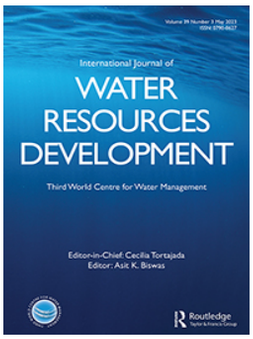

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Water–tourism nexus research in the Mediterranean in the past two decades: a systematic literature review

Sandra Ricart[a,b], Rubén Villar-Navascués[a], María Reyes[c], Antonio M. Rico-Amorós[a,d], María Hernández-Hernández[a,d], Elena Toth[e], Cristiana Bragalli[e], Mattia Neri[e] and Bas Amelung[c]

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ABSTRACT

The water–tourism nexus requires better knowledge, management and governance to address environmental and societal challenges. This review takes stock of the approaches used to address this nexus in the Mediterranean from 2000 to 2020. Bibliometric and exploratory content analysis targeted tourism impacts on water supply, determinants of water consumption, and water-saving mechanisms and technologies. A fundamental insight is that the literature remains rather water centric and technical, paying little attention to behavioural change and stakeholder action. Promising avenues to reinforce sustainable water use include transdisciplinary approaches and integrated tools such as hydrosocial cycle analysis, concept mapping and agent-based modelling.

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Water consumption; tourism behaviour; concept mapping; hydrosocial cycle; agent-based modelling; Mediterranean

Introduction

Water is an essential resource for tourism: it is directly consumed in accommodations, is essential for landscaping and provides the backdrop for a wide range of leisure activities. Globally, direct water use in tourism accounts for less than 1% of water use (Gössling et al., 2012), but in certain regions and seasons, tourism water consumption can severely deplete local resources (Skrimizea & Parra, 2019) and cause conflict between tourist facilities and other industrial sectors, and residents (Hadjikakou et al., 2012). After all, tourism activity is highly concentrated in space and time, so that tourism's share in water consumption varies significantly, as the lockdown periods of the COVID pandemic made abundantly clear. According to García et al. (2022), water consumption in the highly tourism-oriented municipalities on the Balearic Islands of Spain on average dropped by 58% in the lockdown period of June–September 2020, compared with the same period in 2019. The decrease in water consumption was only 14% for the least tourism-oriented

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municipalities. Furthermore, the peak in water consumption still occurred in July and August, but at a much lower level than usual in the highly tourism-oriented municipalities.

The Mediterranean is a key hotspot for both tourism activity and water scarcity. The region accounts for approximately one-third of international tourist arrivals and expects substantial further growth (Fosse et al., 2021). Water scarcity is highest in summer when precipitation is low and agricultural and urban water demands are high. Tourism activity is also at its peak in summer, resulting in a spatiotemporal mismatch between tourism activities and water availability (Liu et al., 2021; Ricart et al., 2020). More tourists, rising industry standards and more water-intense tourism activities combined will likely lead to substantial further growth in water consumption in Mediterranean destinations (Majeed & Mazhar, 2021). At the same time, water availability is affected by climate change (Cramer et al., 2018). The Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) (2022) projects with high confidence that hydrological droughts, the severity and frequency of heatwaves, and rainfall extremes will increase, while annual amounts of precipitation will diminish. Climate change is already influencing investment, planning and operations in the tourism sector while transforming destinations' competitiveness, sustainability and geography (Roson & Sartori, 2014; Scott, 2021). Given the increasing water scarcity challenges, managing water in Mediterranean mass tourism destinations is essential (Tuel & Eltahir, 2020). Successful water management in a tourism context requires input from engineering and the natural sciences, but also from the social sciences, because institutions, power and behaviour are critical to effect real change.

Over the years, a substantial body of knowledge has developed on the interactions between water and tourism, the so-called water–tourism nexus. As the research field developed, new questions emerged, gradually moving from agenda-setting (i.e., flagging problems around tourism and water availability as done by Essex et al., 2004) to problem-solving (i.e., making tourism more congruent with the United Nations' Sustainable Development Goals (SDGs) as done by Moyle et al., 2022; and Demeter et al., 2023). Due to its expanding scope, the water–tourism nexus research field has also become more diverse and heterogeneous, reinforcing its interdisciplinary nature (Correia & Kozak, 2022) and becoming increasingly transdisciplinary by emphasizing citizen empowerment and stakeholder engagement (Shafieisabet & Haratifard, 2020). That is, science alone is not enough to develop and implement solutions: stakeholder participation must be centre-stage, not only because stakeholders are a vital source of practical information but also because transitions towards more sustainable tourism water-use systems cannot be comprehensively achieved without stakeholder support, collaboration and governance (Heslinga et al., 2019).

Accordingly, the purpose of this paper is to systematically assess how the literature on the tourism–water nexus has developed to take stock, identify knowledge gaps and formulate a list of priorities for further research. Two research questions guide the analysis: What are the key topics, primary sources and most relevant authors in the literature on the tourism–water nexus? What are the leading research questions and methodologies? The review focuses specifically on research on coastal mass tourism, much of which is hotel-based, because that is where (1) the tourism–water nexus is most robust; (2) tourism's water consumption can be most easily differentiated from residential water consumption; and (3) the majority share of studies pertain to Rico et al.

(2020) and Rodríguez-Sánchez et al. (2020). The review's geographical scope is limited to the coastal areas of the Mediterranean, inclusive of all northern, southern and eastern shores. The Mediterranean coasts rely heavily on tourism for their economic performance, are among the most vulnerable tourism regions regarding climate change, and feature water resources management as a hotly debated topic (Mejjad et al., 2022; Scott et al., 2019). Regarding its temporal scope, the review focuses on studies published in the past two decades (2000–20), a period that has already been used in similar studies (Antonova et al., 2020).

The remainder of the paper is structured as follows. The next section on methodology describes and justifies the use of a systematic literature review that combines bibliometrics with an exploratory content analysis. The bibliometric analysis characterizes the available literature regarding output, research themes and thematic clusters. The exploratory content analysis provides a more in-depth evaluation of the literature, structured around leading research questions and corresponding methodologies. The third, most extended, section synthesizes findings from bibliometrics and exploratory research in the water–tourism nexus to come up with a detailed analysis of the leading used research topics, methods and approaches. Finally, the discussion in the fourth section puts the findings into a broader context, assesses the limitations, identifies un- or underexplored areas of research, and drafts a set of research priorities.

