

MASTER'S THESIS

How scale matters in joint knowledge production for nature-based solutions

Dynamic proximity among stakeholders in climate adaptive water management for brook catchment Aa, the Netherlands

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Award date:
2021

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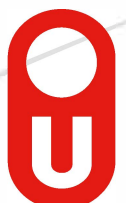
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Dynamic proximity among stakeholders in climate adaptive water management for brook catchment Aa, The Netherlands

How scale matters in joint knowledge production for nature-based solutions

Dynamic proximity among stakeholders in climate adaptive water management for brook catchment Aa, the Netherlands

MSc Thesis in Environmental Sciences

COLOPHON

Course name: Thesis MSc Environmental Sciences

Course code: NM990A

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MSc Programme: Master of Environmental Sciences, Research Group Resilience Science

Date: January 26th 2021

Image on the cover: Weijers (2006)

APA-reference: Brok, E. (2020). *How scale matters in joint knowledge production for nature-based solutions. Dynamic proximity among stakeholders in climate adaptive water management for brook catchment Aa, the Netherlands*. Open University, Heerlen.

This research has been inspired by the project 'Co-Adapt: Climate adaptation through co-creation', which is carried out under the auspices of the European Union Interreg-program 2Seas. In the 2Seas program, flexible, nature-based solutions are sought-after with the aim of adapting to climate change. The solutions the Co-Adapt project will propose, are based on the principle of co-creation between policy-makers, scientists and stakeholders, and aim at reaching sustainable results, putting into practice the concept of adaptation pathways.

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Abstract

In search for climate resilience of brook catchments stakeholders collaborate. Those collaborations involve dynamic proximity, giving rise to innovative, creative solutions using natural hydrological and landscape processes. Dynamic proximity is known from innovation research in the field of high-tech regional economic development. The question is whether dynamic proximity among stakeholders influences success of joint knowledge production (JKP) processes as well. We focus on a more nature-tech context of regional economic development: creating nature-based solutions (NbS) to support climate resilience. The conceptual model to study the creative process of JKP combines the four dimensions of JKP with four forms of dynamic proximity. Along this matrix quotes of stakeholders were analysed from seven semi-structured interviews. At least one stakeholder in the process for the brook-restoration of the Aa (the Netherlands) was selected from industry, academia, government and non-profit organizations (following the 'quadruple helix model'). Findings show that stakeholders who are versatile in using various forms of social, cognitive, institutional and geographical dynamic proximity in the process of JKP experience the process as more successful. Moreover, stakeholders *overdoing* the institutional or geographical aspects of proximity run into adverse effects, a mechanism recognized in economic geography as the proximity paradox. Furthermore, stakeholders are better supported when they use knowledge instruments, but only when keeping in mind the balance of forms of dynamic proximity. Findings were validated against two stakeholders' experiences in another process for the Aa of Weerijis. We suggest refining the model by adding two forms of dynamic proximity relating to interests and to resources, enabling a sharper focus on knowledge production under the heading of cognitive proximity. So, scale matters in such rural, natural processes. The perspective on proximity helps innovation, if proximity among stakeholders does not become *too proximate*.

We have summarised findings in the form of a proximity tool, as our contribution to the regional practice of JKP for NbS in brook catchments.

Samenvatting

In de zoektocht naar klimaatbestendige beekdalen werken belanghebbenden samen. Dynamische vormen van nabijheid spelen een rol in deze samenwerkingen, die leiden tot innovatieve, creatieve oplossingen met gebruikmaking van hydrologische en landschappelijke processen. Dynamische nabijheid is een bekend begrip in innovatie onderzoek op het gebied van *high-tech* regionale economische ontwikkeling. De vraag is of dynamische nabijheid onder belanghebbenden het succes van gezamenlijke kennisproductie ook beïnvloedt. Dit keer kijken we naar een meer *low-tech* context van regionale economische ontwikkeling: het creëren van natuurlijke oplossingen om klimaatbestendigheid te ondersteunen. In het conceptuele model om dit creatieve proces van gezamenlijke kennisproductie te bestuderen zijn de vier dimensies van gezamenlijke kennisproductie gecombineerd met vier vormen van dynamische nabijheid. Langs deze matrix worden citaten van belanghebbenden uit zeven semi-gestructureerde interviews geanalyseerd. Minstens één belanghebbende bij het proces van beekherstel van de Aa (Nederland) is daarbij geselecteerd vanuit de industrie, de academische wereld, overheid en niet-gouvernementele organisaties (volgens het viervoudige helix-model). Een uitkomst is dat belanghebbenden die veelzijdig zijn in het gebruiken van uiteenlopende vormen van sociale, cognitieve, institutionele en geografische dynamische nabijheid in het proces van gezamenlijke kennisproductie, het proces ook als succesvoller ervaren. Ook blijkt dat belanghebbenden die de institutionele of geografische vormen van nabijheid *overdrijven*, te maken krijgen met nadelige effecten. In de economische geografie staat dit verschijnsel bekend als de paradox van nabijheid. Bovendien worden belanghebbenden beter ondersteund wanneer ze kennisinstrumenten toepassen, maar alleen als ze de balans weten te houden tussen de verschillende vormen van dynamische nabijheid. De uitkomsten zijn gevalideerd aan de ervaringen van twee belanghebbenden in een ander proces voor de Aa of Weerij. We raden aan om het conceptuele model te verfijnen door er twee vormen van dynamische nabijheid aan toe te voegen die betrekking hebben op belangen en middelen. Daardoor ontstaat onverdeelde aandacht voor kennisproductie onder het kopje cognitieve nabijheid. Dus schaal doet ertoe in deze landelijke, natuurlijke processen. Het proces van nabijheid helpt innovatie, maar alleen als de nabijheid tussen belanghebbenden niet *te* nabij wordt.

De uitkomsten zijn samengevat in een Schaal-Instrument, als bijdrage aan de regionale praktijk van gezamenlijke kennisproductie voor natuurlijke oplossingen in beekdalen.

Voorwoord

Voor u ligt de MSc-these 'How scale matters in joint knowledge production for nature-based solutions'. Het onderzoek is uitgevoerd aan de hand van de casus 'Dynamisch Beekdal Aa', een beekherstelproject voor het Noord-Brabantse beekdal Aa, uitgevoerd tussen 1998 en 2016. De masterthese is een deel van de afronding van de opleiding Environmental Sciences aan de Open Universiteit (Heerlen), gemaakt in samenwerking met stageorganisatie de Provincie Noord-Brabant. Het onderzoek is uitgevoerd in de periode van november 2019 tot en met december 2020. Bij deze wil ik graag mijn onderzoeksbegeleider Angelique Lansu hartelijk bedanken voor haar intelligente en sympathieke begeleiding tijdens het hele traject. Verder wil ik mijn tweede begeleider Judith Floor en stagebegeleider Frank van Lamoen van harte bedanken. Ook wil ik alle respondenten bedanken die hebben meegewerkt aan dit onderzoek. Zonder hun medewerking had ik het onderzoek niet kunnen voltooien. En ik wil Inge Michels bedanken, mijn voormalig leidinggevende die me heeft geïnspireerd om dit grote studie project aan te gaan. Mijn collega's bij de OMWB bedank ik voor hun bijdrage. Mijn man en twee kinderen wil ik heel in het bijzonder enorm bedanken. Zonder de knuffels van de kinderen en het vele geduld dat ze hebben gehad tijdens al die studiedagen was het niet gelukt. Ook de morele steun en goede tips van mijn man waren onmisbaar om dit project tot een goed einde te brengen. Ik wens u, lezer, veel leesplezier toe.

1 Introduction

Nature-based solutions (NbS) are considered promising as a way of coping with the challenges of predicted global climate change. Used by the International Union for Conservation of Nature and Natural Resources (IUCN), the World Bank and the European Commission since the late 2000's, the concept of NbS is defined by the IUCN as actions to protect, sustainably manage and restore natural or modified ecosystems, which address societal challenges (e.g. climate change, food and water security or natural disasters) effectively and adaptively, while simultaneously providing human well-being and biodiversity benefits. The concept of NbS stems from the attention for innovation in which the dynamics of natural processes is being used. IUCN considers NbS as an umbrella concept, covering a wide range of ecosystem-related approaches, which all address societal challenges as well. Being a recent concept 'under construction', it is not self-evident how the concept of NbS can best be applied in practice (IUCN, 2016). But, once brought into practice, NbS directly feed into the realization of the United Nations (UN) Sustainable Development Goals (SDG's), the shared blueprint for world-peace and prosperity at the heart of the UN 2030 Agenda for Sustainable Development.

NbS are also being proposed for the restoration of degraded riverine systems. Nature-based solutions (NbS) are sustainable restoration and rehabilitation strategies that are based on natural processes and cycles. They use natural flows of matter and energy, take advantage of local solutions and follow the seasonal and temporal changes of the ecosystems. The central theoretical concepts underpinning NbS are the theory of system thinking, and the concept of connectivity (in landscape solutions). System thinking can be understood as 'thinking in wholes', as opposed to considering the properties of individual elements and their interactions, the latter being often referred to as a reductionist approach. Designing NbS therefore requires understanding the dynamics of the system, in this case the processes and feedbacks that determine the sediment and water fluxes in a landscape, and how they interact with the existing landscape (Keesstra et al., 2018). Landscape connectivity is a concept coined in ecology and originally defined by Merriam as 'the degree to which the landscape facilitates or impedes movement among resource patches' (Taylor, Fahrig, Henein, & Merriam, 1993). In ecological terms, the degree to which a landscape is connected determines the degree to which organisms disperse among patches, influencing factors such as gene flow, local adaptation, extinction risk, colonization probability, and the potential for organisms to move (e.g. in reaction to climate change). In designing NbS for degraded riverine systems, connectivity refers to changing the fluxes in the landscape, making it less connected. That way less rainfall is transformed into runoff, reducing flood risk, and increasing soil moisture which again reduces droughts and soil erosion (Keesstra et al., 2018).

On the global scale as well as in the Netherlands, climate change is considered to possibly aggravate the effects of the degradation of riverine systems. The Royal Dutch Meteorological Institute (KNMI) has translated the 2013 research results of the Intergovernmental Panel on Climate Change (IPCC) on global climate change (Stocker et al., 2013) for the Dutch situation. IPCC calculations for the emissions of greenhouse gases, air pollution, and land-use change form the basis of these KNMI '14-scenarios. KNMI expects a generally milder and wetter weather type in winter. In summer, the wind is expected to blow from the East more often, generally causing warmer and dryer weather (Klein Tank, Beersma,

Bessembinder, Van den Hurk, & Lenderink, 2015). These predicted climatological changes may aggravate the summer droughts and winter floodings.

This research will focus on the Dutch Province of North-Brabant. As elsewhere, in the south and south eastern parts of the province brook-systems on sandy soils have been degraded. Human intervention and land use have strongly changed and restricted these water systems during the past hundreds of years, as the North-Brabant population grew to the present 2.5 million people (urbanization), and technological interventions have increasingly been implemented to prevent flooding and improve the quality of agricultural areas. Most important agricultural sectors in the region are dairy farming (with accompanying land-use of pasture and fodder maize), intensive hog and poultry farming (south-eastern part of the Province), and tree-nurseries (southern part of the Province) (Rijksoverheid, 2019). Modifications to the brook-systems have included the digging, deepening, and straightening of brooks and ditches, the excavation of peat, and the lowering of groundwater levels over vast areas to answer to the needs of agriculture and habitation. All measures were aimed at draining surplus water as quickly as possible. In this sense, land use change over the centuries has triggered adjustments to the water-systems. All together, these measures have caused the brook systems to degrade, in the sense that they have strongly damaged the resilience of the water systems, causing soil and water systems to be insufficiently able to cope with extremes.

In natural situations in such sandy brook systems the system itself retains water. Shallow, meandering brooks with gentle slopes and natural riparian vegetation work as “sponges” absorbing water. Hence, in degraded brooks (deep and straight, with steep slopes and little vegetation), the water of heavy rainfall flows fast through the watercourse behaving as a “large wave” (Budding, n.d.). In periods of drought, ditches and brooks drain too quickly to downstream river and sea to maintain a sufficient water holding capacity in the area (Mol et al., 2007). The sandy soils the brook systems are located on reinforce the degradation, because of their naturally low water holding capacity and vulnerability to drought. Moreover, lacking enough space for water storage in the densely populated region, the water systems become vulnerable to flooding in periods of extreme rainfall. On top of these problems, the ecological quality of the North-Brabant brooks and rivers has also degraded, mainly caused by an overload of nutrients in the water from intensive agriculture and run-off from the cities in the region (Bedir, 2017). Water authorities in North-Brabant project a future, in which more shallow streams meander through the landscape again, in this way not draining too rapidly in summer and not causing drought-damage to agriculture and nature (Buijnsters et al., 2018). This image reflects the expectation that brook-systems may be more resilient in facing climate change and land use change when restored into a more natural state. Strategies to reach such a goal are NbS. In that sense, studying viable ways to bring into practice NbS in restoration-projects for the North-Brabant brook-systems on sandy soils has a wider relevance than being of practical use within the Province of North-Brabant alone. It is also a small-scale way of working for the realization of the global SDG's in land and water management.

The implementation of NbS requires a process of joint knowledge production (JKP), which is the focus of this research. In the end effective restoration measures for riverine systems depend on effective human cooperation for their realisation. It has been argued (Cash et al., 2003) that science and technology can best be mobilized for sustainability when they manage the boundaries between knowledge and action. More recently, the success of such

'boundary spanning' has been seen to increase, when a broad set of stakeholders contribute their practical and contextual, place-based knowledge into a project's process (McFadgen & Huitema, 2018). How this can be promoted, has been studied under the heading of joint knowledge production (Hegger, Van Zeijl-Rozema, & Dieperink, 2014). Hence the choice for this theoretical framework of JKP as a starting point for this study.

The study starts from the observation that knowledge about global climate change and understanding of global land use change on the one hand, and local knowledge production for strengthening the resilience of a brook catchment on the other hand, are two things of a very different scale level. Now how does global scale knowledge "reach" such local or regional knowledge production projects? Or in other words: how is the creation of (ecological, climatological) knowledge and understanding, needed for creating NbS, influenced by the scale on which it takes place? To study this influence of scale on joint knowledge production, we build upon the proximity theory stemming from economic geography and regional economics.

2 Theoretical framework

2.1 Climate resilience in social-ecological systems

Strengthening the climate resilience of brook catchments not only concerns the ecological systems of the catchments themselves, but also the social systems that interfere with them, because the ecological and social systems present in the brook catchment form an intricate whole. Therefore, bringing about NbS to strengthen the resilience of ecological systems also involves an understanding of the dynamics of 'manmade' institutions. The intertwined nature of human and natural systems has been characterized in the concept of social-ecological systems (SES). Folke & Berkes (1998) introduced this concept to present an analytical framework for the study of the various links between ecosystems and institutions (figure 1). Folke and Berkes used the SES-framework to study how institutional resilience may arise, and how it can combine with ecological resilience for mutual benefit. They had special interest in local management systems and settings, not (yet) taken over by mechanistic resource management practices, using an approach referred to in anthropology as participant observation. The SES consists of the natural system (left hand side of figure 1), which may consist of a number of nested sub-systems. The SES also consists of the social system (right hand side of figure 1), which is again a nested system.

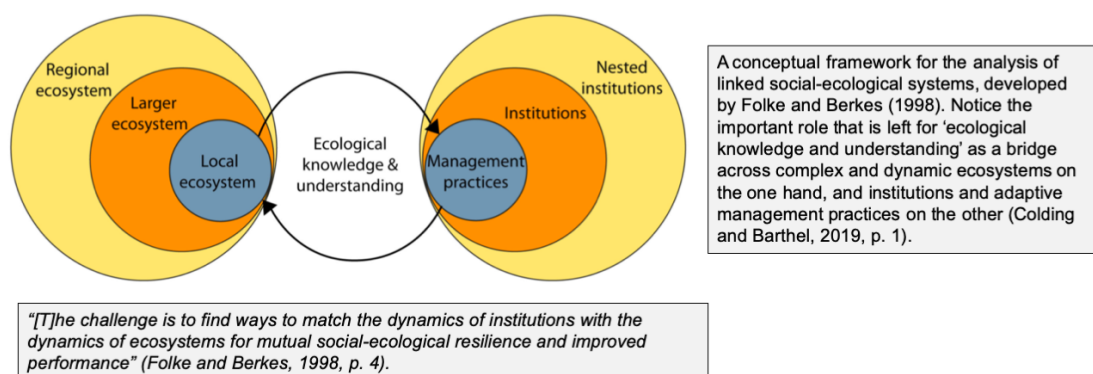


Figure 1. The concept of social-ecological systems, as coined by Folke and Berkes (1998). Adapted from Colding and Barthel (2019, p. 1).

Applying the concept of SES to a North-Brabant brook catchment as an example, we can focus on the brook catchment of the Aa of Weerijis. The natural system consists of the brook's drainage basin, which encompasses a surface of about 19.000 hectares (12.000 ha. of which are situated in Belgium) from its source at the confluence of the Grote Aa and the Kleine Aa (both in Belgium) to the city of Breda, where it flows into the Mark. The drainage basin consists of a number of nested watershed ecosystems by and large flowing from the South-West to the North-East. The social systems may include the farmer with her tree-nursery in Zundert, who uses a set of local management practices. These practices are embedded in institutions, such as the Province of North-Brabant, among other things responsible for sustainable spatial development and nature management. The institutions themselves may be a nested set, e.g. within the European scale of administration, issuing regulations such as the Water Framework Directive and Habitats Directive.

