Towards design principles for successful joint knowledge production, a reflection on Dutch regional climate change projects
Paper for the 2013 Tokyo Conference on Earth System Governance

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Keywords: typology; joint knowledge production; knowledge production for sustainable development; regional climate change adaptation; design principles

Abstract

In the domain of climate change adaptation we see various efforts at joint knowledge production (JNP) through intensive cooperation between scientists, policymakers and other actors. Regional climate change adaptation projects in The Netherlands form prominent examples of this. In literature and in practice, claims have been made that joint knowledge production provides a useful way to reconcile supply and demand for knowledge. However, there is a lack of systematic empirical studies on how to successfully 'do' this. Existing research is restricted to conceptual analyses and fragmented empirical studies. This paper, on the contrary, aims to generate design principles. It does so by confronting a previously-developed assessment framework with empirical reality in six Dutch adaptation projects. Project documents were studied and 30 semi-structured interviews with researchers, policymakers and project financiers in the projects were held. Based on the comparison, the paper derives and elaborates upon two design principles for JNP. First, we have seen that the most successful projects managed to create some distance (a protected niche) for knowledge development, while at the same time establishing connections with ongoing policy processes. Successful JNP seems to be more likely in cases in which actors make a conscious decision for the institutional location of the project on the research-policy nexus, whereby the coordinating entity has some characteristics of a boundary organization. Second, specific resources, including facilities, boundary objects and specific competences increase the chance for success. In conclusion, the paper reflects on the external validity of the analysis and identifies next steps towards developing an empirical knowledge base for JNP.

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1. Introduction

Scientific knowledge is indispensable for governing climate change adaptation. As the introduction paper of this special issue rightly states, the relationship between climate science and adaptation policy is increasingly recognized to be complex. Conceptualisations portraying the domains of science and policy as two separate worlds with a 'gap to be bridged' in between are being substituted with new models emphasizing concepts such as science brokers, the science-policy interface, and boundary organizations. These models emphasize the 'hybrid' (Miller, 2001) character of science-policy interactions: through their very nature, exchanges between science and policy cannot be reduced to either science or policy; and science and policy are continuously being coproduced.

The current paper zooms in on a purposeful form of such science-policy coproduction. Several climate change adaptation programs in Western Europe (e.g. 'Climate Changes Spatial Planning', 'Living with Water' and 'Knowledge for Climate' in The Netherlands, or 'Klimzug' in Germany') include regional projects in which scientists and policymakers cooperate directly through joint knowledge production (JNP) (Edelenbos et al., 2011; Hegger et al., 2012a; Pohl et al., 2010; Regeer and Bunders, 2009; Van Buuren and Edelenbos, 2004). JNP (also called 'knowledge co-production' or 'co-creation') is said to lead to 'better, more policy relevant or more socially robust knowledge' (Climate Changes Spatial Planning, Arcadis, Brinkman Climate change, 2006; Climate Changes Spatial Planning and Knowledge for climate, 2009).

Literature suggests that JNP can lead to knowledge which actors could only, or only that easily, gain through direct cooperation (Climate Changes Spatial Planning and Knowledge for Climate, 2009; Hegger et al., submitted). There are also examples in which scientific knowledge played a role in the policy process (e.g. as co-developer of policy concepts) (Kemp and Rotmans, 2009). On the other hand, one can logically assume JNP to go 'wrong' from time to time, since well-known barriers against connection of science and policy may also occur in JNP projects. Research-based knowledge may fail to match expectations of policymakers, it may be used differently than was expected or intended, science is fragmented across disciplines, and the interaction between science and policy is complex due to differences in timeframes, reward structures, goals, process cycles and epistemologies (Sarewitz and Pielke, 2007; Van den Hove, 2007; Weichselgartner and Kasperson, 2010). The value pluralities and uncertainties associated with global change and sustainability problems may complicate things further (Hoppe, 2011; Kemp and Martens, 2007). In some cases, JNP projects may even risk becoming strategic or symbolic processes (Edelenbos et al., 2011). One can therefore expect some JNP projects to be more successful than others in meeting actors' demands for credible and salient knowledge that has been produced through a legitimate process (Hegger et al., 2012a).

There is a lack of comparative empirical assessments on 'how to do' JNP (Hegger et al., 2012a, but see: Kemp and Rotmans, 2009; Lang et al., 2012). This is understandable since empirical research into JNP practices is challenging. Researchers have to address complicated issues such as what should be normative criteria for determining the success of science-policy cooperation and how to actually measure this degree of success and associated success conditions. However, such empirical assessments of 'practices of hybrid management' (Miller, 2001) are needed to achieve 'reconciliation of supply and demand for knowledge' (McNie, 2007; Sarewitz and Pielke, 2007) in the field of global change adaptation and sustainability (Hoppe, 2011; Lang et al., 2012).

We assume that the 'success of JNP' can – at least partly – be explained by the way in which knowledge production processes are structured. To analyse this, we will conduct a comparative analysis of six Dutch adaptation projects within two recently finalized research programs, Climate Changes Spatial Planning (CCSP) and Living with Water (LWW), using a framework developed by Hegger et al. (2012a). They have conceptualised 'successful JNP' and derived seven success conditions from literature. A preliminary comparison of these projects was made in Hegger et al., 2012b, but without actually confronting the empirical findings with the theoretical success conditions. In the current paper, we will be asking ourselves i) how successful the analyzed projects were, ii) whether, to what extent and how the theoretical success conditions have been met, and iii) to what extent the latter could *explain* success or failure of projects. Our empirical material was collected through desk research combined with 30 semi-structured interviews with researchers, policymakers and program managers involved in the programs and projects. We expect this comparative empirical confrontation to result in empirically scrutinized design principles for JNP.

