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Designing the Virtual River Game to support the collaborative exploration of river interventions

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Environmental decision-making concerns application of (multiple) interventions to pursue various objectives and address pressing challenges. Such decision-making is challenging as it includes evaluating the interventions' effects on different spatial and temporal scales, weighing their inevitable trade-offs, and considering the different stakes at the table. To explore available interventions and their effects, games offer players environments that are inviting, interactive and immersive, and provide a sense of safety to experiment. These qualities make games interesting tools to engage stakeholders and support collaborative decision-making. However, to effectively accomplish this, it is necessary to tailor a game to the various types of stakeholders, who have different backgrounds and levels of expertise.

We present the Virtual River Game, a serious game that challenges players to manage a schematized stretch of a Dutch river. In the game, players freely design and test typical Dutch river interventions. To experience the interventions' effects, the players' scores on flood safety, biodiversity, and costs are updated with each tested design. While developing the game, we focused on how to facilitate discussion and collaboration between domain experts – e.g. hydraulic engineers and flood safety specialists – and non-experts – e.g. local residents and farmers. To accommodate domain experts, including real-world engineering models in the game was key to offer credibility to the river interventions' in-game effects. At the same time, to enable active participation of non-experts, including such models should not make the game too overwhelming. As a solution, we developed an augmented game board, combining the computational power of computer games with the low-threshold and attractiveness of board games. The board has a hexagonal grid of 143 tiles that are always filled with modular game pieces, which combined determine each tile's elevation and land use. Players replace game pieces on the board to apply interventions, changing the elevation or land use or both of chosen tiles. An automatic conversion of the board's layout updates the game's digital elevation model and land use distribution that serve as input for a hydrodynamic, ecological, and cost model. Grounded in tangible interaction, players are provided with a perceptual coupling between their actions and the computed effects

by visualizing spatially explicit model output on the board through projection. Additional model output is accessible to players on a separate monitor.

Both domain experts and non-experts played the game in multiple sessions, with experts playing an in-game role not corresponding to their day-to-day professional role. After playing the game, both experts and non-experts indicated that they enjoyed playing it and that they gained new insights about both river management and the other players at the table. In particular, non-experts mostly (strongly) agreed with statements on learning in the post-game questionnaire. Moreover, observations of the sessions and feedback from players indicated that experts complemented the game's feedback with their domain-specific knowledge, explaining for example the principles (i.e. the physics) that are applied in river management to non-experts. We conclude that the Virtual River Game's hybrid set-up has substantial value by enabling discussion and collaboration between experts and non-experts.