The linkage between both system-types lies in the ecological knowledge and understanding of the dynamics of the user's resource base. This knowledge and understanding is critical,

according to Folke and Berkes, because without it the likelihood of sustainable use of the resource base is assumed to be severely reduced (Colding & Barthel, 2019).

2.2 Proximity

So, Folke and Berkes consider both ecological and social systems as nested systems, consisting of subsystems at different scales. This nested nature of the SES raises the question of how ecological knowledge and understanding, needed for creating NbS, is influenced by the scale on which it takes place. This question seems all the more relevant, as we are dealing with the resilience of North-Brabant brook catchment systems in the face of climate change and land use change. How does global knowledge and understanding on climate and land use change “reach” projects concerning the regional ecological systems of, in this case, brook catchments on sandy soils? Knowledge acquired about climate change, for one, largely concerns the global scale. The authoritative comprehensive assessment reports on climate change the IPCC produces, are all about climate change at a global scale. Is this knowledge applicable one-on-one at a regional scale: North-Brabant brook catchments, and if so, how does this knowledge reach and affect the local SES?

In the literature stemming from economic geography and regional economics on proximity, this aspect of scale is being studied: how does the proximity of stakeholders, in the various meanings of the word, influence knowledge networking, innovation, and thereby regional development? Political scientist and winner of the Nobel Prize in Economics for 2009 Elinor Ostrom has played an important role in linking themes from economical geography (including proximity) to the sustainability of SES, a concept which originated from ecology. She did this in her research on the commons, pointing out that groups are capable of avoiding the tragedy of the commons without requiring top-down regulation, as long as certain design principles are met. In this way, Ostrom linked the ability to self-regulate to the scale of the commons in question and the proximity of human relations in their dealings with the commons (Ostrom, 2009). The role of proximity in regional economic development has also been studied for various economic sectors and in its’ various aspects, for instance for the research and development sector, looking at collaborations in Germany (Broekel, 2015), for the Dutch aviation industry, looking at the aspect of interaction and knowledge sharing (Broekel & Boschma, 2012), for peripheral areas, studying aspects of proximity that influence economic performance (Lagendijk & Lorentzen, 2007; Lagendijk & Pijpers, 2013), and for knowledge networks, looking at the aspects of personal and social proximity (Werker & Ooms, 2020; Ooms, Werker, & Caniëls, 2018).

In this study, we will focus on proximity in an institutional setting, studying (corporate) innovation and regional economical development as a model that can explain successful implementation of NbS as well. Improving the resilience of degraded brook catchment ecosystems may be considered as a form of regional development, requiring innovation as well, because it involves the transition from the more conventional engineering hydrological solutions to the now considered promising NbS for river catchment restoration. This means, that in this study we will not consider space and proximity in a narrow, geographical sense. To the contrary, we will look at space and proximity in the sense the French research-group Proximity Dynamics also uses the concepts (Carrincazeaux, Lung, & Vicente, 2008). Within the scientific field of regional economics, the research-group Proximity Dynamics has been important in developing thought on proximity since the early 1990’s. The group’s aim was to combine industrial dynamics with spatial dynamics. Space, in their view, is not a neutral concept, and it should be integrated into economic analysis. They considered space as a

social construct in an ever-changing context, which is associated with practices and representations of institutional and economic players. In their research, they focussed on the dynamics of production and innovation, in which they saw geographical proximity as one of the dimensions of economic activity coordination, which is a part of the process of innovation and production (Balland, 2012; Torre & Gilly, 2000). In that sense, the Proximity Dynamics-group does not start from territory or geography in the narrow sense, but from a relational concept of economy and social reality, inspired by Bourdieu (Carrincazeaux, Lung, & Vicente, 2008, pp. 617-619). This focus fits well with the image of the SES, which juxtaposes social institutions to ecological systems, which together form a whole.

We start out from the distinction between five dimensions of proximity, as introduced by Boschma (2005): geographical, cognitive, organizational, institutional and social proximity. Balland, Boschma, & Frenken (2015) have subsequently presented a dynamic proximity framework to understand the dynamics between proximity and knowledge networks. They start out from the five forms of proximity (table 1).

Table 1 Five forms of proximity and their definitions

Cognitive proximity	the extent to which two actors share the same knowledge base (a condition for meaningful interaction)
Social proximity	associated with personal relationships between actors, e.g. resulting from past collaboration
Institutional proximity	is high when actors operate under the same set of norms and incentives, e.g. co-located in the same country, or operating in the same social subsystem (within academia, industry or government)
Organizational proximity	referring to the membership of the same organizational entity, e.g. two subsidiaries of the same parent company
Geographical proximity	indicating nearness in place

Note. As presented in Balland, Boschma, and Frenken (2015, p. 909).

Starting from the observations of ‘social influence’ in sociology, Balland et al. (2015) note that the evolution of proximities often is not only due to external influences, but reversely, that participating in knowledge networks may results in proximity, leading to a changing influence of proximity over time. For this reason, they study the five forms of proximity as aspects of the dynamic process of knowledge networking over time. They feel that considering the dynamic nature of proximity is important, because proximity creates knowledge networks in the short run, but in the long run the reverse also applies: knowledge networks create proximity (Balland, Boschma, & Frenken, 2015, p. 911; Ooms et al., 2018). Subsequently, Balland et al. (2015) characterize the dynamic counterparts of the five forms of proximity (table 2).

Table 2 Five forms of proximity, their dynamic counterparts, and their definitions

Dimension of proximity	Dynamic proximity counterpart	Meaning of the dynamic term
Cognitive proximity	<i>Learning</i>	the creation of new overlap in knowledge bases
Social proximity	<i>Decoupling</i>	the autonomisation of personal relations, i.e. when a relation can be decoupled from its original context and ends up existing for itself
Institutional proximity	<i>Institutionalization</i>	the progressive integration of rules and values in actors' behaviour, constructed through the socialization process of individuals and organizations
Organizational proximity	<i>Integration</i>	the progressive rearrangement of subsidiaries, units, departments or establishments within an organizational structure
Geographical proximity	<i>Agglomeration</i>	the choice of location of organizations

Note. As presented in Balland et al. (2015, pp. 911-914).

Balland (2012) has further elaborated on the meanings of the five dimensions of proximity. In the following, we will build upon the five dimensions of proximity including their dynamic pendants and we will interpret the concepts in their meanings as explained by Balland (2012, table 3).

Table 3 Definitions of the five dimensions of proximity as given by Balland (2012, pp. 744-745)

Dimension of proximity	Definition of dimension of proximity in this study, based on Balland, 2012 (page numbers indicated)
Cognitive proximity	refers to the degree of similitude of the knowledge bases of organizations; necessary to communicate and transfer knowledge between partners. There exists an optimal cognitive distance which will ensure novelty but also effective communication. This is because organizations collaborate in order to access external knowledge, which requires a certain degree of cognitive distance between both partners as well. It leads to a trade-off between novelty (cognitive distance of knowledge bases) and communication (cognitive proximity of knowledge bases) (p. 744).
Social proximity	refers to the degree of common relationships, where friendship and trust are central. It is supposed to diffuse informal knowledge and facilitate collaborations. It refers to the intersection between social networks of individuals of two organizations. Focusing on the personal level is very relevant for understanding the mechanisms that provide the diffusion of tacit, sometimes more or less secret, knowledge. Individuals embedded in a social network know each other personally, which determines their accessibility to information exchange or technical advice (pp. 744-745).
Institutional proximity	the similarity of informal constraints and formal rules shared by actors, where common representations, routines and incentives allow organizations to realize an efficient transfer of knowledge. The institutional proximity is thus composed by formal institutions, like laws and rules, and informal institutions, close to the sociological notion of habitus, which is a way of conduct constructed involuntarily through the socialization process. The notion is operationalized by considering institutional proximity as belonging to the same institutional form. We use a 'quadruple helix model' to distinguish among four institutional forms in knowledge creation, namely industry, academia, government, and non-profit organizations (p. 744).
Organizational proximity	the degree of strategic interdependence between two organizations, which reduces uncertainty about the behaviour of the future partner. It is understood as a specific form of proximity among firms of the same corporate group, that is, within parent companies, the subsidiaries and their different establishments (p. 744).
Geographical proximity	refers to the spatial separation between actors, and is supposed to enhance face-to-face interactions. In its simplest form geographical proximity is defined by the physical distance that separates two organizations, and it can be measured by a metric system (miles or kilometres) or by using travel times (p. 743).

Note. These definitions of the five dimensions of proximity will be used in the following of this study.

2.3 Resilience and social-ecological systems

Having introduced the concept of proximity, we now return to the social-ecological systems (SES) we started from. As stated above, Folke and Berkes (1998) have used the SES-framework to study how institutional resilience can combine with ecological resilience to produce mutual benefit. According to Folke and Berkes (1998), the linkage between the natural system (consisting of nested sub-systems) and the social system (embedded in institutions) lies in the ecological knowledge and understanding of the dynamics of the user's resource base, as was explained above. A sustainable use of our resource base therefore depends on the knowledge and understanding linking both system-types.

2.4 Social-ecological systems and nature-based solutions

Following this line of thinking about SES, two questions can be asked, which have been tackled in two separate scientific traditions:

1. What type of knowledge is needed to scaffold the resilience of SES?
2. What is an appropriate process to produce viable knowledge within SES, and how can this be assessed?

The first question is relevant in the context of this study, because present-day thinking about NbS often starts from the notion of wanting to reinforce the resilience of the SES. Scaffolding the resilience of brook system catchments is also a central aspect of the NbS looked for in the projects studied here, and in the institutional settings they are embedded in, such as the EU Interreg program 2Seas/Mers/Zeeën this study is inspired by. The question concerning the type of knowledge needed has been a topic in ecology, and has evolved from the notion of resilience. It leads to the concept of adaptive governance as the answer to the question of what type of knowledge is needed. The use of the term 'resilience' in the SES-framework points to a development in ecology emerging in the 1960s and 1970s. In 1973, ecologist Holling (1973) introduced the idea of 'multi-stable states'. He shifted the focus in prior ecology on the restoration of the stable equilibrium towards behaviour on stability boundaries and the amount of disturbance a system can take before it shifts to another region of stability. This goes to say that, in the line of thought on resilience, instability and disturbance are part of development, and that gradual change and rapid transitions coexist (Folke, 2006). Central in this development as well is the work of D.H. Meadows, founder of the theory on systems analysis (Meadows, 1972; Meadows, 2008). In any complex system, such as an ecosystem, there are levers where a small shift in one thing can produce great shifts in other things, or in the whole, according to her. She speaks about a system in terms of a state (perceived at any time), containing a stock, with inflows (amounts coming into the system) and outflows (amounts going out of the system). Knowledge about these levers is central to solving global problems, such as economic decline, resources depletion, pollution, or conservation issues.

It begs the question of how to deal with these inherently instable and changing ecosystems. In the literature on the resilience of SES the term 'adaptive governance' is used to indicate what is needed. In adaptive governance, there is not only a focus on adaptability, interpreted as the capacity of people in a SES to build resilience through collective action, but also on transformability, which points to people being able to create fundamentally new SES when the old system is untenable (Folke, 2006).

Current findings on nature-based solutions (NbS) show the influence of this development in ecology, leading to the idea of adaptive governance for resilience. To take one example, Nesshöver et al., 2017 in elaborating on the science, policy and practice of NbS, identify key elements which need addressing in order to operationalize the NbS-concept successfully (table 4, left part). The aspects mentioned echo the literature on adaptive governance for resilience, here indicated with a reference to aspects Folke (2006) recognizes as essential for adaptive governance for resilience (table 4, right part).

Table 4 Key elements in successfully operationalizing the NbS-concept according to Nesshöver et al. (2017), and essential parts of adaptive governance in SES, according to Folke (2006)

Key elements for putting NbS into practice, according to Nesshöver et al. (2017, p. 1222)	Essential parts of adaptive governance in SES, according to Folke (2006, p. 262)
Deal with uncertainty and complexity, e.g. by using the adaptive management approach	Develop management practices that combine different ecological knowledge systems to interpret and respond to ecosystem feedback and continuously learn
Ensure the sound use of multi- and transdisciplinary knowledge	Understanding ecosystem dynamics
Ensure the involvement of multiple stakeholders	Supporting flexible institutions and social networks in multi-level governance systems
Develop a common understanding of multifunctional solutions, tradeoffs and natural adaptation, and evaluate and monitor for mutual learning	Building adaptive capacity to deal with uncertainty and surprise including external drivers

Note. Several aspects appear in both the reference on NbS and in the one on governing SES: involving multiple people and institutions, the focus on learning and understanding ecosystems, and on dealing with uncertainty. Adapted from Nesshöver et al. (2017) and Folke (2006).

The take-home message from this digression on adaptive governance for resilience is that the concept of SES, as currently used in ecology and other scientific disciplines, implies a notion of ecosystems that does not start from the stable equilibrium as the “normal” ecosystem state. In contrast, in the SES instability and disturbance are part of development, and gradual change and rapid transitions coexist. Knowledge about this, as the link between the ecological and social systems, is central to get to resilience.

2.5 Social-ecological systems and joint knowledge production

The aim of this study is to determine whether dynamic proximity of the actors in a knowledge network influences the success of the knowledge produced in NbS-projects, and if so, to determine which forms of proximity are most of relevance. That is: we will be looking at the process of knowledge production. This leads us to the second question mentioned above, which was raised in looking for the appropriate knowledge and understanding capable of linking the natural system (consisting of nested sub-systems) and the social system (embedded in institutions) in SES:

2. What is an appropriate process to produce viable knowledge within SES, and how can this be assessed?

This question has been subject of research in the field of environmental governance and policy studies. Cash et al. (2003) have suggested that science and technology can best be mobilized for sustainability when they manage the boundaries between knowledge and action. Their research starts from the idea that effective institutional mechanisms within a system facilitate communication, translation and mediation across the boundaries between knowledge and action. The term boundary spanning is used to point to boundary activities: researchers, policy makers and (other) stakeholders need to understand each other while developing knowledge, so that concepts and ideas can travel across organisational

boundaries. Effective institutional mechanisms, actually able to mobilize science and technology for the sustainability goal, do this “boundary work” in such a way that they enhance the salience, credibility, and legitimacy of the knowledge they produce (Cash et al., 2003). So whether a specific body of knowledge is fit to do the boundary work between knowledge and action, can be evaluated by assessing whether the knowledge produced is considered salient, credible and legitimate, as defined by Cash et al. (2003, table 5).

Table 5 Definitions of the terms ‘credibility’, ‘salience’ and ‘legitimacy’

Credibility	The scientific adequacy of the technical evidence and arguments
Salience	The relevance of the assessment to the needs of decision makers
Legitimacy	The perception that the production of information and technology has been respectful of stakeholders’ divergent values and beliefs, unbiased in its conduct, and fair in its treatment of opposing views and interests

Note. These definitions can be used to evaluate the suitability of knowledge produced for doing boundary work between knowledge and action, necessary for developing resilient ecosystems. Adapted from Cash et al. (2003, p. 8086).

In 2003, Cash defined credible evidence as the perceived scientific adequacy of a science-policy interface’s technical evidence and arguments. However, during its theoretical development, credibility has been broadened to include place-based knowledge in science, by Hegger and others. First, it has become clear that trade-offs exist between the credibility, salience and legitimacy of knowledge produced, requiring an iterative process of knowledge production with intense communication efforts (Girod, Wiek, Mieg, and Hulme, 2009; White et al., 2010). Results of research also suggest that these communication efforts work best within a boundary design, or in some cases an advocacy design, of projects in which ample attention is being paid to contextual, place-based knowledge (McFadgen & Huitema, 2018).

Hegger, Lamers, Van Zeijl-Rozema and Dieperink (2012) have operationalized such insights in the credibility, salience and legitimacy of knowledge production by presenting a research model for use in empirical research. They present an assessment framework for analysing the merits and limitations of projects in which science and public policy collaborate to match the supply and demand for knowledge in the field of global change and sustainability. They term such projects joint knowledge production (JKP) projects. They pinpoint success conditions, the fulfilment of which leads to credibility, salience and legitimacy of knowledge produced. In several studies, Hegger et al. (2014) have tentatively validated the empirical connection between their success conditions for joint knowledge production on the one hand, and credibility, salience and legitimacy of the knowledge produced on the other hand (Hegger, Van Zeijl-Rozema, & Dieperink, 2014; Hegger & Dieperink, 2014). Because we will be conducting empirical research on the process of knowledge production as well, we will also start from the operationalization of Cash’ concepts as proposed by Hegger et al. The research approach proposed here is to look at a project concerning JKP for NbS in a North-Brabant brook-catchment. In our research, we intend to study the influence of proximity on the generation of JKP in this restoration project for a brook catchments. Within our research model, Cash’ notions of credibility, salience and legitimacy will serve as characteristic traits of the experience of success of the project for stakeholders. A successful JKP project is defined by Hegger et al. (2012) 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 less participants of a joint knowledge production project define the outcome in terms of ‘winners’ and ‘losers’, the more successful the project has been, and vice versa*” (Hegger, Lamers, Van Zeijl-Rozema, & Dieperink, 2012, p. 54).