The outline of this paper is as follows. Section 2 depicts our analytical framework, specifying our notion of JNP, conceptualising 'successful JNP' and introducing the seven success conditions that have been derived from literature. Section 3 briefly introduces the researched programs and projects. Section 4 ranks the projects according to their degree of success. Section 5 aims to assess whether, to what extent and how the seven success were met in each project. Section 6 explores the degree to which success conditions may explain success. From this exploration we

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derive two design principles for JNP. The final section reflects on the external validity of the findings and identifies next research steps.

2. Conceptualising joint knowledge production (JNP), its success and success factors

2.1 Conceptual clarification

The term JNP refers to direct cooperation between scientists, policymakers (and sometimes other societal actors) in projects (see also: Edelenbos et al., 2011; Hegger et al., 2012a; Van Buuren and Edelenbos, 2004). It forms a manifestation of Mode 2 knowledge production (Gibbons et al., 1994; Nowotny et al., 2001) and Post Normal Science (Funtowicz and Ravetz, 1993) as well as a broader deliberative turn in environmental governance (Bäckstrand et al., 2010). JNP should be seen as a more direct and recognizable form of something that always takes place at least to some extent: co-evolution or co-production of science and society (Jasanoff, 2004; Latour, 1987).

2.2 Evaluating the success of JNP

Following Hegger et al. (2012a) we argue that JNP is best analysed through a constructivist approach (see also Edelenbos et al., 2012). First, actors involved in JNP projects will have different knowledge interests due to differences in affiliation (university department; public policy body) and personal backgrounds. Second, JNP projects generally involve value pluralities and uncertainties. For those reasons, we propose to focus on a process rather than an outcome evaluation, but assuming that a successful process forms a positive contribution to project outcomes (Hegger et al., 2012a). Hegger et al. (2012a: 54) have defined successful JNP as: 'A process in which the actors involved have managed to maximize synergy and minimize tradeoffs between the salience and credibility of the knowledge produced as well as the legitimacy of the process'.

The notions of credibility, salience and legitimacy were originally coined by Cash et al. (2003) who found that science-policy collaboration is likely effective if criteria for salience, credibility and legitimacy can be met simultaneously for all actors involved. Credibility relates to the scientific adequacy of technical evidence and arguments. Salience refers to the relevance of knowledge to the needs of decision makers. Legitimacy entails that knowledge development has been respectful of stakeholders' divergent values and beliefs, unbiased in its conduct and fair in its treatment of opposing views and interests (Cash et al., 2003:14). Hegger et al. (2012a) threat the three criteria in an *actor-specific* way, assuming that all actors have ideas on how credible and salient knowledge produced has been *for them*, and how legitimate a JNP project has been *according to them*. We will follow this way of operationalizing. We herewith expect to measure the degree to which actors' knowledge interests were met in the studied JNP projects and see the latter as an indicator for these projects' success.

2.3 Success conditions for JNP

Hegger et al. (2012a) have derived seven success conditions for JNP projects from literature. Inspired by the policy arrangements approach (Arts et al., 2006; Liefferink, 2006; Van Tatenhove et al., 2000) they distinguished between four analytical dimensions of JNP processes: actors, discourses, rules and resources. Theoretically each success condition for JNP would fit into one or more of these dimensions. Within each dimension, they denominated at least one success condition, expecting each condition to increase the chance for successful JNP. Table 1 gives an overview of the four dimensions and the seven success conditions. Thereafter, table 2 specifies the expected relationship between each success condition and credibility, salience and legitimacy.

Table 1: Seven expected success conditions for JNP projects (based on Hegger et al., 2012a:56-61)

Dimension	Success conditions
Actors	*1) Broadest possible actor coalition* The success of JNP is enhanced in cases in which the broadest possible coalition of actors is formed, within the practical and strategic limits present. This likely entails both in- and exclusion of actors.
Discourses	*2) Deliberation on goals and problem definitions takes place* The chance that JNP is successful is enhanced in cases in which participating actors deliberate on the nature and denomination of the policy problem (un-, moderately- or well-structured) and on the type of outcome (ideas, closure on problem definition, concepts, arguments or solutions) to be expected. *3) Recognition of differences in actor perspectives* Actors in JNP projects can be expected to have diverging and implicit perspectives on the world around them. The success of JNP will be enhanced if the different perspectives of stakeholders are recognised and taken into account. In this, boundary objects can play a mediating role.

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Rules	*4) Organized reflection on division of tasks by participating actors* The chance that JNP is successful is enhanced if actors decide, reflectively, which role to pursue in a project, how to define their identity in relation to these other actors and to make these choices known to them. *5) Role of researchers and their knowledge is clear* The chance that JNP is successful is enhanced in cases in which the role of researchers and their knowledge is clear. *6) Presence of innovations in reward structures* The chance that JNP is successful is enhanced through novel forms of reward structure.
Resources	7) Presence of specific resources such as boundary objects, facilities, organizational forms and competences The chance that JNP is successful is enhanced through the availability of specific resources (boundary objects, organizational forms and competences).

