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Dynamic adaptive policy pathways: A method for crafting robust decisions for a deeply uncertain world

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ABSTRACT

A new paradigm for planning under conditions of deep uncertainty has emerged in the literature. According to this paradigm, a planner should create a strategic vision of the future, commit to short-term actions, and establish a framework to guide future actions. A plan that embodies these ideas allows for its dynamic adaptation over time to meet changing circumstances. We propose a method for decisionmaking under uncertain global and regional changes called 'Dynamic Adaptive Policy Pathways'. We base our approach on two complementary approaches for designing adaptive plans: 'Adaptive Policymaking' and 'Adaptation Pathways'. Adaptive Policymaking is a theoretical approach describing a planning process with different types of actions (e.g. 'mitigating actions' and 'hedging actions') and signposts to monitor to see if adaptation is needed. In contrast, Adaptation Pathways provides an analytical approach for exploring and sequencing a set of possible actions based on alternative external developments over time. We illustrate the Dynamic Adaptive Policy Pathways approach by producing an adaptive plan for long-term water management of the Rhine Delta in the Netherlands that takes into account the deep uncertainties about the future arising from social, political, technological, economic, and climate changes. The results suggest that it is worthwhile to further test and use the approach.

1. Introduction

Nowadays, decisionmakers face deep uncertainties about a myriad of external factors, such as climate change, population growth, new technologies, economic developments, and their impacts. Moreover, not only environmental conditions, but also societal perspectives and preferences may change over time, including stakeholders' interests and their evaluation of plans (Offermans, 2010; van der Brugge et al., 2005). Traditionally, decisionmakers in many policy domains, including water management, assume that the future can be predicted. They develop a static 'optimal' plan using a single 'most likely' future (often based on the extrapolation of trends) or a static 'robust' plan that will produce acceptable outcomes in most plausible future worlds (Dessai and Hulme, 2007; Dessai and Van der Sluijs, 2007; Hallegatte et al., 2012). However, if the future turns out to be different from the hypothesized future(s), the plan is likely to fail. McInerney et al. (2012) liken this to "dancing on the top of a needle". But, as the future unfolds policymakers learn and usually respond to the new situation by adapting their plans (*ad hoc*) to the new reality. Adaptation over the course of time is not only determined by what is known or anticipated at present, but also by what is experienced and learned as the future unfolds (Yohe, 1990) and by the policy responses to events (Haasnoot et al., 2012). Thus, policymaking becomes part of the storyline, and thereby an essential component of the total uncertainty – in fact, Hallegatte et al. (2012) include the adaptation of decisions over time in an updated definition of 'deep uncertainty'.

To address these deep uncertainties, a new planning paradigm has emerged. This paradigm holds that, in light of the deep uncertainties, one needs to design dynamic adaptive plans (Albrechts, 2004; de Neufville and Odoni, 2003; Haasnoot et al., 2011; Hallegatte, 2009; Hallegatte et al., 2012; Ranger et al., 2010; Schwartz and Trigeorgis, 2004; Swanson et al., 2010). Such plans contain a strategic vision of the future, commit to short-term actions, and establish a framework to guide future actions (Albrechts, 2004; Ranger et al., 2010). The seeds for this planning paradigm were planted almost a century ago. Dewey (1927) argued

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that policies should be treated as experiments, with the aim of promoting continual learning and adaptation in response to experience over time. Early applications of adaptive plans can be found in the field of environmental management (Holling, 1978; Lee, 1993; McLain and Lee, 1996), and involve the ability to change plans based on new experience and insights (Pahl-Wostl et al., 2007). Collingridge (1980) argues that, given ignorance about the possible side effects of technologies under development, one should strive for correctability of decisions, extensive monitoring of effects, and flexibility. Rosenhead (1990) and Rosenhead et al. (1972) presented flexibility, in terms of keeping options open, as an indicator to evaluate the robustness of strategies under uncertainty.

This planning paradigm, in one form or another, has been receiving increasing attention in various policy domains. Dynamic adaptive plans are being developed for water management of New York (Rosenzweig et al., 2011; Yohe and Leichenko, 2010), New Zealand (Lawrence and Manning, 2012), and the Rhine Delta (Delta Programme, 2011, 2012; Jeuken and Reeder, 2011; Roosjen et al., 2012), and have been developed for the Thames Estuary (Lowe et al., 2009; McGahey and Sayers, 2008; Reeder and Ranger, online; Sayers et al., 2012; Wilby and Keenan, 2012). Such applications are also arising in other fields (see Swanson and Bhadwal, 2009; Walker et al., 2010 for examples).