Methods

Data collection

The core of our analyses is a systematic literature review, following the methodology defined by Yang et al. (2017). This review methodology consists of five steps: (1) establishing the research questions and the objective of the review; (2) identifying databases, keywords, and criteria for searching and selecting articles; (3) searching and selecting articles; and (4) completing and (5) analysing summary tables. We performed our search for literature on the water–tourism nexus in coastal Mediterranean mass tourism environments in the Scopus database, which includes more materials from the social science and humanities fields and outperforms the Web of Science database on the review topic. We used a search query made up of two groups of search terms that together constitute the water–tourism nexus: one related to water ('water use', 'water governance', etc.) and the other related to tourism ('tourism', 'hotel', etc.). To be listed, articles had to contain search terms from both groups in the title, abstract or keywords. Only original research articles in English that were published in the period 2000–20 were considered.

This first literature search yielded 1563 records. To filter out irrelevant material, the papers were subsequently assessed based on titles and abstracts. Studies that did not draw on a coastal Mediterranean study case, were not related to coastal mass tourism or did not address the water–tourism nexus were excluded. In cases where titles and abstracts were not explicit enough about the three criteria mentioned to make a decision about inclusion, the spatial scope and objectives were checked in the paper itself. A publication was deemed to address the water–tourism nexus when it partially or fully accounted for tourism activity in the consumption, management and governance of water resources in mass tourism case studies (at the local or regional scale). For the

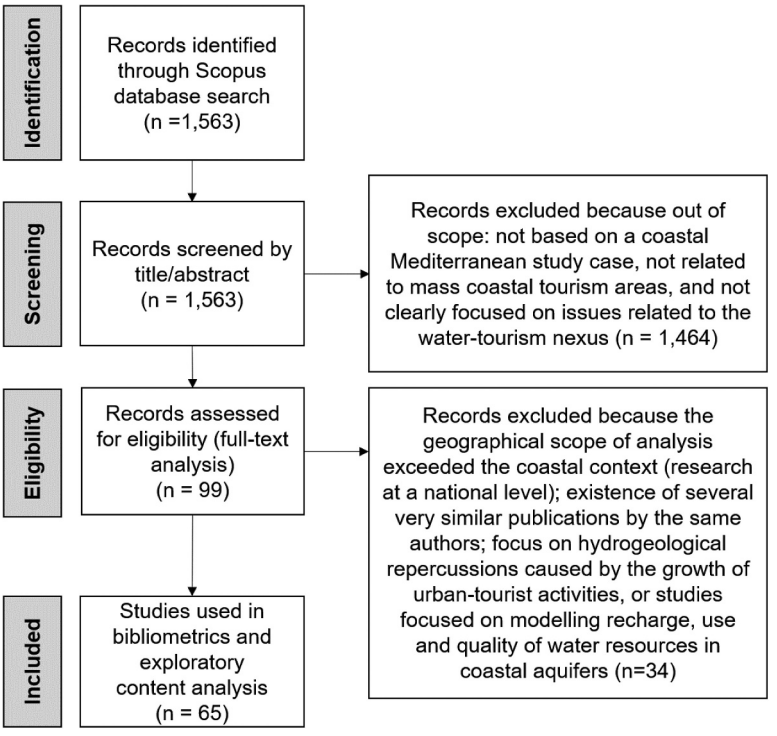

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram of the data-filtering process.

remaining 99 records, full texts were retrieved and reviewed in detail for eligibility. At this stage, studies were discarded for three main reasons: lack of focus on the water–tourism nexus; inappropriate geographical scope (e.g., national as opposed to coastal); and duplication: multiple very similar publications by the same authors. A total of 65 studies were considered eligible for further analysis. The three-step filtering process is summarized in Figure 1, which follows the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher et al., 2009).

Data analysis

The 65 selected studies were used for two types of analysis: a bibliometric analysis of the research field and an exploratory content analysis. The first, the bibliometric analysis, was divided into two sections, adapted from Wu et al. (2021): (1) descriptive statistics of the sample: annual production, main authors and co-authorships, citations and most relevant sources; and (2) research hotspot analysis: (trends in) central keywords and themes. Performance analysis was conducted to assess the temporal distribution of the most cited publications and their impact in terms of citations, while science mapping was employed to depict statistically significant links between publications and content-related conclusions (Rosato et al., 2021). These tasks were supported by R-tool Bibliometrix in combination with VOSviewer

software (Aria & Cuccurullo, 2017), version 1.6.17. In the analysis, a broad interpretation of the term 'keywords' was used, also known as 'keywords+', which encompasses not only the keywords of the selected articles, but also the keywords of the documents that these articles cite. Keywords+ can express article contents more succinctly (Tripathi et al., 2018). They were automatically generated by an algorithm.

The exploratory content analysis classified the papers' central questions and methods in three steps. First, for each paper, information regarding research design (research question, approach and stakeholders involved), methodology (data collection, data analysis, indicators and tools), and main results (including the added value of the method and its main limitations) was entered into a bibliographic database. Subsequently, descriptive information within each category of analysis was coded, aggregated, and abstracted into constructs and themes to facilitate clustering. Finally, the papers were grouped into six clusters, around shared research aims and methodological characteristics.

Results

Bibliometrics

Authorship and sources

Throughout the period of analysis (2000–20), there has been a gradual increase in the number of published articles (Figure 2a), with a clear acceleration since 2015. Total citations obtained (including local citations from inside the set and global citations from outside the set) fluctuate strongly over time, with local peaks in 2004, 2009, 2011 and 2015. The performance of individual papers has strongly influenced annual results as the annual number of publications was very low until 2015. With productivity and academic interest increasing, the pattern of citations obtained will likely become less erratic. Nearly two-thirds of the articles in the collection cite Gössling (2015) and Gössling et al. (2012), suggesting that these are foundational papers in the field, which have provided inspiration for later research, and a solid basis for further exploration and maturation.