It has been shown that the developed framework can be used for analysing whether success conditions have been met and how they have been met (Hegger et al, submitted). However, further broadening of the empirical knowledge base for JNP is still necessary. Only after comparative analysis, one can explore the explanatory value of each success condition across several contexts. By looking for patterns across the projects, we hope to find generic design principles for JNP.

Table 2: Expected relationship between success conditions of JNP projects and the perceived credibility, salience and legitimacy of the knowledge produced (↑ positive; ↓ negative; ↓↑ ambiguous) (adapted from: Hegger et al., 2012a:61)

Dimension	Expected success condition	Credibility	Salience	Legitimacy
Actors	1) Broadest possible actor coalition	↑ through inclusion of place-based knowledge in science	↑ through inclusion of place-based knowledge in science ↓ due to large complexity	↑ through inclusion of various different perspectives in the knowledge production process ↓ due to the need to reconcile many different knowledge interests
Discourses	2) Deliberation on goals and problem definitions	↑ epistemological differences can be bridged	↑ Knowledge resonates with needs as perceived by policymakers and societal stakeholders	↑ Actors believe that the 'right' questions concerning the 'right' problem have been asked
	3) Recognition of differences in actor perspectives	↑ through inclusion of different forms of knowledge in science	↑ through inclusion of different forms of knowledge in science ↓ due to large complexity	↑ through inclusion of various different perspectives in the knowledge production process ↓ due to the need to reconcile many different knowledge interests
Rules	4) Organized reflection on division of tasks by participating actors	No straightforward relationship assumed	↑ due to synergetic task divisions	↑ due to mutual understanding of each others interests and explication of assumptions which would otherwise remain implicit
	5) Role of researchers and their knowledge is clear	↑ due to enhanced trust in researchers (no 'stealth issue advocacy')	↑ clear what contribution of scientific knowledge could be	↑ due to enhanced trust in researchers (no 'stealth issue advocacy')
	6) Presence of innovations in reward structures	No straightforward relationship as such, but willingness of actors to engage in JNP at all is likely enhanced		↑ since more actors are rewarded for their participation in co-production
Resources	7) Presence of specific resources	↑ due to enhanced mutual understanding on viewpoints and interests; learning each others language; intimate human relationships; more efficient information transfer		

3. Introducing the programs and projects

Table 3 characterizes the projects in terms of duration, budget, participants and stated goals. The first three projects received funding from the 'LWW' program (2005-2010), the last three from 'CCSP' (2004-2011). Both programmes were co-financed by the Dutch government (through the 'Economic Structure Enhancing or FES Fund') and by participating societal actors. The FES covered €22 million of the LWW program's budget, while the consortium partners co-financed another €28 million. The CCSP program received €40 million from the FES and €50 million from participating organizations and stakeholders. The LWW projects aimed to i) contribute to a transition from 'keeping down water' to 'accommodating water'; ii) intensify collaboration between technical and social scientists; and iii) strengthen knowledge infrastructures). The CCSP projects aimed to contribute to 'climate proofing'. This notion (Kabat et al., 2005) refers to developing and mainstreaming climate adaptation and mitigation measures; social innovation in risk management and coping strategies; and other technological, institutional and social innovations (Climate Changes

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Table 3: Characteristics of the selected projects (adapted from: Hegger et al., 2012b)

Project	Dura-tion	Budget in Euros	Participants (coordinator in bold)	Roles for scientific researchers	Goals stated in documents
What's the future of low-lying peat land?	2005-2009	3,250,000	Utrecht University; Research Institutes LEI and **Alterra**; Free University Amsterdam; three Ministries; three provinces; three Water Boards; various stakeholders, consultants; other actors.	Two PhD researchers within broad consortium.	Mapping out (ecological, economic, social) consequences of water management strategies in low-lying peat areas; developing new water management strategies.
Co-valuation of water	2006-2009	925,000	**Erasmus University Rotterdam**; research institute TNO; Province of Zeeland; Municipality of Middelburg; regional Water Board; Inhabitants of Arnemuiden; TAUW consultancy.	PhD researcher as main project executor.	Development of two integrated regional visions, supported by inhabitants, on an area near Arnemuiden, in which water plays a profound role.
Transitions Sustainable Urban Water manage-ment (SUW)	2005-2009	730,000	**Erasmus University Rotterdam**; research institutes for water and wastewater management (KWR/STOWA); municipalities of Heerhugowaard and Rotterdam; regional Water Boards; consultants.	PhD researcher as main executor.	Assessing the feasibility of concepts for more sustainable urban water management; analyzing the (potential for) socio-technical transitions needed to implement these concepts.
Hotspot Zuidplas-polder (ZPP)	2007-2008	NA	Wageningen University and Research Centre; VU University Amsterdam; **Province of Zuid-Holland**, regional Water Board; several consulting companies.	Two PhD researchers involved; project was 'a case' for them.	Assessing the climate resilience of development plans in Zuidplaspolder; developing climate proof designs; assessing the costs and benefits of adaptation options.
Hotspot Groningen	2008-2009	NA	Experts from Water Board; universities, research institutes and other organizations; **Province of Groningen**.	Workshops with many researchers.	Providing input to make the regional plan 'climate proof'.
Route-planner (co-executed by LWW and Habiforum)	2006-2007	NA	University researchers from three programs, Ministries of Economic Affairs; Housing, Spatial Planning and the Environment; Traffic and Water Management; **freelance coordinator.**	Different researchers involved in various roles.	Providing policymakers at the national level with state of the art insights from the three participating programs, getting input for a national adaptation strategy.