Such synergy may arise when multiple knowledge-disciplines and approaches are complementary in the types of questions asked, or when new place-based knowledge is included in the process of knowledge production, leading to the inclusion of groups that were excluded before (Hegger, Lamers, Van Zeijl-Rozema, & Dieperink, 2012; Hegger et al., 2013).

According to Hegger et al. (2012), the degree of success of JKP projects depends on four dimensions: the actors involved, the contents of dominant discourses, the presence of rules, and the availability of resources. In starting from these four dimensions, Hegger et al. elaborate on the policy arrangement approach as developed by Van Tatenhove, Arts and Leroy (2000). A policy arrangement, in their context, is a temporary stabilisation of the content and organisation of a policy domain. It is Van Tatenhove et al. who first discerned these four dimensions in a policy arrangement: actors, discourses, rules and resources. They use the model of the tetrahedron to illustrate the interconnectedness of these four dimensions in a policy arrangement. Hegger et al. subsequently specify these four dimensions into seven success conditions for JKP, enabling retrospective analysis of finalized projects, but also reflection by participants in current projects (table 6).

Table 6 Four dimensions and seven success conditions for JKP

Dimension	Success condition	Explanation
Actors	1. Broadest possible actor coalition is present	The success of JKP 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 inclusion and exclusion of actors
Discourses	2. Shared understanding of goals and problem definitions	The chance that JKP is successful is enhanced in cases in which participating actors deliberate on the nature and denomination of the policy problem (unstructured, moderately structured, or well structured) and on the type of outcome to be expected (ideas, closure on problem definition, concepts, arguments, or solutions)
	3. Recognition of differences in actor perspectives takes place	Actors in JKP projects can be expected to have diverging and implicit perspectives on the world around them; the success of JKP will be enhanced if the different perspectives of actors are recognized and taken into account; boundary objects can play a mediating role
Rules	4. Organized reflection on division of tasks by participating actors takes place	The chance that JKP is successful is enhanced if actors decide, reflectively, which role to pursue in a project and how to define their identity in relation to the other actors, and they make these choices known
	5. Role of researchers and their knowledge is clear	The chance that JKP is successful is enhanced in cases in which the role of researchers and their knowledge is clear
	6. Innovations in reward structures are present	The chance that JKP is successful is enhanced through novel forms of reward structure
Resources	7. Specific resources such as boundary objects, facilities, organizational forms, and competencies are present	The chance that JKP is successful is enhanced through the availability of specific resources (boundary objects, organizational forms, and competencies)

Note. As presented by Hegger and Dieperink (2014, p. 3). Reprinted from Hegger and Dieperink (2014).

2.6 The contours of our assessment framework

We have now introduced a dichotomy. On the one hand, we have described the need for adaptive governance to promote the resilience of social-ecological systems (characterized here as the type of knowledge needed). On the other hand, we have introduced JKP as a means to enhance the legitimacy, salience and credibility of the knowledge produced. We have characterized JKP in our context as the *process* to produce viable knowledge in the

social-ecological system. Within a structuralist terminology, this relation can be characterized as a key narrative (governance for resilience) in relation to the context of communicating information about it (JKP), or in other words as a relation -and a possible disconnect- between science and practice. Ingram et al. (2016) characterize the relation between soil carbon science and the role of farmers in similar terms. It is important to note that the frameworks of Cash et al. and of Hegger et al. arise from a structuralist tradition. They do not focus on assessing the knowledge produced itself, but on the dimensions of knowledge production within the process of the knowledge production. Success of JKP is therefore defined in terms of the knowledge production process. Because as many as possible of the actors involved in producing the knowledge (on, in this case, increasing the resilience of brook catchments by NbS) are included in this study, multiple perspectives on what is successful knowledge production are also included. In the study proposed, the quality of the results of climate resilience projects for brook catchments are in this sense inferred from the assessments of the actors involved in the projects. In this way, we will treat Cash' three notions in an actor-specific way, assessing the ideas of the actors on the credibility, salience and legitimacy of the project results in question.

2.7 Project phases

We have selected one NbS project to perform our analysis on. One other project on NbS was selected to validate findings against. In project management terms, the research proposed will focus on the projects selected from the phase of their design, up to and including the actual realization phase. This is partly in line with the theory on JKP, which is directed towards the process of policy making, and focusses less on monitoring the results of a project. In the proposed research as well, the monitoring of results will not be part of the analysis. The initiation and definition phases of the projects (more strongly associated with the process of policy making) will also be outside the scope of the study. In this sense, we deviate from the theory of JKP in the choice of the phases that the projects we study are in (figure 2).

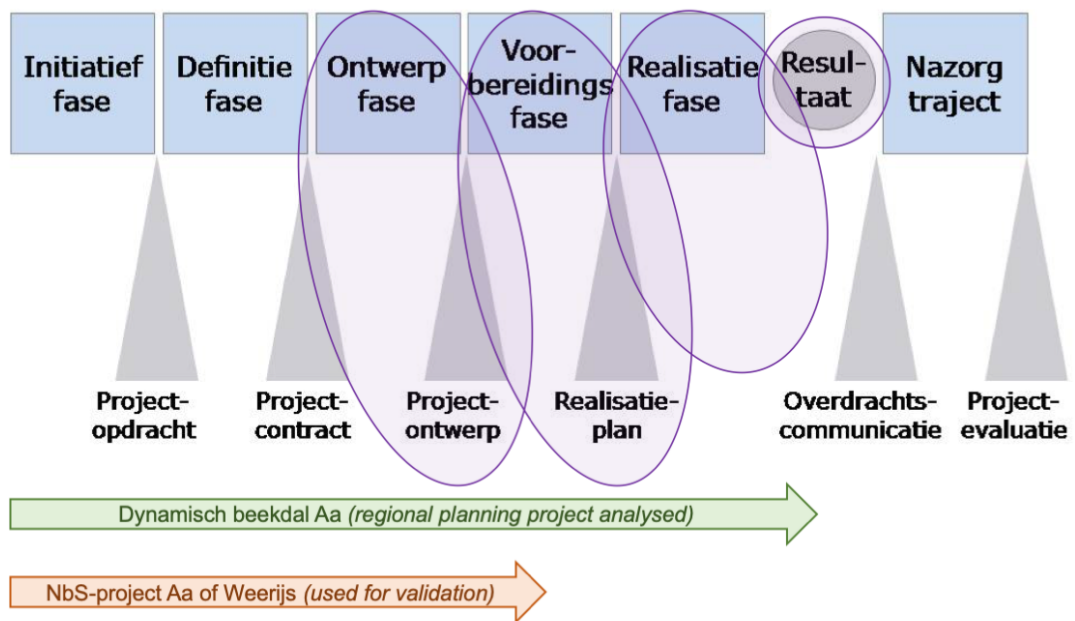


Figure 2. The linear phasing model (Wijnen, 2001) in an adapted version, with the phases of projects under scrutiny in this study circled (in purple). The arrows broadly indicate the phases the projects studied are currently in. Adapted from Wijnen (2001).

3 Problem definition and research objective

From the general introduction to the problem and the chosen theoretical framework for this study the following overall research objective is derived:

The aim of this study is to determine whether dynamic proximity of the stakeholders in a knowledge network influences the success of JKP in NbS-projects, and if so, to determine which forms of proximity are most of relevance.

This overall aim can be analysed into two partial research objectives:

- 1. Research suggests that dynamic proximity is important for the realisation of innovation in the context of high-tech regional economic development. Can it play this important role in creating NbS as well, as it also requires a joint creative process?*
- 2. Secondly, the results of the analysis of the project which has recently been implemented ('Dynamic Brook-Valley Aa') will be tested against the project plans for another North-Brabant brook-system: the Aa of Weerijs. This will result in advice for the Province of North-Brabant concerning the regional planning for the Aa of Weerijs-project. This will be the contribution of the research to the regional practice of JKP for NbS in brook catchments.*

3.1 Central and derived research questions

The research objective of this study leads to the following central research question:

How do the different forms of dynamic proximity among stakeholders influence the success of the JKP project for the North-Brabant brook-catchment of the Aa, aiming at restoring the resilience of this water-system in the face of climate change, applying NbS? Can results from the analysis of the project be validated against project plans for a second, future NbS-project for the catchment of the Aa of Weerijs, and can viable advice for the second project be formulated on the basis of this study?

Three derived research questions function as sub-questions to answer parts of the central research question. Together, the answers to the derived research questions provide a sufficient answer to the central research question from which they are derived. The main function of the sub-questions is steering and structuring of the research process.

Derived research questions:

- 1. Who are the main stakeholders or actors in the knowledge networks involved with the JKP restoration project for the Aa, what are their roles, and can their network relations be graphically shown?*
- 2. How do the main stakeholders experience the success of JKP for NbS in the project?*
- 3. How can the dynamic proximity relations of the main stakeholders towards each other in the project for the Aa best be described?*

4 Operationalization of the theoretical framework

4.1 An assessment framework for dynamic proximity in joint knowledge production

To answer the overall research question and the derived research questions we build upon the assessment framework by Hegger et al. (2012) for analysing merits and limitations of projects aimed at JKP in the field of global change and sustainability. As we focus on proximity within the process of JKP, we supplement Hegger's assessment framework with the forms of dynamic proximity as analysed by Balland et al. (Balland et al., 2015; Balland, 2012). This leads to an adapted assessment framework which allows us to test the success of JKP projects in the experience of the stakeholders interviewed (dependent variable) against the aspects of the dynamic proximity framework (independent variables).

In defining the independent variables of the research proposed, we combine the four dimensions of JKP with the five forms of dynamic proximity in an adapted research model. To start with, organisational proximity with integration as its dynamic counterpart we place in parenthesis and we will no longer use in this study. The reason for this choice is that within the dynamic proximity framework, the concept of integration is strongly connected to the context of innovation for high-tech economic development. The use of the term therefore has a strong business connotation, dealing with rearranging business departments and organisational structures. In the present context of innovation for NbS in brook-systems, this corporate connotation is less relevant. We combine the four dimensions of joint knowledge production with the four remaining forms of dynamic proximity in the following way:

- *We relate actors to social proximity and its dynamic counterpart decoupling.*

We link actors to decoupling, because both concepts concern the actors or stakeholders involved in a project or knowledge network, and their personal relationships.

- *We relate discourses to cognitive proximity and its dynamic counterpart learning.*

We link discourses to learning, because both concepts deal with knowledge, and the underlying knowledge basis and problem definitions that are the incentive for knowledge production.

- *We relate rules and resources to institutional proximity and its dynamic counterpart institutionalization.*

We link rules and resources to institutionalization, because they all concern the formal and informal rules that regulate conduct, cooperation and knowledge production. So we use both the concepts of rules and resources (the third and fourth dimensions of JKP), but we forge rules and resources into one category. In the context of this study we will operationalize institutionalization partly in terms of the 'quadruple helix model' (industry, academia, government, or non-profit organizations). For a stakeholder the belonging to one of the four "helices" will involve a specific understanding of one's role, and of the appropriate division of tasks within a process. Such aspects are therefore included under the heading of institutionalization.

- *Geographical proximity, with agglomeration as its dynamic counterpart, we will consider in its own right.*

We do this, because geographical proximity in the dynamic proximity framework does not have an intuitively evident counterpart in the JKP-framework. We do use geographical proximity in our research model, because it is central to our main issue of scale in collaborations for JKP.

In the definition by Balland (2012), geographical proximity is operationalized by looking at the geographical location of the *organization* under consideration. We take the methodological decision to define our unit of study as the *stakeholder*: a person with an interest or concern in the process under study. Given this methodological decision, we will be looking at the geographical location of the *stakeholders* involved. In our assessment framework, we will consider geographical proximity as the geographical distance between the geographical location of the stakeholder and the geographical location of the catchment system studied. We assess this geographical proximity among stakeholders in a schematic way, for various practical reasons. For example, farmers may own grounds on the banks of the brook, but also miles away from it. Companies and organisations involved may have more than one office, nearer by and further away from the brook. Our schematic representation of geographical proximity among stakeholders consists of drawing three imaginary circles around the catchment system studied: one for local stakeholders, a wider one for regional stakeholders, and a still wider one for nationally or even internationally active stakeholders. Schematically visualizing geographical proximity among stakeholders in a process in this way is inspired by visualizations used in geographical social network analyses, working with nodes and links (Ter Wal & Boschma, 2009). In this sense, the three imaginary circles of geographical proximity around the brook system are analogous to the links of network analyses. The stakeholders are represented by the nodes, as used in network analyses.

Our research model can now be summarized (table 7, figure 3). The meanings of the four basic categories of the model are elaborated upon (App. B). The main concepts used in the research questions and in the operationalization of the theoretical framework are defined (App. A).

Table 7 Combination of aspects of the JKP-framework with the five forms of dynamic proximity in the research model

Independent variables				Dependent variables
<i>Dimensions of JKP</i>	<i>Success conditions of JKP per dimension</i>	<i>Forms of proximity</i>	<i>Meaning of the forms of dynamic proximity</i>	
<i>Actors</i>	1. Broadest possible actor coalition is present	<i>Social proximity (S) and decoupling (D)</i>	The autonomisation of personal relations, i.e. when a relation can be decoupled from its original context and ends up existing for itself	
<i>Discourses</i>	2. Shared understanding of goals and problem definitions 3. Recognition of differences in actor perspectives takes place	<i>Cognitive proximity (S) and learning (D)</i>	The creation of new overlap in knowledge bases	Credibility: the scientific adequacy of the technical evidence and arguments, interpreted by Hegger as the perceived adequacy of the knowledge produced (Hegger et al., 2012, p. 54)
<i>Rules and resources</i>	4. Organized reflection on division of tasks by participating actors takes place 5. Role of researchers and their knowledge is clear 6. Innovations in reward structures are present 7. Specific resources such as boundary objects, facilities, organizational forms, and competencies are present	<i>Institutional proximity (S) and institutionalization (D)</i>	The progressive integration of rules and values in actors' behaviour, constructed through the socialization process of individuals and organizations	Salience: the relevance of the assessment to the needs of decision makers, interpreted by Hegger as the perceived relevance of the knowledge produced Legitimacy: the perception that the production of information and technology has been respectful of stakeholders' divergent values and beliefs, unbiased in its conduct, and fair in its treatment of opposing views and interests, interpreted by Hegger as the extent to which knowledge production has been respectful of the divergent values and beliefs of stakeholders, unbiased in its conduct and fair in its treatment of opposing views and interests
		<i>Geographical proximity (S) and agglomeration (D)</i>	The choice of location of organizations	

Note. D = Form of dynamic proximity; S = Form of proximity

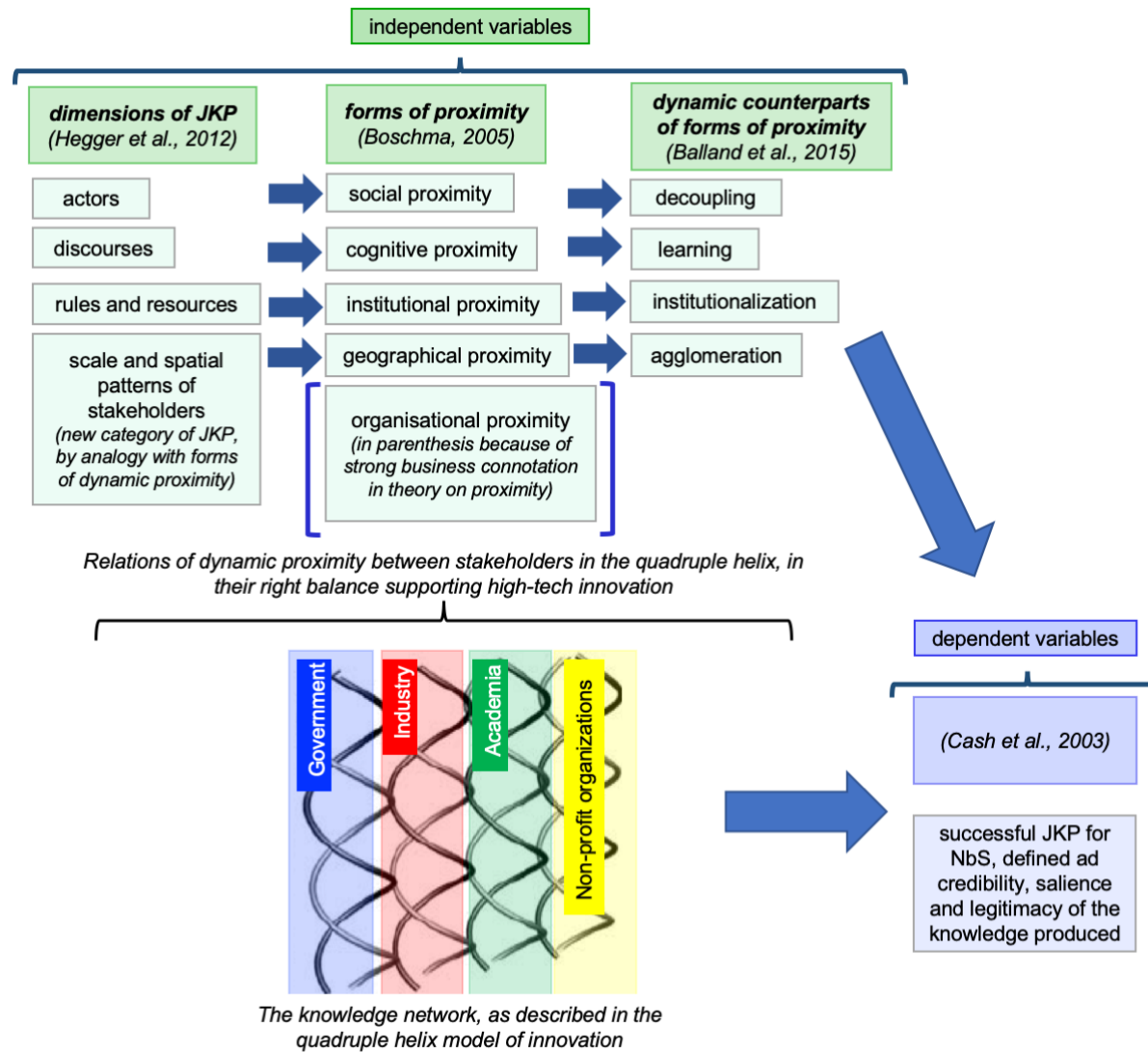


Figure 3. Schematic diagram of the operationalization of the theoretical framework as used in this study.