The 65 articles composing our collection have 156 authors; only six articles are single-authored. The large majority (80%) of authors are involved in just one article, suggesting that there is a small number of core researchers that collaborate with a larger group of incidental or early-career contributors. Four out of five top researchers affiliate with Spanish institutions (Figure 2b) and predominantly report on Spanish case studies. The collection covers 35 different journals. Seven of the 10 leading journals (Figure 2c) belong to the environmental science category (subsection water science and technology), while the remaining three pertain to the business, management and accounting category (subsection tourism, leisure and hospitality management). The post-2015 acceleration in numbers of publications is visible in all leading journals.

Keywords

The keywords+ analysis identified 512 unique keywords, of which 235 were listed by the articles themselves. The most frequent were 'water supply' (mentioned in 43 articles),

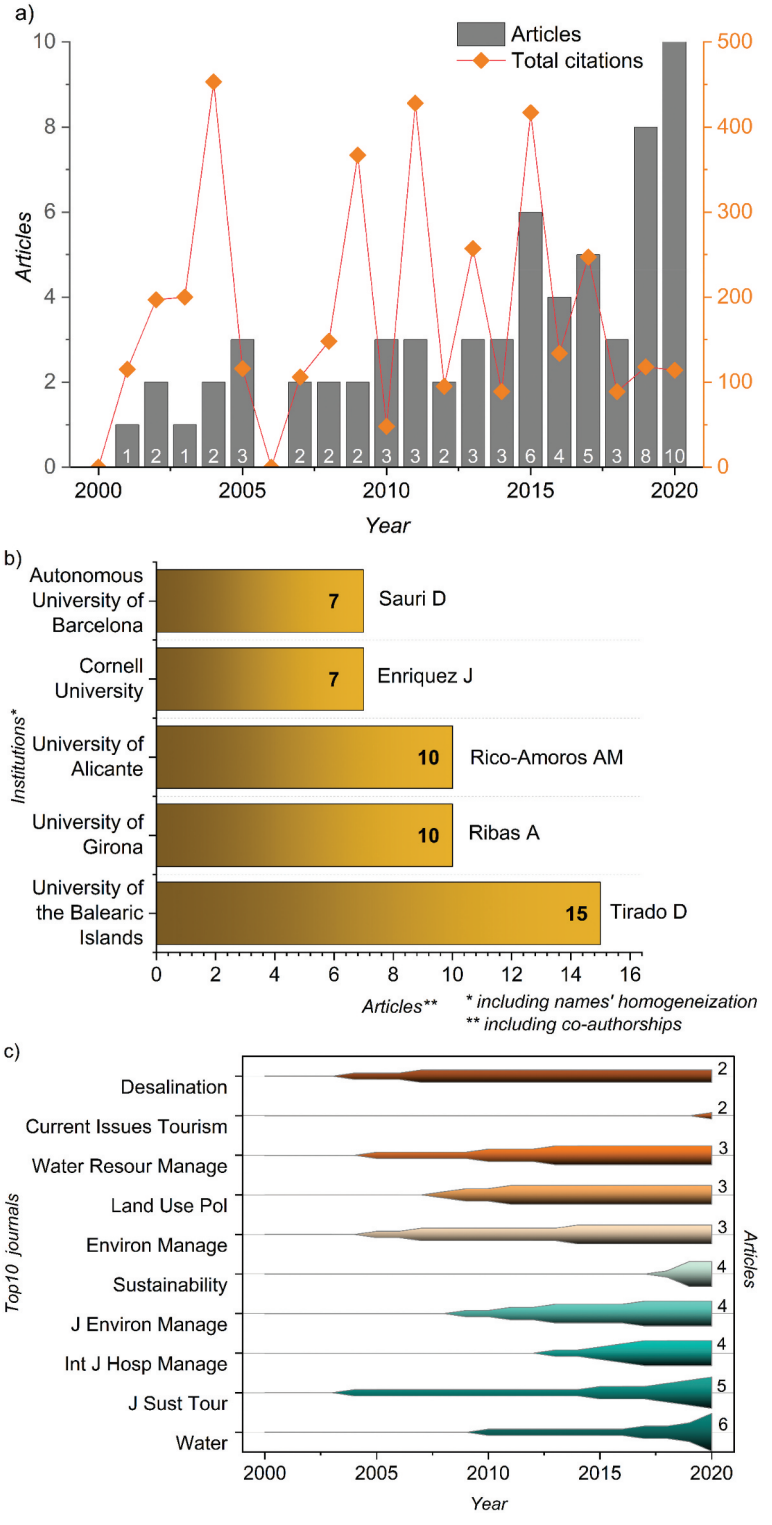

Figure 2. Annual production and total citations (a), most productive authors and related institutions (b), and main journals in terms of cumulative number of articles published (c).

'Spain' (36), 'water management' (30), and 'tourism' (28), while 'climate change', 'sustainability', 'tourist destination', 'water resource' and 'water availability' were cited by fewer than 20 articles each. Some keywords are regularly used together, forming research clusters (Figure 3). Unsurprisingly, the strongest cluster is around 'tourism', which frequently co-occurs with 'water', 'hotels', 'wastewater', 'desalination' and 'water saving measures'. Complementary clusters consist of more specific subjects such as 'sustainable tourism' and 'water scarcity'; 'water management' and 'water recycling'; and 'water consumption', 'mass tourism' and 'Spain'. A further exploratory factor analysis suggests that most of the research field is relatively well connected, with one exception: a cluster around 'droughts', 'water resources' and 'drinking water' seems to exist in isolation.