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Spatial Planning and Knowledge for Climate, 2009). Apart from more fundamental research projects (on climate scenarios, mitigation, and adaption) and knowledge integration and communication activities, the CCSP program has introduced the so-called hotspots. In specific areas such as the Zuidplaspolder and Groningen, scientists, policymakers and practitioners collaborated in practice-oriented research on climate-proofing. As table 3 illustrates, in all projects actors from science and public policy are represented, albeit in different roles. All project goals have been formulated in terms of the projects' societal relevance. In accordance with our criteria, the projects seem to be substantial in terms of duration and budget, but with some differences between the projects. Other differences concern the individual participants, the project goals and the type of coordinating actor (once a research institute, twice a university, twice a provincial entity, and once a freelance coordinator).

What table 3 does not show is that the projects also differ in the dynamics through which they have been initiated. The projects were more often initiated by the 'demand side' than by the 'supply side', contrary to the observation of Talwar et al. (2011), who found that, in Swiss sustainability research, virtually all transdisciplinary projects are science-driven. Nevertheless, issues were put on the agenda and projects were planned via various mutual interactions between scientists, policymakers and program managers. *Routeplanner* was the only 'purely policy-driven' project. The establishment of *What's the future of low-lying peat land?* by applied researchers was a reaction to knowledge needs articulated by national and regional policymakers. The *CCSP Hotspots* were set-up and coordinated by provinces but their participation was a reaction to the research program's funding opportunities. There were two more 'science-driven' projects. In *Transitions SUW*, scientists initiated research and sought collaboration with two municipalities (Rotterdam and Heerhugowaard) who provided the case studies. Both municipalities initially saw their role as 'facilitators of research'. At least in the case of Rotterdam, this changed when it was discovered that the researched concepts could provide economic opportunities. *Co-valuation of Water* was initiated by the Dutch applied research organization TNO and Erasmus University Rotterdam. These institutes sought collaboration with the local stakeholders and applied for funding from LWW.

4. Comparing the success of the projects

This section explores how the analysed projects 'score' in terms of actors' perceived *credibility*, *salience* and *legitimacy* of the outcomes.

4.1 Credibility

In most projects, *credibility* did not seem to be an issue of great concern (*Hotspot ZPP*, *What's the future of low-lying peat land*, *Transitions SUW* and *Routeplanner*). Actors' remarks on *credibility* were general in nature. For instance, it was frequently mentioned 'that practical knowledge enables researchers to do more credible research'. In *Co-valuation of Water* and *Hotspot Groningen*, however, serious criticisms were raised which can be interpreted as a lack of *credibility*. In *Co-valuation of Water*, an interviewee mentions 'that the developed visions were unrealistic and not well-supported'. In *Hotspot Groningen*, some interviewees criticize the project leader, describing him as a visionary person who – although he was officially a policy officer – was seen as a 'representative of science'. Two general observations can be made on the basis of this comparison. First, *credibility* only became an issue in cases in which there were 'dissidents' in the projects (value pluralities). Second, actors sometimes coupled (lack of) *credibility* of *knowledge* to the *credibility* of *persons*.

4.2 Salience

Actors had different criteria for the *salience* of knowledge. As we will show in this section, the projects differed widely in terms of the type of knowledge produced. What mattered, however, were not these differences *as such*, but the extent to which actors succeeded in *reconciling* their diverging knowledge interests. The interviewed researchers liked being involved in a practice-oriented project and deemed the implementation of sustainable concepts and visions important. However, they unanimously indicated that their main interest was to be able to publish. For most researchers, their project yielded enough publishable material, except one of the PhDs in *Hotspot ZPP* (no publications on the project) and one of the researchers in *Routeplanner* (who had wanted to publish more). For the researcher interviewed in *Hotspot Groningen*, the project's relative importance (in terms of time investment) was small, so it could only provide a small contribution to one publication. Most researchers were at the start of their career. For them it was important that the project provided job opportunities. We came across two examples in which job opportunities were generated. One researcher in *'What's the future of low-lying peat land'* found a new job through the project network. *Transitions SUW* resulted in the establishment of a spin-off company, Deltasync, specialized in floating

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Table 4: Some reported results of the analyzed projects

