness and legitimacy, resilience is an important criterion for evaluating these arrangements. The development of governance arrangements is always context- and time-specific, and constrained by the formal and informal rules of existing institutions.

Keywords: climate governance, governance arrangements, adaptation to climate change, design principles

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## Introduction

This introduction section discusses the concept of adaptation to climate change and its increasing prominence on policy agendas across the globe. It argues that adaptation is not only a technical issue, but a governance issue, resulting in a huge growth of climate adaptation governance publications.

Global climate change is expected to increasingly lead to changes in weather conditions for decades to come and to seriously impact people, economic sectors, and regions throughout the world (Rockström et al., 2009; Field et al., 2014). Many of these impacts are visible already, such as increasing temperatures, rising sea levels, melting of glaciers, increasing drought, expansion of dry areas, and more frequent extreme weather (IPCC, 2014). Even if mitigation efforts are successful and greenhouse gas emissions are stabilized or radically reduced, harmful effects will continue to occur (Ford et al., 2013). The recognition of these risks results in a demand for adaptation: coping strategies to avoid, recover from, or benefit from these climate impacts (Biagini et al., 2014). Adaptation has become a core element of climate research and figures prominently in many policies, varying from the Paris Agreement (UNFCCC, 2015) to the Delhi climate change action plan (Hughes, 2013). The initial fear that adaptation would diminish the urgency for mitigation has receded because, amongst other things, reducing the rate as well as the magnitude of global warming may increase the time available for adaptation (Pielke et al., 2007). However, the opportunities to take advantage of positive synergies between adaptation and mitigation may decrease with time (IPCC, 2014; Dow et al., 2013).

Adaptation to climate change is a complicated concept, with various meanings (Bassett & Fogelman, 2013; Biagini et al., 2014; Dupuis & Knoepfel, 2013; Eriksen et al., 2015). Most scholars follow the Intergovernmental Panel on Climate Change (IPCC), which initially defined adaptation as adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC, 2001). In later reports, the IPCC emphasized that adaptation goes beyond infrastructural and technical adjustments only, and also involves enhancing the adaptive capacity of society to deal with unexpected and unpredictable future changes and vulnerabilities (IPCC, 2007). More recently and against the backdrop of discussions on adapting to temperatures of 4°C and beyond, transformational change has been introduced as an additional and necessary response, in particular in situations where the rate or extent of (projected) climate change may cause incremental forms of adaptation to be insufficient (Folke et al., 2010; Kates et al., 2012; Pelling et al., 2014; IPCC, 2012). Adaptation thus can consist of anything between incremental coping strategies and paradigmatic change, low-cost adjustments and expensive infrastructural investments, precautionary measures and end of pipe evacuation plans, and small experiments and

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large-scale forms of capacity building (Biagini et al., 2014; Kates et al., 2012; Lesnikowski et al., 2015; Termeer, Dewulf, & Biesbroek, 2016).

Although a great deal of this adaptation will result from autonomous (spontaneous) or self-governing actions of private actors, many aspects of adaptation will require collective action (Jordan & Huiteima, 2014; Mees et al., 2016). Dealing with adaptation is thus not only a technical issue, but above all a demanding matter of governance (Adger et al., 2009). Climate adaptation presents huge challenges to politicians and policymakers charged with the task of creating ways to avoid serious damage and harm for their citizens (Huiteima et al., 2016; Suykens et al., 2016). Many scholars have convincingly shown that complex climate problems cannot be solved in a straightforward way, with actions taken by governmental actors in a hierarchic or monocentric way (Duit & Galaz, 2008; Ostrom, 2010). It is an illusion that top-down steering by governments and intergovernmental organizations alone can address global problems (Hajer et al., 2015). Governing complex climate adaptation issues also means adopting a realist perspective, in which governance is considered a fragile activity, with labyrinths of struggles, with setbacks, reversals, and miscommunications, and with disagreements and power plays between interdependent actors (Biesbroek et al., 2014; Eriksen et al., 2015). This differs from the dominant portrayal of adaptation governance by both researchers and policymakers as “the purposeful efforts of selecting the best options to solve the problem of climate change impacts as effectively and efficiently as possible” (Biesbroek et al., 2014, p. 2).

Whereas mitigation is a firmly entrenched field of governance, adaptation to climate change is a relatively new topic on policy agendas throughout the world (Huiteima et al., 2016). In the academic field, there has been a growth in the number of publications on the governance of adaptation to climate change. This literature deals with many topics, including, but not limited to, policy innovation (Jordan & Huiteima, 2014), policy diffusion (Hakelberg, 2014), barriers to adaptation (Biesbroek et al., 2014; Dow et al., 2013; Eisenack et al., 2014), social contracts (Adger et al., 2009), adaptive capacity (Gupta et al., 2010; O’Brien, 2012; Pahl-Wostl, 2009), building of resilience (Olsson et al., 2014; Pelling et al., 2014; Tompkins & Adger, 2004), legal issues (Green et al., 2013), communication (Dessai et al., 2007; Moser, 2016), financing (Biagini et al., 2014), and evaluation and assessments (Doria et al., 2009; Haug et al., 2010; Lesnikowski et al., 2015).