Themes

The structure of the co-occurrence network of keywords was analysed further using an exploratory factor analysis technique called multiple correspondence analysis. This technique tracks the extent to which features (in this case keywords) of entities (in this case publications) are interdependent: some combinations of keywords are more likely to occur in publications than other combinations, and some frequent combinations are unlikely to occur together. Figure 4 depicts the results of this analysis. It shows two clusters of frequent keyword combinations that hardly occur together in publications: a large red cluster and a smaller blue cluster. The blue cluster is a niche cluster that centres on the role of unconventional water resources. Wastewater, recycling and irrigation are close to the cluster's centre of gravity (blue triangle), which means that they often occur together in publications. Greater peripherality (e.g., in the case of wastewater

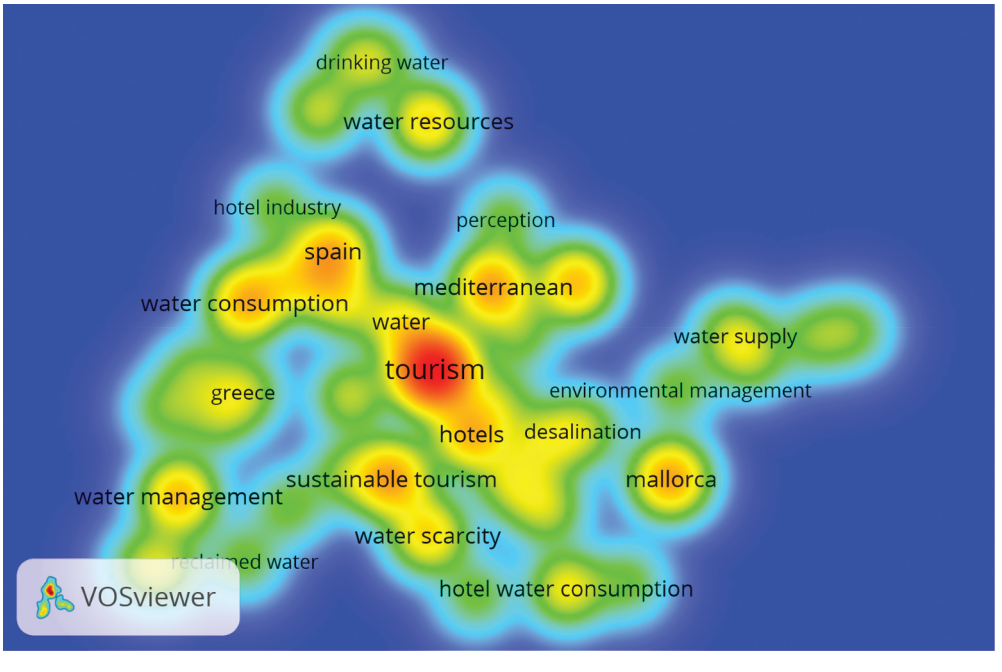

Figure 3. Keywords co-occurrence density map. Note: Only keywords with more than five occurrences are shown. A larger font size and redder colours indicate higher density.

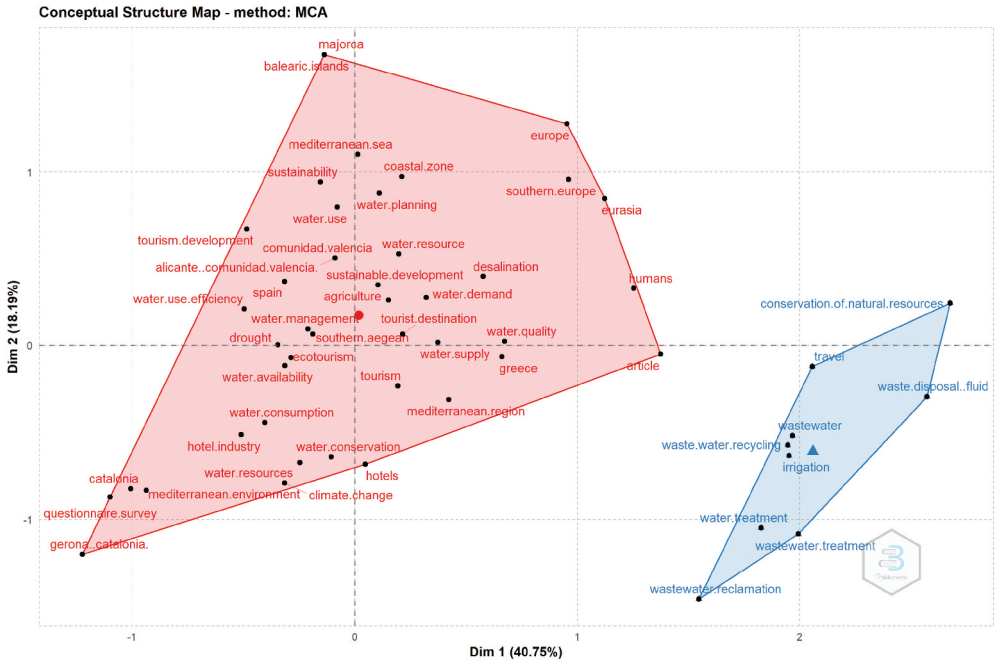

Figure 4. Factor analysis of keywords, with automatic clustering based on multiple correspondence analysis of the 100 most frequent keywords.

reclamation) indicates less frequent co-occurrence with central keywords. The much larger and more complex red cluster contains the main thrust of the water–tourism nexus research field. Central keywords here (close to the centre of gravity, represented by a red dot) are, for example, 'tourist destination', 'water management', 'water demand' and 'agriculture'. The blue cluster has a few very central keywords and relatively many peripheral ones, whereas the red cluster has many relatively central keywords and a smaller proportion of peripheral ones. This suggests that the blue cluster is more focused but less consolidated, whereas the red cluster is more varied and also more interconnected. It not only includes topic-related keywords, but also keywords that refer to location and method. The tourism–water nexus research field would likely benefit from cross-fertilization between the two clusters.

Exploratory content analysis

This section explores and clusters the research questions raised and methodologies applied in the selected articles through content analysis. Research questions inform the methodological approach, affecting data collection, methods and the geographical scale addressed so that a joint discussion is sensible. González-Pérez et al. (2020) discerned three main lines of investigation on tourism-related water demand: water-use estimations, water-use sustainability implications and water management. For our regional analysis, we expand this categorization to six clusters of research questions: How does tourism impact water supply systems? What are the costs and benefits of increasing water

supply? What indicators and tools regarding tourism water consumption have been developed to support regional planning? Which are the determinants of water consumption and water-saving efforts in hotels and tourism destinations? Which are the determinants of tourist water consumption behaviour? How can tourism water consumption be reduced? The scope of the first three clusters extends beyond tourism proper, but since tourism is the dominant sector in the areas studied, and a major force in water consumption, these first three clusters are as relevant to this review as the latter three. Each of the six clusters is analysed below.

