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Reinforcing the Hydrosocial Cycle to foster water governance and stakeholders' interdependence in urban agroecosystems: a local test in Benidorm, Spain

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The Hydrosocial Cycle (HSC) has been widely applied and discussed as a consolidated research line to rethink the contemporary challenges that condition the urban and agroecosystem nexus. However, additional research directions are still open to guide policy and decision-makers in reinforcing stakeholders' engagement and interaction to resolve tensions between water demands. This perspective paper suggests updating the HSC approach to improve the analysis of stakeholder interaction when addressing water scarcity in waterscapes. After briefly review the most relevant contributions of the HSC approach in the last two decades, we develop a preliminary framework to reinforce stakeholders' interdependence analysis by designing a questionnaire to synthesize five main behavioral patterns conditioning stakeholders' interactions: relevance, representativeness, recognition, assessment, and collaboration. Then, each pattern is organized in a triple-loop approach: *to be*, *to do*, and *to share* to characterize the mutual (mis)understanding of the stakeholders. The results of its application to Benidorm (south of Spain), a mass-tourism destination coexisting with rural development in tension for water supply, exemplified how 1) most stakeholders consider themselves important, but some of them are unaware of the role of others, 2) all stakeholders receive a higher punctuation in terms of functions rather than actions, and 3) all stakeholders agree on the benefits of the predisposition of parties (willingness) to achieve agreements in the short or medium term. Future research should consider how to address the lack of representativeness and power imbalance together with mechanisms to reinforce longitudinal studies in which actions from stakeholders could be contrasted.

KEYWORDS

Hydrosocial Cycle, wicked problems, socio-ecological systems, stakeholders, social learning, participation

1 Introduction

Waterscapes and hydrosocial territories, as interfaces built on the interaction of (peri-)urban and agroecosystems, tend to be hybrid –partly natural and social– and dynamic systems resulting from historical developments, power relations, and situatedness in space and time (Müller et al., 2020). Social rules and norms regulate access to water, a control over the resource renegotiated and adapted over time. Thus, 'water' is never simply H_2O, but always produced as a particular 'water', materially and discursively, within specific moments, contexts, and relationships between water users (Budds et al., 2014), areas where divergent socio-environmental imaginaries are generated and contested (Duarte-Abadia and Boelens, 2016). Furthermore, water plays a critical role in exacerbating existing tensions due to water scarcity and unpredictable rainfall patterns, but also flash floods, combined with poor water management, power imbalances, and multifunctional water demands (Unfried et al., 2022). Consequently, water management and governance are often described as 'wicked problems' because solutions can be challenging to identify and implement due to the uncertainty, complexity, and divergence of coexisting stakeholder interests (Hargrove and Heyman, 2020).

Conflict can be prevented by better understanding of the factors that influence cooperative behavior between stakeholders to carry out collective actions (Tatar et al., 2022). Over the years, numerous approaches have been conducted to examine factors influencing the attitudes and behavior of stakeholders, drawing on theories from the social sciences, particularly in the management of hydrosocial territories (Ricart et al., 2019a). Widening participants' involvement in research can identify differences in opinion and understanding across communities, capture valuable local expertise, and facilitate knowledge exchange between stakeholders (Stosch et al., 2022). Participatory research approaches can also ensure that management decisions are more inclusive, socially acceptable, and effectively implemented. In this line arises the concept of the Hydrosocial Cycle (HSC), defined as a socio-natural process by which water and society make and remake each other over space in time (Villar-Navascués and Arahuetes, 2020). Consequently, the approach identifies the relationships between the circulation of water flows and social, political, economic, and cultural processes, which contribute to the redesign of the perceptions of individuals and stakeholders about water management and governance (Eaton et al., 2021).

The HSC can lead to new interpretations or shared meanings to (1) build trust and collaborative problem solving, (2) ensure better collaboration between stakeholders who perceive water resources needs and management processes differently, and (3) increase adaptive capacity to face water scarcity (Rodela et al., 2012). However, to achieve this triple goal, stakeholder analysis should provide a better comprehension of how stakeholders interact and are predisposed to collaborate with others when competing for the same water resources. This paper aims to reinforce the HSC approach by offering an easily replicable tool (questionnaire) and a tentative framework (triple-loop approach) to delve into stakeholders' performance and collaboration capacity.

