Developing a tangible gaming interface for Virtual River

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Introduction

Achieving sustainable river management is generally complex as any issues addressed are multi-scale, concern inherent uncertainty, and affect multiple actors and agencies. To address river management issues, it is important that decision-making processes are adaptive to deal with the uncertainties and include the diversity of knowledge and values of all affected actors. Learning-by-doing—active experimentation and continuous evaluation—has been advocated in natural resources management to facilitate collaboration between and learning among actors.

Serious gaming

Serious games, games with a primary purpose other than entertainment, are increasingly explored in the context of integrated water resources management as facilitation tools in such social learning processes. In the context of multi-actor decision-making, serious games can be defined as "experi(m)ent(i)al, rule-based, interactive environments, where players learn by taking actions and by experiencing their effects through feedback mechanisms that are deliberately built into and around the game" (Mayer, 2009, p. 825). The strength of using such serious games lies in the ability to include both the techno-physical complexity—the river system and its uncertainties—with the socio-political complexity—the strategic interactions in the policy arena—by combining role-play with in-game feedback mechanisms in the safe experimentation environment of a game (Mayer, 2009).

Virtual River serious game

As part of the RiverCare research programme, we are developing a serious game titled Virtual River. Virtual River aims for participants to experience how the river system functions and what the implications of choices are, in particular in regard to spatial riverine measures as executed in the Room for the River programme. By playing Virtual River, participants learn about the socio-political complexity as they engage in active collaborations and negotiations with other participants playing different river basin management roles. On the techno-physical complexity, participants learn about how management measures affect the system and how such measures impact indicators like flood safety, biodiversity, and costs. Moreover, participants learn about the trade-offs that measures present between these indicators.

Formative evaluations—evaluations focused on improving a design—of a board game prototype show that participants found the game engaging and insightful, and that participants understood the link to reality (Den Haan et al., 2018). However, participants, both laymen and river management researchers, also found the game complex and perceived the in-game indicator calculations as a black box, preventing participants from gaining the techno-physical insights into how a river system responds to changes. For further development, the goal therefore became to lower or help navigate the complexity and to remove the black box.

Tangible user interface

The pursued solution is the development of a tangible gaming interface based on the SandBox; a collaborative modeling tool developed by Deltares based on augmented reality that contributes to system understanding and enhanced communication between actors (Ottevanger et al., 2017). The SandBox is, quite literally, a box of sand, which represents the geometry of a river section that can be changed by users. By reshaping the sand, an updated geometry is sent to the hydrodynamic model. Visualizations of the results—e.g water level and flow magnitude—are projected back onto the sand by a beamer (figure 1).

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The SandBox can be classified as a tangible user interface; an interface that provides physical forms to digital information (Ishii, 2008). The physical forms serve as both control and representations for their digital counterpart. Using tangible interaction for Virtual River therefore uses the participants' ability to grab, move, and change physical objects as an easy, intuitive, and low-threshold way to interact with digital information.

Figure 1. SandBox setup and interface (photo from Ottevanger et al., 2017)

3D game board

The tangible gaming interface is based on replacing the sand in the existing SandBox framework with a 3D game board. Based on a hexagonal board design, the arrangement of a limited number of 3D game pieces form the basic geometry of a river basin stretch that includes—based on a Dutch perspective—the main channel, the floodplains, and the dikes (figure 2). Additional 3D game pieces are used to construct spatial measures in the game board—e.g. side-channels, longitudinal training dams, and dike relocations. The integration therefore takes the SandBox's easy and low-threshold interaction with a hydrodynamic model and adds structure to the Virtual River by providing structure through a limited number of options to facilitate gameplay.

At the time of writing, an alternative detection for the 3D game board geometry is explored over the existing SandBox's detection based on a Kinect measuring the distance of the geometry (figure 1). The alternative detection would be based on directly detecting the insertion of game pieces in the game board's hexagonal grid using for example RFID tags. This approach would remove the necessity to calibrate the Kinect at each game session. In addition, it removes the necessity to create 3D game pieces that are smooth and interconnected as shown in figure 2. In this approach, it would be possible to instead use a single standardized game piece. Stacking this game piece raises evaluation and can therefore be used to create the geometry of the 3D game board. Interpolation can be used to smoothen the sharp changes in elevation for the hydrodynamic model. An additional benefit of this approach is that it makes building the geometry universal; game pieces do not necessarily represent the Dutch river system. Next steps include developing and testing this 3D board game approach. This alternative to the game board's design therefore increases its flexibility which is potentially beneficial for when adapting and deploying Virtual River in a non-Dutch setting.

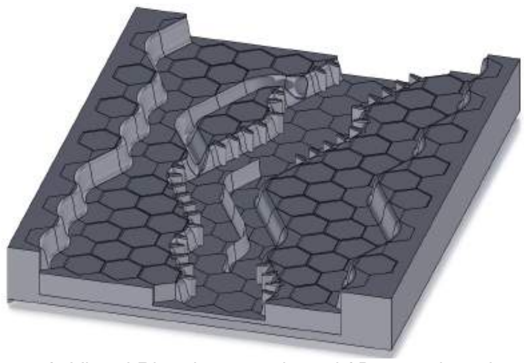

Figure 2. Virtual River hexagon-based 3D game board

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