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# Collaborative modelling or participatory modelling? A framework for water resources management

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ABSTRACT

Decision Support Systems, and, more recently, participatory and collaborative modelling have emerged as a response to increased focus on stakeholder participation in modelling activities for certain fields like water resources management. Researchers and practitioners frequently use 'buzzwords' such as 'participatory modelling' and 'collaborative modelling'. In some cases, both terms are used interchangeably, largely due to unclear distinction between them in literature. This article draws the line between participatory and collaborative modelling by using levels of participation and cooperation as conditioning dimensions. Based on this methodology, a new generic framework is presented. This framework can help identify determinant features of both modelling approaches currently used in water resources management. It permits analysis of these approaches in terms of context, specific use, information handling, stakeholder involvement, modelling team and means. The article concludes with an application of the framework to a collaborative modelling approach carried out for a groundwater study in the Netherlands.



## 1. Introduction

Over recent decades Water Resources Management (WRM) has experienced a significant transformation. The top-down, mono-disciplinary and single sector managerial and planning approach was reformulated into Integrated Water Resources Management (IWRM) (GWP, 2000). IWRM is a bottom-up, demand-oriented approach based on multi-disciplinary activities. It has paved the way for stakeholder participation in planning and decision making processes (Rees, 1998). In particular, IWRM principles (known as Dublin Principles) have served as a turning point for public participation in WRM decision making processes (GWP, 2000). Ever since their declaration in 1992, stakeholder participation has become increasingly institutionalized in legislation like the EU Water Framework Directive (Directive, 2000/60/EC) and in global WRM frameworks and guidelines (GWP-ToolBox; Pegram et al., 2013; UNESCO, 2009). As the integrated approach to water management is widely accepted, the terms IWRM and WRM are often used interchangeably, also in this article.

A wide variety of participatory approaches and methods for participatory planning and decision making in WRM have been developed in response to the prominence of public participation in IWRM. Focus groups (Dürrenberger et al., 1997; Gearin and Kahle, 2001), the Delphi method (Linstone H. and Turoff M. (Ed), 2002), citizen panels (Armour, 1995), World Café (Brown, 2002), and Participatory Rural Appraisal (PRA) (Chambers, 1994; Mukherjee, 1993) among other forms are being used to increase stakeholder participation in decision making (Bousset et al., 2005). Much research has been oriented towards engaging stakeholders in planning and decision making processes. Much less scientific research has been undertaken for exploring the use of conventional computer-based models within these participatory planning and decision making processes. The development of Decision Support Systems (DSSs) emerged as a means to address this gap. However, in many cases DSSs were not used by stakeholders and decision

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makers after their development. This was due to a variety of reasons, primarily associated with the different knowledge and expertise of the developers of such systems and the diverse stakeholders as intended users. Participatory modelling approaches then started to be conceived to strengthen stakeholder ownership of DSSs and modelling tools by increasing stakeholder involvement in the actual modelling process. Although stakeholder participation cannot be considered as the unique pre-requisite for guaranteeing long term use of computer-based models, it can be a critical factor. Consequently, today there are various participatory modelling approaches being used worldwide. Some refer to these approaches as participatory modelling, whilst others employ the term collaborative modelling. Although certain differences between the two terms may be identified, their inherent similarities can result in them being used interchangeably. This is in large part due to unclear distinction having been made between them in the literature. This makes it difficult for researchers, practitioners and policy makers to identify which participatory or collaborative modelling approach is best suited to each type of decision making and related processes (Bots and van Daalen, 2008; Hare, 2011; Serrat-Capdevila et al., 2011). To support such identification, a new framework for evaluating participatory and collaborative modelling approaches in WRM has been developed and is presented in this article.