2 The HSC cornerstones

The HSC approach represents an ontological perspective of the water cycle, which considers the hybrid character of water as a socio-natural product. Water results from interactions between water itself, social power structures, and technology/infrastructure (Linton, 2014), and any change in technical interventions, water policies, land use planning, extreme events, user discourses, or water governance schemes can affect the established relationships (Linton and Budds, 2014). HSC analysis enables an integrated assessment of the relationships between coexisting and competing water users. It contributes to a more comprehensive understanding of tensions and conflicts over water access, control, and decision-making (Budds and Hinojosa, 2012). This approach was promoted to overcome the limits of the previously dominant infrastructural and resource-orientated hydraulic paradigm and to reinforce the Integrated Water Resources Management (IWRM) approach, which emerged in the 1990s. Beyond integrating social, cultural, and political aspects in the analysis of water conflicts, water and society are conceived as connected elements of the same spatial and geographical context.

To identify how, by whom, through which strategies, and with what interests the water is circulating, distributed, and controlled, the studies on HSC analysis have been based on different methods and tools. Historical and discursive analysis have been central in these studies to ascertain the political use of concepts such as water scarcity (Kaika, 2006); collective self-water governance (Boelens et al., 2016); reconfiguration of decision-making scales in water governance (Loftus et al., 2016); unequal social and political power in water management and governance (Swyngedouw, 2004); or the agency of nonhuman objects in shaping social relations (Usón et al., 2017) and reproducing existing relationships between stakeholders (Mills-Novoa et al., 2016). Generally, this approach has been limited to certain study cases of the Global South and focused on the right to water, environmental justice, and unequal water governance schemes, as clearly exemplify processes of inclusion-exclusion, development-marginalization, and unequal distribution of welfare (Boelens et al., 2016). Nevertheless, the adaptation of this approach to case studies of the Global North is pending, understanding that the inequalities in this context are not so evident, nor do they imply the satisfaction of fundamental rights. However, in areas of the Global North, there are also unequal power relations that prevent resolving of some conflicts around water management and governance.

3 Complementing the HSC approach

The HSC, as a political ecology approach, asks three main questions to orient thinking around water and how stakeholders interact with it: 1) The ontological question, 'What is water?'; the epistemological question, 'How is water known?'; and the relational question, 'How does water internalize social relations, social power, technology, and infrastructure?' (McLean, 2022). We aim to focus on the third question as we consider that the relations between water and society are extensive, so that analysis could identify countless interactions but fail to delve deeply into specific interactions. As conflict analysis always requires valuable and practical tools to clarify the nature of the conflict and the behavior of stakeholders (Zanjanian et al., 2022), we provide a primary and replicable tool (questionnaire) able to synthesize the attitudes and interactions of stakeholders by highlighting five behavioral issues: relevance, representativeness, recognition, assessment, and collaboration. They aim to better understand stakeholders' roles and relationships and simplify how their perception and interaction could be tested in hydrosocial territories (Ricart and Rico-Amorós, 2022). Furthermore, these issues are combined to configure a triple-loop approach (*to be*, *to do*, *to share*) based on mutual understanding and recognition of stakeholders, through which analyze stakeholders' performance (*to be* represented and *to do* actions) and collaboration predisposition (*to share* knowledge). This approach can be seen as a tentative and intuitive road from theory (loop one) to practice (loop two) in a mutual understanding framework (loop three). More details on behavior patterns and the triple-loop approach are included in previous research (Ricart and Rico-Amorós, 2022).

The questionnaire aims to deepen collaborative governance through structured information about stakeholders' roles, actions, and alliances when addressing water scarcity and management scenarios from coexisting and confronting water demands. The questionnaire was pre-tested in previous works (Ricart and Clarimont, 2016; Ricart et al., 2016; Ricart and Gandolfi, 2017; Ricart and Rico-Amorós, 2022) and updated to systematize stakeholders' behavior and interaction. It contains 11 closed-ended questions and combines multi-response answers (for Q3, Q5, Q8, Q9 and Q10), double entry tables (Q6, Q7 and Q11), and 5 points Likert scale (Q1, Q2 and Q4). Each behavioral issue is addressed through different topics: (1) relevance (stakeholder's role, importance, interest, and power in decision-making processes), (2) representativeness (stakeholder's perception of being included in decision-making processes), (3) recognition (relevance of the stakeholder's role according to others' perceptions), (4) assessment (relevance of stakeholder's actions according to others' perception, including ignorance and unknown according to others' perception), and (5) collaboration (stakeholder's capacity to establish agreements) (Figure 1). The questionnaire has been analyzed using descriptive statistics, represented properly in graphs, and, when appropriate, by matrices. The following sections will test the questionnaire in a case study, Benidorm.