Much of this literature is rather anecdotal, reflects poor relationships between theories and activities on the ground, and is difficult to translate into practical recommendations (Biagini et al., 2014). Meanwhile, governing climate adaptation requires governance actors to develop appropriate governance arrangements. This requires difficult choices to be made about: the framing of the problem; the level(s) at which to act; the alignment across sectoral boundaries; the timing of the policies; the selection of policy instruments; the organization of the science-policy interface; and the most appropriate form of leadership (Huiteima et al., 2016). In addition to effectiveness and legitimacy, resilience is an important criterion to guide the development and evaluation of governance arrangements (Termeer et al., 2011). Arrangements are legitimate if they ensure transparency,

accountability, fairness, and equity. Effectiveness means that they address the adaptation task decisively and efficiently through the right mix of strategies and tools. Resilience means that the governance arrangement itself is able to adapt to changing physical, socioeconomic, and political circumstances without losing its reliability. This chapter aims to identify design principles that take the particular complexities of climate adaptation into account, start from a realist perspective on governance, and elaborate on the various theoretical insights. The style of this chapter is theoretical and exploratory; however, to support and illustrate the argument, some examples of climate adaptation in the Netherlands, Germany, and the European Union (EU) are added.

## General and Specific Features of the Governance of Climate Adaptation

This section addresses the question if the governance of climate adaptation is new and thus requires new knowledge, or if it can elaborate on knowledge from other policy fields with similar governance challenges. It argues that climate adaptation does indeed show many general features of wicked problems and that the discourse is part of a broader governance research. In addition, adaptation to climate change poses four more some specific features, resulting in particularly demanding governing challenges.

### General Features of Wicked Problems

Because climate change exhibits many features of wicked problems (Rittel & Webber, 1973), it has been called a wicked problem par excellence (Jordan et al., 2010; Termeer et al., 2013). Wicked problems are hard to pin down because “the formulation of a wicked problem is the problem” (Rittel & Webber, 1973, p. 161). Disagreement on both goals and facts makes climate adaptation prone to controversies that inevitably result in power plays, as stakes are high (Hoppe, 2010). Because of their multi-dimensional and interconnected characteristics, “every wicked problem can be considered to be a symptom of another problem” (Rittel & Webber, 1973, p. 162). Adaptation measures can have unpredictable consequences because of the inherently incomplete understanding of problems, so that today’s solution can become tomorrow’s problems. Finally, wicked problems have no “stopping rule” (Rittel & Webber, 1973, p. 162). The problem of adaptation to climate change can never be resolved definitively, and actors can always try to do better. Because the benefits of adaptation can take a considerable amount of time to become evident, it is also very hard for actors to assess how much adaptation is good enough. What is more, adaptation strategies can result in unintended dynamics in other places, often triggering new problems.

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Governance of adaptation thus faces all the usual difficulties, hindrances, and opportunities involved in dealing with wicked problems. Consequently, adaptation governance can elaborate on emerging discourses and insights on the governance of wicked problems in general. In addition, climate adaptation poses some specific interrelated complexities: an emerging policy domain, fragmentation, deep uncertainties, and a long-term horizon (Davoudi et al., 2009; Haug et al., 2010; Huitema et al., 2016; Jordan et al., 2010; Termeer et al., 2011).

### **Specific Feature One: An Emerging Policy Domain**

Since the beginning of this century, the need for climate change adaptation has been debated at various national and international policy venues (Berrang-Ford et al., 2011; Biagini et al., 2014; Dupuis & Biesbroek, 2013). In 2005, Finland was the first country in the world to develop a comprehensive national adaptation strategy (Biesbroek et al., 2010). In comparison to many other policies, adaptation is a rather young and emerging policy field with, at least for the time being, only weakly defined ambitions, responsibilities, procedures, routines, solutions, and evaluation methods (Haug et al., 2010). The lack of a well-institutionalized policy domain creates both advantages and hindrances. Within this institutional void, policymakers have the opportunity to make certain basic choices (Huitema et al., 2016; Massey et al., 2015, Jordan et al., 2010). Which agency should be given the responsibility for climate adaptation policy? How should necessary behavioral change be enhanced? Do we need national, international, or locally formulated adaptation strategies, or all of these? However, these choices do not take place in an institutional vacuum. In general, most conventional governance institutions are poorly equipped to enable, or at least tolerate, new policy strategies (Head & Alford, 2015; Hendriks & Grin, 2007). This chapter assumes that this is especially true in the case of climate adaptation, because most governance institutions date back to a time when the climate issue was of hardly any importance (Gupta et al., 2010). New governance arrangements will inevitably face tensions with the formal and informal rules of existing institutions, protected by historically grown power relations (Driessen & van Rijswick, 2011).