Project	Documents produced	Other output/outcomes	Illustrative interview quote
What's the future of low-lying peat land?	Two PhD theses (ecology; public administration, both in progress), several articles (some in progress); many project reports.	Platform for ongoing debate, development of COP; knowledge exchange via broad consortium meetings during project.	'People within the agricultural sector started to see that the problems in peat land areas are real (…) One of the farmers is still saying: 'you want to deprive us of the best soil'. My answer is always: '[that is the best soil] because the speed of soil subsidence is highest there'' (hydrologist).
Co-valuation of water	Two regional visions (not executed) based on participatory process with inhabitants; a PhD thesis; several reports and articles.	Knowledge on the merits and limitations of participatory processes.	'There were questions posed to the experts by people who did not understand what they were asking. A public administration scholar does not know what 'cubic meter per second' means (…) if you do not know that, you cannot talk to techies' (scientific project supervisor).
Transitions SUW	PhD thesis (boundary of civil engineering, transition management, water management); several articles.	Knowledge on feasibility of new concepts; application of some of them (floating pavilion in Rotterdam harbour).	'You have to make sure that all stakeholders, including your professor, are a bit satisfied. (…) that's your scope for action (…) the stakeholders put a lot of pressure on you and are not always satisfied. On the other hand, it can be functional to get critical feedback at the start (PhD researcher).
Hotspot ZPP	Reports on climate effects, climate resilient designs and societal cost-benefit analyses.	Bypass to the ongoing policy process; knowledge exchange via key persons; contribution to two PhD projects.	'You may have read a book (…) but that does not automatically imply that you can use the knowledge in the book (...) this only happens once you put people together and almost force them to start thinking beyond the short-term interest of their own organization (project leader).
Hotspot Groning-en	Various thematic reports (e.g. energy, agriculture, water supply etc.).	Advice for provincial government on regional climate resilience; agenda setting function for regional actors.	'Some space was left in the provincial plan to allow for using some of the project results. At a certain moment, however, the timing of the Hotspot lagged behind that of the regional planning process, making it more complicated to actually influence the plan' (project supervisor).
Route-planner	Various reports (a.o. on climate resilience, climate effects, knowledge gaps, evaluation of adaptation options); some journal articles and book chapters.	Providing insight to policymakers in consequences of climate change; introduction of concepts (e.g. robustness, resilience) to policymakers.	'Routeplanner and ARK [national adaptation program] were conducted in parallel. Sometimes knowledge exchange took place. You saw a clear distinction between those demanding and those supplying knowledge. [the two coordinators] often had to act as a knowledge broker, explaining things in a specific way, or act as spokesperson' (researcher).

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urbanization. Although it was not their primary interest, researchers in several projects (*What's the future of low-lying peat land*; *Hotspot ZPP*; *Routeplanner*) indicated that they valued the acquisition of practical knowledge. They learned about terminologies and about how policymaking works. One interviewee (*Routeplanner*) – with a natural science background – also learned 'to think in terms of actors rather than processes'. Policymakers and program managers deemed the applicability of the knowledge most important. The projects differed in the types of knowledge deemed applicable and actually produced. A first type of knowledge production observed is *agenda setting knowledge*. Policymakers in *Hotspot ZPP* became more aware of the importance of desiccation for the area. Various policymakers in *Groningen* started to think about the regional consequences of climate change. A reported result of *What's the future of low lying peat land* was 'that it is no longer possible to deny the existence of soil subsidence'. Second, in some projects *policy concepts* were developed. Policymakers portrayed *Routeplanner* as a knowledge dissemination project, familiarizing national level policymakers with such concepts as 'climate proofing', 'climate scenarios', 'uncertainties' and 'resilience'. The project also provided policymakers with a state-of-the-art of climate change knowledge. Third, some policymakers referred to the generation of *insights and ideas.* A policymaker in *Transitions SUW* claims to have learned most from the project's 'transitions part' which made him familiar with the role of actors in transitions, long-term thinking and thinking in terms of opportunities. According to several interviewees, *What's the future of low-lying peat land* contributed to the development of a nuanced and pragmatic plan for implementing a new policy concept *'Functie volgt peil'* (in which land-use functions depend upon the water level in certain areas rather than the other way round). Amongst other things, knowledge was developed on the strengths and weaknesses of underwater-drainage, a mitigation technology. Fourth, several projects provided *arguments* supporting and legitimizing ongoing planning processes. In *Hotspot ZPP*, scientific underpinning of existing plans and approaches – a.o. the so-called 'layer approach', a relatively new Dutch spatial planning principle – was generated, reducing controversies. The project also legitimized the plans for building in Zuidplaspolder. Fifth, policymakers referred to the identification of *economic opportunities*. This was the case in *Transitions SUW* (Rotterdam municipality). Sixth, especially actors at program level deem the development of *process-related knowl*edge important (e.g. in *Hotspot ZPP*, *CCSP*'s first hotspot).

Two projects differ negatively from the others: *Co-valuation of Water* and *Hotspot Groningen*. Actors involved perceived the quantity of 'relevant knowledge' produced to be relatively low. Worse, actors did not manage to reconcile their different views on 'relevance'. Actors in *Co-valuation of Water* had different views on whether *implementing* the developed visions was desirable, and whether this was a goal of the project. In *Hotspot Groningen* we see a distinction between people who found that input should be given to the provincial plan, including the board of CCSP (which was initially dissatisfied about the project outcomes, but approved the project later on) and others who emphasized 'awareness raising' and 'having scenarios available for future use'. In these two projects some actors' thresholds for *salience* were not met.

4.3 Legitimacy

In two projects actors referred to a perceived lack of *legitimacy*: *Co-valuation of Water* and *Hotspot Groningen.* In the former project, a civil servant believes 'that the local population was fooled'. Inhabitants were asked to participate in the development of plans, while 'it was clear from the outset that these would not be executed'. Also, several interviewees claimed that the position of experts in the project was problematic. They were not familiar with the 'subordinate' role they were expected to play, providing feedback on, rather than making plans (see also: Edelenbos et al., 2011). A PhD researcher in *Co-valuation of water* learned that commitment of organizations is largely dependent on individuals. After a civil servant and the responsible alderman left, the municipality turned out to be no longer committed. The same researcher mentions 'that scientists are wrong in assuming that practitioners know everything about 'integrated water management', 'stakeholder involvement' and 'making room for water''. The fact that the project leader of *Hotspot Groningen*, a policy officer, was seen by some as 'a representative of science' was claimed to be a crucial factor complicating the internal acceptance of his work within the province. An employee of one of the participating water authorities tells that he believes that he was 'merely facilitating science'. This employee indicated that 'if the local water authority had been the principal, the current project results would not have been sufficient'.