4 Testing the Benidorm context

4.1 Context and motivation

Benidorm is the second leading tourist destination on the Spanish Mediterranean coastline after Barcelona, attracting around 2 million visitors annually and 16 million overnight stays. It is located in Marina Baja County, in southeast Spain, characterized by a semi-arid climate, with limited availability of water resources, and affected by recurrent drought episodes. Since its consideration as a coastal mass tourism destination in the 1960s, it has produced up to seven severe water crises, which have contributed to establishing a complex water governance model and highly technically intervened water supply system. In 1977, the Marina Baja Water Consortium was created by the initiative of the most populated municipalities in the county, including Benidorm, to overcome the water crisis and guarantee the water supply and tourist activity. This water supply system is dependent on several sources. First, surface water is stored in two reservoirs, Guadalest and Amadorio, from which two pipelines supply water for urban and tourists. Secondly, groundwater is used, especially during droughts, and stored (Beniardà pumping wells) or pumped (Algar pumping wells, owned by the Callosa d'En Sarrià irrigators) in the Guadalest reservoir by pumping water from the Algar river.

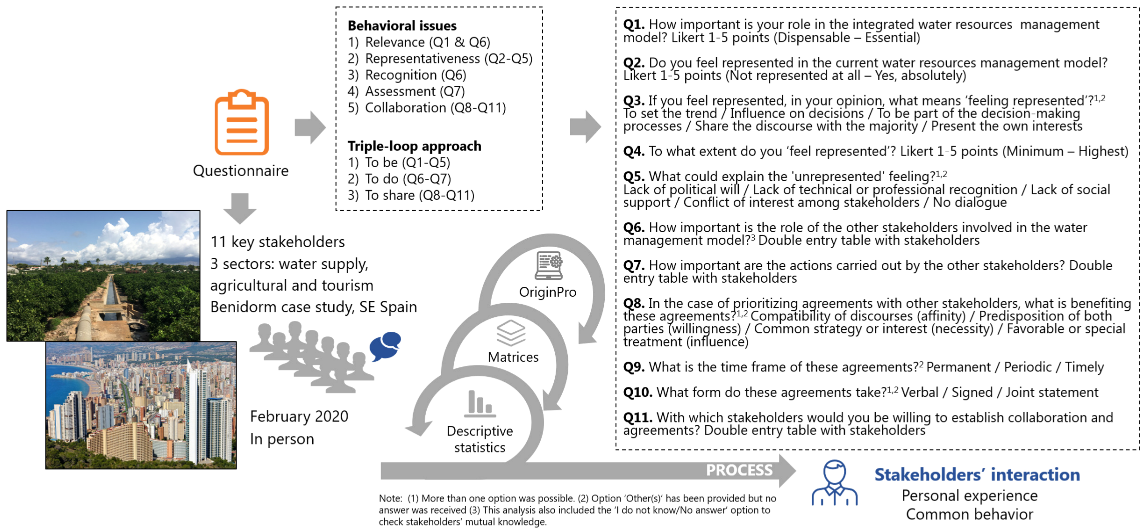

FIGURE 1
Methodological framework.

The contrasting scenario between the water deficit affecting the Amadorio River basin and the high precipitation patterns occurring in the Guadalest River basin motivated the interconnection of both reservoirs (Guadalest and Amadorio) through two infrastructures owned by the Irrigation Community of the Canal Bajo del Algar: The Canal Bajo del Algar and a 900 mm pipeline. Two pumping stations are used to feed the Amadorio reservoir from the Guadalest: the Mandem pumping station (to supply irrigation infrastructures) and the Torres pumping station (to later raise water to the reservoir). In third place, the water consortium manages the reclaimed water produced at the Benidorm wastewater treatment plant. Recently, the consortium has added desalination to its supply sources, as it can receive up to 11.5 hm^3/year from the Mutxamel desalination plant through the Rabassa-Fenollar-Amadorio emergency pipeline.