### **Specific Feature Two: Fragmented Governance System**

Most governance systems are characterized by their polycentric nature; this refers to the fact that they consist of many centers of decision making that are formally independent of one another, make their own decisions, but do engage in mutual adjustment (Ostrom, 2010). Fragmentation arises because public and private agencies have developed various ways of managing collective goods at multiple scales (Ostrom, 2010). Because climate change potentially impacts upon a variety of physical and social systems that are heavily interconnected, the governance systems that deal with the consequences of climate change are possibly even more fragmented than their counterparts in other policy domains (Termeer et al., 2011). Climate adaptation governance affects many different

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domains as varied as water management, infrastructure, forestry, energy supply, spatial planning, tourism, agriculture, nature conservation, health, industry, and other economic activities. These domains all relate to different jurisdictional levels, policy sectors, and societal systems, which have particular interests, ways of addressing problems, and historically grown networks (May et al., 2006). Furthermore, both climate change impacts and adaptation policies trigger new interdependencies among these domains. For example, if a changing local climate pushes certain species to new territories, regional water management and national nature conservation policies may all be significantly affected. In turn, policies to tackle heat stress in cities may induce new linkages with urban planning and urban healthcare (Uittenbroek, 2014). A confounding complexity is that climate vulnerabilities are often not easily separable from economic or social vulnerabilities, and therefore need to be linked to other such domains (Tompkins & Adger, 2004). The resulting institutional fragmentation is too readily perceived as a negative context that hinders and delays concerted collective action (Edelenbos & Van Meerkerk, 2015; Ostrom, 2010). The key argument of authors who perceive fragmentation as negative is that fragmented governance structures will never be able to provide the capacity required to tackle such an important issue as climate change (Termeer et al., 2011). However, this multi-actor, multi-sector, and multilevel governance world forms the inescapable context for climate adaptation. Furthermore, and contrary to the view that the presence of multiple governmental units without a clear hierarchy is chaotic, research on polycentric systems has shown that they are very able to manage natural resources (Ostrom, 2010). Fragmented networks are also a fertile breeding ground for innovations and empowerment, and can provide the governance capacity to enable climate adaptation (Huiteima et al., 2011; Ostrom, 2010). Whereas fragmentation may thus increase the innovativeness and adaptive capacity of the system, too much (conflicting) fragmentation can result in bad performances (Biermann et al., 2009). Ostrom (2010, p. 25) therefore emphasizes that scholars need to analyze “how polycentric institutions help or hinder the innovativeness, learning, adapting, trustworthiness, levels of cooperation of participants, and the achievement of more effective, equitable, and sustainable outcomes at multiple scales.”

### Specific Feature Three: Inevitable Uncertainties

Decision making in relation to climate change is knowledge intensive. Without systematic observations and advanced mathematical models, awareness of climate change would be very limited. At the same time, important uncertainties persist about the nature and scale of risks and the effectiveness of solutions (Arvai et al., 2006). For example, the effort needed to adapt to a 4°C increase in global mean temperature would be significantly greater than that needed to adapt to lower magnitudes of temperature increase (IPCC, 2014). In addition, controversy is inevitable because the many actors involved bring with them a variety of perspectives to make sense of an issue like climate change where the stakes are high (Hulme, 2009). Climate change knowledge, because of its complexity and uncertainty, has a particular feature: as data and models are gathered and constructed mainly at global or, in some cases, at continental or national levels, applying these at the level of affected regions requires a huge effort that risks multiplying the uncertainties; this can lead to either overreaction or insufficient action. Both the uncertainties and the ambiguities ascribed to the climate change issue affect the perceived legitimacy of climate science and climate adaptation policy in particularly challenging ways. Scientific uncertainty does not necessarily prevent political action, but bad decisions can result when scientists or decision makers misunderstand the uncertainty with which they have to deal and underestimate the range of policy alternatives (Pielke, 2007).

### Specific Feature Four: The Long-Term Horizon

Although many impacts are already visible, in general climate change processes are, from a human perspective, very dispersed, slow, and long-term (Dewulf & Termeer, 2015). Long-term meteorological records and advanced climate models and scenarios are crucial for projecting possible future developments. As projections of climate change impacts reach further into the future, often decades or centuries ahead, the number of unknowns increases (Dessai et al., 2007). These deep uncertainties generate difficult dilemmas. On the one hand, it is necessary to anticipate future developments, which are (highly) uncertain. On the other hand, there are strong pressures to give priority to economic interests in the short term (Sheehan et al., 2008). A further complication is the different timeframes of physical, economic, and political processes, which are difficult to align and easily result in temporal mismatches (Cumming et al., 2006). Budgets for adaptation infrastructures, for example, are dependent on political decision-making cycles, which play out in a much shorter term than processes of climate change (Dewulf & Termeer, 2015). A large number of yearly policy cycles will occur before any climate impacts become visible and the effects of adaptation measures can be evaluated (Vink, Dewulf et al., 2013). Short-term interventions based on a long-term vision demand a specific and enduring commitment by taxpayers, politicians, or residents, and it is thus tempting for politicians to postpone difficult or expensive long-term decisions (Termeer et al., 2011). However, short-sighted decision making that emphasizes reducing short-term over long-term risks



may potentially increase vulnerability and therefore the costs associated with future adaptation efforts (IPCC, 2014; Berrang-Ford et al., 2011). In the case of adaptation tipping points, postponements of decisions can become very expensive and even disastrous (Huntington et al., 2012). Despite these risks, Huitema et al. (2016) conclude that many governance actors take a wait-and-see approach to climate adaptation issues.