4.2 Research approach for the first research question

Who are the main stakeholders or actors in the knowledge network involved with the JKP restoration project for the Aa, what are their roles (and can their network relations be graphically shown)?

First, we describe how the project was prepared and (largely) realized on the basis of desk research and information directly from stakeholders (Chapter 5). Subsequently, we visualize the network of stakeholders in the knowledge network involved with the process studied. The information needed for this is collected by doing desk research, supplemented by information directly from stakeholders, gathered in seven semi-structured interviews. We have selected relevant stakeholders for the interviews in an iterative manner, starting from desk research and progressively obtaining information about central stakeholders during the interviews. At least one stakeholder is selected from industry, academia, government and non-profit organizations (following the 'quadruple helix model'). We have chosen to conduct semi-structured interviews, because they allow for open-ended responses and in-depth qualitative information from respondents.

We have listed the persons that were found to play a role in the Aa-process, and have indicated who have been selected for the semi-structured interviews (App. C.1). Transcripts of all the interviews conducted are included (App. C.4).

4.3 Research approach for the second research question

How do the main stakeholders experience the success of creating NbS in the project aimed at reinforcing the resilience of the brook system of the Aa?

The experience of success of the process studied is analysed by conducting seven semi-structured interviews with relevant stakeholders (Sekaran & Bougie, 2016; Baarda, 2014). The original intention was to also carry out participant observation (Sekaran & Bougie, 2016) (for example by participating in workshops or meetings), but the Corona-outbreak has limited possibilities for doing this. In our research model, Cash' notions of credibility, salience and legitimacy are being used as the dependent variables. We will treat these three notions in an actor-specific way, assessing the ideas of the actors on the credibility, salience and legitimacy of the process' results during the semi-structured interviews. We have defined the three central concepts defining success: credibility, salience, and legitimacy (Par. 2.5). Hegger and Dieperink (2014) have used the concepts of credibility, salience and legitimacy in their empirical work on JKP for climate change adaptation. In that context, they have phrased open questions for the actors in the knowledge networks they interview. Inspired by these authors, we address the following broad questions and themes in the semi-structured interviews with stakeholders in the Aa-project. They are also phrased in the questionnaire (table 8, App. C.2 and C.3).

Table 8. Open questions for the respondents concerning credibility, salience, and legitimacy

Concept	Open question in semi-structured interview for the operationalization of adaptive governance
Credibility	What were your interests in the project, and to what degree were your interests met in the course of the project?
Salience	What were your passions in relation to the project? And looking back at the process and results of the projects, was it worth being passionate about? In what sense?
Legitimacy	Do you feel the science-policy cooperation in the project has been a fruitful one?

Note. These questions were asked during the same interviews that were also used to gain information about the nature of the stakeholders' dynamic proximity relations

4.4 Research approach for the third research question

How can the dynamic proximity relations of the main stakeholders towards each other in the Aa-project best be described?

The way the forms of dynamic proximity among stakeholders within the process for the Aa can be described according to the stakeholders, is studied by conducting seven semi-structured interviews. Relevant stakeholders were selected to interview (Par. 4.2). On the basis of the operationalization of our theoretical framework (Fig. 3), we have phrased questions for use in the semi-structured interviews. The questions asked all focus on the four forms of dynamic proximity and the way they exist among the stakeholders in the process studied, which leads to a set of questions (App. C.2 and C.3).

We will analyse the answers given in the semi-structured interviews using Atlas.ti. Aim of this coding exercise is to enable a qualitative analysis of the transcripts of the seven semi-structured interviews conducted (Chapter 6). We code the data according to the four forms of dynamic proximity, in the interpretation as presented above in the combination with the four dimensions of JKP (table 7 and App. B.1). In an iterative manner, we have made a code-book for this purpose, using different codes to be used for coding in Atlas.ti. We have started the work on the code-book by paying attention to four questions, the answers to which qualify the meaning of each of the four aspects of proximity, in the way the interviewees speak about it. Using the aspect of 'social proximity / actors / decoupling' as an example, we have looked at four questions relating to this aspect:

1. **What seems to be** social proximity / actors / decoupling in the way the persons interviewed speak about it? (or: defining traits of the aspect of proximity under consideration)
2. **What can be done in relation to** social proximity / actors / decoupling, when the aim is to stimulate JKP? (or: instruments to promote the aspect of proximity under consideration)
3. **(How) are these aspects helpful**, in the view of the persons interviewed? (or: experiences of success for the respondent concerning the aspect of proximity under consideration)
4. **What are potential problems** the persons interviewed see in relation to social proximity / actors / decoupling? (or: experiences of failure for the respondent concerning the aspect of proximity under consideration)

In the next phase, we have looked at the occurrence of combinations of two aspects of proximity, so that we can show how (often) each of the combinations of two aspects of proximity are mentioned in the interviews. We do this, because the combinations of aspects

of proximity give an additional insight into the relative relevance of the different aspects. Given the four aspects of proximity, there are six possible couples of concepts:

1. social proximity/actors/decoupling **AND** cognitive proximity/discourses/learning
2. cognitive proximity/discourses/learning **AND** institutional proximity/rules and resources/institutionalization
3. institutional proximity/rules and resources/institutionalization **AND** geographical proximity/agglomeration
4. geographical proximity/agglomeration **AND** social proximity/actors/decoupling
5. social proximity/actors/decoupling **AND** institutional proximity/rules and resources/institutionalization
6. cognitive proximity/discourses/learning **AND** geographical proximity/agglomeration

Here again, we have used an iterative way of working to phrase the various codes pertaining to the combinations of aspects of proximity. Carefully listening to the way the interviewees speak about each of the aspects now discerned, we have phrased the codes in the code-book according to the way interviewees speak about these aspects. In a next session we have coded the interviews in accordance with the preliminary codes phrased in the code-book, and so on. These exercises have resulted in a completed code-book using 62 codes, which is the basis for the final coding of all interviews conducted in Atlas.ti (App. D). After having finished this iterative exercise, we can show how, and how often specific aspects are mentioned in the interviews. In this way, the degree of success that interviewees experience regarding project results is also included into the coding of the interviews.

When scoring codes with the help of Atlas.ti, we have chosen to use two different ways of counting codes, each conferring a different meaning in relation to the research questions. Sometimes we use a *0/1-scoring* on codes, other times we count *how often* any specific code is being scored by respondent(s). The *0/1-scoring* means we count whether a specific code has been scored, yes or no (irrespective of how often it was mentioned). It says something about the *variety* in the use of codes by respondents. Counting how often any specific code is scored says something about the *relative relevance* of this code for the respondent(s).

We can now summarize our research approach (figure 4).

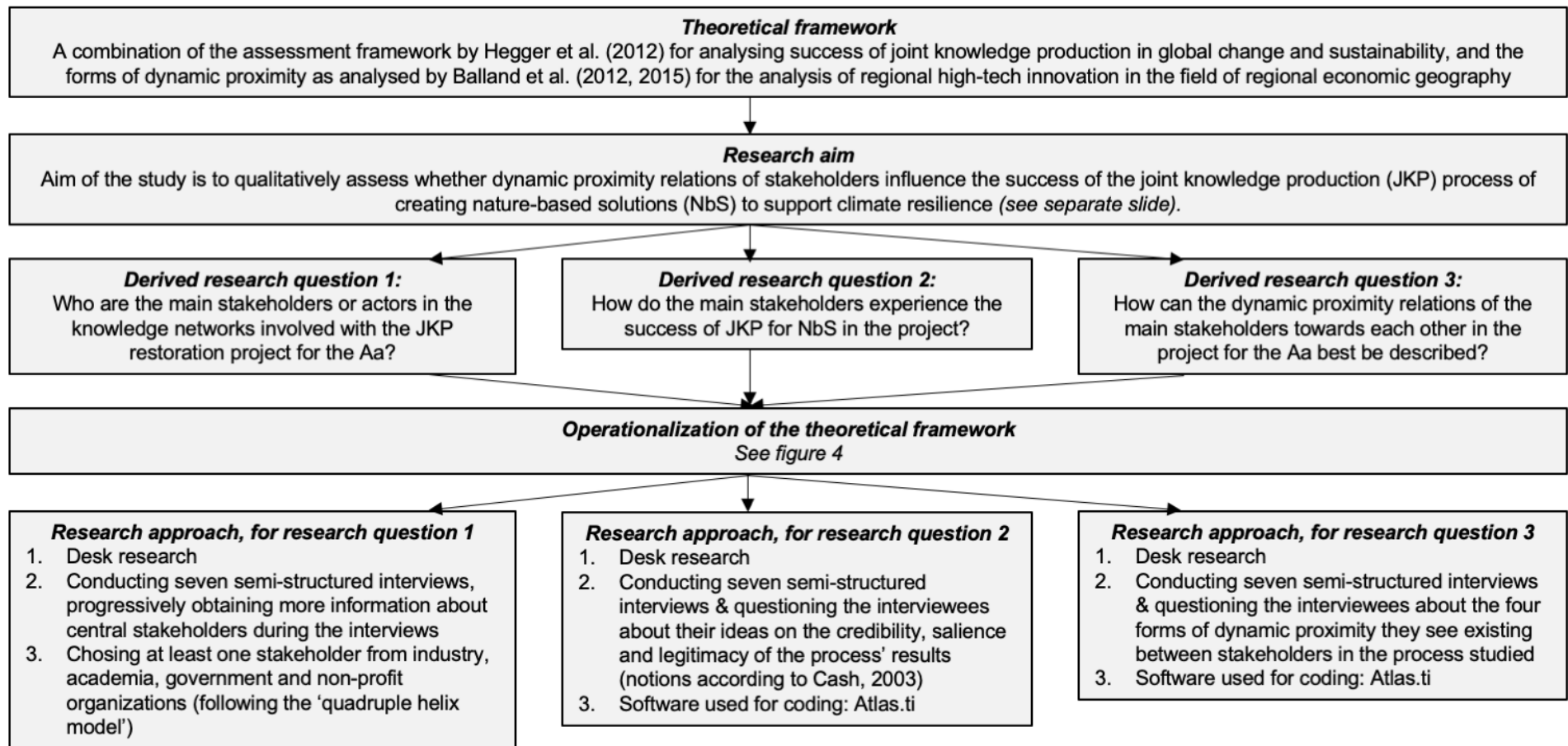


Figure 4. Schematic diagram of the relations between our theoretical framework, the operationalization of the theoretical framework as used in this study, and the research approach for the three partial research questions.

4.5 Research approach for the validation

As a final step in the methodology, results of the analysis of the 'Dynamic Brook-Valley Aa'-process are tested against the project plans for the process 'Klimaatrobuust beeklandschap Aa of Weerij's'. We do this by conducting a semi-structured interview with two key stakeholders in the project 'Klimaatrobuust beeklandschap Aa of Weerij's'. We present our proximity tool (App. H), which is developed on the basis of the findings and discussion in this study, to the two key stakeholders. We ask them, whether they recognize the three main elements of the proximity tool in their daily work; and if so, in what sense. If the persons interviewed recognise the three main elements of the proximity tool in their daily work, and should they be able to confirm the possible value of working with the proximity tool, than the proximity tool can serve as an advice for the Province of North-Brabant. It can serve as advice, specifically concerning the regional planning for the Aa of Weerij's-project, or more generally for use in preparing regional planning projects aimed at implementing nature-based solutions to strengthen the climate resilience of regional brook catchments. This will then be the contribution of this research to the regional practice of JKP for NbS in brook catchments. We have chosen to ask stakeholders in the Aa of Weerij's regional planning project for the validation interview, because this project has comparable goals to those for the Aa-project. A partial transcript of the interview held, and the contact information of the persons interviewed is included (App. I).

The most important way in which we aim at strengthening the validity of this study, is by providing an in-depth, step-by-step description of the research project throughout this research report, as opposed to validating the qualitative findings of this study in the statistical sense. Additionally, the purpose of the interview is to augment the credibility of the research findings. We do this, by testing the extent to which the research results have external validity (meaning that the results can be generalized or transferred to other settings or contexts) in the opinion of the two stakeholders in this other regional planning project (Sekaran & Bougie, 2016, p. 349). This way of validating research results, rather than establishing the (statistical) validity of the results, points to a development in scientific thought about research validity in qualitative research. Duiveman, in his research on urban renewal, has pointed out that the success and value of a research project should be decided upon jointly, involving stakeholders studied during the research (Duiveman, 2015). Validation of research is in this way considered as a process in which stakeholders evaluate research results during the research (Baarends & Simon, 2017, p. 11).

5 Study area

5.1 Research case: 'Dynamisch beekdal Aa'

As in all of the south and south eastern parts of the Province of North-Brabant (The Netherlands), the Aa brook-systems on sandy soils has been degraded by engineering interventions to prevent flooding and improve agricultural areas, amplified by a growing population and effects of climate change. The project 'Dynamisch beekdal Aa' has aimed at restoring the brook system, using NbS. 'Dynamisch beekdal Aa' involves the regional development of the spatial area from Landgoed Heeswijk to the city of 's-Hertogenbosch. This project is currently in the implementation phase and results of the project are emerging. The trajectory between the Castle of Heeswijk (in the municipality of Heeswijk Dinther) and the city of 's-Hertogenbosch has been completed. For other parts of the Aa further upstream (to the south) various partial projects are being implemented. In this study, we look at the part of the Aa-project which has been finished, from the Castle of Heeswijk to 's-Hertogenbosch.

'Dynamisch Beekdal Aa' was an initiative of the Water Authority (*Waterschap*) Aa en Maas, in which it cooperated with the two municipalities within the project area Sint-Michielsgestel and Bernheze, and the Province of North-Brabant. In the design of the project dating from 2006 (*Eindontwerp Inrichtingsplan Dynamisch Beekdal*, 2006) the project has been divided into six phases intended to be carried out successively. Execution of the project concurs with the realization of two other regional development projects within the same plan area. The first is the displacement and widening of the Zuid-Willemsvaart channel, for which the Department of Waterways and Public Works (*Rijkswaterstaat*) is the mandator. The second is the widening of the provincial road N 279, with *Rijkswaterstaat* as the commissioning party again.

Following the big river inundations in the south of the Netherlands of 1995, the design phase of the Aa-project took place over the period of 1998 to 2005. The project leader who was one of the interviewees for this study started work on the project in 2005 and further prepared the project plans in the period of 2005 to 2011. In this period some land needed for the project execution was purchased from a non-profit organisation (*Brabants Landschap*), owning land in the project area. The initiating authority of the project, *Water Authority Aa en Maas*, had three goals for the Aa-project:

- Preventing flooding of the city of 's-Hertogenbosch (which acts as a lower-lying floor drain for the higher brook-catchment of the Aa);
- Restoring natural and ecological values in the Aa brook catchment and a more natural functioning of the brook-system;
- Reinforcing the resilience of the brook-system for climate change.

Agricultural land by the brook could remain in agricultural use (grass lands and silage maize). The lower lying agricultural grounds (nearest to the brook) would need to be reserved for water storage (calculated to happen once every 100 years). Recreation (canoeing, walking and bicycling through the project area) would become more important in the area, and existing cultural-historical and archeological elements would be accentuated in the landscape, to make the area even more attractive. The *Eindontwerp Inrichtingsplan Dynamisch Beekdal* (2006) was the result of this preparatory project phase.