The water consortium established several agreements with various irrigation communities to use part of their infrastructure and water use rights in exchange for economic compensation and reclaimed water supply. This complex system is not exempt from tensions and conflicts since each group of stakeholders (water supply, irrigators, and tourism sector) has its interests and ability to influence decision-making. One critical aspect that threatens the stability of the agreements between irrigators and the consortium is the quality of the regenerated water and the request to build new hydraulic infrastructures that satisfy the demand for agricultural water. As climate change is already manifesting on the Spanish Mediterranean coast with the loss of thermal comfort, increased temperatures, erratic rainfalls, and increased extreme events (Olcina Cantos, 2020; Quereda Sala and Montón Chiva, 2022), the Benidorm Climate Change Adaptation Plan was promoted in 2022 to ensure, among others, efficient water management by achieving complete reuse of wastewater or encouraging rainwater use, promoting desalination, but also encouraging the implementation of efficient water distribution systems in tourist facilities (Ayuntamiento de Benidorm, 2022).

4.2 Data collection and analysis

A semi-structured face-to-face interview with each stakeholder (represented by the main expert or the spokesperson) was conducted to recap their perspectives and challenges on water management, which provides valuable data to contextualize the questionnaire on collaborative governance. A total of 11 stakeholders representing the water demands coexisting in the agricultural and urban-tourism nexus where selected: 1) the water supply and management sector, including the Benidorm city council (BEN), the Júcar River Basin Authority (JUCAR), the Marina Baja Water Consortium (CAMB), the Public Entity for Sanitation and Wastewater Regional (EPSAR), and the Benidorm water utility company, Hidraqua (HIDRA); 2) the agricultural sector, represented by three irrigation communities: Callosa d'En Sarrià (CALL), Canal Bajo del Algar (ALGAR), and La Vila Joiosa (LAVILA), and 3) the tourism sector, which involves the Benidorm, Costa Blanca, and Valencia Region Hotel Association (HOSBEC), and two departments of the regional government: the Tourism Planning Regional Department (GENT) and the Urban Planning Regional Department (GENU). Key stakeholders have been identified from previous research work in the area (Ricart et al., 2019b), being updated by key informants and local experts. The selection criteria were based on three main issues: Who is affected, interested in, and impacted by the management of the water system, that is, actors dependent on the site for their livelihood and with capacity to act on its management (Colvin et al., 2016). Then, the questionnaire containing 11 closed-ended questions was applied.

Oral consent was obtained for each stakeholder after being contacted by telephone or mail. Each interview plus questionnaire were conducted in person in February 2020 and lasted between 60 and 90 minutes. Descriptive statistics have been used to identify similar and divergent stakeholders' behavior, including affinities at the individual and collective levels. Contrasting results have been represented with figures, while stakeholders' interactions have been represented with matrices to facilitate the interpretation of stakeholders' positioning according to each behavioral issue and as a first step for the triple-loop approach.

4.3 Results

4.3.1 *To be*: relevance and representativeness

According to the answers provided in Q1 about the role of stakeholders in the water management system (only considering self-evaluation), most stakeholders consider themselves important, ranking high-interest values – between 4 (necessary) and 5 (essential) (Figure 2A). However, when asking about the roles of others and their importance in the water management system (Q6), some stakeholders do not know the functions carried out by the rest of the stakeholders or perceive a complementary or unhelpful role in decision-making processes (e.g., JUCAR, GENT, and GENU). Role and representation are two sides of the same coin. Most stakeholders feel represented in the system (Q2), but theoretical (Q3) and real (Q2+Q4) representation must be differentiated: the agricultural and tourism sectors feel more represented in theory than in practice (Figure 2B). Reasons for feeling represented are diverse, highlighting the possibility of putting pressure and influencing the decision-making process (e.g., tourism sector), setting the trend, or acting as a leader (e.g., water supply). However, the lack of political will to ensure stakeholders' engagement (e.g., agricultural sector), poor technical or professional recognition (e.g., tourism sector), and conflict of interests among stakeholders (e.g., water supply) can be barriers to stakeholders' representation. Remarkably, the role of the tourism sector in the water management system is generally perceived as secondary. The lack of representativeness may indicate the need for some stakeholders to reinforce their role in the water management system or the need to solve any current or latent conflict.

