ARTIFICIAL INTELLIGENCE, HUMAN AGENCY AND SOCIAL DECISION-MAKING IN WATER MANAGEMENT SYSTEMS

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ABSTRACT

This PhD project deals with the effects of artificial intelligence (AI) in human agency and decision-making when this technology is integrated on automated and supported decision-making processes in water management for climate change droughts. A case study settled in Catalonia has already been defined to focus the research and frame the empirical data collection. Qualitative and participatory methodologies will be implemented, including an agent-based model (ABM) co-created with stakeholders involved in this sociotechnical water management system.

Keywords: artificial intelligence, water management, human agency, uncertainty, resilience

1 RESEARCH QUESTION

Climate change is one of the most pressing challenges our societies are facing, being intense droughts (expected to increase in length and intensity) one of the main impacts on our planet and for those living in it. Artificial intelligence (AI) has been increasingly introduced as a tool to support actions and decision-making to respond to climate change. It has been highly developed to support adaptation strategies to water scarcity, with purposes of drought assessment, monitoring and forecasting, and water management [1].

Water management systems can be understood as socio-ecological-technical systems, since they are "composed of technical artifacts, human agents and institutions" [2]: in a context of climate change drought, countries' governments, regulations, state agencies handling water distribution, media informing about consumption restrictions, citizens dealing with water scarcity, technological innovations for improving forecasting or desalination plants to deal with water shortages, all these agents, can be part of this sociotechnical system. Some research states that integrating AI to sociotechnical systems implies changes in decision-making processes, given that these systems include also artificial agents and technical norms, besides the usual elements in a sociotechnical system [2]. Other contributions point to risks related to this kind of technology applied to handle sustainability challenges [3]: the fact that AI is commonly used to increase efficiency in water management, may set aside resilience strategies that were more developed before the introduction of this technology. Finally, uncertainty [4] and systems resilience [5, 6] have been pointed as relevant elements related to human agency and decision-making in sustainability studies.

Since human behaviour is the main trigger of climate change and is also the hope for reversing or at least containing the situation [7], AI systems interacting with this human behaviour through decision-making processes or sense of agency, in the context of water management as an adaptation strategy to climate change droughts, appear as a relevant object of analysis. Nevertheless, as far as the PhD candidate knows, no contributions related to AI technologies applied automated or supported decision-making in water management also tackle human agency or decision-making processes. This research tries to fill this gap by answering the following research question: **How does AI technologies integration for automated or supported decision-making processes impact human agency and decision-making in the context of climate change adaptation to droughts through water management?**

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2 RESEARCH IMPLEMENTATION

Catalonia is a territory settled in the north-east of the Iberian Peninsula, bordering on France and next to the Mediterranean Sea. The latter has been identified by the European Commission as one of the European regions most vulnerable to climate change, with droughts being one of its main effects on the region [8]. Catalonia suffered a drought period between 2007 and 2008, and has suffered an even more intense drought since 2021. That is why the Catalan Government has deployed several adaptation strategies to drought [8]. Among them, AI for automated and supported decision-making for water management has been recently implemented and is still being explored [9]. Since the previous drought experienced between 2007 and 2008 was handled without debate about AI technologies, while in drought beginning in 2021 AI technologies have been widely implemented and discussed, this context provides an ideal case study with two situations to be compared. A second case study is being explored in Germany to complete the comparative frame.

The Catalan Water Agency (ACA in its Catalan acronym) is the public institution in charge of the water management in Catalonia. The ACA sets alarm levels in case of drought and implements restrictions, as well as penalties for those city councils who don't comply with these restrictions. City councils are responsible for water supply and distribution, and they are responsible of implementing penalties for citizens and companies who don't comply with the restrictions. Public and private companies can be designated for performing different management tasks, such as distribution, purification or canalisation. Research institutions assessing public bodies and developing innovations for facing water scarcity are also involved, as well as citizens who need to reduce water consumption.

In regard to methodologies, firstly, documentary and media analysis, interviews, focus groups, Participatory System Mapping (PSM) and social network analysis (SNA), the two latter co-created with stakeholder [10], will be applied to feature the past and the current water management system during both drought periods in Catalonia and to describe how does the integration of AI for decision-making processes modify the role of the agents involved and the decision-making processes. Secondly, this description will make it possible to analyse how this AI usage impacts the individual and the collective agency and the decision-making processes of different actors involved, and how does it relate to perception and management of uncertainty. This analysis will allow to identify the agency and decision-making features that are replaced by AI, and will look at how public policies implementation and discourse about the citizens' role in water management in Catalonia impact the sense of agency of actors involved. Finally, from the PSM, the SNA and the qualitative analysis, an ABM will be designed [11] to model the current system with two purposes: (1) coming up with a model to understand the water management system when AI is already introduced and (2) running ABM experiments [12] meant to shed light on questions such as how AI and human agency interact with system's resilience, or which are the impact of different adaptation strategies and how AI prevents or fosters certain strategies.

At this point, preliminary media and documentary analysis have already been conducted in order to pre-identify relevant actors. Also, some meetings with experts in the field have been developed, and the first fieldwork is being prepared and will be run in the following weeks. By May 2024, when the ANNSIM conference takes place, a preliminary PSM describing both water management systems and co-designed with different stakeholders will be already built, and a first draft of the SNA will also be drawn: these results are the first step for the design of the ABM: already the discussion about how to design an ABM from qualitative data and tools co-created with stakeholders (the PSM and the SNA) can yield relevant insights.

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