Some may question the value of yet another 'framework' given that others have previously been developed. For example, several evaluation frameworks have been developed for assessing participatory processes (Abelson et al., 2003; Rowe and Frewer, 2004). Similarly, evaluation frameworks and protocols for participatory and collaborative modelling approaches have been variously developed to assess the value of these approaches and their outcomes. For instance, Smajgl and Ward (2015) present an evaluation protocol based on the Challenge and Reconstruct Learning (ChaRL) Framework to assess the learning process of decision makers. Jones et al. (2009) developed the Protocol of Canberra to evaluate the influence of tools on the sharing of information among participants, their relations between each other and the outcomes of the participatory process. This was also even based on an earlier participatory modelling evaluation initiative (HarmoniCOP) developed by Mostert et al. (2007a). Plus, other scholars have developed frameworks to compare case-specific participatory modelling processes, such as the Comparison of Participatory Processes (COPP) framework (Hassenforder et al., 2015). The generic framework presented in this article differs from all of these other existing frameworks as it distinguishes between the key characteristics and features of both "participatory modelling" and "collaborative modelling" approaches based on 20 relevant parameters for WRM. This helps to categorize existing approaches and corresponding tools into one of the two generalized terms via a consideration of their generic characteristics and features (trade-offs).

The focus of this research is to both distinguish between and highlight the importance of participatory and collaborative modelling approaches in the field of WRM. For this, we first describe background information necessary to understand this research, including definitions and typologies. In Section 3, we propose four pillars of both modelling approaches. Based on this, and taking levels of participation and cooperation as the critical conditioning dimensions, we make a classification of participatory and collaborative modelling approaches in Section 4. Finally we describe the new generic framework to help categorize existing approaches into "participatory modelling" or "collaborative modelling" based on their key characteristics and features (Section 5). This framework is then applied to evaluate interactive modelling though a collaborative groundwater modelling study in the Netherlands (Section 6). The article concludes with a general discussion on the suitability of the framework and future research directions.

## 2. Background information

### 2.1. Challenges of decision support systems for IWRM

The IWRM process aims to strike a balance between using currently available water and land resources for socio-economic purposes and protecting them in such a way that they can also be used in the future (GWP, 2000). Within this framework, the development of DSSs has served as a major initiative targeted towards bridging the gap between the development and use of computer-based models with stakeholders and how the planning and decision making processes are actually carried out (Alter, 1980; Georgakakos, 2007; Giupponi and Sgobbi, 2008; Jolk et al., 2010; Keen, 1987; Loucks and da Costa, 2013; Serrat-Capdevila et al., 2011; Sharda et al., 1988; Soncini-Sessa et al., 1991; Thiessen and Loucks, 1992; Walsh, 1993; Zindler et al., 2012). However, in many instances these initiatives have not been sufficient, with the DSSs not actually used by stakeholders and decision makers. Extensive research has been carried out to identify the main challenges of the use of DSSs in WRM planning and decision making. These are:

1) The key points of a planning and decision making process are the objectives and criteria. DSSs need to focus on the goals the decision maker and stakeholders wish to achieve, which might differ depending on the decision making process and might evolve over time (Bousset et al., 2005; Medema et al., 2008; Mintzberg, 1978);
2) Most DSSs focus on the tool to be developed rather than on their participatory use by or with stakeholders and decision makers. The main focus is often on the software structure, the user interface and the visualization capacities. Less emphasis is placed on stakeholder-model interactions or the specific conditions that makes the use of models being more effective (Refsgaard et al., 2005; Serrat-Capdevila et al., 2011);
3) The use of DSSs in decision making processes often demands that the modeller remains a central part of the process. Consequently, these models are commonly perceived as 'black boxes'. They are often developed and implemented in the back-room, even in those instances when there is interactive work done during data collection and results are shown and discussed with stakeholders (Bourget L. (Ed.), 2011; Loucks et al., 2005).

### 2.2. Definitions and typologies of participatory and collaborative modelling

'Participatory modelling' and later 'collaborative modelling' emerged as possible solutions to address certain challenges encountered with traditional DSSs. At the core level, both generic sets of approaches emphasize the importance of involving stakeholders in a modelling process (Voinov and Bousquet, 2010) Stakeholders should be exposed to the same information and problems encountered during the modelling process (Castelletti and Soncini-Sessa, 2007). Various scholars have built upon this basic definition; for instance, by distinguishing stakeholder involvement in various modelling stages (Hare, 2011), by specifying the stakeholder groups to be involved (Voinov and Gaddis, 2008), or by emphasizing the importance of communication activities and visualization tools (Evers et al., 2012).

Specific types of participatory and collaborative modelling have emerged in the last few decades. Some are extensively used for WRM, whilst others are emerging approaches. The most frequently applied approaches in WRM are listed in Table 1. As Voinov and