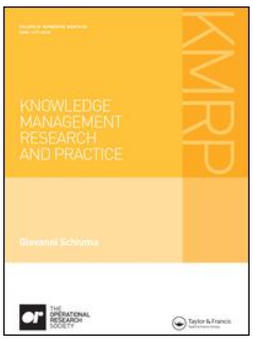

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ARTICLE

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Organising knowledge generation and dissemination in the Dutch high-water protection programme – a sender-receiver approach

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ABSTRACT

In 2012 the Dutch High-Water Protection Programme (HWPP) was initiated. This programme prioritised dike strengthening projects for the near future with a yearly budget of around 350 million Euros. A safety assessment 2011–2013 indicated the need to strengthen 748 km of dikes. To achieve this, it was recognised that generation and dissemination of state-of-the-art-knowledge was necessary. For this purpose, four Spatial and Technical Research Projects (STRPs) were initiated. The challenge for these STRPs is to generate and disseminate the developed knowledge that is relevant for other dike strengthening projects within the HWPP. This paper examines whether the STRPs have successfully undertaken activities to generate and disseminate new knowledge to relevant stakeholders. We examine how the generation and dissemination of knowledge from the STRPs to the HWPP-projects and water management organisations in the Netherlands took place and might be further facilitated.

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Knowledge generation and dissemination; knowledge management; sender – receiver perspective; high-water protection; science – policy interface

1. Introduction

Continuously learning and innovation of over almost seven centuries shaped the Netherlands into the dike, dunes and dams dominated landscape that it is today. Recent changes in Dutch policy and new technical insights in dikes, dams and hydraulic structures have led to an increased attention towards knowledge management. Within the domain of Flood Risk Management (FRM) the need for knowledge management is omnipresent. To keep FRM-infrastructures up to date with evolving new standards, the High-Water Protection Programme (hereafter: HWPP) was launched in 2012. In the programme the need for knowledge management was addressed by initiating so-called Spatial and Technical Research Projects (hereafter STRPs) that had to generate and disseminate new knowledge and practical experiences for HWPP-projects, aimed at upgrading FRM-infrastructures.

This paper examines whether the STRPs have successfully undertaken activities to generate and disseminate new knowledge to the relevant stakeholders, including regional water authorities, consultancies, construction firms and research organisations, both in the HWPP and in the separate dike strengthening projects. We also have addressed the question how the generation and dissemination of knowledge from the STRPs into the HWPP-projects and water management organisations might be further facilitated based on the findings of the assessment.

In this paper we subsequently address the following topics. First, the current context and organisation of FRM in the Netherlands and its approach to knowledge management are described. Next, a description is provided about the approach to knowledge management through its most prominent relation, that is between sender and receiver of new knowledge and practical experiences. Third we present our research design, a multiple case study analysis in which four STRPs serve as separate cases. Fourth, the results of this analysis are presented and discussed. Lastly, some conclusions are drawn about the outcomes of the research conducted here and their applicability for other knowledge-intensive projects in FRM.

Before describing the current context and organisation of Dutch FRM, it is important to note that both HWPP and STRPs were already put in place by the Ministry of Infrastructure and Water, prior to the request of the board of directors of the HWPP to assess the cause of affairs in this specific structure and, based on the assessment, formulate recommendations for improvement.

2. Context and organisation of Dutch flood risk management

Major flood incidents in the 20th century marked several breakthroughs in Dutch FRM. In response to the large flood in 1953, the Delta Commission advised for the construction of the so-called Delta works.

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These involved the realisation of a nation-wide programme of measures for improving coastal and river protection system (Correljé et al., 2010). In the decades after 1953, the institutionalisation of Dutch FRM approach was strengthened in research, policy and society. From 1960 onwards, scientific analysis was formally used to inform policy. One of the novelties was the development of technical safety standards for dikes. Since 1996, these technical safety standards became statutory (in the Flood Protection Act), and all flood protection structures were to be tested against these standards every 5 (later 6) years. When a flood defence fails to meet the statutory standards, it is placed in the flood protection programme for future dike re-strengthening and/or renovation.

In 2008, the second Delta Committee, commissioned by the Secretary of Public Works and Water Management, provided recommendations on how to defend the Netherlands against the expected impacts of climate change, such as sea-level rise, longer periods of drought, more intense periods of rainfall and additional land subsidence over the coming 200 years (Delta Commission, 2008, 9-10). One of the Delta Decisions concerns new, usually stricter, flood protection standards.

In 2012 the HWPP was initiated as a genuine alliance between the national government and the regional water authorities. The ministry of Infrastructure and Water Management is represented by its directorate-general of Water Management and Public Works. Together with the 21 regional water authorities, HWPP consists of 22 organisations that prioritise dike strengthening projects for the near future with a yearly budget of around 350 million Euros. The safety assessment 2011–2013 had set the initial scope of the HWPP to strengthen 748 km of dikes (out of 3,700 km) (see Figure 1). It is expected that overtime, the scope of the HWPP will be expanded to roughly 1,900 km dikes.

The Dutch FRM-programme has the following comprehensive goals for the realisation of their flood protection projects: (1) increasing the production rate (effectiveness) of flood protection projects, (2) improving efficiency of flood risk management by reducing the costs per kilometre, (3) enhancing the societal value of flood protection projects, (4) improving the cooperation between the authorities involved, and (5) assuring the quality and control of both the programme and the projects. In a cycle of 6-years Dutch water managers, i.e., the DG RWS and the 21 regional water authorities, evaluate the quality of the primary flood protection infrastructures, based on the most recent safety standards. If necessary, they upgrade (through renovation, reconstruction or refurbishment) these infrastructures, and the Minister of Infrastructure and Water Management sanctions and includes these renovation projects in the HWPP. However, some of these HWPP-projects cannot be implemented based on existing knowledge and experiences because of progressing safety standards. New standards are grounded in new climate change scenarios, changed geotechnical or physical-spatial circumstances and/or societal preferences. The required new knowledge and experiences are then developed by the HWPP, through the earlier mentioned STRPs. As such, the generation and dissemination (transfer and uptake) of knowledge plays an important role (Tromp, 2019).