How does tourism impact water supply systems?

This research cluster contains studies of tourism impact on the vulnerability of water supply systems and the measures carried out to address these vulnerabilities. The main impacts refer to the inability of underground resources, typically the primary water supply source in Mediterranean areas, to satisfy a growing tourism-induced water demand, leading to the overexploitation of aquifers (García & Servera, 2003). Water scarcity can also be caused by the underuse of available water resources due to infrastructural deficiencies or by the degradation of existing infrastructure, causing large losses in the water distribution network. These situations often result from long periods of time characterized by low investments and poor water management, as is the case with some islands of the Adriatic Sea (Ljubenkov, 2012). Island destinations are particularly vulnerable to water scarcity, because of their spatial isolation and limited water supply (e.g., Crete and Rhodes in Greece, Korcula in Croatia, and Mallorca in Spain).

This cluster focuses on increasing water supply as a way to address water scarcity problems exacerbated by tourism activity in coastal mass tourism areas, considering dam construction, river basin transfers, increased extraction of groundwater resources, the use of non-conventional sources (Baños et al., 2019; Chartzoulakis et al., 2001; Essex et al., 2004; Gabarda-Mallorquí & Ribas Palom, 2016; Kent et al., 2002; Martínez-Ibarra, 2015), and improving the resilience of water-supply systems (Argamasilla-Ruiz et al., 2020; Ljubenkov, 2012; Roberts, 2002; Skrimizea & Parra, 2019).

All articles in this cluster are retrospective and descriptive regional case studies. Data are typically extracted from bibliographical reviews and secondary data sources, both qualitative (regulations, territorial, urban, and hydrological plans, press releases) and quantitative (urban, tourist and climatic data and water availability). In most cases, data analysis comprises an evaluation of the institutional framework, water availability, the environmental impact of tourism, and any measures taken to guarantee water demand. Some research on tourism-induced land-use changes included spatial environmental and territorial assessments using aerial photographs, image-processing techniques, and water balance information (Bellot et al., 2007; Valenzuela-Montes & Matarán-Ruiz, 2008). Most studies were carried out without involving the main stakeholders, but Essex et al. (2004) and Skrimizea and Parra (2019) also collected primary data from interviews with public administration officials, environmental scientists and non-governmental organizations. Martínez-Ibarra (2015) and Skrimizea and Parra (2019) used qualitative multi-method research and data triangulation, combining analyses of data in-depth interviews, secondary sources, and detailed press releases to accomplish a contrasted and in-depth retrospective analysis of the impact of water supply crises on tourism activities. Only Skrimizea and Parra (2019) conceptualize the vulnerability to water stress of a tourist area from

a systemic point of view, linking information on water governance and management with global environmental changes to go beyond retrospective analysis and build narratives that address the interdependencies between scales and sectors.

What are the costs and benefits of increasing water availability?

This cluster focuses on the economic pros and cons of options to guarantee water supply in coastal mass tourism destinations, in particular the use of treated wastewater and/or desalinated water. Although the use of non-conventional sources increases the cost of water management (González-Pérez et al., 2020), it is unavoidable in places where conventional water sources are insufficient to satisfy urban demand. This cluster of articles includes three sub-themes: (1) evaluations of capital, operational and maintenance costs of wastewater treatment plants for different uses of reclaimed water (Borboudaki et al., 2005; Gonzalez-Serrano et al., 2005); (2) cost assessments of different water supply sources (Gikas & Tchobanoglous, 2009; Karagiannis & Soldatos, 2007; Yamout & El-Fadel, 2005; Zachariadis, 2010); and (3) economic evaluations of water-efficiency measures in the tourism sector (Tirado et al., 2006).

With a focus on non-conventional water sources, the estimates of economic costs and benefits depend on many factors, such as the population served, salt concentrations and the required wastewater treatment level. Despite the costs involved, the use of non-conventional water sources is likely to increase, in particular when and where tourism demand grows, and water tariffs increase (Yamout & El-Fadel, 2005). On relative costs of non-conventional sources, the literature shows that for irrigation, wastewater treatment is usually a cheaper option than desalination (Gikas & Tchobanoglous, 2009). Desalination, in its turn, is significantly cheaper than other options such as water transportation (Karagiannis & Soldatos, 2007).

The analyses in this cluster typically take a regional perspective. Most articles base their water balance and economic estimations on secondary data sources such as official figures from regional or municipal water management agencies (Gikas & Tchobanoglous, 2009; González-Pérez et al., 2020; Karagiannis & Soldatos, 2007) and quantitative and qualitative data from wastewater treatment plants (Borboudaki et al., 2005; Gonzalez-Serrano et al., 2005). For the economic evaluation of different wastewater treatment options, Gonzalez-Serrano et al. (2005) estimated a series of cost functions to determine capital, operational and maintenance costs. Yamout and El-Fadel (2005) used linear programming to determine the optimal water allocation under several water management options and future scenarios. Zachariadis (2010) used a simple demand function to analyse water scarcity costs, under three different scenarios of future water demand.

The articles' limited methodological detail hampers replication and renders their results less rigorous. The studies also suffer from large uncertainties around the share of tourism consumption in total urban consumption, the actual water consumption in tourism establishments, and the indirect water footprint of tourism (Cazcarro et al., 2014). Likewise, some of these studies do not carry out comprehensive cost–benefit analyses that incorporate the benefits generated by economic activity or the impact of tariff policies on the adoption of water efficiency measures.

What indicators and tools regarding tourism water consumption have been developed to support regional planning?