## Towards Design Principles for Governance Arrangements

Having described the general and specific features of the governance of adaptation to climate change, this section turns to the question of the design of governance arrangements. First it defines the concepts of design, governing, and governance arrangements. It presents seven elements, that are crucial for designing governance arrangements. For each of these elements, this section summarizes the literature and suggests some tentative design principles.

Designing governance arrangements is a sensitive issue. This chapter follows Huitema et al. (2016), who nuance the concept of willful design by emphasizing that governance arrangements are often the emergent outcomes of complex political processes, rather than the result of a rational design, implicitly made by governance actors. Whereas Huitema et al. (2016) limit their analysis to important choices and their consequences, this chapter is seeking to further the discussion by suggesting tentative design principles.

Governing refers to “all those interactions and activities of social, political[,] and administrative actors that can be seen as purposeful efforts to guide, steer, control[,] or manage (sectors or facets of) societies” and governance refers to “the patterns that emerge from governing activities” (Kooiman, 1993, p. 2). More particularly, this chapter follows Dupuis and Biesbroek (2013, p. 1480), who define adaptation governance as

the process leading to the production of outputs in forms of activities and decisions taken by purposeful public and private actors at different administrative levels and in different sectors, which deals intentionally with climate change impacts, and whose outcomes attempt to substantially impact actor groups, sectors, or geographical areas that are vulnerable to climate change.

A governance arrangement is the ensemble of rules, processes, and instruments that structure these processes to realize collective goals for climate adaptation (Termeer et al., 2011).

A series of basic issues have to be addressed in designing climate adaptation governance arrangements: the framing of the problem, the levels of action, the timing of the policies, the alignment across sectoral boundaries, the selection of policy instruments, the

organization of the science-policy interface, and the most appropriate form of leadership (Haug et al., 2010; Huitema et al., 2016; Termeer et al., 2011).

### Element One: Framing the Problem

The first element relates to which problems to address and how to frame them. This issue addresses the specific problem feature of uncertainties and contested knowledge, as described in section two. Rather than being a single problem, climate change adaptation poses a confusing set of interrelated problems, resulting in competing framings of the issue (Dewulf, 2013; Hulme, 2009). The backgrounds of the different actors cause them to differ in their overall causal conception of climate change, their assessment of its seriousness and urgency, its risks and impacts at the geographical and political level concerned, the burdens and benefits it may cause, and the normative and political questions of how to legitimately pool or allocate these risks, burdens, and benefits. Actors often engage in struggles to frame climate adaptation as problems that suit their pre-existing political interests or policy competences (Jordan et al., 2010). This process of framing involves an interplay between *puzzling*—to develop plausible storylines and solutions—and *powering*—to decide whose frames are most relevant (Hoppe, 2010; Vink, Dewulf et al., 2013).

Climate adaptation is framed in various different ways, such as a risk minimization problem, a capacity-building problem, a way to take advantage of new climatic conditions, and an issue of equity and justice (Massey et al., 2015; Huitema et al., 2016). A good frame helps to focus, but also to activate the right people, to prevent exclusion, and to overcome controversies. Emphasizing the enormous challenges of climate change can overwhelm people and may result in actors drawing back and reverting to defensive strategies (see Rittel & Webber, 1973; Vink, 2015). The adoption of a climate-centered angle in the problem framing leads to greater chances of attention and commitment problems in the policy cycle (Dupuis & Knoepfel, 2013). To prevent this risk of failure, the Dutch Delta Program, for example, successfully reframed the issue of climate-proofing the Netherlands as one of economic prosperity in relation to flood safety, omitting the term climate change from their press release altogether (Vink, Boezeman et al., 2013). This frame was able to attract and activate both left- and right-wing policymakers.

In general, governance arrangements that organize room for reflexivity are better able to appreciate and deal with multiple frames and to avoid the risk of tunnel vision and intractable controversies between powerful players (Termeer, Dewulf, Karlsson-Vinkhuyzen et al., 2016). It is preferable not to settle on a fixed problem definition, because allowing for ambiguity may encourage a variety of actors to join in. The absence of a definition of adaptation and vulnerability in the UN Framework Convention on Climate Change (UNFCCC) agreements, for example, resulted in more parties participating (Moore, 2012). Also, the consensus frame in the EU adaptation policies leaves member states lots of room to develop their national strategies in the way they deem necessary

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(Keessen, 2014; Termeer, Dewulf, Karlsson-Vinkhuyzen et al., 2016). However, too much abstract, ambiguously understood, technical depoliticized framing may result in a bystander effect (Vink, 2015).

### Element Two: The Levels of Action

The second element of governance arrangements involves the choice of level(s) at which to act. The archetypical issue is finding the right fit between the scale of a problem and the scale at which it is governed (Cash et al., 2003). Given the context of a fragmented polycentric system however, addressing cross-level issues and enhancing a vertical interplay between different levels of governance is also crucial (Young, 2002).

Whereas climate mitigation puts the global and the national level center stage, climate adaptation is a typical multilevel governance challenge that needs connections across scales (Adger, 2001). The variety of local conditions and impacts points towards a prime role for local authorities and regions in climate change adaptation, but the scale of impacts and mutual interdependencies require national or international responses as well (Jordan et al., 2010). Because many adaptation policies are embedded in international agreements of the UN Framework Convention on Climate Change and the European Union's adaptation strategy, in practice the key choices left for parties and member states are about the roles of national, regional, and local governments (Massey et al., 2015). Obviously, the choice of level(s) at which to act has far-reaching consequences in terms of responsibilities and inclusions or exclusions of actors, and thus power positions (Van Lieshout et al., 2014).