The first results of a large research programme called "Strength and Loading of flood defence structures" indicated that some failure mechanisms of dikes were underestimated, leading to new safety standards and design principles. This led HWPP to

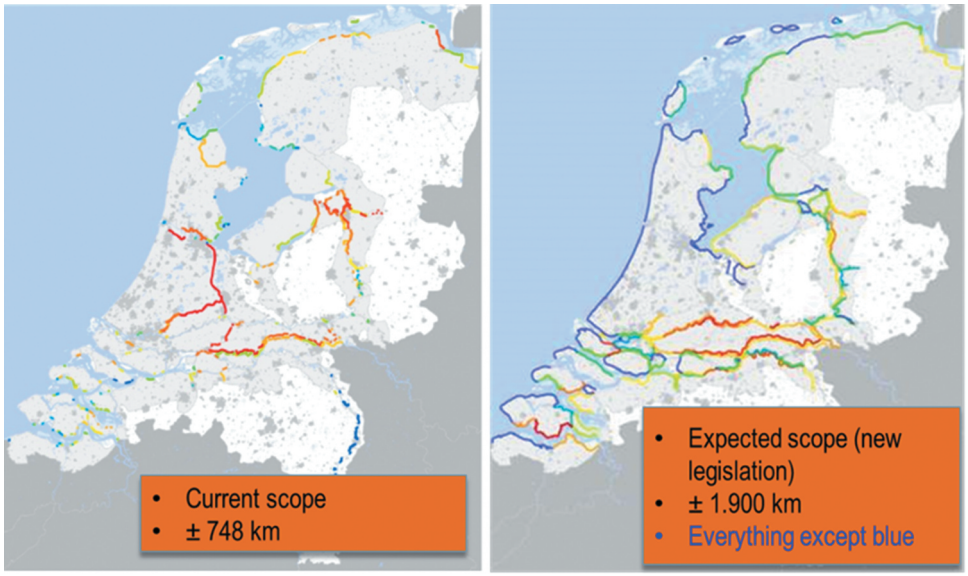

Figure 1. Current and future scope of the High-Water Protection Programme until the year 2050 (source: HWPP, 2015).

formulate specific research questions that needed to be answered in order to upgrade the dikes according to the latest safety standards. Hence, it was recognised that generation and application of state-of-the-art- knowledge was necessary to reach the HWPP goals. For this purpose, STRPs were initiated in which a limited number of regional water authorities, private sector firms (contractors, engineering consultancies, designers) and knowledge institutes (universities, large technological institutes and colleges) took on exemplary technical and/or spatial challenges with regard to strengthening existing dikes. The generic process of knowledge generation and dissemination and the actors involved in the different process stages, are presented in Figure 2.

Innovations are essential to reach the overall HWBP goals. A large part of the innovation scope follows from the dominant failure mechanisms of levees: macro-stability and piping. Traditional measures to prevent these mechanisms are either quite expensive or require a lot of space. The HWPP has asked all parties involved in the preparation and construction of dike strengthening projects (contracting companies, consultancy firms, public authorities, research institutes, and universities) to identify potential technical and non-technical innovations including contracting, stakeholder participation, landscape design and decision-making. These envisaged innovations must be explored, developed and tested in the STRPs. At the start of the HWPP, four STRPs were defined: two are technically oriented (Piping and Macro-Stability) and two are more spatially oriented (Central-Holland and Wadden Sea).

Here, the HWPP organised its needs for new knowledge through a "sender – receiver" relation between the programme level and the four STRPs. The latter were to generate, test and disseminate new, practical knowledge for dike strengthening projects within the HWPP. This knowledge must enable HWPP-projects to 1) acquire more insight in the complete engineering challenge, 2) provide practical guidelines for making and engineering designs and 3) upscale product innovations towards accepted techniques. In addition, the new knowledge from the STRPs must inform policy making by the HWPP, e.g., for new safety standards and/or for future STRPs. The science – policy interface that is organised for the HWPP is visualised in Figure 2 .

To provide an idea of the challenges with regard to knowledge generation and dissemination in the HWPP – STRP structure, Table 1 gives an overview of the specific substantive focus of the four and STRPs and the HWPP programme level, as well as of the parties involved in the separate components.

The STRPs are hybrid communities of experts from 1) regional water authorities, 2) regional agencies of the Ministry and 3) knowledge institutes and engineering consultancies. Sometimes the STRPs involved additional parties in the knowledge generation, testing and dissemination efforts, depending on the specific challenges. The inclusion of experts from diverging organisations, all active in knowledge management for FRM, give the STRPs a Janus head characteristic because they represent both sender and receiver perspective. The involved experts are, next to their role in the STRPs, also members of organisations that will receive the generated knowledge, sent by the STRPs. These organisations obliged to use this knowledge to fulfil their water managing and FRM tasks, according to the new standards that the HWPP pursues. These experts are well capable "to carry" the new knowledge to their home organisations and urge and inspire their colleagues to use it.

The HWPP represents the potential end users of the new knowledge, both for policy (e.g., advancement of safety standards and policy guidelines) and for

