A participatory process to support sustainable water resources management in the Ebbsfleet Garden City

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ABSTRACT

The present work describes the development of a participatory System Dynamics Model (SDM) aiming to explore sustainable urban water management (UWM) in a structured way and to understand where policy interventions might be best focused. The proposed multi-step process is useful for supporting decision-making at a strategic, system-wide level and for exploring the long-term consequences of alternative strategies. The strongly participatory base of the SDM allows both to include local knowledge held by relevant stakeholders, and to support a collective learning process, which should improve the effectiveness of the selected strategies. In the following sections on the SDM co-development to enhance sustainable urban water management in the Ebbsfleet Garden City are provided.

1. Introduction

Several challenges, such as rapid growth in urban population, extreme weather events and ageing infrastructure have an adverse impact on the effectiveness and safety of urban water management (UWM). This increases the need to search for sustainable and adaptive pathways, which may support cities in becoming resilient to these pressures in an uncertain future. Indeed, many cities are now rethinking their approaches to deal with flood risk management, water security and safe/sustainable water supply issues, since their complexity and the interconnectedness of problems require the adoption of innovative perspectives.

In this context, the Urban Flood Resilience (UFR) research project is investigating how a transformative approach to water management in urban areas can be achieved. The two pillars of the methodological approach proposed are i) the increased recognition that the direct involvement of local stakeholders support developing a joint understanding of problems and the selection of effective solutions; ii) the need of holistic approaches to UWM, and of decision support tools capable to describe the impacts of multiple drivers and multiple different measures. The present work summaries the key aspects of a participatory modelling process

developed to investigate the UWM challenges in the Ebbsfleet Garden City (UK) and explore different options (including socio-environmental and policies) using a participatory System Dynamics Model (SDM).

2. Materials and methods

SDM is an effective method for the analysis and simulation of the behaviour of complex systems over time. A participatory SDM is used in the present work to support a structured exploration of interdependencies within the urban water system, and an improved understanding of where policy interventions might be best focused. Starting from a semi-quantitative representation of system structure it is particularly useful for supporting decision-making at a strategic, system-wide level and exploring the long-term consequences of alternative strategies, particularly those that are difficult to include in quantitative models (e.g. socio-institutional changes) (see e.g. Pluchinotta et al. 2018). Building a participatory SDM allows to build a shared view of the system under investigation, and to include relevant local knowledge. With specific reference to the proposed case study, the SDM was developed over the course of five stakeholder workshops (November 2017 – February 2019) and adopting a group modelling perspective (Fenner et al. 2019). The main concern according to the stakeholders is the water use optimisation, and all activities were specifically oriented to the comparative assessment of multiple strategies to support sustainable UWM.

3. Results

The basic steps of the proposed approach are: i) problem definition and identification of the main 'dimensions' to analyze (i.e. water use optimization, flood risk management, water quality, biodiversity, quality of the place); ii) identification of the main variables and classification (e.g. drivers, causes, impacts, objectives); iii) collective building of a Causal Loop Diagram, representing the qualitative part of the SDM, directly focused on the interconnections between different variables and problem dimensions; iv) model discussion and validation; v) development of the SDM. Specifically focusing on the last step, the final workshop was oriented to SDM analysis and validation with specific attention to model variables, links and equations.

The developed model is a stock and flow model (Vensim® Software by Ventana Systems) and is built upon a water balance principle, performing a comparison between water demand and water supply, and taking into account specifically the potential impact of innovative strategies such as mainly Rainwater Harvesting (RWH) and Greywater Reuse (GWR) at urban scale. The model runs over a 30 years time frame, which considers the gradual evolution of the city from 2019 to 2049, and is based on a yearly time step (i.e. the water balance is computed annually). The main assumption is that stakeholders' behaviours are aggregated for the analysis.

Multiple different scenarios were co-designed and tested. In this process, the suggestions provided by the stakeholders were considered, and the role several strategies were considered, such as structural actions (e.g. increase of water storage), but also socio-environmental incentivizing policies (e.g. educational programs and best practices), economic (e.g. water pricing and incentives) and regulatory instruments (e.g. improved planning policies). The effectiveness of such strategies on the long-term water balance was directly investigated. Among the main outcomes of the analysis, the importance of activating socio-economic actions alone or along with infrastructural actions was strongly evidenced.

4. Concluding remarks

The participatory SDM built for analyzing UWM in Ebbsfleet suggests that a range of paths could be followed to reduce potable water use in the Ebbsfleet Garden City. The SDM allows modelling the impacts of these strategies on the system as a whole, highlighting the role of socio-institutional measures, and their synergistic impacts with structural actions. The general interventions suggested should be further explored, also with coupling with other models, and then translated into more specific actions.

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