According to the project leader interviewed, in the period from 2011 to 2013 the entire project proceedings before that moment in 2011 were repeated, because project results over the 2005-2011 period were considered disappointing. During this iteration of the project preparation phase, the initiating authority decided to start out from all the stakeholders' interests, using a so called mutual gains approach. In this period the initiating authority also hired an independent process supervisor, who is one of the interviewees in the context of this study as well. This time around, project preparations lead to an adapted plan for the project. And during this 2011-2013 period, an agreement was reached with a number of stakeholders in the area. Following the agreement, a period of about three years was spent making all individual contracts, following the tendering procedures to hire a contractor, and carrying out the project plans. In 2016 the Aa-project between the Castle of Heeswijk and 's-Hertogenbosch was completed (transcripts of the semi-structured interviews, App. C.4; Pastor, 2014).

5.2 Validation case: 'Klimaatrobuust beeklandschap Aa of Weerij's'

The project 'Klimaatrobuust beeklandschap Aa of Weerij's' concerns the catchment of the Aa of Weerij's-brook from Zundert to Breda, and focusses on the area around Zundert. The brook valley near Zundert is of economic importance, because of the intensive cultivation of strawberries and trees in the area, which makes high demands on the soil and water system and makes the brook valley extra vulnerable (for climate change, and demographic developments). This project has only recently been started up and has not reached the implementation phase yet. The municipality of Zundert, the Province of North-Brabant, Water Authority Brabantse Delta, and various village councils are now in the phase of designing a project, aimed at restoring and reinforcing a natural soil and water system in the brook valley. Where possible, nature-based solutions will be chosen; if necessary, they will be supplemented with technical and other spatial measures. The goal is to produce a cohesive implementation program to make the Aa of Weerij's brook catchment 'climate-robust', and to provide the area with its water needs of the future. The project parties intend to produce a concept implementation program in 2021. The Province of North-Brabant intends to include this implementation program for 'Klimaatrobuust beeklandschap Aa of Weerij's' in their Provincial Program for 2022-2027. The project is also a part of the pilot-project 'Vital Countryside' ('*Vitaal buitengebied*'), initiated by the municipality of Zundert. And the project aligns with the Brabant Environmental Vision (*Brabantse Omgevingsvisie*), in which 'rendering Brabant climate-proof' is listed as one of the Province's main societal tasks. The Province and Water Authorities wish to start the work on this "climate-proofing" goal by working on three projects concerning 'climate-robust' brook landscapes, with various stakeholders in three areas of North-Brabant. The Aa of Weerij's in Zundert is one of those three brook landscapes (Axxia, n.d.; figure 5).

The Province of North-Brabant

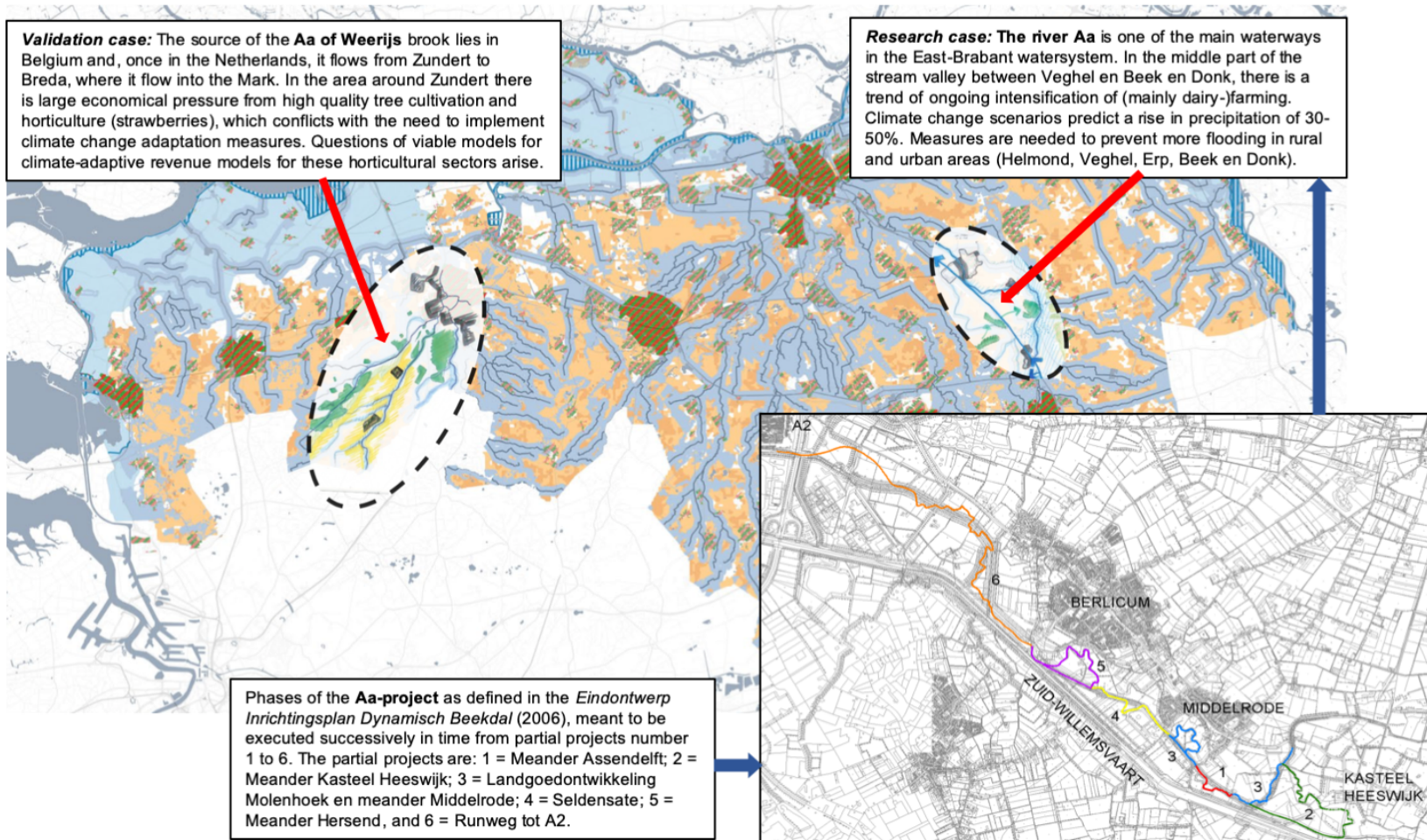


Figure 5. The North-Brabant water-systems of the brooks Aa (research case) and Aa of Weerijis (validation case), with stream valleys indicated in blue, dry sandy soils indicated in orange, and urban areas coloured in red and green. Adapted from Buijnsters et al. (2018) and *Eindontwerp Inrichtingsplan Dynamisch Beekdal* (2006).

6 Results and analysis

6.1 First research question: visualisation of the knowledge network

Answering derived research question 1: visualisation of the main stakeholders in the knowledge network involved with the JKP restoration project for the Aa, including their positions in terms of the quadruple helix model, and their relations of geographical proximity.

Fourteen stakeholders are selected for the visualisation of the knowledge network in the Aa-process (table 9).

Table 9

Node	Stakeholder	Quadruple helix	Geographical proximity
1	Municipality of Sint-Michielsgestel	Government	Local
2	Four farmers nearby the villages of Berlicum and Middelrode (municipality of Sint-Michielsgestel)	Industry	Local
3	An agricultural contracting company, employing personnel	Industry	Local
4	Estate 'De Wamberg'	Non-profit organisation	Local
5	Inhabitants of Berlicum and Middelrode	Non-profit organisation	Local
6	Local inhabitants with recreational interests, notably (Nordic) walking and bicycling	Non-profit organisation	Local
7	Water Authority Aa en Maas	Government; <i>aspects of Academia</i>	Regional
8	The Province of North-Brabant	Government; <i>aspects of Academia</i>	Regional
9	Municipality of 's-Hertogenbosch	Government	Regional
10	Het Groene Hart	Non-profit organisation	Regional
11	Het Brabants Landschap	Non-profit organisation	Regional
12	P2	Industry <i>aspects of Academia</i>	(Inter)national
13	Arcadis	Industry <i>aspects of Academia</i>	(Inter)national
14	Grontmij/Sweco	Industry <i>aspects of Academia</i>	(Inter)national

The analyses of the network active in the Aa-process is visualized (figure 6). The nodes visualised represent the stakeholders involved in the project. Nodes are placed within a coloured frame, representing their belonging to a “helix” of the quadruple helix model. Conspicuous in the visual representation is the fact that there are no purely green nodes present, indicating that no representatives of academic organisations, such as universities or other research institutes, were involved in the project implementation. This may be a characteristic of the way regional planning is organised in the Netherlands, where consultancy and engineering firms are important for including science and engineering into regional planning. More details about all stakeholders are presented, including reasons for their selection in the visualisation, and their roles in the Aa-project (App. E).

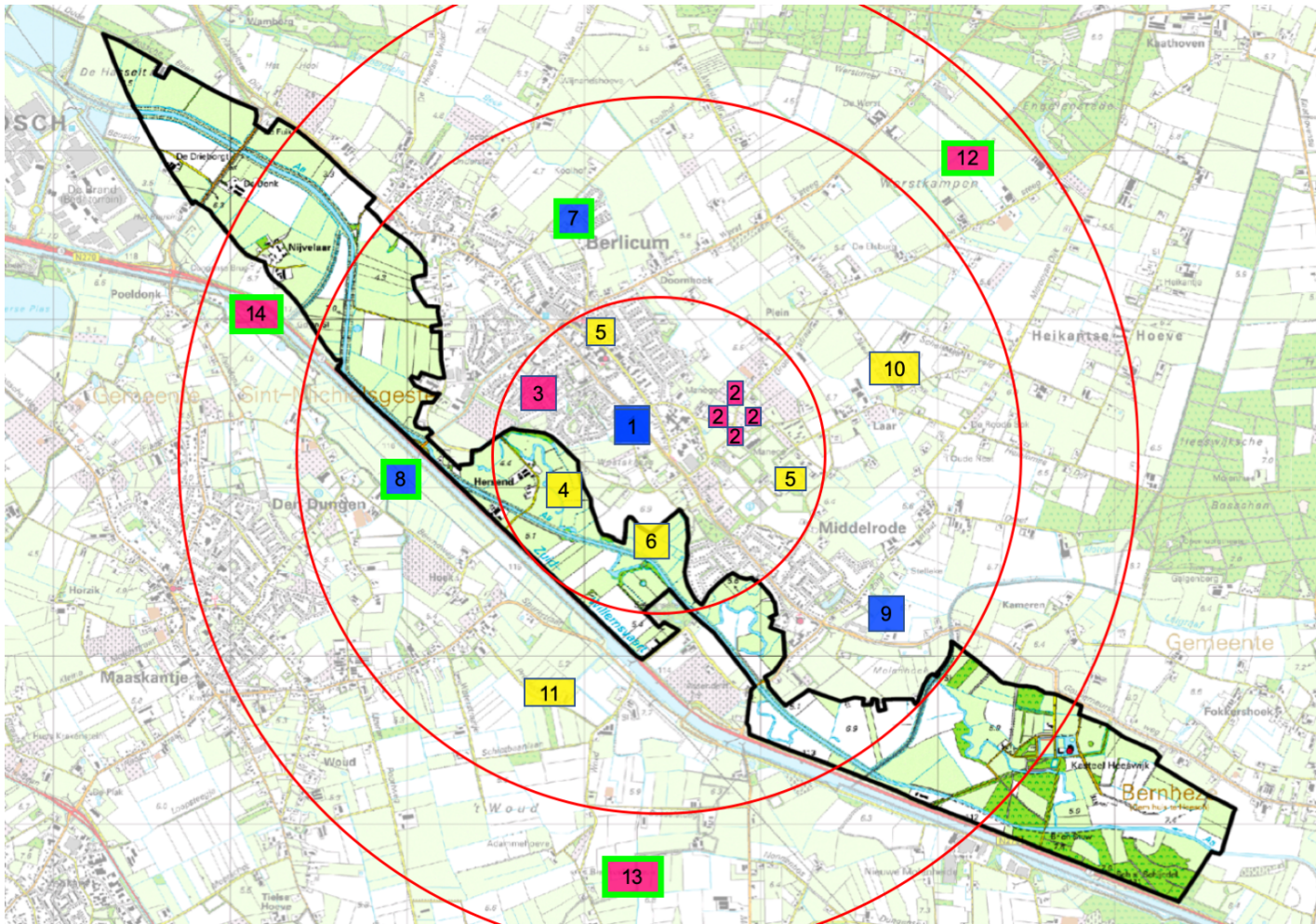


Figure 6. Visualization of the network analyses of the Aa-process, projected on the trajectory of the river Aa. Reprinted and adapted from Burgmans, Jong, & Staak, 2009. In the visualisation, the black line around the Aa-brook represents the border of the regional planning area for the Aa. The coloured frames around the nodes represent their belonging to a “helix” of the quadruple helix model. A blue coloured frame represents a government stakeholder. A red coloured frame represents an industrial stakeholder, or a stakeholder who is associated with a company. A green coloured frame represents a stakeholder working within academia, or a stakeholder who will likely contribute scientific or engineering insights to the project. A yellow coloured frame represents a stakeholder who represents a non-profit organization, or private interests.

6.2 Second research question: the success of the project for the stakeholders

Findings, related to answering derived research question 2: the experiences the main stakeholders report on the success of JKP for NbS in the Aa-project

We have created a database on the basis of the coded interviews, which we use to perform the analysis of the data (App. F). From the coded interviews in Atlas.ti we can now show how often each code from the code-book, based on the four forms of dynamic proximity (Chapter 4), is mentioned in the interviews. And we can summarize the data, showing how often each family of codes from the code-book is mentioned in the interviews (summary in table 10, complete results in App. G.1).

Table 10 Summary of scores on notions of dynamic proximity for every respondent interviewed and for every code (phrases on notions of dynamic proximity), in this table summarized in code-families.

	R1	R2	R3	R4	R5	R6	R7	Endtotal
cognitive	34	15	29	49	29	74	36	266
cognitive+geographical	0	15	16	44	32	58	45	210
cognitive+institutional	25	24	20	31	13	34	16	163
geographical	1	11	8	11	17	27	10	85
geographical+social	0	4	4	13	3	13	19	56
institutional	37	24	28	63	23	42	41	258
institutional+geographical	7	6	13	13	20	35	28	122
social	18	8	25	40	5	26	19	141
social+cognitive	1	0	9	3	4	21	4	42
social+institutional	6	16	21	11	0	24	14	92
Endtotal	129	123	173	278	146	354	232	1435

Note: The codes are grouped together in code-families of dynamic proximity, as described in the code-book. *Legend:* traffic light colour coding: the darkest red – no scores – amber: mediate scores – the darkest green: highest scores

First, we note that in the quotes coded, the incidence of code-families is unevenly spread, with over 200 quotes coded in the cognitive, institutional and combined cognitive and geographical code-families. On the other hand, under 100 quotes were coded in the geographical, and in the combined social and cognitive, geographical and social, and social and institutional code-families (figure 7). Also differences between interviewees appear (further analyzed in the following).

Total - dynamic proximity dimensions

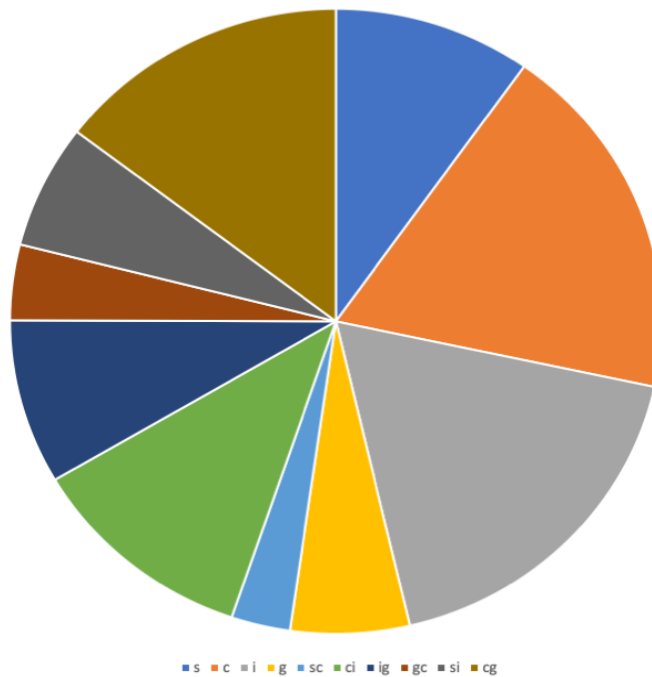


Figure 7. Shown is the relative incidence of quotes in the code-families concerning the social (s), cognitive (c), institutional (i), and geographical (g) forms of dynamic proximity; and concerning the combined institutional and geographical (ig), geographical and social (gc), social and institutional (si), cognitive and geographical (cg), social and cognitive (sc), and cognitive and institutional (ci) forms of dynamic proximity.

6.2.1 The Aa-project is successful for the majority of respondents

Focussing now on the respondents' experiences of success or failure, in a broad sense the scores show that respondents experience the results of the Aa-project more strongly as a success than as a failure. Four respondents report more success-experiences than failure-experiences; three respondents experience more failure-experiences than success-experiences (summary in table 11, complete results in App. G.2). For example, respondents were positive about the speed of achieving process-results over the 2011-2013 period, during which time agreement was reached with stakeholders. Also, a number of respondents have praised the natural feel of the Aa brook catchment area after completion of the project.