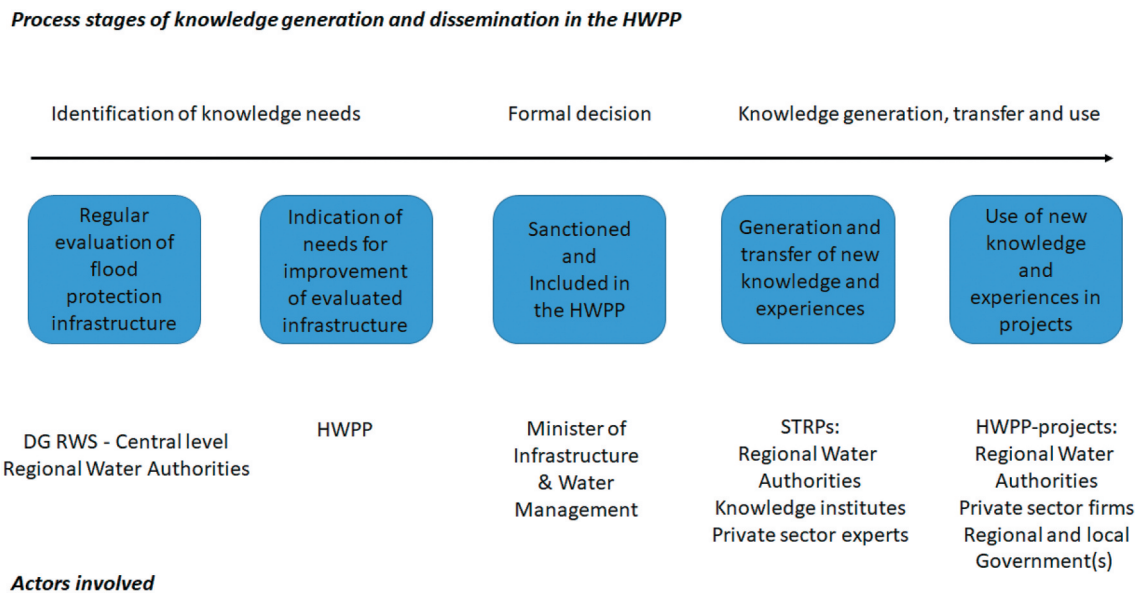

Figure 2. Generic process scheme of knowledge generation and disseminate in the HWPP.

Table 1. Scope and parties involved in STRPs and HWPP.

	STRP Piping (PP)	STRP Macro-stability (MS)	STRP Waddensea dikes (WSD)	STRP dike Strengthening Central Holland (CH)	High-Water Protection Programme (HWPP)
Scope of STRP	Search for innovations to be able to effectively deal with the dike failure mechanism piping.	Search for innovations in order to be able to effectively deal with the dike failure mechanism macro - stability.	STRP WSD focuses on dike ring 6, from Harlingen to the German border. This dike ring must be improved in the coming years, preferably in a cheaper, quicker and better way.	The area Central Holland needs to be better protected from flooding from the rivers. This area is the economic heart of the Netherlands and includes the cities of Utrecht and Amsterdam. STRP CH will strengthen the dikes and keep or make them beautiful.	The High-Water Protection Programme focuses on actions to ensure that dikes, dams and dunes and locks, weirs and pumping stations satisfy the legal safety requirements. Now, and in the years to come.
Involved parties	Representatives from regional water authorities within the formal structure. Research institutes and private parties are contracted in research projects.	Representatives from regional water authorities, research institutes and private parties within the formal organisation structure.	Representatives from regional water authorities within the formal structure. Research institutes and private parties are contracted in research projects. Local stakeholders are involved to arrive at acceptable results.	Representatives from regional water authorities within the formal structure. Research institutes and private parties are contracted in research projects. Local residents, businesses and organisations are involved to create additional value.	Representatives from the Directorate General for Public Works, regional water authorities and Rijkswaterstaat. Research institutes and private parties are contracted in research projects.

practice (e.g., the preparation and implementation of HWPP-dike strengthening projects). Further HWPP-policy making will be executed by the Ministry of Infrastructure and Water; HWPP-projects will be carried out by the home organisations that also deliver the experts for the STRPs. The first end users of this state-of-the-art knowledge are the geographically designated organisations that are involved in concrete projects for improving flood protection at a certain location. These are the regional water authorities, the regional agency of DG RWS, the province(s) and the local government(s). Second, the technical experts, such as engineering consultancies and contractors, will make use of the generated knowledge in modelling, designing, detailing and constructing the works for improving the existing infrastructures (dike strengthening). Third, local stakeholders, such as citizens, landowners, entrepreneurs and nature conservation and recreational organisations will, at least critically monitor the use of the generated knowledge for the intended improvement works.

The entire process of uptake and interpretation of HWPP-objectives by the STRPs and the generation, testing and dissemination of the STRP-knowledge to HWPP and its projects, is perceived as knowledge management. Knowledge management is elaborated in the following Section.

3. Knowledge management from a sender – receiver perspective

For many organisations, knowledge and its management are deemed necessary for their survival, development and performance (Hislop et al., 2017). A dominant perspective on knowledge management emphasises the relation between the sender and the receiver of knowledge (Burmeister et al., 2018; Noorderhaven & Harzing, 2009; Vlachos, 1978). The knowledge sender as well as the knowledge receiver can be an individual or a collective, such as a team, an organisation or a unit at an organisation (Lin et al., 2005). Senders and receivers of knowledge must perform knowledge sharing behaviour on the one hand and knowledge-seeking behaviours on the other, thus being able and willing to transfer knowledge in a dyadic and interactive process (Burmeister et al., 2018; Reinholt et al., 2011).

To understand how knowledge is sent and received some definitions of knowledge management may be helpful. Wijnhoven (2003: 194) defines knowledge management as "the processes that create, distribute, use, exploit, and maintain knowledge". According to Kwan and Balasubramanian (2003: 204) knowledge management "involves setting up an environment that allows workers in organizations to create, capture, share, and leverage knowledge to improve performance". Quintas et al. (1997: 387) think that knowledge management is "the process of continually managing knowledge of all kinds to meet existing and emerging needs, to identify and exploit existing and acquired knowledge assets and to develop new opportunities". These definitions perceive knowledge as a "tangible" asset for the organisation's capacity to perform. These definitions indicate that knowledge management involves processes in which knowledge is produced, transferred, received and used.

To address the research issue here, we took the same perspective to knowledge management as the HWPP did, i.e., This perspective represents the way in which knowledge management is organised with the STPRs as senders of knowledge and the HWPP, its key actors (regional water boards, the ministry of

Public Works and Water Management and its regional agencies) and its projects as receivers. The STRP-HWPP structure puts knowledge management in a context of project-based organisations that inevitably have looser communication links because they often cooperate as separate endeavours at geographically dispersed locations (Wiewiora et al., 2009). Knowledge management as a relation between sender and receiver is presented in the Figures 4a and 4b.

A more elaborated relation between sender and receiver is depicted as follows.