In order to avoid a mismatch between the scale of a problem and the scale at which it is governed, a lot of attention has to be given to the search for an optimal level (Cash et al., 2006). However, an optimal fit from a technical point of view often neglects: the formal and political reality of decision procedures; the lack of support from uninvolved levels or from levels that become involved too late; or the importance of scale dynamics (Cash et al., 2006; Newig & Fritsch, 2009; Young, 2002). Moreover, the question of whether certain adaptation issues are a local, regional, or international problem is not pre-given and the result of framing, including the inherent power play (Van Lieshout et al., 2014). Matching the scale of the problem with the scale of governance thus requires sensitivity to scale dynamics and scale frames (Dewulf & Termeer, 2015).

The multilevel approach starts from the idea that governance actions may be required at several levels simultaneously instead of focusing on "the one right level" (Verkerk et al., 2015). Governance actors must operate at multiple levels in order to capture variations in both the impacts of climate adaptation as policy outcomes and externalities (Hooghe & Marks, 2003). The main choice addresses the issue of interplay between levels (Young, 2002). For example, a climate adaptation strategy developed at a local level may be less effective if it neglects or even hinders adaptation strategies at other levels (Moss &

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Newig, 2010). Various structures and processes, or bridging mechanisms, are suggested to manage collaboration and coordination across levels (Gilissen et al., 2016; Isett et al., 2011; Provan et al., 2007). Synchronization—also known as mutual adjustment in the literature on polycentric governance—goes beyond orchestrated interplay and starts from the often assumed self-organizing quality of governance processes (Jaworski, 1996). Synchronization arises when actors at different levels give meaning to their processes in relation to the “whole” governance context and, based upon that, position their actions in such a way that they attune to other actions and strengthen one another (Verkerk et al., 2015; Van Buuren et al., 2010; Teisman & Edelenbos, 2011). Boundary actors are crucial in these synchronization processes, as well as specific interventions at junctures when specific issues hinder synergy (Verkerk et al., 2015).

### Element Three: The Timing of Policies

The third element involves the choice of when and in what sequence to act. In spite of inherent long-term uncertainties, decisions about adaptation strategies need to be taken or prepared now (Burton et al., 2007). An important choice, therefore, is whether to act in a more precautionary manner or wait for more scientific evidence about the impacts of climate change or the projected harm (Driessen & van Rijswijk, 2011; Jordan et al., 2010). Whereas too late responses may cause irrecoverable problems, too early responses risk lock-ins (the impossibility of moving away from a particular adaptation strategy that proves to be maladaptive) or regrets (the political and financial costs of having to move to another policy option; Dewulf & Termeer, 2015).

To prevent lock-ins or regrets, many scholars suggest robustness and flexibility as design principles to enhance resilience (Haasnoot et al., 2013; Pahl-Wostl, 2009; Olsson et al., 2014). Robust measures can be defined as those interventions that maintain performance under a different range of plausible future scenarios. This does not mean that measures are developed assuming the most likely or the worst-case scenario, but that they do account for uncertainties by continuing to rely on multiple possible future scenarios. Strategies are flexible if it is possible to intensify or adjust measures when needed and thus can be adapted to new developments or knowledge over time. If deliberate attention is paid to robustness and flexibility, the long-term perspective can be brought into short-term decision making (Dewulf & Termeer, 2015).

Forward-looking policymaking may also result in a deliberate decision to postpone measures and keep options open. Although a wise strategy in certain circumstances, it involves the political risk of losing momentum. If crises like flooding or intensive periods of drought elevate climate adaptation to the top of the media agenda, the pressure increases on politics to take action (True et al., 2007). However, this momentum does not last forever, and opportunities to develop new policies must be cherished before this window of opportunity closes. In “normal” times, it is tempting for politicians to postpone difficult or expensive long-term decisions. The Dutch Delta Fund is an interesting

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example of how to overcome this dilemma (Dewulf & Termeer, 2015; Vink, 2015). At a time when climate adaptation was high on the political agenda, the Dutch government installed an independent Delta Fund. This fund is a solid foundation with a fixed annual budget up to 2028 that secures sufficient financial resources to be able to invest in projects for climate-proofing the Netherlands.

### Element Four: The Alignment Across Sectoral Boundaries

The fourth element involves alignment across sectoral boundaries. This element addresses the challenge that the governance systems to deal with the consequences of climate change are highly fragmented, as described in section two. Many adaptation measures need to be addressed and implemented in policy sectors that are not primarily driven by climate adaptation concerns and interests, such as water management, environmental management, nature conservation, health, agriculture, or housing. Adaptation to climate change is a typical cross-cutting policy issue. It is an ongoing debate whether it is more effective to incorporate adaptation measures within existing policy domains and strategies, or whether a separate policy domain of climate adaptation is necessary (Kok & de Coninck, 2007; Massey & Huitema, 2013). Uittenbroek (2014) suggests that positioning adaptation as a separate domain is useful for organizing attention and support, whereas incorporating, integrating, or mainstreaming adaptation measures within existing policy sectors is effective in the stages of decision making, implementation, and enforcement. The European Union started by mainstreaming adaptation in other policy fields, and specific legislation for climate adaptation may be developed if the mainstreaming approach does not appear to be successful. A related question is whether adaptation programs can best be organized as bypasses of existing bureaucracies or whether they have to be structurally anchored and embedded within existing sectors. Plausible arguments can be made for either of these.