Table 11 The number of times each code has been scored for every respondent, grouped in the categories 'failure', 'neutral', and 'success'

	R1	R2	R3	R4	R5	R6	R7	Endtotal
Failure	55	43	14	28	37	48	21	246
Neutral	72	75	128	204	92	256	175	1002
Success	2	5	31	46	17	50	36	187
Endtotal	129	123	173	278	146	354	232	1435
Value for S/F ratio	0,04	0,12	2,21	1,64	0,46	1,04	1,71	0,76

Note. The table is sorted in three categories: codes indicating success-experience; codes indicating failure-experience; codes indicating a normatively neutral experience. The bottom row shows the success (S) / failure (F)-ratio: a score of 1 means: the respondent reported just as many experiences of success as experiences of failure. A score higher than 1: indicates relatively more success-experiences. A score lower than 1: indicates relatively more failure-experiences. So, respondents scoring over 1 we consider as experiencing the Aa-project as successful on the whole.

6.2.2 Relative success-experiences go together with relative variety in codes scored

The respondents who experience relatively little success in relation to the project-results, generally also show relatively little variety in their scores on the various codes. Reversely, those experiencing relatively more success in relation to the projects-results, generally score on a relatively wider range of different codes (table 12).

Table 12 The relation between variety in scoring on codes by respondents and the experience of success or failure by the respondents concerning the project

	Failure	Neutral	Success	End total	Ratio S/F	Ratio div.
R1	10	13	2	25	0,20	0,40
R2	10	19	3	32	0,30	0,52
R3	8	33	12	53	1,50	0,85
R4	9	35	11	55	1,22	0,89
R5	10	24	6	40	0,60	0,65
R6	9	37	11	57	1,22	0,92
R7	10	38	10	58	1,00	0,94
End total	66	199	55	320	0,83	0,74

Note. In this table, it is not the number of scores on a specific code which has been counted, but only whether the respondent has scored on a specific code or not. So shown here are results on the basis of a 0/1-scoring on codes. In this way, the table scores diversity in the use of codes by respondents. In the code-book 12 codes indicating an experience of success are used, 12 codes indicating an experience of failure, and 38 codes indicating a normatively neutral experience. Therefore the S/F-ratio in a 0/1-count is meaningful, as it starts out from 12 possible scores on both success- and failure-experiences. The Ratio S/F in this table differs from the S/F ratio in table 11, only in this sense: table 12 is based on the 0/1-counting of the use of codes. A score of 1 in this table means just as many *different* codes expressing an experience of success as *different* codes expressing an experience of failure have been used by the respondent. >1 Means relatively more *different* success-scores; <1 means relatively more *different* failure-scores. The column on the right Ratio div. is the End total / 62-ratio. In the code-book 62 different codes are used. The Ratio div. is a number for the degree of diversity in codes scored on for each respondent. A score of 1 is the maximum, meaning that the respondent has scored on every code in the code-book during the interview. Both right side columns together show that each respondent who scores >1 on Ratio S/F, also scores $\geq 0,85$ on Ratio div. Reversely, each respondent who scores <1 on Ratio S/F, also scores $\leq 0,65$ on Ratio div.

6.3 Third research question: the dynamic proximity relations between the stakeholders

Findings, related to answering derived research question 3: describing the dynamic proximity relations between the main stakeholders towards each other in the Aa-project

6.3.1 Overdoing institutional or geographical aspects of proximity

Qualitatively analyzing the interview transcripts, some quotes seem to indicate that it is possible to overdo an aspect of proximity, in such a way that it gives rise to adverse effects.

Overdoing the aspect of institutional proximity:

Respondent: "Ja eh, dan moest je; soms had je de bestuurders nodig om ambtenaren 'ja' te laten zeggen. Of onder de kont te laten schoppen thuis. En dan moest je, dan gingen we wel eens een keer koffie

drinken bij een [stadsbestuurder, red. EB] ja, in Den Bosch ook en zo [Name of private person, red. EB] hadden we; en die deed dat ook goed. Maar, ja, dan moest je ook soms, hebben we gewoon mensen laten wisselen, want die willen we niet meer zien. En, ja, ik bedoel dat moet dan, als je niet in dat proces mee kunt. Dat was bij het Waterschap ook, de grondverwerver, ja een goede mens, maar totaal ongeschikt voor zo'n proces. Ja, die hebben ze toen ook geparkeerd, en.."

Interviewer: "En dat is.. waar zit hem dat dan in?"

Respondent: "Ja, de houding hè. Van, uhm, niet zich kunnen verplaatsen in het gevoel van de ander. En als je de grondverwerver van de Provincie, dat was een eh... en die van de gemeente [name of Municipality, red. EB], dat waren boerenzonen, van huis uit."

Interviewer: "En dat hielp?"

Respondent: "Dat helpt, want die snappen het probleem."

In the above quote, institutional proximity seems to be used to exclude certain stakeholders (social exclusion), which can be considered as a trade-off between institutional and social proximity.

Interviewer: "In die tijd dat u erbij betrokken was, was uw gevoel toen dat alle mensen die belang hadden bij de uitvoering van het project, dat die ook inderdaad bij het project 'Dynamisch Beekdal Aa' betrokken waren?"

Respondent: "Weet je, als je zo'n gigantisch, vreemd project, hè.. voor de meesten was; Dynamisch Beekdal is één van de eerste grotere projecten in het kader van waterbeheersing, hè. Dan uh, ja dan is dat voor een heleboel mensen is dat toch nog, ja lastig om te begrijpen. Dan krijg je uhm, vooral via het waterschap, is dan toch zeg maar meer de, hoe zeg je dat, de trekker, de duwer, om toch iets te gaan doen. Nou, dan komen daar een heleboel partijen bij, de gemeente, waterschap, natuurclubs, nouja, uhm, misschien, hoe heet het, de heemkundekring, nou, historische vereniging noem het maar op hè. Dus mensen van allerlei pluimage. De landbouw ben ik nog vergeten, één van de belangrijke partijen. Nou en dan moet je proberen om, eh, die groeperingen, om die allemaal een beetje naar, één richting in te krijgen. Die moet je overtuigen van het nut dat er zo'n gigantisch project, waar zoveel geld mee gemoeid is, waar zoveel landbouwgrond mee gemoeid is, hè. Want uiteindelijk zaten best veel boeren langs dat Dynamisch Beekdal. En die moet je, eh, die moet je meekrijgen. Het belang van economisch-ecologisch, hè. Want als je, zodra het je lukt om economie en ecologie in balans te krijgen, dan ben je een heel eind."

Interviewer: "Ja."

Respondent: "Nou, da's echt eh, een bloed-zweet-en-tranen traject geweest."

Interviewer: "Ja?"

Respondent: "Ja. Eh, omdat, wat je net zegt: er spelen zoveel verschillende belangen. En leg dat maar eens goed uit; waarom hier boeren moeten wijken, omdat Den Bosch geen natte voeten meer mag krijgen in de toekomst."

In the above quote, institutional communication-channels seem to be used to "push" stakeholders towards a discourse, preferred by one, possibly dominant institutional stakeholder, which can be considered as a trade-off between institutional and cognitive proximity.

Overdoing the aspect of geographical proximity:

Respondent: "want [a municipality in the region, red. EB] moest bijvoorbeeld zijn bijdrage; die hebben heel veel gronden en die verpachten ze elk jaar. En we hadden afspraken gemaakt dat er voor die boeren door [same municipality, red. EB], ik geloof 15, 20 hectare of zo, vrijgehouden zou worden. Die zij dan konden gebruiken, hè, voor dat.."

Interviewer: "Ja, als ruil?"

Respondent: "Om die Rosmalense Aa enzo te kunnen maken, het laatste stuk grond tegen het kanaal enzo. Dat was hun inbreng. Ja, dan, als je dan een techneut, mee begonnen ze daar op Economische Zaken, want dat is allemaal, dat moet aanbesteed worden elk jaar opnieuw en dat is, dat zijn enorme.."

Interviewer: "Ja, ja."

Respondent: "En je kunt niet voortrekken, en weet ik het niet meer. Nouja, dan moet er dus iemand zitten, die zegt van: 'godverdomme, ik heb dit, en je kunt die boeren...' Dat moet daar in dat huis moet dat opgelost worden.

Interviewer: "Ja, dat is ook een vorm; misschien een kwestie van betrouwbaarheid. Dat je afspraken.."

Respondent: "Ja, maar dat kan niet. Die 20 hectare reserveren voor.."

Interviewer: "Nee, want dan zit je met Europese aanbestedingsregels?"

Respondent: "Nee, dat kan wel, als je het maar wilt."

In the above quote, local interests and conflict-solving on the one hand and larger-scale institutional rules (such as European tendering procedures) on the other hand seem to conflict, which can be considered as a trade-off between geographical and institutional proximity.

Respondent: "Ja, deelprojecten. Even kijken.. Je ziet hoe hoogwaardig het gebied is gewaardeerd in de, in het formele beleid. Maar goed, het werd in acht stukken gehakt. Die werden als, die werden als stand-alone plannen werden die ontwikkeld door het waterschap, en door het waterschapsbestuur beoordeeld. En wat was nou de keuze die wij gemaakt hebben? ... Ze hadden twee keuzes. Die keuzes zijn, we gaan, want het was in het kader van droge voeten voor Den Bosch, we gaan ervoor om die beek, het beekdal weer te laten functioneren zoals het vroeger was. Want deze genormaliseerde beek, die zat helemaal tussen dijken. Dus dat betekende gewoon: het dal kon niet meer overstromen. We gaan het weer terugbrengen zoals vroeger. We gaan het dal weer terugbrengen als een waterbuffer om te voorkomen dat Den Bosch natte voeten krijgt. Of, B, we gaan naar gestuurde waterberging. Dan gaan we toch weer gebruik maken van dijken, maar dan maken we daar sluisjes in en dan kunnen we, als de nood eraan komt, trekken we een sluisje open en dan kan er ergens een stuk van het beekdal onder water lopen, dus gestuurd. Maar dat zou betekenen dat het niet meer natuurlijk zou functioneren. Natuurlijk is gewoon: daar stroomt een beek, die meandert er. Er komt water toevloed. De beek stroomt over en de toevloed van het water wordt geborgen in het beekdal. Het beekdal is ongeveer 100 keer breder dan de beek zelf, dus op een gegeven moment krijg je een gigantische waterberging en het beekdal zelf werkt als een brede rivier; stroomt af. Dat heet dan natuurlijke afstroom. En je had dus de gecontroleerde. Nou, er is een MER rapportage gemaakt, en die zei: als je terug wilt naar het natuurmodel, wordt de natuurwaarde het best gediend door een vrij stromend model. Dus de dijken weg, weer hermeanderen, laat de natuur zijn werk maar doen. Dat is eigenlijk automatisch: hoog water, loopt vol; laag water, loopt leeg. Of gedeeltelijk loopt het vol, als het minder hoog water is. Toen heeft het waterschap, moest beslissen: waar gaan wij voor? Voor onze boeren is het beste als we naar het gestuurde model gaan. Maar de MER heeft geleerd dat daar de milieuwaarden minder mee gediend worden dan met het andere. Toen hebben ze gezegd: we brengen een offer; wij vinden ook dat de boeren maar een offer moeten brengen. Wij besluiten te kiezen voor het vrij stromend model."

In the above quote, just the reverse seems to happen: local interests seem to be "pushed away" by institutional means, which may be considered as a trade-off between institutional and geographical proximity.

Respondent: "Want je kunt er heel veel mensen bij roepen. En we hebben het eerst eigenlijk hier, ons, ehm, de boeren zeg maar. Die ronde hebben we eerst afgewerkt. Daar waren we eigenlijk mee rond, en toen zijn we pas naar de burgers gegaan.

Interviewer: "Oh, hhmh."

Respondent: "Dat vonden ze minder leuk."

Interviewer: "Wie vond dat minder leuk; de burgers?"

Respondent: "De burgers. Want ja, iedereen wil natuurlijk iets zeggen."

Interviewer: "Ja. En de burgers, dat was inclusief [*name of municipality, red. EB*]?"

Respondent: "Nee, dat was eigenlijk hier meer [*name of another, smaller municipality, red. EB*] eigenlijk. Kijk, wij zitten hier zeg maar, maar dan heb je een hoop mensen die grenzen weer aan die rand en iedereen heeft een zegje; dat mag ook. Dus toen waren wij op een gegeven moment rond, en toen hebben ze een grote bijeenkomst in het dorps huis gehouden en daar mocht dan ook iedereen uit [*smaller municipality mentioned before, red. EB*] mocht daar ook komen, en die mochten dan de plannen kijken, en dan mochten ze ook hun zegje doen en noem maar op, en ja. Er waren wel een paar puntjes die, ja, die wat minder waren, of minder vonden en ja... Was eigenlijk hetzelfde als waar wij ook mee begonnen zijn. Ja, die dijk en dit en dat. Want je hebt ook mensen hier bij de protestantse kerk. De protestantse kerk is een hoger gedeelte van [*smaller municipality mentioned before, red. EB*] zeg maar. Want dat lieten ze vroeger ook niet onder water lopen. Dat wisten ze wel waar ze het moesten bouwen. Die hadden een hoger stuk, en daar langs hebben ze ook allemaal wel gebouwd, maar die liggen allemaal lager. Dus toen moest er eigenlijk ook een beetje een natuurlijke dijk komen, en met die mensen zijn ze toen eigenlijk in gesprek gegaan zeg maar. 'Maar hoe gaan we dat proberen op te lossen', of eh, dit en dat. Maar dat was pas de tweede ronde in principe eigenlijk, en daar zijn ook nog wel een paar puntjes uitgekomen, dat we eigenlijk in eerste instantie niet wilden, maar uiteindelijk dan toch, ja, voor het dorp, dan toch wel gedaan hebben."

In the above quote, the most geographically near stakeholders (living closest to the Aa) seem to participate in the earliest roundtable discussion, already taking some important decisions before other stakeholders (geographically a bit further away) are involved, which can also be considered as a trade-off between geographical and social proximity.

Respondent: "[*The project leader, red. EB*] had een training gevolgd, MGA, *mutual gains approach*, en had bedacht: als we het op dezelfde manier blijven doen als we die 17 jaar gedaan hebben, bereiken we misschien geen doorbraak. Misschien moeten we het eens op een hele andere manier gaan doen. En toen is in een tijdsbestek, ik denk dat dit ongeveer 2012 was, die periode, in een tijdsbestek van een, iets meer dan een jaar, zijn we gekomen tot overeenstemming met het gebied, van: zo gaan we het doen. En ik denk dat het daarna nog een jaar of twee geduurd heeft, voordat ook alle individuele contracten er lagen, en de aanbesteding met de aannemer rond was. En misschien toen nog een jaar of twee jaar uitvoering. Zoiets, dus dat., en mijn betrokkenheid was vooral dat ene jaar om tot overeenstemming te komen met de partners." ...

Respondent: "Ik ben best wel trots op het resultaat, en wat we met elkaar hebben bereikt. Ik ben nooit tevreden; dat is een beetje mijn aard. Ik zie vanuit reflectie en zelfreflectie zie je altijd dingen die beter hadden gekund, of efficiënter hadden gekund... ik heb in dit proces weinig combinatie van echt wetenschappelijke kennis nodig gehad. Ik merk dat dat nu meer komt. Ik heb een paar stikstof vraagstukken op mijn bord liggen. Daar heb je dat meer hè. Maar dan, dan gaat het nog niet eens zozeer om de kennis, maar veel meer om het proces: welke kennis gaan we eigenlijk met elkaar erkennen? Gaan we net doen alsof er geen stikstofprobleem is? En welk van de rapporten vinden wij leidend in dit gesprek? En gaan we daarop varen of niet? Dus, eh, dat komt wel meer en meer."

In the above quotes the respondent seems to point to a focus within the Aa-project on reaching "consensus with the area" (geographical proximity), and less on the use and creation of knowledge (cognitive proximity), which may be considered as a trade-off between geographical and cognitive proximity.

Overdoing the aspect of social proximity was not a conspicuous feature in the interview-transcripts. Possibly this has to do with the setting of the type of project studied. In regional planning projects, there is automatically a great diversity of stakeholders. The existence of

this diversity of stakeholders possibly prevents a social comfort-zone (or: too much social proximity) from emerging easily.

Overdoing the aspect of cognitive proximity was not a conspicuous feature in the interview-transcripts either. Again, this may also have to do with the setting of the type of project studied. The diversity of stakeholders involved in regional planning projects entails a variety of interests the stakeholders wish to defend, and a diversity in knowledge they wish to spread.

6.3.2 Respondents living near the Aa-brook experience relatively more success

The respondents who live (and often work) near the Aa-brook relatively report more success-experiences in relation to the project results, than the respondents living further away from the Aa (table 13). We have defined 'respondents living near Aa' as those stakeholders who have been labelled as 'local' in Chapter 5.1 (table 9). We have defined 'respondents not living near Aa' as those stakeholders who have been labelled 'regional' or '(inter)national' in Chapter 5.1 (table 9).