In some of the other projects, statements were made which can be linked to a lack of *legitimacy*; although the issues addressed seem to be less serious ones. The PhD researcher within *Transitions SUW* found working at the intersection of science, policy and practice exiting and instructive. It resulted, however, in a high workload since policymakers were interested in easily accessible reports, while his supervisors were interested in journal articles. This could be interpreted as a lack of *legitimacy* in the eyes of the PhD researcher, although this researcher himself does not use the term. Some interviewees in *What's the future of low lying peat land* referred to the, according to them theoretical, possibility that actors would prematurely use intermediary products. Farmers could have an interest in claiming 'that

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underwater drainage is a solution for continuing agricultural activities in low-lying peat areas'. Claiming more than science justifies can be interpreted as a lack of *legitimacy*. However, at the time of writing, such premature use had not taken place, so legitimacy seems to have been uncompromised.

Table 5 portrays the projects' 'scores' for credibility, salience and legitimacy. We also gave an indicative 'overall score' to be able to rank the projects (adding 1 point in case of a + score, subtracting 1 point in case of a – score and adding 0 points in case of a +- score).

Table 5: Projects' 'scores' for *credibility*, *salience* and *legitimacy* (+no serious criticism encountered; +–some remarks or comments which seemed 'minor'; –criticism encountered).

Project	*Credibility*	*Salience*	*Legitimacy*	*'Overall score'*
What's the future of low-lying peat land?	+	+	+	3
Co-valuation of water	–	–	–	-3
Transitions Sustainable Urban Water management (SUW)	+	+	+–	2
Hotspot Zuidplaspolder	+	+	+	3
Hotspot Groningen	–	–	–	-3
Routeplanner	+	+	+	3

5. Identifying success conditions in the projects

We have tried to assess for each project, whether, to what extent and how the theoretical success conditions have been met. Table 6 provides an overview of the results. The table also repeats the overall scores for 'success' given in table 5. Below, we will compare the differences in 'scores' for each condition.

1) Broadest possible actor coalition. We did not find any obvious 'gaps' in actor participation. All projects included the actors one would logically expect given the stated goal of the project. Whether this was 'the broadest possible' actor coalition remains of course arbitrary. Nevertheless, we have some reasons to differentiate between the scores of the projects. In the case of *Covaluation of Water (-)*, some interviewees were of the opinion that execution of the developed visions was a project goal. However, the parties that can play a role in the execution (building contractors, project developers) were not involved. The projects *What's the future of low-lying peat land* (++) and *Hotspot ZPP* (++) managed to include a rather large proportion of the policy actors (and some societal actors) related to the geographical area under study. They did so in different ways, but have in common that that they managed to create both distance and connections between knowledge development and the policy process (see Hegger et al (submitted) for a detailed description of the set-up of Hotspot ZPP).

2) Deliberation on goals and problem definitions. Deliberation on goals and problem definitions took place in all projects at least to some extent. In all cases, at some point before the official start of the project or at the beginning decisions have been made on how to delineate the project. In none of the researched projects, however, we found examples of extensive deliberations *during* the project.

3) Recognition of differences in actor perspectives. Based on our empirical material, we cannot judge if differences in actor perspectives were actually *recognized*. But as table 6 shows, all projects did undertake actions that could enable this. In *What's the future of low-lying peat land* boundary objects were a prominent means to do so, In *Covaluation of Water* there was reflection by parties. In *Hotspot ZPP* and *Transitions SUW* there was physical proximity between the people that had to collaborate most closely. In *Hotspot Groningen* there were meetings at and site visits to interesting locations. In the *Routeplanner* project, exchange via knowledge brokering took place.

4) Organized reflection on division of tasks. In none of the projects, we found examples of extensive reflection (e.g. reflection workshops, retreat days) on the division of tasks. Only in the case of Covaluation of Water we found examples of some bilateral reflection on the role of individuals.

5) Role of researchers and their knowledge is clear. The projects differ in terms of the roles played by researchers. In all projects, this included roles as scientific or applied researcher. In *What's the future of low-lying peat land* and *Transitions SUW*, researchers provided direct input to ongoing policy processes. In all cases the role of researchers and their knowledge seemed to be clear.

6) Presence of innovations in reward structures. All projects have in common that the Dutch national government made funding for science-policy cooperation available in the first place. Besides that, however, we found only one more specific example at project level. In 'What's the future of low-lying peat land' actors were allowed to use 5% of the project budget for the right to 'extract' knowledge from the project (e.g. Water Boards could ask researchers to give a presentation for their board, without being charged for this). We found more frequently that actors thought that they

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Table 6: presence of success conditions in the projects (++clearly present, +seemingly present, +-neutral, -seemingly absent, --clearly absent); the table also repeats the overall scores for success of table 5.

