The potential of web-collaborative platforms to support knowledge exchange in river management

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Knowledge exchange in river management

Adaptive and integrated river management is increasingly required by European directives to cope with changing river systems and multi-functional requirements (Pahl-Wostl 2006). Such perspective becomes evident in policy guidance for flood protection (European Commission 2007) and river restoration prjects through national river programmes such as "Room for the river" in the Netherlands. Moreover, the importance of stakeholder involvement in river management and related decision-making processes has been widely recognized (Reed 2008).

Borrowing the definition of Baede et al. (2007) from Aye et al (2015), stakeholder is related to the variety of scientific, institutional and local organizations that have a legitimate interest or may be affected by river management actions. Information sharing and knowledge exchange between relevant stakeholders can lead to more collaborative interactions, for example in decision-making (Failing, Gregory, and Harstone 2007; Edelenbos, van Buuren, and van Schie 2011). In river management, the collaboration between different stakeholder groups into a multi-disciplinary environment differ according to the level of stakeholder participation and governance style (Neuvel and Van Der knaap 2010). Knowledge exchange can be for example, in the form of guidance for project formulation, understanding and interpreting available information, communicating uncertainties and underlying assumptions, identifying critical points, elicitation of decision-making criteria, evaluating and negotiating about management options (e.g. Evers et al. 2012; Voinov and Bousquet 2010).

Stakeholder participation traditionally ranges from information sharing or one-way communication to more interactive or two-way communication forms (Arnstein 1969). However, Wehn et al. (2015) highlights the importance of contextual aspects of participation as referred by Fung (2006). Thereby, the goals of involvement, those who actually participate and the ways in which they are invited to do so, become relevant to support collaborative processes and knowledge exchange. However, the extent to which collaborative interactions are achieved and translated into meaningful knowledge for river management is still under debate (Wehn and Evers 2015).

Therefore, a preliminary but important pre-requisite to support collaborative interactions is facilitating a knowledge management base through information (ISs) and decision support systems (DSSs). Web-collaborative platforms offer important opportunities to combine capabilities of such systems for information sharing and supporting tools for river management. Moreover, guiding principles for collaborative interactions (Reed et al. 2014) should be adapted according to the specific study area and river management phase. Management phases often comprise a decision-making process for problem identification and framing, formulation of management alternatives, alternatives evaluation and negotiation, monitoring and re-evaluation.

User-centred design of web-based information and support systems

Advances in web-based GIS and information technologies have increasingly supported the development of ISs and DSSs. Standardization of technologies and open-source innovations have facilitated management of geo-spatial data, information sharing as well as visualization and analysis of relevant information for river management (Choi, Engel, and Farnsworth 2005).

Such systems usually comprise of a three-tier architecture for the data model (including metadata), logic and presentation functionalities (See Figure 1). In river management, ISs should generally satisfy a multi-stakeholder environment that often includes non-specialists. Therefore, user groups have different skills, information needs, and various degrees of data synthesis and analysis requirements (Mcdonnell 2008).

Moreover, DSSs go beyond IFs by assisting interpretation of available knowledge for defining decision criteria, formulating and evaluating management options through a variety of methods, for example, multi-criteria evaluation (Matthies, Giupponi, and Ostendorf 2007). When collaborative interactions exist, access to available data, information and knowledge is provided to participant stakeholders (user groups) according to accessibility rights. Different knowledge types as well as related uncertainties (e.g. lack of information) must be clearly communicated (e.g. metadata) to comprehensively frame river management problems. Scientific knowledge comprise available data from official sources and modelling outputs. Direct interaction with scientific models into the system is initially not considered to limit complexity to the variety of user groups. Instead, systems may incorporate interactive elements such as multimedia resources, management of comments and role playing (see Fig. 1). The specific case is under consideration.

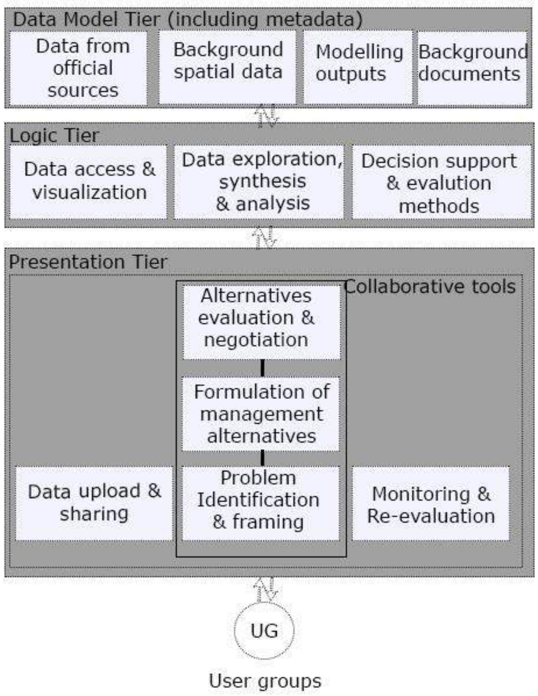

Figure 1. Components of a knowledge management base. (adapted from Gouveia et al. 2004)

