Networked Environments for Stakeholder Participation in Water Resources and Flood Management

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NETWORKED ENVIRONMENTS FOR STAKEHOLDER PARTICIPATION IN WATER RESOURCES AND FLOOD MANAGEMENT

DISSERTATION

Submitted in fulfilment of the requirements of
the Board for Doctorates of Delft University of Technology
and of the Academic Board of the UNESCO-IHE
Institute for Water Education
for the Degree of DOCTOR
to be defended in public on
Tuesday, 18th March 2014, at 10:00 hours
in Delft, the Netherlands

by

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To Mylene, Ian Jeremy and Iliana Jianese

To my father Jesus, mother Remedios, siblings Anthony, Aireen and Azenith

To my grandmother Eduvijis and the memory of my grandfather Demosthenes

SUMMARY

Lack of stakeholder awareness, involvement and participation in water resources and flood management (WRFM) planning and decision making processes often creates problems related to the implementation and acceptance of the proposed measures. Stakeholder awareness and participation in disaster prevention and management are crucial and should cover all phases of any disaster event. Moreover, since stakeholders often have a better understanding of the real potential and limitations of their local environment, their involvement in planning and management are of crucial importance.

Stakeholders can be classified in categories, such as government institutes, flood prone communities, NGOs, basin communities, private sector and scientific communities. Information sharing and repeated interaction between stakeholders are needed so as to build trust, negotiate for best possible benefits, and to enhance cooperation across jurisdictions and sectors. The challenge in stakeholders' participation is launching and maintaining the participatory process. Spatial distribution and diverse (even opposed) stakeholders' interests may come as one of the hindrances in maintaining the participatory process.

This research entitled "Networked Environments for Stakeholder Participation (NESP) in Water resources and Flood Management" addresses some of these challenges and hindrances in stakeholder participation. Networked Environments (NE) are web-based computer-aided or mobile environments for remote virtual interaction between participating entities such as stakeholders. NESP is envisioned to enable stakeholder participation in water resources and flood management by providing sharing of information, planning, negotiating and decision support.

The recent advancements of ICT (Information and Communications Technology) provide innovative solutions for the development of the NESP. Since the beginning of the computer and the Internet era, the World Wide Web has been increasingly used in our societies as a technology to access sources of information and for communication among organizations and individuals. Moreover, mobile technology has demonstrated even more advantages for reaching and engaging most of the citizens and potential stakeholders. The advancement of mobile technology and its application development paves a way for its usage for data gathering, remote execution of models and information dissemination. In effect, the Internet, World Wide Web, mobile and wireless technologies present a powerful environment for development and deployment of NESP as envisaged in this study.

The main objective of this work is research into conceptualisation, design and implementation of innovative web-based and mobile environments for stakeholder participation using the recent advanced ICT technologies. It incorporates novel approaches in stakeholder involvement in all phases of project planning and analysis, including negotiation support for deriving options with joint benefits.

Three case specific NESP frameworks were conceptualised to address the three different types of participation: (1) Information and knowledge sharing, (2) Consultative participation and (3) Collaborative decision making. These frameworks were named accordingly based upon the type of participation: (1) NESP-IKS, (2) NESP-CP and (3) NESP-CDM.

The framework termed *NESP-IKS* (**I**nformation and **K**nowledge **S**haring) was conceptualised for an effective assimilation of stakeholders' information and knowledge in WRFM. This can lead to mobilization and utilization of more reliable and up to date information in WRFM processes. Moreover, the framework offers professionals the possibility of using stakeholders' observations to improve their models and forecasts. The conceptual framework has three main components and one optional component: (1) Background information, (2) Information access, (3) Stakeholder participation and (4) Improvement of models and forecasts (*optional*).

The developed framework *NESP-CP* (**C**onsultative **P**articipation) was conceptualised for an effective and more inclusive type of participation. More inclusive participation through consultation can influence existing practices in the management and planning of water resources or floods. The developed NESP-CP application is expected to be a valuable system for awareness raising and stakeholder empowerment in WRFM. The framework has three main components: (1) Risk awareness, (2) Information access and (3) Stakeholder participation.

Lastly, the framework *NESP-CDM* (**C**ollaborative **D**ecision **M**aking) is intended for a collaborative type of participation where stakeholders together with experts identify relevant scenarios and realistic management alternatives that address commonly agreed management objectives. The participating parties subsequently assess the preferred alternatives, first by enabling the individual stakeholders to provide their own ranking of alternatives, which is then followed by aggregation of these rankings to represent the view of the whole participating group. When carried out in a fully transparent manner this process can possibly lead to negotiations (amongst the stakeholders) towards a consensus on the preferred management alternatives to be implemented. The framework also considers stakeholders' participation in modelling activities (e.g. model validation). Since stakeholders have more knowledge of their local environment, proper assimilation of this knowledge may significantly improve the model results. Moreover, their engagement in modelling-termed Collaborative modelling can be used as a learning process for better understanding of the system in question and some of the introduced measures. The framework can be summarised as consisting of two main stages: (1) Collaborative modelling and (2) Participatory decision making.