In the case of incorporation, the challenge is to develop arrangements that bring actors, issues, and sectors together to realize creative climate adaptation options that do justice to different values, interests, and motives (May et al., 2006). Here, the main choice is often presented as between mandatory mainstreaming or more bottom-up collaboration (Huitema et al., 2016). It is important to note that the effects of fragmentation, especially the lack of inter-policy connections, are not limited to policymaking processes about climate adaptation strategies, but also strongly affect implementation practices (Dupuis & Knoepfel, 2013). The realization of many climate adaptation strategies will, for example, lead to land-use claims, which can be accommodated more easily if they are integrated with existing land use or linked to other land-use claims. For instance, the development of special areas for water retention in cities is more easily achieved when those areas are designed as multi-functional city squares that creatively integrate water retention strategies with landscaping and more recreational facilities (Termeer et al., 2011). Advanced modes of process management are required to organize cross-boundary interactions to develop multi-functional plans in pillared governance systems.

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Collaborative advantage is very time- and resource-intensive, and the advice for practitioners is to strive for this only when the goals are well worth it (Huxham & Vangen, 2004; Van Broekhoven et al., 2015). Moreover, too much emphasis on connecting climate adaptation to other policy agendas can harm its legitimacy (Van Buuren et al., 2014).

Candel and Biesbroek (2016) suggest that policy integration is not a fixed outcome but a dynamic process. The level of integration can vary in terms of: the broadness of the problem frames, the range of policy sectors involved, the density of boundary-spanning interactions, the coherence of policy goals, the mutual consistency of policy instruments, the presence of overarching ambitions, and the scope of coordination instruments (Candel & Biesbroek, 2016). The value of lower degrees of integration should not be underestimated, as these may sometimes be the most feasible or appropriate for the cross-cutting climate adaptation problem (Candel & Biesbroek, 2016; Gilissen et al., 2016). Van Broekhoven et al. (2015) also emphasized that policymakers must not try to connect everything to everything. In addition to spanning boundaries, it is also important to cherish boundaries in terms of responsibility and accountability. Clear demarcations can help to create a sense of order that facilitates decision making and implementation. A clear allocation of responsibilities helps to get adaptation planning and action off the ground (Mees, 2016).

### Element Five: The Selection of Policy Instruments

The fifth element involves the selection of policy instruments to influence the behavior of citizens or firms in a certain direction or to increase the adaptive capacity of society. Jordan et al. (2010) identify possible packages: hierarchical governance imposing a set of enforceable norms through the instrument of regulation, market-based governance allowing for the dissemination of norms via economic instruments, or relying on network-based modes in which communications and trust-based incentives play a more important role.

In general, a tailor-made mix of policy instruments, attuned to the specific context of a particular climate adaptation issue, is most appropriate (Howlett & Rayner, 2007). Modes of climate adaptation governance tend to vary across policy stages, so that different modes coexist for a particular adaptation issue/measure (Mees et al., 2014). A combination that is often found is hierarchical steering in the early stages and market or network steering in the implementation stages. There are, however, also many adaptation policies that just start with informal network approaches and end up as formal laws. Mees et al.'s (2014) research also highlights the importance of combining policy instruments in climate adaptation to compensate for one another's weaknesses and to serve different target groups. An example of an effective combination is the use of a regulatory instrument (technical requirement) with an economic instrument (tax reduction). In Basel and Stuttgart, for example, such a combination has proved to induce massive green roof installations (Mees et al., 2013; Mees, 2016). Scholars must not forget that the choice of

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policy instruments is also rooted in ideological debates (Keessen et al., 2013). Despite the proven effectiveness of such combinations, liberal parties, for example, are more willing to apply economic instruments than issue new regulations.

Contractual agreements are an interesting alternative policy instrument. They offer a nice balance between voluntariness and regulation: partners are free to enter, but once they enter they are bound by the agreed rules within the agreement (Mees et al., 2014). Furthermore, they are very able to take account of the dynamic social complexity (multitude of public and private actors with different interests and values) and spatial diversity (climate impacts differ depending on varying levels of vulnerability) that characterize many local adaptation issues. Specific attention needs to be given to legal instruments that provide enough flexibility for an adaptive approach (Keessen et al., 2013).

An underlying dilemma involves the allocation of public and private responsibilities (Driessen & van Rijswick, 2011; Mees et al., 2013). Is adaptation typically a public responsibility of the state or a private responsibility that should be left partially or entirely to citizens? In general, a hierarchical arrangement with a large role for public authorities seems to be necessary in the early stages, in order to start the policymaking process (Mees, 2016). However, if firms and citizens expect the government to take care of them, they will not develop the preparedness or the learning capacity needed for times of crisis (Gupta et al., 2010). This moral-hazard dilemma challenges the development of instruments whereby private parties are encouraged to play a role in developing adaptation strategies (Termeer et al., 2011).