A large number of approaches and computational techniques exist to support decisionmaking under deep uncertainty (see e.g. Dessai and Van der Sluijs, 2007; Hallegatte et al., 2012; IISD, 2006; Metz et al., 2001; Swanson et al., 2010; Walker et al., accepted for an overview of a strand of approaches). With respect to approaches, the Thames2100 project used decision trees to analyze sequential decisions for preparing the Thames Estuary for future sea level rise. In the Netherlands, Real Options Analysis has been used to assess optimal costs and benefits of pathways for fresh water supply of the Southwestern Delta (van Rhee, 2011) and for studying how flexibility can be built into flood risk infrastructure (Gersonius et al., 2013). To show dependencies of choices for shipping, a decision tree has been used in the Dutch Delta Programme (Delta Programme, 2011). Roadmaps have been used to illustrate a sequence of actions in water management studies (e.g. for the lakes IJsselmeer (unpublished) and Volkerak Zoommeer (Projectteam Verkenning oplossingsrichtingen Volkerak-Zoommeer, 2003). The Backcasting approach aims at describing a desirable future, and then looking backwards from that future to the present to develop a pathway of actions needed to realize this future (Höjer and Mattsson, 2000; Lovins, 1976; Quist and Vergragt, 2006). Assumption-Based Planning begins with an existing plan and analyzes the critical assumptions in this plan (Dewar et al., 1993). It uses signposts to monitor the need for changes. Robust Decision Making is an approach that uses many computational experiments to create an ensemble of scenarios against which candidate actions are evaluated in order to develop robust actions (Groves and Lempert, 2007; Lempert et al., 2006). Several planning approaches consider reassessment and the ability to change policies based on new insights in a planning circle (Loucks and Van Beek, 2005; Pahl-Wostl, 2007; Ranger et al., 2010; Swanson et al., 2010; Willows and Connell, 2003). The Panel on America's Climate Choices (2010) refers to this as 'iterative risk management' that 'is a system for assessing risks, identifying options that are robust across a range of possible futures, and assessing and revising those choices as new information emerges.' Among the computational techniques are Scenario Discovery (Bryant and Lempert, 2010; Lempert and Groves, 2010), Exploratory Modeling and Analysis (Bankes, 1993; Bankes et al., 2013), and Info-Gap decision theory (Hall and Harvey, 2009; Korteling et al., 2012).

These approaches and computational techniques, although developed for different purposes, have been found valuable for designing adaptive policies (Bankes, 2002; Hall et al., 2012; Hallegatte et al., 2012; Hamarat et al., 2012; Lempert et al., 2000, 2002). They differ in terms of the concepts employed, and provide different kinds decision support information (Hall et al., 2012). Consequently, they have different strengths and limitations. This situation calls for research into comparing the various approaches and techniques, providing an understanding of their relative strengths and weaknesses, and identifying the contexts within which each of the approaches and techniques is most appropriately employed (Hall et al., 2012; Hallegatte et al., 2012; Ranger et al., 2010). In addition, we argue that it is worthwhile to assess the extent to which the different terminologies used signify real differences in the underlying concepts, for this can contribute to harmonizing the field.

In this article, we analyze two existing adaptive planning approaches and show how the employed concepts are partially overlapping and partially complementary, resulting in an integration of the two approaches. We look at *Adaptive Policymaking* (Kwakkel et al., 2010a; Walker et al., 2001) and *Adaptation Pathways* (Haasnoot et al., 2012). Adaptive Policymaking provides a stepwise approach for developing a basic plan, and contingency planning to adapt the basic plan to new information over time. Adaptation Pathways provide insight into the sequencing of actions over time, potential lock-ins, and path dependencies. An example of a family resemblance between concepts used by these two approaches is the concept of an *adaptation tipping point* (Kwadijk et al., 2010) used in Adaptation Pathways and the notion of a *trigger* from Adaptive Policymaking. An adaptation tipping point is the point at which a particular action is no longer adequate for meeting the plan's objectives. A new action is therefore necessary. A trigger specifies the conditions under which a pre-specified action to change the plan is to be taken.

A fundamental challenge in planning research is the assessment of the efficacy of new planning methods and concepts. The problem is pointedly summarized by Dewar et al. (1993, p. 58) "nothing done in the short term can 'prove' the efficacy of a planning methodology, nor can the monitoring, over time, of a single instance of a plan generated by that methodology, unless there is a competing parallel plan". With respect to how a planning concept is tested, the planning research literature tends to look toward controlled real world application (Dewar et al., 1993; Hansman et al., 2006; Straatemeier et al., 2010). However, analogous to other design sciences (Frey and Dym, 2006), the evaluation of a planning concept can also utilize other sources of evidence (Kwakkel and Van Der Pas, 2011; Kwakkel et al., 2012). Evidence can come from planning practice, from virtual worlds that represent the world of practice but are not the world of practice (Schön, 1983), and from theoretical considerations. In this paper, to assess the efficacy of the outlined integration of Adaptive Policymaking and Adaptation Pathways, we use such a virtual world in the form of applying the presented planning concepts to a real world decision problem currently faced by the Dutch National Government. This application serves to illustrate the concept, describes how it could be used to develop a dynamic adaptive plan, and offers a first source of evidence of its efficacy through a critical reflection on the application.

The paper ultimately proposes a method for decisionmaking under deep uncertainty called *Dynamic Adaptive Policy Pathways*, which is a combination of Adaptive Policymaking and Adaptation Pathways. We first provide short introductions to each of the underlying approaches, and then explore how the two approaches can be integrated into a single approach based on the strong elements of both to produce a dynamic adaptive plan. We demonstrate the approach by producing a dynamic adaptive plan for water management of the Rhine Delta region of the Netherlands that takes into account the deep uncertainties associated with global climate change.