The main criteria for selection of a particular NESP framework are case-specific and depend on the environmental characteristics, the type of the management problem and its objectives. Moreover, as part of identifying the NESP frameworks to be used it is important to first asses the case study characteristics and only subsequently design the participatory process. This assessment will also guide the construction and implementation of the NESP.

The NESP frameworks were used to develop and test applications for five case studies with different environmental problems and management objectives. These case studies are the (1) Lakes of Noord Brabant, the Netherlands, (2) Somes Mare catchment, Romania, (3) Danube river (Braila-Isaccea section), Romania, (4) Cranbrook catchment, London, UK and (5) Alster catchment, Hamburg, Germany.

The Noord Brabant case study implemented the *NESP-IKS* framework. It aims to provide up-to-date bathing water quality information about several small lakes located in the study area to various types of users, such as swimmers or surfers.

The *NESP-CP* was implemented for both the Danube River and the Somes Mare catchment. Both case studies are related to flooding issues and aim at improved flood management through awareness raising and information dissemination and sharing among water authorities, professionals and broader stakeholder groups and citizens.

NESP-CDM was applied for the Cranbrook catchment and the Alster catchment case studies, with similar aims of empowering stakeholders in planning and decision making in flood risk management.

For the Noord Brabant case study an integrated web-mobile application was implemented, while for the other four case studies web environments were developed and implemented. In all the case studies these applications were developed and tested in combination with face-to face workshops with the end users / stakeholders. Commonly the NESP deployment was initiated with such workshops, aiming to introduce and demonstrate the NESP applications to the stakeholders; the number of subsequent face to face workshops depended on the type or level of participation. Afterwards, stakeholders were given time to use and test the applications. Finally they evaluated the applications using evaluation forms during the final workshops.

In general the NESPs developed were well appreciated by the users / stakeholders and they clearly recognised the value of using such environments. Water authorities, decision makers and some stakeholders and citizens expressed wishes for extensions of the NESP applications with additional information and development of similar applications for other study areas.

For the development of the applications several technologies have been applied and tested in this research. General Public Licence (GPL) technologies were intensively used for the development. The selection of GPL technologies was critical in building the NESP. Such selection was based on the design of the participatory process and the resources available. More specifically, this research demonstrated that the selection of available GPL technologies must be done carefully following a set of criteria: (1) their applicability within the framework, (2) flexibility and compatibility with other technologies, (3) for the pre-built application components, the general stakeholders should be familiar with their interfaces (e.g. Google maps), (4) the ease of using the technology and (5) the technology should be widely supported by software development community and continually developed.

In general the use of GPL technologies for such platforms is highly feasible. They do provide the desired level of interactivity in the developed components and have the flexibility to be adopted in other case studies. However, it should be also stated that for these kinds of applications programming skills are not sufficient by themselves. When developing platforms for stakeholder participation in water resources or flood risk management interdisciplinary knowledge and skills are needed usually available only in teams of developers with diverse expertise.

The work presented in this dissertation demonstrated that NESP such as web-based and mobile environments have the potential to overcome the hindrances in stakeholder participation in water resources and flood management.

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Chapter 1
General Introduction

This chapter introduces the research on Networked Environments for Stakeholder Participation (NESP) in water resource and flood management. Firstly it presents the research background on stakeholder participation and the use of networked environments for water resources and flood management. Next is an overview of water resources and flood management directives/strategies of European Union (EU) and non-EU countries, followed by a brief introduction to the importance of stakeholder participation. A brief review of several web-based systems for participatory environmental management and their shortfall is also presented. Lastly presented are the objectives and the structure of the thesis.

1.1 Background

Decision making in water resources and flood management (WRFM) is usually implemented through a top-down approach without sufficient involvement of stakeholders. This often leads to blockages and deadlocks in the implementation of the proposed measures. Ideally the decision making in WRFM should be carried out via combining both top-down and bottom-up approaches. Since stakeholders have a better understanding of the real potential and limitations of their local environments, empowering them for participation in planning and decision making is essential for the sustainability of the measures to be adopted (Webler et al., 1995; Abbott and Jonoski, 2001; UN-ESCAP, 2003; White et al., 2010).

Participation in water resources and flood management can be in different forms. It can take place through sharing of information and knowledge or through active collaborative decision making. The nature of this involvement obviously depends on the type of management strategies (e.g. long term planning or event management) and the nature of the problem (e.g. management of watershed, bathing water quality, floods etc...).

The major challenge in stakeholder participation is launching and maintaining the participatory process. The limitation of financial resources, stakeholders' spatial distribution and their interest to participate are some of the possible hindrances in initiating and maintaining the participatory process (WMO, 2006). With the widespread

availability and usage of the Internet, researchers and practitioners increasingly try to address these challenges and hindrances by developing and using web-based networked environments.

Networked environments are web-based computer or mobile-aided environments for remote interaction between participating entities such as stakeholders. A networked environment can not only answer the limitation of financial resources and stakeholders' spatial distribution, but this can also provide a more informative and interactive means for participation.