4.3.2 *To do*: recognition and assessment

Interest also affects stakeholders' importance and influence in the water management system. Importance (recognition or theoretical power) is related to how stakeholders' functions are

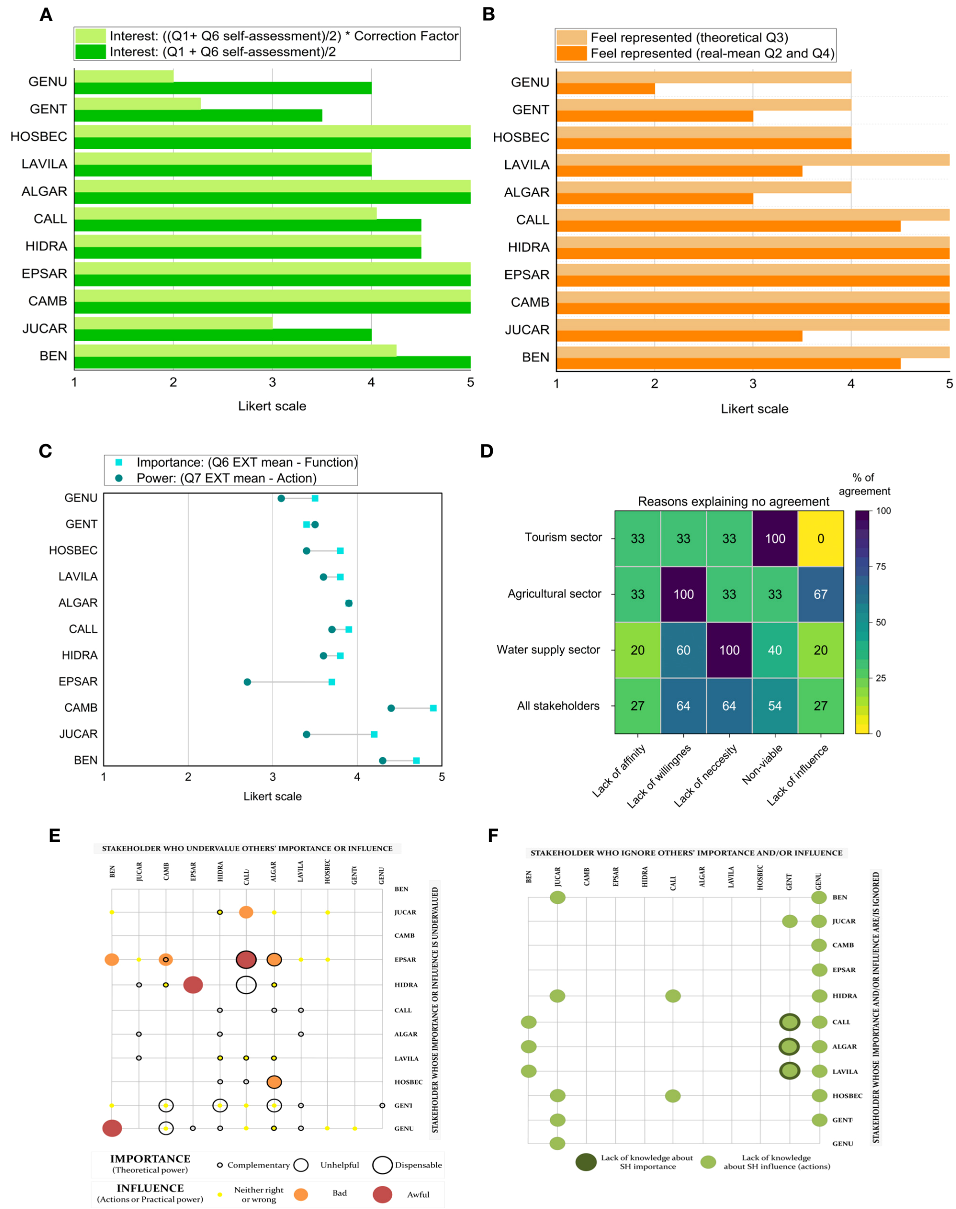

FIGURE 2
Main results from behavioral issues and the triple-loop approach: *to be* – stakeholders interest and representativeness **(A, B)**; *to do* – importance, power, and agreements **(C, E, F)**; and *to share* – influence and mutual knowledge **(D)**.

perceived by others (Q6). On the contrary, influence (assessment or usable power) is about the perception of actions carried out in compliance with their functions (Q7). Except for ALGAR, which receives the same punctuation for functions and actions, all stakeholders receive higher punctuation in terms of functions than actions (Figure 2C). Interestingly, BEN and CAMB obtain the highest values in both parameters, while EPSAR and JUCAR obtain the highest difference between functions and actions.