The sender – receiver perspective on knowledge management that was put in place in the HWPP might be perceived as an attempt to informing policy and projects, as receivers, by providing state of the art knowledge, through STRPS as senders. This hints towards the (implicit) emergence of a so-called science-policy gap (Bradshaw & Borchers, 2000) that needs to be bridged. In the HWPP the relation between senders and receivers of new knowledge and practical experiences represents the science – policy interface. The sending perspective largely covers the science domain whereas the receiving perspective represents the policy (and practice) domain. Dissemination efforts must enable the bridging of boundaries between STRPs and HWPP-policy and projects.

Scientific knowledge and policy frameworks are developed in separate communities. This is accurately captured by the Two Communities concept (Caplan, 1979; Weiss, 1977). Working in two separate communities – with different cultures, codes, rewarding systems and rules – inevitably means that boundaries will emerge between them. Leifer and Delbecq (1978) define a boundary as "the demarcation line or region between one system and another, that protects the members of the system from extra-systemic influences and that regulates the flow of information, material, and people into or out of the system". For informing policy making through scientific knowledge, i.e., policy analysis, this gap needs to be bridged by organising an interface. In literature, many different concepts of organising interfaces for policy analysis and facilitating the border or boundary traffic between both communities, have been developed of the years. These concepts aim at facilitating productive communication between science and policy communities to inform policy making and implementation.

3.1. Sending

Somehow knowledge will cross the boundary between sender and receiver. Often these boundaries follow the lines of organisational structures. Tushman and Scanlan (1981) indicate that the crossing of boundaries, often referred to as boundary spanning, is performed by individuals and concerns the exchange of information from an organisation to its external environment. Leifer and Delbecq (1978: 40–41) identify boundary spanners as "people who operate at the periphery or boundary of an organization, performing organizational relevant tasks, relating the organization with elements outside it".

It is therefore critical to describe and discuss what is transferred – often referred to as boundary objects – and by whom this transfer is executed. In Figure 3a and 3b, it is assumed that the knowledge processes are constructed around so-called knowledge objects or repositories (Brown & Duguid, 1991) such as reports, charts, maps, (quantitative) models and data sets in which new findings, ideas or insights are wrapped up. The sender produces knowledge and "wraps it up" in a product that will be "unwrapped" by the receiver. However, this representation of a knowledge management process doesn't explicitly address the human factor in knowledge management. Weggeman (1996) includes the human factor in his definition of knowledge management: "the design and governing of the processes of the knowledge value chain that increases the output and pleasure of the production factor knowledge". The production factor knowledge is vested in people.

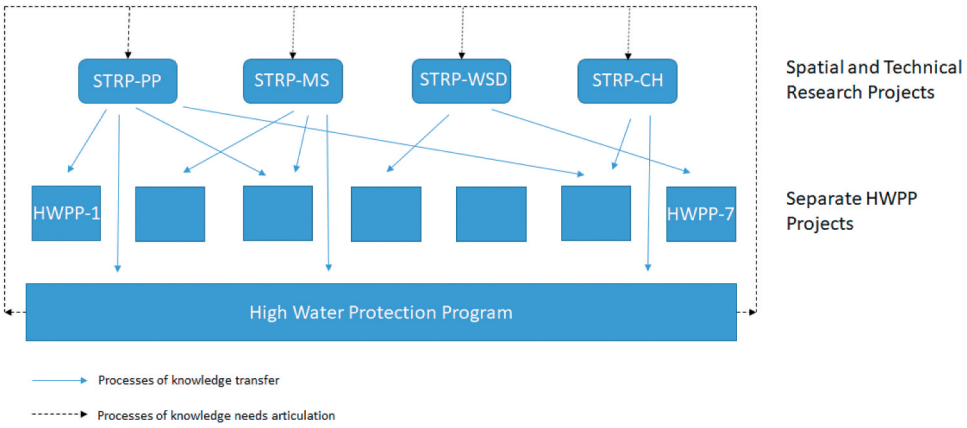

Figure 3. Visualisation of the science – policy interface in HWPP and STRPs (between 2015 and 2018).

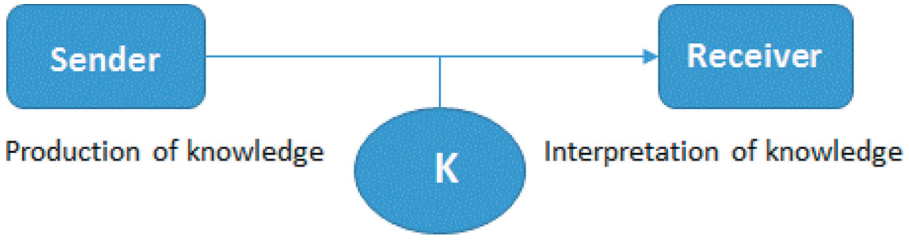

Figure 4a: Schematic relation between the production and interpretation of knowledge.

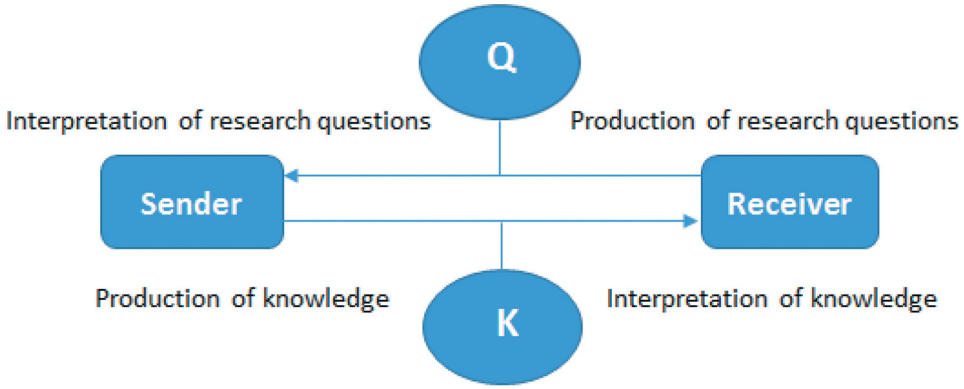

Figure 4b: Schematic of the relation between sender and receiver, including knowledge needs articulation.