Following the realisation of the potential of using networked environment for stakeholder participation, within the last decade several web-based computer-aided environments have been developed. However, the focus of most such developments was on appropriate structuring and visualisation of decision-making problems, primarily targeting decision makers, without sufficient attention to interactions between decision makers and stakeholders, and even less to interactions among stakeholders themselves. In general there is insufficient research on using networked environments for participation of different types of stakeholders.

In recent years mobile technology has demonstrated even more advantages to reach most of the citizens and potential stakeholders. The advancement of mobile technology and its application development paves a way for its usage for data gathering and information dissemination. In effect, the Internet, World Wide Web, mobile and wireless technologies, present a powerful environment for development and deployment of networked environments as envisaged in this study.

This research presents a generic conceptual framework and specific design and implementation of Networked Environments for Stakeholder Participation (NESP) in WRFM. The NESPs case specific adaptation of the conceptual framework was applied in five real case studies: Noord-Brabant lakes in the Netherlands, two from Romania - the Somes Mare catchment and Danube River Braila-Isaccea section, the Cranbrook catchment in London, United Kingdom, and the Alster catchment in Hamburg, Germany.

The NESPs were developed using the advanced and open source ICT and were implemented for the two types of management strategies, the long-term and event management cases. The NESPs for long term planning supports transfer of knowledge, exchanging of ideas and negotiation to reach a common goal. The NESPs for event management supports awareness raising through information sharing and dissemination.

1.2   Water resources and flood management in EU and non-EU countries

National directives for the management of water resources and floods are important. They provide guidelines and standards for experts, authorities and decision makers in the planning and implementation of management strategies, leading to a better management of water resources.

Most developed countries have implemented legislation or directives for the management of their water resources and floods. In the developing world more and more countries are also developing legislations to better manage their water resources.

The following summarises legislations and guidelines in EU and non-EU countries.

In the EU, the European Commission (EC) established the Water Framework Directive (WFD) and Flood Directive (FD). The WFD, established in 2000, aims at sustainable management of all coastal waters, inland surface waters and groundwater in the European Union and its member states (EC Directive, 2000). Realising that there is a need to establish a directive on the assessment and management of flood risks, in 2007 the EC established the FD (EC Directive, 2007). The FD aims to reduce the negative impact of floods on human health, environment, economic activity and cultural heritage. Moreover, both directives (WFD and FD) encourage the EU and its member states to have management plans that incorporate public information and consultation.

In the United Kingdom (UK), the 2009 Flood Risk regulation and 2010 Flood and Water Management (FWM) act aimed on improving water and flood risk management was established. These regulations encourage policy and decision makers to incorporate short term and medium to long term actions and increase capacities and skills of local authority, citizens and stakeholders (Defra, 2010).

In most developing countries there are no established legislations or official guidelines on flood risk management. The World Bank (WB) initiated the development of guidelines on integrated urban flood risk management (World Bank, 2012). The WB guidelines were based on twelve key principles, some of which are: FRM should consider different scenarios, be designed to cope with changing and uncertain future and FRM should be integrated in urban planning and governance. Of interest here is that according to these guidelines FRM should also encourage multi-stakeholder cooperation and continuous communication to raise awareness and reinforce preparedness.

In summary the directives, regulations, guidelines and practices in water resource and flood management aim not only to properly assess and mitigate impacts of floods, they also recognise that it is crucial to involve the stakeholders and the public in any water-related planning and management.

1.3   Importance of stakeholder participation

The role of people at the local level is crucial in active management of many aspects of water resources. Residents of the local community often have better knowledge on the potential and constraints of their environment. Thus, empowerment of stakeholders who can represent the local people has become an essential objective of many water professionals (Bonn Conference, 2001; Abbott, 2001).

Empowering the stakeholders should be a top-down and bottom-up approach, which means that they should be involved in the planning and management through participation. Lack of stakeholders' awareness, involvement and participation creates problems in disaster management planning.

An example of participation in a long-term planning is by exchanging ideas, knowledge and negotiation to reach a common goal. In event management, participation of stakeholders can be through awareness raising and sharing of information (e.g. information on current water level, flooded area, water quality status).

Stakeholders' participation should not be seen as a burden in water resources and flood management. Instead, it should be treated as an essential part of the management and planning processes, because:

1. It brings together a diverse range of stakeholders to share ideas, knowledge, information, needs and concerns.
2. It helps all stakeholders to be aware of the impending problem and its proposed counter measures.
3. Promotes effective cooperation and understanding between stakeholders.
4. It builds resilience by enabling them to be more knowledgeable about the vulnerable areas, thus providing them adequate information to prepare the community in an event of a water related disaster.
5. It ensures the sustainability of measures adopted.
6. It brings autonomy and flexibility in decision-making and implementation.

More details on the importance and type of participation are presented in Chapter 2, containing the literature review of stakeholder participation in WRFM.

1.4   Towards a Networked Environment for Stakeholder Participation (NESP)

Initiation and maintaining the participatory process is a major challenge for stakeholders' participation in the water resources and flood management. Factors such as spatial distribution, diverse interest of the stakeholders and limited financial resources are some examples that may come as hindrances in maintaining the participatory process. The use of Networked Environment (NE) was hypothesized as a general solution to address these challenges and hindrances.