Success condition	What's the future of low-lying peat land? (Score: +3)	Co-valuation of water (Score:–3)	Transitions Sustainable Urban Water Management (Score: +2)	Hotspot Zuidplaspolder (Score: +3)	Hotspot Groningen (Score:–3)	Routeplanner (Score: +3)
Actors						
1)Broadest possible actor coalition	**++** Core project team collaborated with large consortium (almost all relevant policy actors; some societal organizations).	**+-** Broad participation, including citizens. Some participants claimed that other experts and partners capable of executing the visions should have been involved.	**+** No missing links in actor network, but cases were restricted to two municipalities	**++** Large involvement of various knowledge producing parties. Embedding of Hotspot in regular planning process and political processes was claimed to be very strong	**+** Involvement of many different parties, but involvement of individual researchers relatively limited	**+** No missing links in actor network
Discourses						
2)Deliberation on goals and problem definitions takes place	**+**	**+**	**+**	**+**	**+**	**+**
3)Recognition of differences in actor perspectives	**+** a.o. use of GIS maps	**+** Reflection on project design and role of participants	**+** Physical presence of PhD in case study municipalities	**+** Physical presence (Xplorelab)&site visits	**+** Site visits; interesting locations for meetings	**+** Exchange through knowledge brokers
Rules						
4)Organized reflection on division of tasks by participating actors	**+-** Project approach largely determined before/at the start	**-+** Some examples of bilateral reflection, but not organised reflection	**+-** Project approach largely determined before/at the start	**+-** Project approach largely determined before/at the start	**+-** Project approach largely determined before/at the start	**+-** Project approach largely determined before/at the start
5)Role of researchers and their knowledge is clear	**+** Carrying out scientific research (PhD researchers) & carrying out more applied research (research institutes)	**+** Carrying out scientific research (PhD researcher & supervisors); process facilitation (PhD researcher & supervisors)	**+** Carrying out scientific research (PhD researcher & supervisor);Providing input for policy processes at municipalities (PhD researcher)	**+** Carrying out specific parts of the project (PhD researchers)	**+** Providing input to workshops based on themes on the agenda	**+** Carrying out sub research projects defined by knowledge brokers.
6)Presence of innovations in reward structures	**+** Participants could use 5 % of the project budget to 'extract' knowledge from the project	**-**	-	-	-	-
Resources						
7) Presence of specific resources: boundary objects, facilities, organizational forms, competences	**+** Participants could use 5 % of the project budget to 'extract' knowledge from the project	**+-** Involvement of local actors.	**+** Local support in case study municipalities. Project was carried out by a very active PhD researcher.	**++** Entities (e.g. Xplorelab) and boundary objects (meeting tables in the shape of a map of the province). Specific competences (e.g. knowledge-driven policy makers)	**+-** Meetings at special locations (e.g. old factories). Project leader with large scientific network but limited secretarial support.	**+-** Competences of knowledge brokers.

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had to cope with the perceived shortcomings of 'conventional' reward structures. For instance, researchers are expected to publish, and there were differences in the extent to which these researchers succeeded to do so.
7) Presence of specific resources. We found many different factors which can be seen as 'specific resources'. Besides project-specific and contingent resources, we came across some replicable resources: the establishment of specific entities (Xplorelab); but also the presence of persons with competences needed for regional transdisciplinary cooperation (leadership skills; experience with both science and public policy). As the differences in scores indicate, there seem to be some differences in the quantity of the measures taken.

6. Exploring the relationship between success factors and success

Table 7 depicts the six projects as well as their scores for success and for the success conditions again. We have changed the projects' order in the table according to the degree of success. The pattern found is, grosso modo, in line with what we expected on the basis of our causal model: the more successful projects score higher on the success conditions than the less successful projects, suggesting that the success conditions have a stimulating influence on project success. As expected, *Hotspot ZPP* and *What's the future of low-lying peat land* score relatively high on the theoretical success conditions, *Co-valuation of Water* and *Hotspot Groningen* score relatively low, with *Transitions SUW* between these extremes. Routeplanner scores lower on the success conditions than expected. This may be explained by the fact that, contrary to the other projects, this project focused on bringing together existing knowledge (rather than developing new knowledge). Also, our interviews suggest that the actors involved in this project see their project less as a joint effort than actors in the other projects, possibly reducing the relative importance of the success conditions, being success conditions for *joint* knowledge production.

Table 7: presence of success conditions in the projects (++clearly present, +seemingly present, +-neutral, -seemingly absent, --clearly absent); the table also repeats the overall scores for success of table 5.

Success condition	What's the future of low-lying peat land? (Score: +3)	Hotspot Zuidplas-polder (Score: +3)	Routeplanner (Score: +3)	Transitions Sustainable Urban Water Management (Score: +2)	Co-valuation of water (Score:–3)	Hotspot Groningen (Score:–3)
Actors						
1)Broadest possible actor coalition	++	++	+	+	+-	+
Discourses						
2)Deliberation on goals and problem definitions takes place	+	+	+	+	+	+
3)Recognition of differences in actor perspectives	+	+	+	+	+	+
Rules						
4)Organized reflection on division of tasks by participating actors	+-	+-	+-	+-	+-	+-
5)Role of researchers and their knowledge is clear	+	+	+	+	+	+
6)Presence of innovations in reward structures	+	-	-	-	-	-
Resources						
7) Presence of specific resources: boundary objects, facilities, organizational forms, competences	+	++	+-	+	+-	+-

Success condition one (broadest possible actor coalition), six (presence of innovations in reward structures) and seven (presence of specific resources) are more distinguishing than the other four conditions. The former conditions show differences between the projects in accordance with the general pattern found. For the other success conditions, we

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could not find clear differences in the degree to which the success conditions were met (but as discussed in the previous section, we did find differences in *how* these conditions were met).