This cluster contributes tools for territorial, hydrological and tourism planning at the local and regional scales, related to water consumption and water balance. It encompasses two strands of research: (1) analysis of performance indicators regarding water use by tourism accommodations and other tourism stakeholders (García et al., 2020; Gössling, 2015; Hadjikakou et al., 2013, 2015; Hof & Schmitt, 2011; Rico-Amorós et al., 2009); and (2) hydrological modelling and water balance studies that consider different scenarios for population growth and climate change (Bonacci et al., 2012; Demertzi et al., 2014; Klein et al., 2015; Köberl et al., 2016; Koç et al., 2017). While the first strand is mainly retrospective, the second strand is future-oriented.

Analysis of performance indicators regarding water use by tourism accommodations and other tourism stakeholders. This group of studies show tourism's direct impacts through water-use indicators (usually daily water use per tourist or guest night), comparing water use between different types of tourist accommodation (apartments, detached dwellings and hotels; García et al., 2020; Hof & Schmitt, 2011; Rico-Amorós et al., 2009). Most of these studies have a regional and quantitative approach, in which stakeholders from water companies or regional water suppliers provide the water consumption data. A key contribution of these investigations is the creation of water-use indicators that are easily reproducible and easily comparable between study areas. In mass tourism destinations with their high urban density and greater hotel presence, water consumption is much lower than for residential tourism, dominated by a low-density urban model (Hof & Schmitt, 2011; Rico-Amorós et al., 2009). Water consumption in coastal mass tourism areas increases with the presence of (1) aquaparks, golf courses and other heavy outdoor water users; (2) luxury hotels (Rico-Amorós et al., 2009); and (3) port facilities for drinking water supply to cruise ships (García et al., 2020).

Other studies used an environmentally extended input–output framework, based on quantitative secondary data to estimate tourism's direct and indirect water consumption (Hadjikakou et al., 2013, 2015). Gössling (2015) argues that the lack of basic data on direct tourist water consumption (e.g., water use by room) and indirect water use for energy and food (e.g., food consumption patterns) hinders scientific analysis, for example, regarding differentiation between tourists and between different water uses. On a higher level, differentiation between accommodations is often also problematic, because samples of tourist establishment are not usually representative. To obtain more detailed information, collaboration with tourism stakeholders is essential.

Hydrological modelling and water balance studies in tourism regions. This group of studies evaluate, using hydrological modelling, how the supply systems respond to the future evolution of key variables, in particular changes in population (Koç et al., 2017) and climate (Bonacci et al., 2012; Demertzi et al., 2014). They use secondary sources for monthly or annual regional water availability and water demand. Some focus on modelling the impact of climate change on tourist demand and its implications at the hydrological level (Köberl et al., 2016). One of the limitations of these models is that they are affected by stationarity bias since they do not always consider the potential changes in all the components of their equations (water demand, water availability and climatic

conditions), which would affect the water balance. Also, they do not model how water demand management policies may reduce demand, especially during drought situations, or how water exchange or incorporating non-conventional resources can increase water availability. A comprehensive water management plan in a tourist destination requires scenarios that consider both changes in population and changes in climate in order to estimate peaks in demand and variability in water availability. However, only few water balance modelling studies consider integrated scenarios of climate change, land and water management, and tourist demand (Klein et al., 2015; Köberl et al., 2016).

Which are the determinants of water consumption and water-saving efforts in hotels and tourism destinations?

This cluster of studies explore the determinants of water consumption in Mediterranean mass tourism destinations (Torregrosa et al., 2010; Toth et al., 2018) and hotels (Deyà-Tortella et al., 2016, 2019; Deyà-Tortella & Tirado, 2011; Gabarda-Mallorquí et al., 2017), and the determinants and effectiveness of water-saving measures in hotels (Dinarès & Saurí, 2015; Razumova et al., 2016; Rico et al., 2020; Tirado et al., 2019; Torres-Bagur et al., 2019a). The studies typically consider a wide range of explanatory variables, including (1) physical hotel characteristics (size, category, age, amenities offered, water-saving devices); (2) seasonality and occupancy rates; (3) hotel management characteristics (business strategy, board type, opening period, environmental certifications and chain affiliation); and (4) other variables, such as climatic conditions and water tariffs.

According to Torregrosa et al. (2010) and Toth et al. (2018), tourism accommodation capacity, tourist occupancy and temperature are strongly and positively related to municipal water consumption. For hotels, Deyà-Tortella and Tirado (2011) and Gabarda-Mallorquí et al. (2017) find that size and category, the presence of pools and golf courses, opening period, the presence of water-saving initiatives, the types of board offered, and chain affiliation are important determinants of water consumption. The cost of water is of insufficient financial significance to directly affect water consumption in hotels (Tirado et al., 2019; Torres-Bagur et al., 2019a). Razumova et al. (2016), however, report that the rigorous increase of water tariffs on the island of Mallorca have led to more water-saving innovations in hotels. The studies confirm the effectiveness of water-saving measures in reducing hotel water consumption. The most widely implemented water-saving measures are low-cost, low-tech, and legally enforceable measures; more complex measures such as the introduction of non-conventional water resources are less frequently adopted due to a lack of incentives (Tirado et al., 2019; Torres-Bagur et al., 2019a).

Studies in this category typically relate to mature sun-and-beach tourism destinations, such as Mallorca, Benidorm, Lloret de Mar and Rimini. They aim to inform policymaking and are usually carried out in collaboration with hotel managers and/or water suppliers. Studies are predominantly quantitative, using primary data obtained through surveys on water consumption and implemented water-saving measures, and potential explanatory variables. Nevertheless, there are also qualitative analyses of factors motivating hotel managers to implement water conservation measures. Sample sizes vary. Some studies include more than 150 hotels (Deyà-Tortella & Tirado, 2011; Deyà-Tortella et al., 2016; Razumova et al., 2016). Other studies include fewer hotels, but support the survey results by performing longitudinal analyses of water consumption, or by including additional

methods, such as inferential statistics, contrasting hypothesis tests or interviews with hotel managers (Dinarès & Saurí, 2015; Rico et al., 2020).