People transfer knowledge through interaction in their professional practice. To do so, people often resort to tangible artefacts to convey their knowledge. These tangibles are often referred as boundary objects. Star and Griesemer (1989: 393) define boundary objects as "tangible artefacts or object-like forms of communication that inhibit several intersecting social worlds and satisfy the information requirements of each of them". Examples of these boundary objects in our organisations are work manuals, intranet and administrative forms.

Boundary objects have specific characteristics. First, they represent a shared language that conveys the domain-specific knowledge in a format that is recognisable on the other side of the knowledge boundary (Carlile, 2002). Second, they provide concrete means for specifying differences and dependencies across a boundary, resulting in tangible representations of the perspectives involved. Based on these representations, practitioners are encouraged to take on new perspectives (Boland & Tenkasi, 1995; Carlile, 2002). Third, boundary objects facilitate reification and transformation around which the practices of the various actors and co-constructed, emergent, shared meanings are coordinated (Carlile, 2002; Wenger, 1998). Through boundary objects and people that construct, share and use them, knowledge integration and transfer across organisational boundaries will gradually unfold (Wenger, 1998).

Next it is critical to identify the different roles that these "boundary object creating and using people", often referred to as boundary spanners (Van & Edelenbos, 2018; Williams, 2012) can take in knowledge management. It is important to consider the network environment in which many of these people are engaged in. The relational capacities of boundary spanners elicit "their ability to engage with others and deploy effective relational and interpersonal competencies" (Williams, 2002: 110). Trevillion (1991) regards boundary spanners as "cultural brokers" who are capable of understanding, empathising and respecting other values, beliefs and perspectives. In turn, boundary spanners must be capable of managing the reciprocity between them and the others they are working with. They must be aware of the danger of becoming too involved in another's dilemmas and problems. Williams (Ibid.: 111) describes this as "a balancing act between inclusion and separation, dependence and autonomy".

In theory about boundary spanning, three different roles are often identified: broker, translator and synthesiser. The broker role matches demand for and supply of knowledge, which requires an up-to-date insight into reliable knowledge sources and emerging knowledge demands. The translator role interprets the need for knowledge and formulates research questions that knowledge suppliers should answer. In turn, translators are capable of interpreting the supplied knowledge back into information that demanders are able to use. The synthesiser is capable of synchronising knowledge supply and demand simultaneously. This requires an understanding of knowledge disciplines and sources and how they might contribute to problem-solving. In turn, synthesisers must be capable of

(re)framing (policy) problems into scientifically relevant and viable questions.

3.2. Receiving

What determines whether knowledge is considered useful, accepted and used? To understand this, we look at the receiving organisation. The perceived quality and consequent usability of the knowledge for the receiver or user is affected by three aspects: salience (relevance), credibility (reliable) and legitimacy (Cash et al., 2003). Knowledge is relevant when it matches the need of the user, is sufficiently concrete and consistent with its scope for action and available at the right time in the right form. Knowledge is reliable if it meets the standards of the recipient on what knowledge is scientifically plausible and technically adequate. The extent to which there is consensus about knowledge thereby often plays an important role. Controversial knowledge is usually at a disadvantage when it comes to the perceived reliability. And finally, knowledge is considered legitimate if users or recipients feel that she is "fair", which hinges on whether the knowledge sufficiently takes into account different values, interests and problem definitions. If users are actively involved in the creation of knowledge products, they are more likely to appreciate it as legitimate.

Besides the knowledge itself characteristics of the receiving party play a role when it comes to the impact of the developed knowledge. An important concept is the absorbency of an organisation or actor. A characteristic of innovative companies is their ability to acquire new knowledge and that connect with what they already know. In the words of Cohen and Levinthal (1990): " ... The ability of a firm to recognise the value of new, external information, assimilate it, and apply it to commercial ends is critical to its innovative capabilities. We label this capability as a firm's absorptive capacity and suggest that largely it is a function of the firm's level of prior related knowledge". Organizations with a high absorptive capacity are not only able to gain new insights but are also able to give it a meaningful place within their own expertise and ways of acting. The absorptive capacity of an organisation consists of the routines and processes of an organisation to translate and gain new knowledge and to assimilate the knowledge (Zahra & George, 2002). In obtaining new knowledge important aspects to take into consideration are how large an organisation is, how easily it establishes new links and which knowledge it has developed in the past. New knowledge will be easily absorbed especially if it is in line with what is already known in an organisation.

Finally, it is important to identify different levels of knowledge use. This can be referred to by output (for example, by the number of downloads of a report on a web page) and by outcome, for example, the change of policy as a result of new insights. Knott and Wildavsky (1980) identify seven cumulative stages of knowledge use ranging from reception, cognition, reference, effort, adoption, implementation, to impact. However, knowledge will not be absorbed, i.e., if the developed knowledge is perceived as not reliable, legitimate and/or relevant. Tromp and Bots (2016) distinguish cognitive, institutional and cultural barriers, a lack of resources and failing mechanisms such as disqualification of the developed knowledge.

4. Research design; multiple case study analysis

Before the research efforts were started, the HWPP – STRP structure – a.k.a. the sender – receiver relation – was already organised by the Ministry. The STRPs were already operative in organising their activities for knowledge generation and dissemination. Therefore, we had to construct an evaluative framework, serving as the analytical basis for the study (see Tables 2 and 3). The state-of-affairs in knowledge generation and dissemination in the four STPRs was assessed through 1) document analysis and 2) in-depth, semi-structured interviews with professionals involved. In each STRP four professionals have been interviewed about their perception on the progress, results and impact of the knowledge management process. The state-of-affairs in the HWPP itself was examined through 1) document analysis, and 2) an assessment of the perception of the HWPP's board members through a focus group session.

Because we examined four STRPs, within the programmatic framework of the HWPP, this study

Table 2. Evaluative framework for evaluating the sender-perspective.

Concepts	Separate aspects
Presence of boundary organisation strategies	Proactive interaction between both developers and end users of knowledge. Using boundary objects or integrated knowledge products Being able to resolve knowledge conflicts Communication of knowledge
Production of Mode 2 Knowledge (coproduction)	Organise meetings/gatherings between scientists and policy makers Working together on a (knowledge) product Making agreements and living by these agreements.
Presence of boundary spanning roles	Fulfilment of roles: Broker, Translator and/or Syntheziser.