Table 13 Success- and failure-experiences in relation to living near or far from the Aa

	Failure	Neutral	Success	End total	Ratio S/F
<i>Not living near Aa</i>	160	531	88	779	0,55
<i>Living near Aa</i>	86	471	99	656	1,15
End total	246	1002	187	1435	0,76

Note. In the table the number of scores on a specific code has been counted (so no 0/1-count). So here again, a score higher than 1 indicates relatively more success-experiences; a score lower than 1 indicates relatively more failure-experiences.

A possible explanation for this difference may be that in the Aa-project there has been relatively much attention for stakeholders' interests and for available project-resources, which may have favoured stakeholders living nearest to the Aa-brook. This relative focus shows in the fact that relatively many quotes were scored within the broad family of cognitive codes (including stakeholders' interests) and the broad family of institutional codes (including available project-resources) (table 14).

Table 14 Relatively many codes were scored in the broad families of cognitive and institutional codes, possibly pointing to a focus in the Aa-process on stakeholders' interests and available project-resources

	R1	R2	R3	R4	R5	R6	R7	End total
cognitive	34	15	29	49	29	74	36	266
cognitive+geographical	0	15	16	44	32	58	45	210
cognitive+institutional	25	24	20	31	13	34	16	163
geographical	1	11	8	11	17	27	10	85
geographical+social	0	4	4	13	3	13	19	56
institutional	37	24	28	63	23	42	41	258
institutional+geographical	7	6	13	13	20	35	28	122
social	18	8	25	40	5	26	19	141
social+cognitive	1	0	9	3	4	21	4	42
social+institutional	6	16	21	11	0	24	14	92
Eindtotaal	129	123	173	278	146	354	232	1435
Cognitive broad	60	54	74	127	78	187	101	681
Geographical broad	8	36	41	81	72	133	102	473
Intitutional broad	75	70	82	118	56	135	99	635
Social broad	25	28	59	67	12	84	56	331
Ratio cognitive broad	0,47	0,44	0,43	0,46	0,53	0,53	0,44	0,47
Ratio geographical broad	0,06	0,29	0,24	0,29	0,49	0,38	0,44	0,33
Ratio institutional broad	0,58	0,57	0,47	0,42	0,38	0,38	0,43	0,44
Ratio social broad	0,19	0,23	0,34	0,24	0,08	0,24	0,24	0,23

Note. The table shows which families of codes have been mentioned more often, and which ones have been mentioned less often by the respondents (counting number of scores on every code). The 'Ratio cognitive broad' shows how many scores in the 'cognitive broad'-family have been counted for each respondent, relative to each respondent's total number of scores (on all codes), and so on for the other Ratio-categories. It shows that over all seven interviews, 'cognitive broad' and 'institutional broad' scored relatively highest.

Moreover, considering the scores on all the normatively neutral codes and comparing how often each of these codes was scored in all seven interviews shows that the individual codes pertaining to stakeholders' interests (code 11) and the project's resources (code 21) score relatively high. This again illustrates that negotiating interests and resources played a prominent role in the Aa-project (table 15), possibly favouring respondents living near the Aa brook system.

Table 15 Negotiating interests and resources seemed to play a prominent role during the Aa-process

Codes	Times scored
33 social+cognitive/introduce discourse reluctant stakeholder in project	4
32 social+cognitive/roundtable for reluctant stakeholder	4
07 social/minimize time investment	5
03 social/roundtable	7
50 geographical+social/include preparatory process-phase for deciding who are all stakeholders	7
14 cognitive/science-practitioner	9
06 social/meeting objections	9
04 social/consultation structures	9
48 geographical+social/balancing involvement of stakeholders near & far	9
13 cognitive/situation assessment	9
05 social/being heard	11
49 geographical+social/take time for deciding who are all stakeholders near & far	11
24 institutional/consciousness of quadruple helix	12
12 cognitive/joint fact finding	12
44 institutional+geographical/MGA + negotiating local rules	14
55 social+institutional/urge reluctant stakeholders with own rules & roles to participate	15
43 institutional+geographical/meeting up nearby to include local rules	17
47 geographical+social/all stakeholders near & far involved	17
54 social+institutional/take time for deciding who are all stakeholders with own rules & roles	17
28 geographical/meeting up nearby	19
31 social+cognitive/the reluctant stakeholder	19
15 cognitive/vizualise science on local scale	21
42 institutional+geographical/balancing with local rules	21
38 cognitive+institutional/use process management in planning & realisation	22
02 social/fair play	23
23 institutional/open discussion on rules & roles	24
37 cognitive+institutional/take time for clear rules in planning & realisation	25
22 institutional/due diligence of process	27

53 social+institutional/all stakeholders with own rules & roles are involved	30
61 cognitive+geographical/success thanks to viable combinations of local & large-scale knowledge	37
21 institutional/appropriate resources	38
41 institutional+geographical/local rules, roles, tasks in project	38
11 cognitive/MGA	39
60 cognitive+geographical/incorporating local knowledge into general models/scenarios	39
27 geographical/local or practical knowledge included	42
19 institutional/shared set of rules	45
59 cognitive+geographical/balancing the combination of local & large-scale knowledge	45
01 social/participation	48
20 institutional/clear division of tasks & roles	52
36 cognitive+institutional/clear rules during planning & realisation	60
58 cognitive+geographical/local & large-scale knowledge is included in project	61
10 cognitive/shared problems & goals	91
End total	1064

Note. The table shows the order of the frequency in which the various codes without a normative intention appeared in the seven semi-structured interviews

This relative focus within the Aa-project on stakeholders' interests and available project-resources can be interpreted in the light of the history of the project. The interview transcripts paint a picture of the process of the Aa-project, in which the first years are characterized by conflict and troubled relationships between stakeholders. Before starting a more productive phase of the project's process, existing conflicts and frustrations had to be tackled. This required ample attention for and openness about stakeholders' interests and available project-resources.

6.3.3 Knowledge-production in the Aa-project

Has no shared knowledge been produced during the process of the Aa-project then? The question remains unanswered when looking at the coding in Atlas.ti, as the broad family of cognitive success-scores (which includes success-experiences on the field of knowledge production) scores high in relation to other broad families of success-scores (for broad social, institutional, and geographical success). But the broad family of cognitive success-scores includes success on the subject of negotiating stakeholders' interests, which is no knowledge production in the narrow sense (table 16).

Table 16 The table shows the relative importance in the interview-transcripts of the broad family of cognitive success-experiences on the one hand, and the other three broad families of success-experiences on the other hand

	R1	R2	R3	R4	R5	R6	R7	End total
Success	2	5	31	46	17	50	36	187
05 social/being heard	1	0	3	5	0	0	2	11
06 social/meeting objections	0	0	1	4	1	3	0	9
07 social/minimize time investment	0	0	1	2	0	2	0	5
16 cognitive/success thanks to shared problems & goals	0	0	4	8	3	12	5	32
25 institutional/success thanks to clear rules & roles	1	3	2	6	2	3	6	23
29 geographical/success thanks to meeting up nearby	0	1	1	3	3	7	1	16
34 social+cognitive/success through introduction discourse reluctant stakeholder	0	0	2	0	0	2	1	5
39 cognitive+institutional/success thanks to clear rules during planning & realisation	0	0	5	4	0	4	3	16
45 institutional+geographical/success thanks to inclusion of local rules & roles	0	0	2	2	3	4	2	13
51 geographical+social/success thanks to inclusion of right balance in stakeholders near & far	0	0	1	3	0	1	2	7
56 social+institutional/success thanks to participation of all stakeholders with own rules & roles	0	0	5	2	0	2	4	13
61 cognitive+geographical/success thanks to viable combinations of local & large-scale knowledge	0	1	4	7	5	10	10	37
End total	2	5	31	46	17	50	36	187
Cognitive success	0	1	15	19	8	28	19	90
Ratio cognitive success vs. success total	0,00	0,20	0,48	0,41	0,47	0,56	0,53	0,48

Note. A ratio of 0,25 would mean an even spread of scores on the four different families of success-experiences. The table shows that the broad family of cognitive success-experiences scores higher than 0,25 in five of the seven interviews.

Therefore, in possible future research on the basis of our theoretical model, we would recommend to refine the aspects of proximity discerned by adding two separate aspects. In accordance with Hegger's theory, we would add an aspect of proximity related to resources again. We recommend this, because resources (as opposed to other elements of institutional proximity) are often used as a means of exchange for stakeholders' interests (for "paying off" stakeholders' interests). Also, we would add an aspect of proximity related to interests, in this way dividing the aspect of cognitive proximity in two, because we want to study joint *knowledge* production. To analyse the use and production of knowledge in a project, knowledge should be separated (in as far as this is possible) from interests.

Nevertheless, the interview-transcripts do give important clues as to how *knowledge* production can be enhanced within the studied type of regional planning projects. In the interviews, various instruments are discussed which specifically aim at promoting knowledge production in the project (table 17). From the instruments mentioned, only the mutual gains approach (MGA), which has been thoroughly discussed during the interviews, should be excluded (code 11), as this instrument exclusively aims at negotiating interests (Karl, Susskind, & Wallace, 2007; Susskind & Cruikshank, 2006). The code-book (App. D) provides more elaboration on the meaning of the instruments mentioned, in the context of the interviews conducted.

Tabel 17 Table showing a list of all neutral codes (without a normative component) within the broad family of cognitive proximity

Cognitive instruments	R1	R2	R3	R4	R5	R6	R7	End total
11 cognitive/MGA	1	0	7	13	3	6	9	39
12 cognitive/joint fact finding	0	0	2	1	0	7	2	12
13 cognitive/situation assessment	0	0	1	2	1	4	1	9
14 cognitive/science-practitioner	0	0	0	0	0	8	1	9
15 cognitive/vizualise science on local scale	0	0	1	2	3	11	4	21
32 social+cognitive/roundtable for reluctant stakeholder	0	0	1	0	0	2	1	4
33 social+cognitive/introduce discourse reluctant stakeholder in project	0	0	0	0	0	3	1	4
37 cognitive+institutional/take time for clear rules in planning & realisation	0	4	4	6	1	6	4	25
38 cognitive+institutional/use process management in planning & realisation	0	4	5	5	1	3	4	22
59 cognitive+geographical/balancing the combination of local & large-scale knowledge	0	1	4	9	6	16	9	45
60 cognitive+geographical/incorporating local knowledge into general models/scenarios	0	2	4	9	5	10	9	39
Total quotes cognitive instruments	1	11	29	47	20	76	45	229
Total quotes	129	123	173	278	146	354	232	1435
Ratio cognitive instruments quotes / total quotes	0,01	0,09	0,17	0,17	0,14	0,21	0,19	0,16
Ratio cognitive success vs. success total	0,00	0,20	0,48	0,41	0,47	0,56	0,53	0,48

Note. The codes include several valuable instruments (all codes mentioned, except code 11) that can be used to promote knowledge production during the project's process.

6.3.4 No relation shown between success-experiences and the quadruple helix
Specific relations between belonging to a certain pillar in the quadruple helix model on the one hand, and the experience of success of the project on the other hand, have not been found (table 18).

Table 18 Table showing the relation between belonging to a 'pillar' of the quadruple helix of the persons interviewed on the one hand, and the success-failure ratio (counting number of scores on every code) on the other hand

	Failure	Neutral	Success	End total	Ratio S/F
Government	72	395	84	551	1,17
Industry	119	535	101	755	0,85
Non_profit	55	72	2	129	0,04
End total	246	1002	187	1435	0,76

Note. We expect that the table shows no relevant relations, because the persons interviewed are not evenly spread over the four 'pillars' of the quadruple helix. For example, there was no stakeholder involved within the Aa-project, who purely belonged to the Academia 'pillar' (so such a stakeholder could not be interviewed). Also, we only interviewed one stakeholder from the Non profit 'pillar'. We would need more interviewees from this 'pillar' to separate personal views of one individual from more general points of view related to the Non profit 'pillar' of the quadruple helix.

7 Discussion and conclusion

Our aim is to study whether forms of dynamic proximity of the stakeholders in a knowledge network influence the success of joint knowledge production, and if so, to determine which forms of dynamic proximity are most of relevance. We have chosen to look at a process of joint knowledge production in a project, aimed at implementing nature-based solutions to strengthen the climate resilience of a regional brook catchment. In this study, we have directed our attention to such a project for the Aa, a brook catchment in the Province of North-Brabant (the Netherlands). Prior research has suggested that dynamic proximity is important for the realisation of innovation in the context of high-tech economic development. We have asked whether dynamic proximity may also play this important role in creating nature-based solutions, as it also requires a joint creative process. In a qualitative analysis of seven semi-structured interviews, held with stakeholders in our studied project, we have phrased a number of findings, three of which seem central.

7.1 Success-experience goes together with heterogeneity in dynamic proximity

The first finding we presented was that the respondents who experienced relatively more success in relation to the process-results, also generally scored on a relatively wider range of different codes than the respondents who experienced less success. We interpret this finding as meaning that those stakeholders who are able to vary the using of different forms of dynamic proximity in a process are better equipped to experience a process gone through as successful, or to see various successful aspects of it.

This finding is reflected in the literature on proximity and heterogeneity in the field of regional innovation and development. For example Mattes (2012) notes that learning and innovation rely on proximity, but are also closely connected to heterogeneity. According to her, the development of new ideas and creativity is triggered by interaction between heterogeneous actors. At the same time, heterogeneity between actors relies upon some form of cooperation, because one person in isolation cannot be heterogeneous. This insight shows in our findings, because scoring on a variety of different codes from the code-book (in the context of this study) apparently brings in the heterogeneity within the project's process, which is needed to share, acknowledge and absorb new knowledge and insights, and thus to develop and innovate.

7.2 Proximity paradox: overdoing institutional or geographical aspects of proximity

The second main finding we presented was about overdoing certain aspects of proximity, or in other words: about getting too proximate in some respect(s). In the project studied, this 'getting too proximate' primarily showed on the aspects of institutional and geographical proximity, and less on the aspects of social and cognitive proximity. We explained this in terms of the (historical) coming-about of the Aa-project. In more general terms, this showing of the proximity paradox may have to do with relations of dominance. Possibly, the institution(s) initiating this type of regional planning projects, and the stakeholders living nearest to the brook catchment (and especially: owning land near it) are likely to be the most powerful stakeholders in such projects. Therefore, they may be more prone to be caught up in such a paradox of proximity, showing as 'too much proximity' on the aspects of institutional or geographical proximity.

This aspect has been observed within various scientific disciplines and under different headings. Within the field of economic geography it has been described as the proximity

paradox, for example by Broekel and Boschma (2012) who empirically tested the proximity paradox in Dutch aviation industry, concluding that too much proximity on any one dimension of proximity seems to harm innovative performance. In the literature on the credibility, salience and legitimacy of knowledge production (Chapter 2) a comparable point is being made in terms of trade-offs between the credibility, salience and legitimacy of knowledge produced, indicating that one of those three measures for evaluating new knowledge has received too much attention. According to some authors, avoiding such trade-offs requires an iterative process of knowledge production with intense communication efforts (White et al., 2010). According to others, avoiding these trade-offs requires a boundary design, or in some cases an advocacy design, of projects in which ample attention is being paid to contextual, place-based knowledge (McFadgen and Huitema, 2018). Finally, a comparable concept appears in the literature on the historical-institutionalist approach to political science, namely the concept of path dependence (Pierson, 2000). Path dependence points to institutions changing less than might be expected (and holding back advancement), given the existence of improved knowledge or practices, for example because of cost implications, caution, or failure to learn from experience (Jordan & Matt, 2014; Biesbroek, Termeer, Klostermann, & Kabat, 2014). A specific form of path dependence, relevant in the context of this study, is that of lock-in (Kotilainen et al., 2019; Klitkou, Bolwig, Hansen, & Wessberg, 2015). For example, Seto et al. (2016) study the inertia of the reduction of carbon emission, which in their view is caused by various, mutually reinforcing constraints of a physical, economic, and social nature. They call this slow carbon reduction the carbon lock-in. The relevance of the concepts of trade-offs and of lock-in for this study, is that they both describe a “too much of one thing”. Knowledge production, and innovation, apparently require being proximate to each other to enable knowledge transfer, and at the same time they require heterogeneity, a distance, or an openness to new and diverse influences to enable innovation and knowledge production.

7.3 In knowledge-production instruments should be used

The third main finding we presented pertains to knowledge production of the stakeholders in a project aimed at implementing nature-based solutions to strengthen the climate resilience of regional brook catchments. Our findings show that if knowledge production is an aim of the project, as distinct from for example negotiating different interests of stakeholders, than knowledge-production instruments should be used. From the interview-transcripts a number of knowledge-production instruments emerge. Where relevant, we have listed references from the literature, providing more background for specific knowledge-production instruments (table 19). We have made queries in Atlas.ti, listing all the quotes made by the respondents that have been coded as being about knowledge-production instruments, so as to provide more context for the knowledge-production instruments listed (App. G.3).