Most studies apply regression techniques. To identify the determinants of water consumption, Gabarda-Mallorquí et al. (2017) apply generalized mixed linear models, Toth et al. (2018) use non-linear models based on artificial neural network architectures, Deyà-Tortella and Tirado (2011) apply hierarchical regression modelling using ordinary least squares (OLS), Torregrosa et al. (2010) use OLS regression and simultaneous equation modelling, while Deyà-Tortella et al. (2016, 2019) apply a quantile regression within artificial blocks to determine the influence of water tariffs.

The dependent variable in most studies is total hotel water consumption, either in absolute terms or after applying a logarithmic transformation to ensure the variable's normal distribution and facilitate interpretation (Deyà-Tortella & Tirado, 2011). To account for occupancy and seasonal closure, some studies use annual hotel water consumption per room and per month open (Deyà-Tortella et al., 2016, 2019), or the water consumption per guest and night (Gabarda-Mallorquí et al., 2017). However, this latter approach overestimates in-room tourist water consumption as the indicator includes all the components of the hotel water consumption (spas, pools, restaurants, and sport and health centres) and does not account for daytime guests (Dinarès & Saurí, 2015). To identify determinants of the adoption of water-saving practices, Razumova et al. (2016) and Tirado et al. (2019) apply binary and ordered probit models, with water-saving innovations as the dependent variable, either as a dummy variable or as an ordinal one, reflecting the number of saving measures adopted.

This category of research is well-established and has produced solid results. Data collection and analysis are rigorous, and the involvement of hotel managers and water suppliers boosts accuracy and salience. A recurring problem, however, is that the hotel industry is generally reluctant to disclose indicators of hotel performance, including water consumption and occupancy levels. A self-selection bias may therefore ensue towards hotels that are more committed to environmental concerns. In practice, hotel samples are usually biased towards higher category hotels because of their greater environmental information management and accountability and higher cost control levels.

Which are the determinants of tourist water consumption behaviour?

Studies in this tourist-oriented cluster aim to help hotel managers devise new, guest-centred strategies to save water. Methodologically, two broad strands of research can be discerned. The first strand aims to define tourist profiles in terms of environmental awareness and water consumption behaviour, based on cluster analysis and hypothesis contrasting tests between tourists' sociodemographic and hotel stay characteristics (Gabarda-Mallorquí et al., 2018; Torres-Bagur et al., 2020). The second strand aims to identify determinants of the behaviour or environmental perceptions of tourists, residents or other tourism stakeholders (Casado-Díaz et al., 2020a, 2020b; Gabarda-Mallorquí et al., 2020; March et al., 2014; Rodríguez-Sánchez et al., 2020; Torres-Bagur et al., 2019b). These latter studies usually combine surveys with Likert-scale questions with regression analysis. In their evaluations of the influence of multi-item constructs on psychometric variables, Casado-Díaz et al. (2020b) and Rodríguez-Sánchez et al. (2020) applied confirmatory factor analysis to assess the reliability and validity of their models. Other analyses in this strand assess what factors determine tourist behaviour

regarding water consumption by implementing generalized linear models (Gabarda-Mallorquí et al., 2020; March et al., 2014) or multigroup structural equation models (Casado-Díaz et al., 2020b; Rodríguez-Sánchez et al., 2020). Casado-Díaz et al. (2020a) assess which variables explain the willingness of customers to pay a supplement to guarantee water-saving measures in hotels, applying a Heckit model. General insights are that environmental awareness does not directly determine water consumption in hotels, that hotel tourists are not very aware of environmental issues in the first place and that they are reluctant to pay a financial price for water saving measures. However, the tourist population is very heterogeneous, and awareness and behaviour can be redirected through marketing strategies.

Most studies are conducted in coastal mass tourism destinations with water scarcity problems and significant pressure on water resources, such as Benidorm (Casado-Díaz et al., 2020a, 2020b; Rodríguez-Sánchez et al., 2020) and Lloret de Mar (Gabarda-Mallorquí et al., 2018, 2020) in Spain. All studies are based on primary data, mainly from face-to-face surveys among tourists in their respective hotels. Some surveys have been performed in different hotel establishments to make results more robust and representative. Hotel managers are usually involved in these studies to secure access to their facilities. The questionnaires are designed in the main languages that tourists speak. All samples are statistically representative at a confidence level of at least 95%, which generally implies a sample size of more than 600 surveys. The sample design usually includes tourist quotas based on age, gender, and country of origin. Questionnaires are typically drafted based on a literature review and subsequently validated by a panel of social scientists, and hotel technicians, managers and staff. They are designed to be completed in 8–10 minutes and usually contain Likert-scale questions and other types of closed questions.

One of the main limitations of these studies is that tourists may misrepresent their current behaviour or attitudes for reasons of political correctness, or exaggerate their green credentials. To address these potential biases, some studies have followed strategies such as guaranteeing anonymity, using self-administered questionnaires, reordering questions to not reveal the purpose of the survey earlier than necessary, and pre-testing questionnaires (Casado-Díaz et al., 2020a, 2020b; Rodríguez-Sánchez et al., 2020).

How can tourism water consumption be reduced?

This cluster of studies explores various technical and management solutions to reduce tourist water consumption or manage water resources more broadly in a variety of study areas. Despite the vast scientific production in relation to this topic, we have been able to identify in the literature analysed only the following two main strands of research: (1) monitoring hotel water consumption to promote water-savings at hotels (Antakyali et al., 2008; Atanasova et al., 2017; March et al., 2004; Gatt & Schranz, 2015; Hocaoglu, 2017; Santana et al., 2019); and (2) water management measures and governance arrangements at the local (Alonso-Almeida, 2012; Tekken & Kropp, 2015) and regional scale (Enriquez et al., 2017; Ricart et al., 2020; Rico-Amorós et al., 2013; Vila et al., 2018). These studies stand out for the participation and involvement of stakeholders from the tourism sector, water supply and local public administration.