Table 3. Evaluative framework for evaluating the receiver-perspective.

Concepts	Separate aspects
Perceptions on generated knowledge	Salient, credible and legitimate
Absorptive capacity of the receiver(s)	Recognition, assimilation and application
Level of knowledge utilisation	Reception, cognition, reference, effort, adoption, implementation and impact

has characteristics of multiple case-study research (Eisenhardt, 1989; Stake, 2013). Here the four STRPs serve as representative cases for the way that knowledge generation and dissemination will be organised in the sequel of the HWPP. The STRPs are analysed to develop an in-depth understanding of the phenomenon under examination, here the process of knowledge management for FRM. Yin (2003: 13–14) claims that "a case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not evidently clear". Case-study research examines a phenomenon by deliberately taking its contextual circumstances into account. Feagin et al. (1991) confirms that case-study research aims at a holistic understanding of a culturally defined system of action.

Yin (2003) advocates triangulation for collecting "multiple sources of evidence" as it enables a researcher to address a broader variety of cultural-historical, attitudinal and behavioural aspects of the object of study. Patton (1987) identifies four types of triangulation: 1) triangulation of data resources, 2) of researchers, 3) of theoretical perspectives on the same data set and, 4) of methods. Our approach to triangulation addressed these types as follows. First, we used several different data resources and data collection methods. Through document analysis, semi-structured in-depth interviews, participatory observation and a focus group session diverging data types were collected. Second, the involvement of multiple researchers from different back grounds and research organisations was deployed to prevent self-referentiality and theoretical "tunnel vision". Third, the use of multiple theoretical perspectives on the collected data enabled a multi-dimensional interpretation of the findings.

5. Evaluative framework for sender and receiver perspectives

In this research design the basic elements of the evaluative framework are visible. The STRPs function as sender of new knowledge and professional competencies. The HWPP – both its implementation projects as the programme itself – are the receivers of the knowledge. To assess the activities within the processes of knowledge management between the four STRPs and the HWPP, an evaluative framework was constructed based on the sender – receiver relation that was put in place to facilitate knowledge management for the high water protection policy and projects. As a consequence, the evaluative framework has two components, one for evaluating the sender-perspective, the other for the assessing the receiver-perspective.

First, for evaluation of the sender-perspective two concepts are used to assess the efforts in the HWPP-STRP construction: development of so-called Mode 2 Knowledge (Gibbons et al., 1994) and Boundary Spanning (Brown & Duguid, 2002; Wenger et al., 2002).

Next, for the assessment of the receiver-perspective a second component of the evaluative framework was constructed, based on the perceptions on the generated knowledge (Cash et al., 2003), the absorptive capacity of the receiving organisation(s) (Cohen & Levinthal, 1990; Zahra & George, 2002) and the level of utilisation of the generated knowledge (Knott & Wildavsky, 1980).

Through this evaluative framework a qualitative appreciation was made of the knowledge management activities that were deployed between the STRPs and the HWPP (see Table 4). These appreciations were formulated based on criteria for the document analysis and on the items in the questionnaires for the in-depth interviews. Moreover, in the participatory observation of working group meetings in the STRPs and in the focus group meetings organised, these criteria were also used to assess the outcomes. A five-point scale was defined and used to make the qualitative appreciation of the identified activities in the knowledge management processes between HWPP and STRPs.

6. Results

Below we describe the results of the analysis of the four STRPs and the HWPP, first for the sender-perspective and then for the receiver-perspective (summarized in Tables 5 and 6).

Table 4. Five-point scale for the qualitative appreciation of identified knowledge management activities.

Score	Description
++	Clearly articulated in the knowledge management activities
+	Sometimes articulated in the knowledge management activities
-/+	Ambiguously articulated in the knowledge management activities
-	Not articulated in the in the knowledge management activities
–	Negated/ignored in the in the knowledge management activities
n.a.	Not available in the empirical data collected.

Table 5. Summary of the findings on the Sending-perspective, represented by the STRPs (indicated on a Likert scale: –, -, 0, +, ++; n.a.).

		PP	MS	WSD	CH	HWPP
Presence of boundary organisation strategies	Proactive interaction with both developers and users of knowledge	+	+	+	++	+
	Using boundary objects or integrated knowledge products	+	+	-	0	0
	Being able to resolve knowledge conflicts	0	0	+	0/+	+
	Communication of knowledge	+	+	+	+	+
Knowledge co-creation actions	Organise meetings/gatherings	+	+	+	0	n.a.
	Working together on a (knowledge) product	+	+	++	-	n.a.
	Making agreements and living by these agreements	n.a.	+	n.a.	n.a.	n.a.
Presence of Boundary Spanning roles	Covering the roles of Broker, Translator, Syntheziser.	+	++	n.a.	+	+

Table 6. Summary of the findings on the Receiver-perspective, represented by the HWPP (indicated on a Likert scale).

	PP	MS	WSD	CH	HWPP
Knowledge is considered: 1) salient, 2) credible and 3) legitimate.	+	++	++	++	0
Absorptive capacity: The knowledge is new but also connects/relates to the knowledge that is already available within an organisation.	0/+	n.a.	n.a.	n.a.	+
Level of knowledge utilisation: reception, cognition, reference, effort, adoption, implementation, impact.	0	0/+	n.a.	n.a.	n.a.

6.1. Sender-perspective

6.1.1. Boundary spanning strategies

All STRPs use boundary organisation strategies to encourage proactive interaction between developers and users of knowledge. For example, STRP-PP integrates users in project management teams, the programme manager visits the water authorities, a steering committee provides guidance, expertise networks are involved in the process, and seminars and trainings within the regional water authorities are organised. STRP-MS collects research questions from the HWPP. Every year the developers and potential end users of knowledge collaboratively evaluate whether the STRPs deliver the results to the HWPP and its projects in such a way that they can use the state-of-the-art knowledge. An executive board links the results for further uptake with all the water management organisations in the Netherlands. STRP-WSD organises contact (formal and informal) between users and developers and jointly work on knowledge. Additionally, considerable attention is paid to communicating and "translating" research. STRP-CH acquired knowledge questions actively at the constituting organisations. The STRP prioritised and selected knowledge questions. Approval of this selection is done by the broad core team and the programme management of HWPP. Knowledge questions that will be externally procured are reviewed beforehand by knowledge institutes. HWPP proactively organises interaction, for example, through the launch of a Community of Practice, workshops, conferences, market days, etc.