### Element Six: The Organization of the Science-Policy Interface

The sixth element involves the organization of the interface between science and policy. Decision making in relation to climate change is knowledge intensive. However, the science underpinning climate problems and adaptation strategies has increasingly become contested, in particular because opponents use scientific arguments too, interpret uncertainties differently, or exploit scientific disagreements (Boezeman et al., 2013). Pielke et al. (2007) even claim that society's ultimate success in responding to, and preparing for, climate change in the face of ongoing uncertainty depends on the renewed relation between climate scientists and policymakers.

The recognition is growing that the relation between science and policy is much more complex than originally assumed (Boezeman et al., 2013). The traditional role of science of "speaking truth to power" is being transformed into an argumentative policy analysis as "making sense together" (Hoppe, 2010). Cash et al. (2003) suggest that scientific advice is likely to be effective if relevant stakeholders perceive the knowledge as credible—meaning scientifically adequate, salient—meaning relevant and timely for decision makers, and legitimate—meaning acceptable to different stakeholders. Boundary organizations, joint fact-finding, and co-production are important notions for relating science and policy. Boundary organizations exist at the frontier of the two relatively different social worlds of politics and science, with definite lines of accountability to each. They involve actors from both sides and provide the opportunity for the creation of models or maps that help both parties to make sense of the situation (Guston, 2000). Boundary organizations can organize processes of joint fact-finding in which stakeholders work together to collectively identify critical scientific questions, scope their needs, commission studies from experts that all parties support and trust, and collectively receive and evaluate the results (Karl et al., 2007). They can also organize processes of co-production by facilitating the collaboration between science and policy and the creation of a combined scientific and social order (Jasanoff, 2004).

These forms of close collaboration can help to bridge the gap between policymakers and scientists, but also brings the danger of collusion; when there is not enough room for reflection, a climate of non-confrontation arises (Gray & Schrujjer, 2010). In the context of transformative change in particular, it may limit a critical appraisal of science itself (Kates et al., 2012; Pelling et al., 2014). A related risk is the lack of transparency vis-à-vis the outside world. As soon as actors become issue advocates without being explicit about it, the credibility and legitimacy of scientists and their knowledge become compromised (Hegger & Dieperink, 2014). Hence, a boundary organization needs to be clear about its roles, and others need to be explicit about their expectations of the organization (Hegger & Dieperink, 2014). Both the politicization of science and the scientization of politics must be avoided (Guston, 2000).



### Element Seven: The Appropriate Forms of Leadership

The final element involves the choice of leadership. Government officials, elected politicians, and private actors involved in practices of climate adaptation all face the challenge of enhancing coordination and cooperation across different problem frames, levels, sectors, time horizons, science-policy interfaces, and public-private spheres. The leadership literature focuses largely on the role of positional leaders; these are individuals who have a formal responsibility to lead an organization or group (Osborn & Hunt, 2007). Because fragmented systems lack leaders with formal control over all resources needed to implement adaptation measures, governance arrangements for climate adaptation should go beyond traditional, hierarchical conceptions of leadership. Allen et al. (1998) pointed to the specific features of what they termed sustainability leadership. Fragmented systems challenge leadership to take a leading role in connecting actors, issues, sectors, and scale levels to realize innovative climate adaptation options that accommodate different values, interests, and motives (Olsson et al., 2014). All that can never be done by a single leader (Chrislip, 2002).

More recent leadership research points to complexity leadership; this is in particular relevant for uncertain fragmented governance systems that require the capacity to adapt flexibly to uncertain future developments (Uhl-Bien et al., 2007; Osborn & Hunt, 2007). Scholars distinguish various leadership dynamics that are not connected to formal positions or fixed persons, and simultaneously occur at all levels of the governance system. Inspired by complexity leadership theory, Meijerink and Stiller (2013) distinguish between four functions of leadership, crucial for adaptation governance: administrative, adaptive, connective, and enabling. Administrative leadership aims to create order within an organization, for example by dividing tasks, allocating budgets, and monitoring task performance, and can be performed by positional leaders only. Adaptive leadership is about the development of new ideas and practices; this is often the result of group dynamics within an organization. Connective leadership aims to connect different levels of government, policy sectors, and public and private parties. Enabling leadership, which can be performed by both positional and non-positional leaders, aims to create the necessary conditions for innovation. Parties may demonstrate enabling leadership by convening parties, stimulating interactions, leaving room for parties to deviate from existing organizational routines, and managing the entanglement between informal and formal leadership networks.