In order to understand, categorize and prioritize user groups' requirements, we recognize the importance of user-centred design approaches since early development stages (Bijl-Brouwer and Voort 2008; Cortes Arevalo et al. Submitted). Moreover, relevant research questions (RQ) for the design of such systems include (Mcdonnell 2008; McIntosh et al. 2011):

- RQ1: Who and what are the roles and needs of data/knowledge providers and users?
- RQ2: What are the core-functionalities for the different user groups to support data sharing and knowledge exchange for decision support?
- RQ3: What are the components, workflow and data management model for the different user cases and which collaborative are required?
- RQ4: Which system architecture is the most appropriated according to available funding and technological resources towards reusing, upgrading and maintaining the system in long-term basis?
- RQ5: How can we test and validate usefulness and applicability criteria according to the context of use? For example a river management phase or decision-making process in an specific study area.

Such questions are generally part of a software development cycle of ISs and DSSs (Gulliksen et al. 2003). Thereby, prototypes are developed and refined incrementally (Fig. 2). Focus of this research is on designing a web-platform prototype with core-functionalities supporting usefulness.

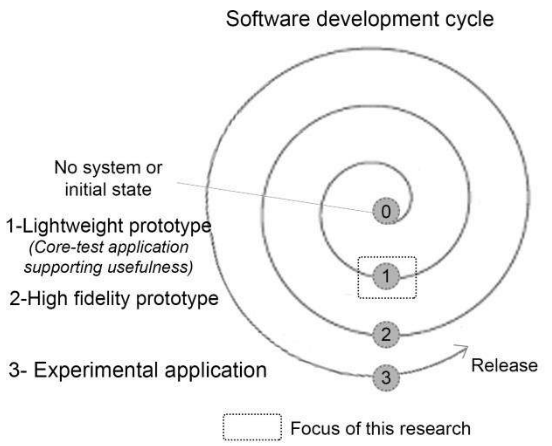

Figure 2. Software development cycle based on Mysiak, Giupponi, and Rosato (2005)

Potential usefulness and applicability: RiverCare Project context

River restoration projects have been implemented in many developed countries to address multi-functional requirements of river systems such as safety, navigation and biodiversity (e.g. ECRR 2015; REFORM 2015). However, stakeholders should better understand the long-term effects of river interventions in dynamic natural river processes such as erosion and sedimentation. That knowledge is particularly important, not only to reduce maintenance costs, but also to increase awareness about perceived benefits of river interventions (Schielen, Augustijn, and Hulscher 2015).

Thereby, we aim at evaluating the potential usefulness and applicability of web-collaborative platforms for information sharing and knowledge exchange for decision support in river management. We understand usefulness criteria according to the extent in which users believe that a system is useful to perform their activities and it is appropriate for the context of use (Laitenberger and Dreyer 1998). Although usefulness is a preliminary requirement for usability, it is important to define the functionalities of the system (Bevan 1999).

In the context of this research, knowledge providers comprise but are not limited to the RiverCare researchers. Knowledge users are initially represented by the institutes, companies and governmental bodies in the Netherlands that integrate the user staff committees. Methods will be implemented in coordination with researchers of RiverCare that share user requirements. Important consideration is given to support knowledge exchange by means of collaborative tools. Both collaborative tools and usefulness criteria will be the user requirements output.

Design steps account for user requirements, design and implementation, testing and evaluation of the first development stage of a web-platform prototype. Therefore, the user requirement analysis stage will account for different methods such as interviews, questionnaires, focus groups and participatory design workshops to define both user needs and usefulness criteria. For the design and implementation in Table 1, modular components of applications such as OpenEarth are under consideration following implemented web-platforms examples (Van Koningsveld et al. 2013). For evaluation and testing, one of the pilot cases of the project will be considered.

Concluding remarks

Although the intended *outcome* of this research is the design of a web-collaborative platform. Such *outcome* will not automatically imply a higher stakeholder involvement and knowledge exchange for river management (Wehn and Evers 2015). Thus, from the scientific perspective, the research aims at evaluating the usefulness and applicability of such *outcome* as a *mean* towards collaborative interactions. Gaps between design and use require to start simple, to combine ease of use, usefulness and validity of methods implemented. Moreover, the design process requires to agree on accountable outputs with participant stakeholders according to available funding and resources for development (Junier and Mostert 2014; McIntosh et al. 2008).

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