Bilateral or lack of recognition/importance (Q6) among stakeholders may be related to current or potential conflicts, predefining the nature and closeness of their relationship. Otherwise, bilateral or lack of assessment/performance (Q7) among stakeholders can exemplify specific weaknesses to overcome and some practical milestones to face current or potential conflicts between stakeholders. Figure 2E confirms current/potential conflicts between EPSAR and JUCAR, while new punctual tensions and bilateral conflicts can be prevented (e.g., BEN vs. GENU and EPSAR vs. HIDRA). Likewise, the tourism sector concentrates on lower values in terms of importance. In the same way, the responses '*I don't know, no answer*' also reveal significant information, for example, how the tourism sector and BEN are unaware of the functions carried out by the agricultural sector in the water management system. Furthermore, GENT and GENU seem partially disconnected (even wholly) (Figure 2F).

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4.3.3 *To share*: collaboration

Stakeholders tend to promote and formalize mutual knowledge and interests (partially or completely based on recognition and assessment values) through agreements, which can be used as a guide to plan or deepen collaborative water governance. All stakeholders agree on the benefits of the predisposition (willingness) to achieve agreements in the short or medium term (Q8). However, different reasons can be expected when agreements are not reached (Q11). All stakeholders choose more than one reason, determining the influence of multiple factors (Figure 2D). The two most common factors are the lack of willingness and the lack of a shared strategy (e.g., to face water scarcity or to increase water efficiency). Interestingly, a sectorial behavior can be identified: While the agricultural sector insists on the lack of influence as a barrier to promoting agreements, the water sector considers that the main reason is the lack of relevance of some stakeholders (e.g., GENT and GENU from the tourism sector), while the tourism sector identifies the non-viable nature of some agreements (more related to technical and legislative reasons than behavioral drivers). Most permanent and signed agreements are established with the most relevant stakeholders (BEN and CAMB), while the tourism sector lacks periodic or permanent agreements with the rest of the groups.

5 Discussion and future research

Although much of water science still has a functionalist orientation and preference for quantification, many scholars extensively investigated water and infrastructure's politics, historicity, and their connectedness to social and epistemic hierarchies (Venot et al., 2022). Stakeholder analysis is one of the methods used to understand, confront, and visualize water users' behavior and their interaction with decision-makers determining urban agroecosystems dynamics (Keeler et al., 2015). The HSC has been used to harmonize and confront stakeholders' perspectives and influences in complex coupled human-nature systems, contrasting the social, institutional and environmental spheres of water management and governance (Kumar and Saizen, 2023). Our proposal to reinforce the HSC moves in this direction. It aims to provide a replicable tool for data collection, a questionnaire, as the basis for building a triple-loop approach to investigate the attitudes and interactions of stakeholders to discuss water governance standards. Its application to the Benidorm case study exemplifies the usefulness of the approach and the tools to characterize agreements and share responsibilities among the water supply and demand sectors. Some learnings for further research can be highlighted from the results: 1) 'feeling represented' is conditioned by the capacity to influence decisions, putting pressure on those more power balanced, 2) the lack of political will to recognize current and potential stakeholders' involvement and roles increase stakeholders' feelings of underrepresentation and motivate power imbalance, 3) stakeholders' actions are less valued than stakeholders' functions, and 4) agreements among stakeholders tend to be benefited by the predisposition of both parties (willingness), but also when exists a common strategy (necessity) and the compatibility of discourses (affinity) are reinforced. The information provided through the recognition-assessment and agreement matrices can be used to identify which types of interactions should be promoted to reduce the lack of representativeness, especially in the tourism sector, and reduce the reasons for water conflicts (Narain and Singh, 2017). We consider this approach easily applicable and capable of depicting the value of stakeholders' relations and the power of their functions and actions, including their influence on the decision-making process or when an agent-based model needs to be discussed (Paletto et al., 2015).

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by University of Alicante, Data protection office. The patients/participants provided their written informed consent to participate in this study.

Author contributions

SR and RV: conceptualization, formal analysis, investigation, writing – original draft, writing – final version; AR-A: resources and text revision; MH-H, JO-C, CB: text revision; all: discussion – final version. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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