In addition to administrative leadership, connective, enabling, and adaptive leadership is crucial for the development and implementation of new adaptation concepts (Meijerink & Stiller, 2013). One person may contribute to different leadership functions. Besides positional leaders, active citizens, representatives of NGOs, and entrepreneurial university researchers may fulfill important leadership functions (Meijerink & Stiller, 2013). Increased attention is paid to the role of local and regional leaders (Hjerpe & Storbjörk, 2016). Leadership challenges in bottom-up-initiated project initiatives are

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different from leadership challenges in government-led adaptation projects (Meijerink et al., 2015). Governmental leaders, for example, who initiate new adaptation projects may have good access to decision-making arenas but may face problems in mobilizing societal actors. On the other hand, active citizens or researchers are able to build new networks and generate innovative solutions to adaptation issues but face major challenges in integrating their newly developed ideas into formal policies (Chrislip, 2002). These parties sometimes invest a lot of time, energy, and resources in initiating new practices of climate change adaptation. Positional leaders may help such bottom-up initiatives by expressing support, arranging financial resources, giving the necessary room for innovation, or helping to translate newly developed ideas into formal policies (Stiller & Meijerink, 2016).

## Conclusions

Section three has synthesized the scientific literature on climate adaptation governance into seven elements for governance arrangements. Together, these seven elements result in a governance arrangement to deal with the general and specific features of adaptation to climate change. Table 1 summarizes the main challenges for each element and the related design principles. Furthermore, this section critically discusses the application of the suggested design principles. It argues that thinking about governance arrangements for adaptation to climate change implies thinking about these seven elements and making deliberate, context- and time-specific choices, constrained and/or enabled by existing institutions.

Table 1: Summary of Challenges and Design Principles

<b>Element of the Governance Arrangement</b>	<b>Main Challenges</b>	<b>Design Principles</b>
The framing of the problem	Dealing with a variety of conflicting problem frames Avoiding intractable controversies and bystander effects Awareness of puzzling and powering	Leave room for reflexivity Cherish ambiguity Avoid frames that are too overwhelming, too abstract, too one-dimensional, or too depoliticized
The level(s) at which to act		

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	<p>Organizing a fit between the scale of a problem and the scale at which it is governed</p> <p>Vertical interplay between different levels</p> <p>Sensitivity to the dynamics of scales and scale frames</p>	<p>A variety of scale arrangements</p> <p>Coordination processes and structures</p> <p>Synchronization</p> <p>Boundary actors</p>
The timing of the policies	<p>Deciding when to wait and when to act</p> <p>Including long-term projections in short-term decisions</p>	<p>Taking advantage of windows of opportunity</p> <p>Robust measures</p> <p>Flexible strategies</p>
The alignment across sectoral boundaries	<p>Deciding what to organize in separated climate adaptation programs and what to incorporate in sectors</p> <p>Organizing linkages and coherence between climate adaptation and sectoral policies</p> <p>Awareness of various dimensions and levels of integration</p>	<p>Balancing mandatory mainstreaming and bottom-up collaboration</p> <p>Boundary-spanning interactions</p> <p>Cherry picking</p> <p>Clear demarcation of sectoral boundaries and allocation of responsibilities</p>
The selection of policy instruments	<p>Developing packages of policy instruments (legal, economic, communicative) and governance modes (hierarchy, market, network)</p> <p>Allocation of public and private responsibilities</p> <p>Awareness of ideological debates regarding these selections</p>	<p>Stacking of modes of governance</p> <p>Smart mixes of policy instruments</p> <p>Activating citizen</p>

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<p>The organization of the science-policy interface</p>	<p>Organizing a renewed relation between climate scientists and policymakers Stakeholders must perceive knowledge as credible, salient, and legitimate Avoiding the politicization of science and the scientification of politics</p>	<p>Boundary arrangements Co-creation Joint fact-finding</p>
<p>The most appropriate form of leadership</p>	<p>Organizing leadership while nobody has formal control over all resources needed Connecting actors, issues, sectors, scale levels Accommodating different values, interests, and motives Enhancing adaptive capacity</p>	<p>Multiple leaders, varying from elected politicians to active citizens Ensuring administrative, connective, adaptive, and enabling leadership functions</p>

Applying this list of design principles requires modesty. It especially requires sensitivity to dilemmas, trade-offs, and changing conditions. As noted, choices of arrangements cannot be reduced to technocratic managerial decisions. Mostly, they are not the result of purposive and organized decision processes, but of emerging patterns and behaviors (Huiteima et al., 2016). Furthermore, these choices are always embedded within the formal and informal rules of existing institutions. New governance arrangements are almost always constrained by previous choices that have become institutionalized (Howlett & Rayner, 2007). Moreover, although there certainly are some generalities in how countries respond to climate risks, the administrative traditions of states still shape the particularities (Vink et al., 2015). It is for example interesting to analyze to what extent this list is applicable to adaptation in developing countries, that are characterized by different governance systems and limited resources.

Normative principles are an important element of these institutions. Besides the principles deducible from the UNFCCC and its implementation in domestic law, most states rely on legal principles of a more general kind, but which are also relevant for climate adaptation (Driessen & van Rijswijk, 2011). Choices regarding the various elements of the governance arrangements implicitly or explicitly touch upon a whole range of normative principles, such as the user-pays or polluter-pays principle, the non-

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shift principle, the precautionary principle, the right to be compensated when one suffers more than others from governmental measures, and the subsidiarity principle (Driessen & van Rijswick, 2011). Judgments on these issues are intimately tied to considerations of fairness, solidarity, proportionality, and legitimacy. These normative principles have been given limited attention, but there is a need to address and reconcile tensions between normative principles in order to develop policies that are perceived as fair (Keessen et al., 2013).

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