Table 19 List of all the knowledge-production instruments that have been mentioned by respondents during the semi-structured interviews

Code	Code-title	References
12	<i>Cognitive/joint fact finding</i>	Practice joint fact finding with all stakeholders who hold an interest in the project, and be conscious of who commissions the joint fact finding. (When a representative of one specific interest initiates the joint fact finding-exercise, results may be compromised in advance.) See e.g. Karl, Susskind, & Wallace, 2007
13	<i>Cognitive/situation assessment</i>	Make a situation assessment and share it with all stakeholders.
14	<i>Cognitive/science-practitioner</i>	Have a science-practitioner participating in the project who can suggest and filter relevance of scientific insights. See e.g. Kunseler, Tuinstra, Vasileiadou, & Petersen, 2015
15	<i>Cognitive/visualize science on local scale</i>	Translate scientific insights to the local scale and visualize them on that scale for all stakeholders. See e.g. Shaw et al., 2009
32	<i>Social+cognitive/roundtable for reluctant stakeholder</i>	Mentioned under this code is mainly the organizing of multiple roundtable discussions with “incompatible” stakeholders. In one interview, the goal of this is phrased as ‘informing the reluctant stakeholder, so she can at least take her (legal) steps outside the project’s process in a well-informed way’.
33	<i>Social+cognitive/introduce discourse reluctant stakeholder in project</i>	Not explicitly mentioned in the interviews, but intuitively following from the previous point, is the reversal of the direction of the information. Although the reluctant stakeholder does not participate in the project, the views or discourse of this “outsider” may still be incorporated into the project’s proceedings, so that the arguments and insights of the “outsider” are weighed in somewhat the same way as those of the other stakeholders.
37	<i>Cognitive+institutional/make time for clear rules in planning and realization phases</i>	When building the shared and clear sense of the division of tasks and roles within the project organization, there should always be ample attention for the cognitive aspect, not only in including the (institutional) interests of stakeholders, but also in including (scientific) knowledge. Also captured in this code are quotes about how time should be made to create a clear, shared sense of the division of tasks and roles, the rules applying (fair play, etc.) and the resources available across the different phases of the project. In our interviews these quotes are often about the transition from the regional planning phase to the realization phase of the project.
38	<i>Cognitive+institutional/use process management in planning and realization phases</i>	There seems to be an important role here for the initiator and contracting authority of the project. This stakeholder has the authority to decide on having process management in place during not only the regional planning phase, but also the realization phase. In other words: there should be an authority with enough power to make sure that the same clear, shared sense of the division of tasks, roles and rules exists throughout

		the different phases of the project, and that in all project-phases ample attention is being paid to the cognitive aspect.
59	<i>Cognitive+geographical/balancing the combination of local and large-scale knowledge</i>	When interests and knowledge considered are too strongly directed towards the geographically proximate, there seems to be the possibility of adverse effects. So, the combination of cognitive and geographical proximity seems to partly be about an act of balancing to ensure legitimacy, salience and credibility of the project's proceedings.
60	<i>Cognitive+geographical/incorporating local knowledge into general models or scenario's</i>	Starting from the instruments mentioned under cognitive proximity (above), the combination of cognitive and geographical proximity involves a reversal of the direction of the information. Under the heading of cognitive proximity, the aim was to translate general, large-scale scientific data to the local scale. Now, the focus is on translating local insights into known scientific frameworks and visualizing them as well. E.g. results from joint fact finding sessions might be integrated into models or scenario studies for the project area, in this way using local knowledge from the project's process to complement the scenario's or models.

Note. We have supplemented the knowledge-production instruments that have been mentioned during the interviews with references to scientific literature where informative.

7.4 Conclusion

From the whole of our research, we can now draw our conclusion. We have found that the various forms of dynamic proximity among stakeholders influence the perceived success of the JKP process for creating NbS to support climate resilience of the Aa, in three ways:

1. Stakeholders who are versatile in using the dynamic forms of social, cognitive, institutional and geographical proximity in the process of JKP for NbS, or in other words who are able to mix heterogeneity and proximity, experience the process as more successful;
2. Stakeholders who avoid overdoing the institutional or geographical aspects of proximity also prevent experiencing adverse effects. The various adverse effects that may arise when overdoing the institutional or geographical forms of dynamic proximity, recorded in quotes from the interviews, can be visualized (figure 8);
3. When the right balance of the four forms of dynamic proximity is kept in mind, then specific knowledge production instruments that emerged from the interviews may facilitate the process of JKP for Nabs (Chapter 7.3).

Having shown how relations of dynamic proximity between stakeholders influence the perceived success of the JKP process, we can now state that our contribution to the scientific debate on JKP for NbS lies in showing the usefulness of supplementing the JKP framework by Hegger et al. (2012) with the aspects of dynamic proximity as analysed by Balland et al. (2015).

Additional empirical research is necessary to further validate our conceptual model for the creative process of JKP, which combines the four dimensions of JKP with the four forms of dynamic proximity among stakeholders. For this, we suggest refining our conceptual model by adding two more forms of dynamic proximity. They are about being open about, and

creating shared resources for the project, and being open about, and negotiating stakeholders' interests. These two extra forms of dynamic proximity will enable a sharper focus on knowledge production under the heading of cognitive proximity. This proposed refined conceptual model for future research would then be about balancing six forms of dynamic proximity (table 20).

Table 20 List of the six forms of dynamic proximity, proposed for future research

Code	Code-title	Type of statement made by respondent/Meaning of the code
1	<i>Social/participation</i>	Participation and involvement by <i>all</i> stakeholders
10	<i>Cognitive/shared problems & goals</i>	Shared problem definitions and goals for the project
11	<i>Cognitive/MGA</i>	Use an instrument, whether or not consciously chosen, to have the discussion among stakeholders about interests and possible ways of aligning these various interests, e.g. by using the mutual gains approach (MGA)
19 & 20	<i>Institutional/shared set of rules, and clear division of tasks and roles</i>	There is a shared set of rules which organizes the process of the project. There is a shared and clear sense of the division of tasks and roles within the project organization. An important starting-point for building up this shared sense is the recognition by each stakeholder (always also representing an institutional interest) of the institutional interests of all other stakeholders.
21	<i>Institutional/appropriate resources</i>	Appropriate resources are available to facilitate the project proceedings. Resources may refer to financial resources, but also to legal resources (e.g. the ability to start legal procedures), etc. Knowledge about available resources is shared.
27	<i>Geographical/local or practical knowledge included</i>	Local and practical knowledge is embraced in the project, such as area specific characteristics (e.g. about soil layers, or feeding live stock), and knowledge about the history of the area.

Note. We present the four main forms of dynamic proximity from our theoretical framework, completed with the forms of dynamic proximity related to resources and interests.

Too much proximity may give rise to adverse effects (proximity paradox)

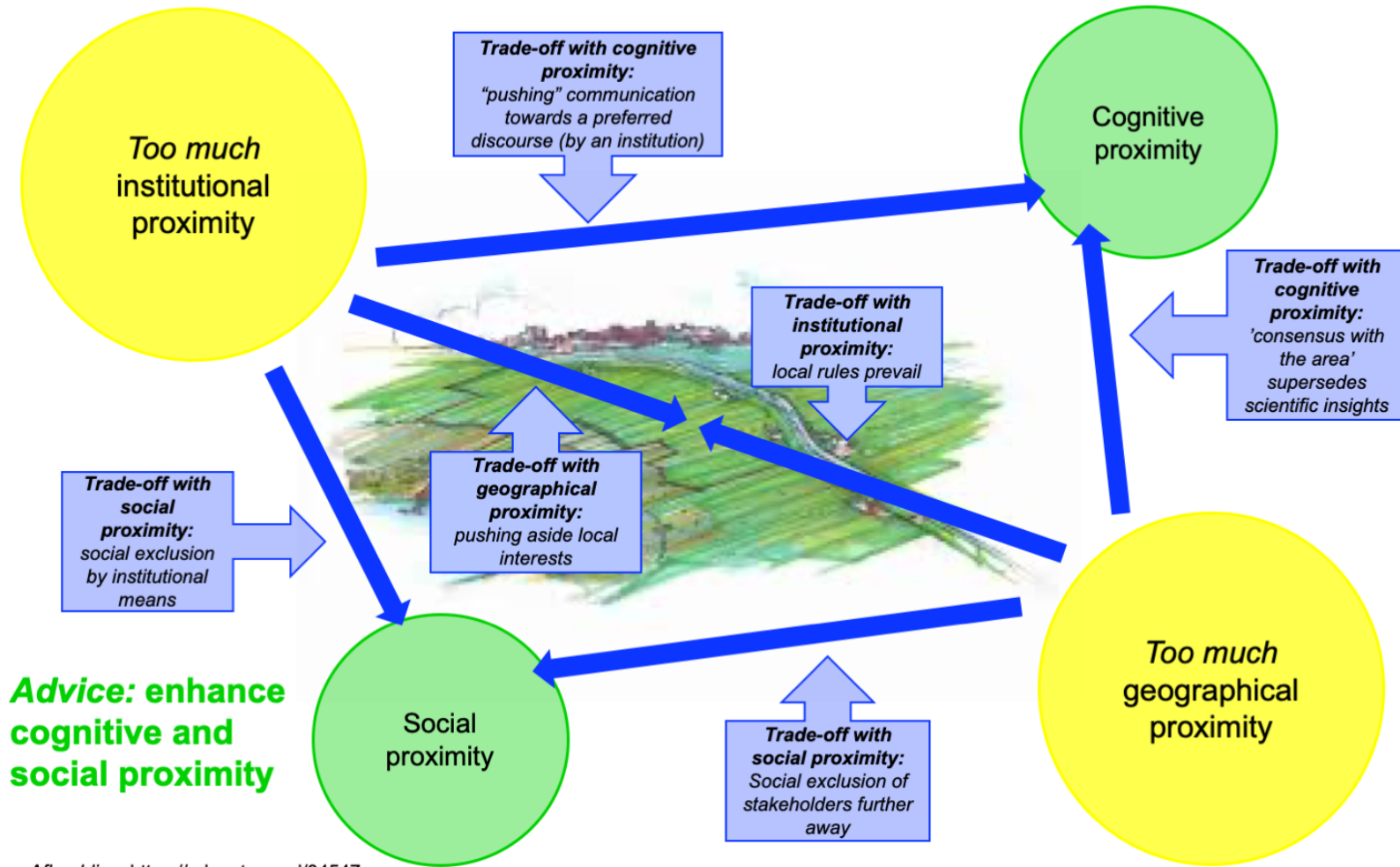


Figure 8. Shown are the ways in which a too much of proximity in its' institutional or geographical forms may give rise to adverse effects.

8 Validation

8.1 Results of the validation

The first main finding of the research presented to the stakeholders interviewed, is 'be heterogeneous'. The key stakeholders have made the following remarks on this statement:

1. The stakeholders interviewed observe that in regional planning processes there often is a focus on the knowledge aspect, at the expense of the social, geographical, or institutional aspects. They acknowledge that getting stakeholders involved in the process on all of the four forms of dynamic proximity may help creating a better process. They endorse the principle that an area-based approach should start from a broad focus. One of the stakeholders compares regional planning processes to the now topical Covid-outbreak and the role played by the Dutch Outbreak Management Team, which has been criticized for not including a broader (scientific) community, including for example sociologists.
2. Stakeholders stress the importance of paying ample attention to motivations and incentives, driving the behaviour of stakeholders. If motivations and incentives of stakeholders in a regional planning process remain too far apart, it is difficult to accomplish the project. One of the stakeholders speaks of getting stakeholders "switched to ON", which requires paying attention to existing resistance, and being able to present an understandable story about the project.
3. Stakeholders acknowledge that the mutual gains approach (MGA) can be a suitable instrument to get stakeholders into "on position", but also point to a risk involved in using the MGA. The MGA-method is meant to open up the process, and in this way lets stakeholders diverge. But during the MGA-process, there should be a moment of convergence as well, so as to reach results. If differences in motivations and incentives of stakeholders remain too comprehensive, than the moment of convergence may not come. An area, in the phrasing of the interviewee, should be "ready" for the MGA-method.

The second main finding of the research presented is 'avoid the proximity paradox'. The key stakeholders have made the following remarks on this statement:

1. According to one stakeholder, a central issue in regional planning processes is indeed: on what domains should one act, so as to balance all relevant aspects in the process? Before starting the process itself one should consider, in some sort of stakeholder analysis, what is still lacking in a project group, according to this stakeholder. What is needed to get people "on board" in a process? Often stakeholders are not conscious of these aspects. Once these aspects have been made conscious and explicit, than a process leader should demand for the lacking aspects to be supplemented before starting the actual process.
2. The other stakeholder links the issue of balancing forms of dynamic proximity to a changed relationship between government and citizens. Where historically government imposed its' will on the people, now government officials tend to be more open and transparent. They aim at an open discussion with stakeholders. But historical relations have left "old aches", and those "aches" have surfaced a number of times during the Aa of Weerij's project's process. Taking away these "old aches" before starting a new discussion is of central importance, according to this

stakeholder. At the same time, in trying to do so, the applicable legal framework can and should not be discarded. The first mentioned stakeholder adds that trying to take away these “old aches” as a first phase in a process frequently is difficult for process leaders, because strong emotions and resistances tend to surface.

3. One stakeholder adds that this also has its’ consequences on the institutional level. For example in the provincial organization, managing board, program managers, and the Provincial Council (*Provinciale Staten*) should realize that this type of process is time consuming. Budgeting resources for a specific period of for example six years, and demanding project results within the budgeted period, is often not possible in these types of projects.

The third main finding of the research presented, is ‘use knowledge production instruments’. In the proximity tool, ten such instruments are mentioned. To keep the interview concise, we have discussed the four first mentioned instruments. The key stakeholders have made the following remarks on these instruments:

- *In general*: One stakeholder points out that one should be aware of not letting knowledge or science become a delaying factor in the process.
- *On the science practitioner*: One stakeholder interprets the term as referring to a broad-based, (politically and institutionally) independent person who combines practical insights with knowledge (without being too academically oriented), but most importantly who is accepted and trusted by the project group. This person joins in the conversation on the project, helps analyzing the project’s issues and presents her vision on the broad project’s proceedings, which is then accepted by the project group. Central is this person’s attitude. The stakeholder speaks of a certain “cuddle-factor” in this type of science-practitioner, being a person who evokes no resistance in the project group.
- *On visualization on the local scale, and on making a situation assessment*: One stakeholder observes that local inhabitants and professionals have profound knowledge about their living area (which in this context is the project area), whether they are local farmers, or water level managers for the regional Water Authority. Therefore, visualization should primarily be the visualization of knowledge local people brought into the project group, in a project phase where decisions are still to be made. It can then be used as an instrument to reach shared visions about the project area, visualizing different stakeholders’ ideas in a repetitive process. In this sense, visualization can be part of the social and psychological process any project needs to go through. It can be an instrument for creating trust and mutual understanding, as “one picture says more than a thousand words”, according to the stakeholder.
- *On joint fact finding*: Both stakeholders view joint fact finding as related to ‘visualization on the local scale’. A walk by the brook may lead to shared knowledge and understanding, and may be called ‘joint fact finding’ or ‘visualization’.

8.2 Conclusion of the validation

We conclude that the findings of this study may be fit for use in preparing regional planning projects aimed at implementing NbS to strengthen the climate resilience of regional brook catchments. Central findings of the study are recognised by the stakeholders in the Aa of Weerijis-project who were interviewed. A precondition for applying the findings in other

regional planning projects, is that the main remarks as made by the stakeholders in the validation interview and presented above are taken into account.

9 Recommendations for future regional planning projects: the proximity tool

On the basis of the findings and discussion in this study we have produced a proximity tool (App. H), to be used in preparing regional planning projects aimed at implementing NbS to strengthen the climate resilience of regional brook catchments. In the proximity tool, we have summarized the three main findings of this study. We have taken into account results of the validation interview. In using the proximity tool, four preconditions for applying the knowledge production instruments that are described should be kept in mind:

- Make sure knowledge or science does not become a delaying factor in the process;
- Visualization should primarily be the visualization of knowledge local people brought into the project group, preferably early on in the process;
- More general, larger-scale scientific knowledge (such as for example climate scenario's) may help, but only when presented in a practical framework, not getting too abstract. Presenting multiple scenario's should be used with restraint, as it may lead to resistance in stakeholders;
- Joint fact finding on the local scale may be very productive as an instrument to enhance mutual understanding between stakeholders.

The proximity tool is our contribution to the practice of JKP for NbS to support the climate resilience of regional brook-systems. It is meant for use in preparing the regional planning phase of such projects.

More specifically, our proximity tool serves as our advice for the Province of North-Brabant, and can be used by the Province or its' contractors in preparing regional planning processes such as the one for the Aa of Weerijs.

Thesis committee

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Appendices

Appendix A. Definitions

Appendix B. Meanings of the four basic categories of the assessment framework

Appendix C.1. NON PUBLIC Selection of persons interviewed in the Aa-project

Appendix C.2. Questions for the semi-structured interviews in English

Appendix C.3. Questions for the semi-structured interviews in Dutch

Appendix C.4. NON PUBLIC Transcripts of the seven semi-structured interviews

Appendix D. Code-book

Appendix E. NON PUBLIC Roles of the fourteen stakeholders in the visualisation

Appendix F. NON PUBLIC Database

Appendix G.1. Scores for every respondent in 6.2

Appendix G.2. Scores in code-families success, failure, neutral

Appendix G.3. NON PUBLIC Quotes for codes 12 to 15, 32-33, 37-38, 59-60

Appendix H. Proximity tool

Appendix I. NON PUBLIC Partial transcript of interview validation case