6.1.2. Boundary objects or integrated knowledge products

Formalised mechanisms are put in place to resolve knowledge conflicts, including an approval procedure by the steering group and a possibility to withdraw subsidies in case of non-delivery or excessive costs (PP, CH) or the use of escalation (MS, WSD). The working plan is subject to fraternal review rules for quality assurance, including external audits (CH). WSD also receives advice from an external independent party on knowledge results. Communication occurs through websites, newsletter, STRP-days and other events and conferences, social media like Twitter, intranet, publications, and reporting to the Minister. Results of projects and explorations of new testing instruments and spatial embedding are reported.

6.1.3. Knowledge co-creation actions

Co-creation actions of STRP PP include diverse meetings, including working groups, in which representatives from the regional water authorities, research and consultancy work together on the final product. However, this is not the case for individual project results – individual projects have their own agenda and strategy. STRP-MS encourages co-creation through working together on the final product, and making agreements on deadlines, input etc. For at least one of the relevant HWPP-projects special agreements are made on who is involved and when the knowledge should be transferred and shared with the HWPP-project. STRP-WSD organises that different stakeholders meet and work on knowledge development. STRP-CH uses consultation meetings to explore how to create synergies. Specific co-creation activities have been initiated (including an interactive website, consultation workshops and brainstorm meetings); and authorities involved or consulted (e.g., EIA committee); however, for STRP-CH, the focus was on the initial stages and discussing preliminary results, but less on the actual design. For HWPP knowledge development itself is not a core activity; the focus is rather on integrating knowledge, translating and communicating this during events, websites etc, Hence, little focus on co-creation.

6.1.4. Boundary spanning roles

For STRP-PP the programme manager and the so-called "piping director" act as boundary spanners by coordinating and synchronising demand and supply and translating knowledge back into information. At STRP-MS boundary spanning is taking place at all relevant levels. Several people fulfil the role of "translator" and synthesisers to synchronise the developed knowledge with the new Dutch flood protection standards. STRP-CH has incorporated boundary spanning roles in the programme through 5 management roles and through the professionals who work both at the STRP and at one of the constituting organisations. HWPP has the ambition to be a knowledge broker. Important boundary spanners are project-oriented or region-based "connectors" that initiate and facilitate knowledge sharing among managers and administrators.

6.2. Receiver-perspective

6.2.1. Perceived quality of the knowledge received

The quality of the received knowledge is generally considered high to very high – depending on whose perspective you take. Reasons are that the knowledge is directly connected with the request of the user, because those projects are selected in which their questions or potential solutions are addressed (PP, MS, CH, HWPP), or that research proposals are made through broad stakeholder processes. Knowledge is developed through the coupling of STRP research projects with "real" HWPP projects; e.g., soil investigation for a STRP is based on a specific dike strengthening project. However, this also makes that the relevance for other water boards and HWPP seems to be less in some cases, although in other the developers consider the knowledge useful for others as well (STRP-CH). To foster uptake effort is taken to transfer knowledge to all relevant parties (STRP-MS). In PP there are some interactions with projects outside the explorations of the STRP, but knowledge is not always equally applicable. To overcome this latter problem an additional exploration is launched. There is generally no doubt about the reliability of knowledge. However, it is considered desirable in some cases to further increase reliability by doing additional studies. Reliability can be obtained when the research is done by colleagues who are trusted and when the Dutch Expert Panel on Water Safety gives its approval. Involving this expert panel (in STRPs PP, MS, WSD), renowned engineering consultancies and e.g., the Dutch Knowledge Platform Risk Management is important for the credibility of the knowledge generated. STRP-WSD also explicitly concludes each stage of a project to secure the credibility. Legitimacy may vary across projects and is usually not explicitly considered during the development of knowledge. Within the projects, different interests and problem perceptions of the participating parties are taken into account. For STRP-CH the knowledge is considered legitimate because its "production" was ordered by the formal authorities and (will be) sanctioned by them before it will be used.

6.2.2. Absorptive capacity of the HWPP as receiver

To know more about the absorptive capacity, one should examine the receivers such as the regional water authorities (active in separate HWPP-projects) and the HWPP programme level (on behalf of national policy making). It may be expected that at least those that are actively involved in specific projects have a large absorptive capacity as the knowledge process is tailor-made for their specific question. Other regional water authorities will be less or non-absorptive. However, to make specific statements, the individual regional water authorities should have been studied, but that is not the case. HWPP has a high absorptive capacity as the knowledge addresses their research questions and answers these for the Dutch FRM as a whole, for both current HWPP-projects and future water safety projects.

6.2.3. Level of knowledge utilisation in the HWPP and its projects

During the research, the STRPs were still running, so the extent to which the knowledge will be used was not crystalized. It might have the possibility to reach implementation.

7. Discussion

Below we provide a discussion about the way in which knowledge generation and dissemination took place in the HWPP-STRP construction and to what extent this is serviceable to the two types of receivers we identified earlier.

Each STRP has a different substantial focus, composition and stage of development. Each of them undertakes visible attempts to cross the gap by sending generated knowledge, even if the end users and their specific needs are not always clear yet. Co-creation seems to be a key issue for organising targeted generation and dissemination of new knowledge, hinting at the dyadic, interactive process that is indicated by e.g., Reinholt et al. (2011). In STRPs with significant co-creation, knowledge tends to meet the needs of the users more directly. In other STRPs an ex ante exploration of knowledge needs is executed, but the actual co-creation of knowledge is limited. Some STRPs seem to put clear emphasis on making knowledge available to the national policy level in the HWPP, but this is no standard practice.