We have three explanations for the fact that success condition one, six and seven were more distinguishing than the others. First, the distinguishing conditions may be more important. According to this line of reasoning, involving as many actors as possible in a smart way (success condition one) is one of the crucial factors influencing the course of a project. The methodology used in *Hotspot ZPP* and *What's the future of low-lying peat land?* in which researchers were connected to a specific policy issue but with some distance between the research process and the policy process can then be considered to be a best practice. It is also plausible that the mobilization of specific resources (success condition seven) increased the chance for success. The empirical material seems to indicate that the projects differed in terms of the amount of specific resources. Interviewees in *What's the future of low-lying peat land* and *Hotspot ZPP* could easily point at a *multitude* of such resources, while in other projects (e.g. Hotspot Groningen) actors referred to a *lack* of resources (e.g. a lack of secretarial support for the project leader). Both condition one and seven can, furthermore, be expected to enable and constrain the extent to which the other success conditions can be met, suggesting that these conditions form the main leverage points for setting up successful JNP projects.

A second reason why success condition one, six and seven were more distinguishing than the others is that we have been better able to 'measure' the distinguishing conditions than the others. We may have missed some probably subtle ways to achieve deliberation on goals and problem definitions (condition 2). Also, we only measured *actions* that could lead to recognition of actor perspectives (condition 3). We neither measured the perspectives themselves nor the degree to which they were recognized. On the other hand, we may have researched a specific group of 'less controversial' JNP projects, reducing the need for deliberation and reflection.

Third, the framework deliberately excludes some explanatory factors for the success of JNP. The framework is aimed at the identification of *actions* increasing the chance for successful JNP (Hegger et al. 2012) and hence strongly focuses on action perspectives at project and program level. Contingent and contextual factors are not included in the framework. In the case of *Co-valuation of Water*, for instance, interviewees referred to set-backs resulting from the fact that perceived crucial contact persons within the involved municipality had to quit their project activities. At the same time, some interviewees in the case of *What's the future of low-lying peat land?* told us that the fact that funding became available for a project of its size was because there was a political window of opportunity at the time of setting up the project (actors at ministries, provinces and water boards perceived problems of soil subsidence in low-lying peat areas as urgent).

More research is needed to learn more about the relative importance of each of the three explanations.

7. Design principles for JNP, reflection and next steps

The previous sections provide arguments in favour of the relevance of joint knowledge production as a means to reconcile science and policy in the domain of climate change adaptation. Actors involved in JNP did point at lessons which they would not, or not that easily have learned without cooperation. Our comparative analysis of six adaptation projects, using our analytical framework, has brought to light two design principles for JNP projects. First, it is imperative to make a conscious decision for the institutional location of the project on the research-policy nexus, whereby the coordinating entity functions as a boundary organization (e.g. applied research institute, knowledge broker, transdisciplinary innovation lab within a province) (Guston, 2001). Most successful projects managed to build a large network of actors, including actors from science and society. These projects managed to create some distance (a protected niche) for knowledge development, while at the same time establishing connections with ongoing policy processes. Second, specific resources, including facilities, boundary objects and specific competences should be employed to increase the chance for success. The range of 'specific resources' employed in the analysed projects was very heterogeneous. We therefore propose to start differentiating between different forms of resources, including i) specific material arrangements (GIS maps, places to meet); ii) manpower, iii) competences and iv) finances.

However, our analysis has shown that success or failure of JNP projects lies not solely in the hands of actors at project and program level. Set-backs in projects cannot always be avoided, and similarly windows of opportunity cannot always be created but often emerge. Our design principles may be necessary, but may not be sufficient preconditions for successful JNP. From this we conclude that failure should to some extent be tolerated and that space is needed for making and learning from mistakes.

Reflecting on the external validity of our analysis, we think that we researched a specific type of projects in which deliberation and joint reflection was less essential than in other projects. Most projects departed from societal problem in which 'knowledge producing parties' were subsequently involved. As we put it in section 3, the projects were more

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often initiated by the 'demand side' than by the 'supply side'. After recruiting the knowledge producing parties, the added value of their expertise was more or less taken for granted. In this respect, the analysed projects seem to differ from other projects. Kemp and Rotmans (2009) as well as Lamers et al. (2010) have analysed projects in which there appeared to be a bigger tension between the interests of researchers vis-à-vis policymakers. It would be an interesting point for further research to assess the origin of such differences.

To conclude, there are still many steps to be made in the empirical analysis of JNP as a means to reconcile climate science and adaptation policy. The work done thus far shows that such analyses require the use of different empirical data collection methods simultaneously. For instance, one can assume that successful JNP requires actors to have a positive attitude towards science-policy cooperation and to have congruent expectations regarding one another's contributions. To find out whether this is the case, we recommend to study actor perspectives and the degree to which they have been reconciled in projects through additional data collection methods, including perspective maps (Offermans and Cörvers, 2012) or Q-sorts (Hoppe 2009: Raadgever et al 2010). We invite other scholars to join us in this endeavour.

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