Each STRP has its own significant boundaries – between organisations, projects and policy – across which connections will have to be made. In each STRP boundary spanning knowledge brokers are present, in some more than in others. However, making

the connection to knowledge needs of other actors active in water safety projects, should get more attention. In achieving this it is important to asses which actors or actor networks might be capable of establishing these connections. Representative networks of the entire Dutch water safety knowledge network – such as the Knowledge Platform Risk Management and the Expert Network Water Safety – could serve as "carriers" of STRP-knowledge, next to organisations that are often active in other dike strengthening or water safety projects, such contractors and engineering consultancies. A relatively easy step to set favourable conditions for knowledge uptake, is the smarter use of their websites to disseminate the knowledge from the STRPs.

Knowledge dissemination from the STRPS is visible in in the reception of knowledge in HWPP-projects and for national policy, as different receiving targets of the knowledge disseminating efforts. For the first type of receivers, it can be observed that STRPs must give more attention to embed the knowledge generated more directly in running and future dike strengthening projects. To achieve this, it should become clearer how knowledge dissemination is organised in the internal procedures at the receiving regional water authorities. They tend to look at each other, use each other's knowledge and experts, and have specific knowledge networks that they use and value. The legitimacy, relevance and credibility of the generated knowledge is usually well perceived but differs with the stage of development of the STRP. In this sense, STRPs and HWPP must make it more credible that the generated knowledge contributes to quicker, better and more cost-efficient implementation of dike strengthening projects. Next, to effectively receive knowledge, the absorptive capacity at the knowledge users, should be well-developed. However, it can be expected that new knowledge is not easily absorbed because it might not immediately connect to existing knowledge-in-use. Some regional water authorities actively distribute the knowledge by training their employees. These training courses can be perceived as boundary activities (using boundary objects such presentations and course material), aimed at increasing the absorptive capacity and so the level of knowledge use at the receivers' end.

For the second type of receivers, that is the national policy level for FRM and water safety, it remains rather implicit how and by whom the generated knowledge in the STRPs is transferred, translated and used for new policy guidelines in FRM and water safety measures. Some STRPs actively pursue this, but the role of the HWPP-management and the Ministry of Infrastructure and Water Management, by means of the directorate-general for public works and water management, as receivers remains concealed. As such, the simultaneous presence of knowledge sharing and knowledge seeking behaviour (Burmeister et al., 2018) cannot be clearly identified.

In this specific study, the efforts to cross the boundaries between HWPP and STRPs, as representation of the science-policy gap, seem to depend on three aspects of the knowledge generation and dissemination process: 1) substantial aspects, 2) processual aspects and 3) inspirational aspects. In the table 7 below the characteristics of the three aspects are elaborated in more detail.

This table indicates that targeted knowledge generation and dissemination can be reached by devoting attention to the value this knowledge must have for the end users, that is the receivers of knowledge, in the sender-receiver constellation. This attention should be directed to the substantial quality of the knowledge generated and the way this is presented to the receivers. To inform policy and practice in an appropriate way, end users must be in the lead of shaping the dissemination efforts that must meet their organisational learning processes. The actual use and uptake of the knowledge generated by the receivers cannot be forced by the senders. By generating knowledge that is inspires receivers to meet their objectives – putting the rationales of their very existence at the centre of their performance – and by paying close attention to the organisation of the dissemination process, senders can have a positive impact on this.

8. Conclusion

This study shows that critical reflection on the organisation of knowledge management in the HWPP, by specific STRPs, must be executed to the background of

Table 7. Three types of aspects in the process of knowledge generation and dissemination.

Aspects	Characteristics
Substantial	• Substantial quality of the knowledge generated is highly appreciated • Learning objectives are precisely pre-described • The main responsibility of the STRPs is supplying various receiving actors with "pieces of information"
Processual	• The receiving organisations are in the lead, the STRPs do not have control over knowledge dissemination but have some influence on its organisation • The knowledge sharing should be aligned with existing learning processes of the regional water authorities – their knowledge sources should receive the knowledge as much as the water boards themselves • The outcomes of the learning process are not always predictable • The main responsibility of the STRPs lies at the process of knowledge dissemination, and not so much on its outcomes
Inspirational	• The receiving actors should not be influenced but must be inspired to develop high quality HWPP-projects (based on the knowledge provided) • Knowledge dissemination should be a free process without the objective to control what the receiving actors should learn • The main responsibility of the STRPs is to monitor the knowledge dissemination process and to safeguard the HWPP-projects from "bad" knowledge

the specific context of Dutch FRM. Informing both policy and practice requires a targeted "two-receiver" approach to knowledge generation and dissemination. It is not clear if this is actively pursued. Our study indicates that a targeted approach towards the national policy level seems to be lacking. Knowledge management to support and inform FRM should be (more) tailored to 1) the specific context of each HWPP-project, its underlying research questions and the designated actor network, and 2) the more abstract and evolving knowledge needs of the national policy framework. As such the development of more differentiated knowledge strategies should be at the core of the relation between the STRPs, the HWPP-projects and the HWPP itself.

Our study indicated that in the HWPP, new knowledge is largely developed by practice-oriented experts in STRPs. These are frontrunning professionals in regional water authorities, seconded by experts from private sector firms that will support them in designing and building these projects and by experts from knowledge institutes. This results in an approach to knowledge management that attempts to avoid an unbridgeable gap between abstract knowledge supply and practical knowledge demands and/or an undesirable lag time between knowledge generation and actual use in HWPP- and other water safety projects. This approach can be of value for other pressing, knowledge intensive and practical challenges in the Dutch water policy and management domain, such as dealing with drought, water quality management, programme Managing Large Waters and separate components of the Dutch Delta Programme (spatial adaptation, fresh water supply). For these challenges, new state of the art knowledge and practical experiences are also needed, similar to the needs of FRM. The HWPP-STRP construction indicates that this can be organised in a targeted way.

The results indicate that the HWPP-STRPs construction could benefit from a more targeted knowledge management strategy, consisting of 1) an assessment of the end users, their specific needs and their knowledge networks, 2) understanding of the readiness level of the knowledge generated and 3) senders and receivers should be intertwined during knowledge generation and dissemination processes. Active attitudes and behaviour are necessary at both senders and receivers in order to generate, share and seek "the right knowledge at the right moment" and facilitate learning processes, both for practical projects and for the policy framework.

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