Monitoring hotel water consumption to promote water-savings. This research strand analyses the effectiveness of using treated wastewater or grey-water for non-drinking purposes in hotels to promote water-saving. Some of this research is based on case studies (hotels) and the acquisition of primary data on water consumption, tourist occupancy, grey or wastewater flow rates and/or chemical and microbiological parameters through monitoring. This sometimes requires the installation of additional water meters to differentiate between different water uses within hotels, which is only possible with significant involvement and interest from hotel managers or directors, apart from the necessary investment and technical advice. With this kind of primary data, Hocaoglu (2017) developed water balance equations that take into account potential wastewater production and demand for various individual reuse purposes considering scenarios of wastewater treatment and reuse, while Santana et al. (2019) employed life cycle assessment to explore city-wide environmental impacts. Some of these studies complement technical monitoring with a cost–benefit analysis to ascertain economic feasibility (Atanasova et al., 2017), or with questionnaires to assess tourist acceptance of water-saving applications in holiday resorts (Antakyali et al., 2008; March et al., 2004). Gatt and Schranz (2015) used monitoring to evaluate the impact on water consumption of common, cheap, and easy-to-apply water-saving measures, such as low flow aerators and showerheads and volume displacers in toilet cisterns (Gatt & Schranz, 2015).

By monitoring hotel water consumption, very specific water-use indicators can be established, and the water saving potentials of water reuse systems and reclaimed water systems can be assessed. For example, around 23% of tourist water consumption, estimated at 146 litres/guest/day, is generated by toilet flushing, which may be replaced by grey-water reuse (March et al., 2004). Although this strand of research provides valuable information, it should be noted that these studies are usually carried out in a single hotel or a non-representative sample of hotels.

Water management measures and governance arrangements. The second research strand evaluates specific hotel water management measures and regional water governance arrangements, such as the practice in Benidorm (Spain) of farmers supplying their freshwater resources to meet urban and tourism water demand in exchange for reclaimed water and a financial compensation during water scarcity or drought periods (Ricart et al., 2020). In both types of studies, hotel water management measures and evaluations of regional water governance arrangements, data sources are qualitative. Some research analyses primary data from semi-structured and in-depth interviews with hotel managers (Alonso-Almeida, 2012) or main stakeholders involved in the regional water governance and management scheme (Enriquez et al., 2017; Ricart et al., 2020; Skrimizea & Parra, 2020). Others focus solely on analysing secondary sources and reviewing literature (Rico-Amorós et al., 2013), in some cases complemented by a strengths, weaknesses, opportunities and threats (SWOT) analysis (Tekken & Kropp, 2015). The primary or secondary data are typically subjected to discursive or thematic analysis. Vila et al. (2018) and Skrimizea and Parra (2020) argue that purposive sampling and seeking information-rich participants who represent diverse interests are of critical importance for effective qualitative research. Two common limitations of the approaches in this second research strand are the lack of representativeness of hotel managers and the limited value of the stakeholders' perceptions and preferences which may be affected by various biases that arise in qualitative

research. Both limitations can be resolved by complementing the stakeholders' statements or intervention proposals with additional indicators. Vila et al. (2018), for example, used the Delphi technique to elicit stakeholder preferences via a questionnaire, resulting in a list of influential factors for sustainable water management. In addition, they used fuzzy scales to capture the experts' opinions in a context of uncertainty and imperfect knowledge.

Discussion

Research on the water–tourism nexus goes back for decades; in the new millennium the field has matured. The coastal Mediterranean is a hotspot in this emerging field, with 65 articles covering this area in the last two decades. The first 15 years of this period were characterized by few publications, sometimes even none at all. This clearly affected some of the results, such as the number of citations obtained by year of publication. Since 2015, however, the number of publications has accelerated. Our analysis shows that the current body of literature is dominated by a handful of Spanish researchers who typically report on case studies in Spain. This finding may have been influenced by our article selection process. We exclusively used Scopus, albeit after making sure that it outperformed Web of Science, for our keyword-based search, looking for publications in English with a combination of tourism- and water-related terms. We may have missed relevant publications that were either published in another language such as French or Arabic, in (regional) journals not included in the Scopus database, or not mentioning our selection of keywords. Given our intensive engagement with the literature and the reference lists of all articles in the dataset, we think it is unlikely that we have missed much material due to a keyword mismatch. The other two sources of bias may be more important, but only if there are parallel and separate publication networks, because in the reference lists we reviewed, we have not seen any trace of articles in other languages than English or non-Scopus journals.

Our cluster analysis suggests that a wide range of topics and connections have been studied, but that the field remains well-integrated, except for one cluster of publications on nonconventional resources. The high level of integration may well be connected to the small number of key authors involved, who seem to have been building a growing research community. It may also be connected to the young age of the field; specialization may well become stronger as the field develops. At present, the picture of a diverse but well integrated research field, with a few central concepts and a larger number of peripheral concepts, is robust and does not seem to greatly depend on the specific clustering algorithm used.

In our exploratory literature review, we identified six clusters of publications based on main research question and methodology. When comparing our six clusters with the three main lines of research identified by González-Pérez et al. (2020) we found great similarities. They pointed out that one study research line is on water-use estimations, which is similar to our clusters on analysis of performance indicators regarding water use and determinants of water consumption by tourists and hotels; their cluster on water-use sustainability implications is similar to our cluster on tourism's contribution to water scarcity. And their cluster on water management is a combination of our clusters on

options to increase water supply, ways to monitor water demand and options to reduce demand, respectively.

Three of our clusters pertain to water consumption in tourism systems proper, in particular hotels and destinations. Respectively, they identify the determinants of water consumption in hotels, the determinants of tourist behaviour regarding water consumption in hotels, and the options to reduce water demand (monitoring hotel water consumption and through water management measures and governance arrangements). These three clusters have yielded robust insights into the main factors that play a role. It could be considered that these research clusters present established methodologies and more solid results, partly because they present real data on water consumption and have the participation of tourism stakeholders. However, the main limitation is lack of data on water consumption. This is a recurring problem, particularly to access disaggregated data on tourist water consumption in residential establishments (holiday homes, Airbnb, etc.), which limits the identification of the total impact of tourism on urban water consumption. In addition, acquiring data on water consumption in hotels tends to be labour intensive, as it requires close collaboration with hotel staff and datasets are often difficult to retrieve, incomplete, or both. Perhaps even more importantly, water consumption data is typically available per hotel and per month or per year. Critical information about where the water is used (e.g., rooms, kitchen, laundry services, garden) and when (seasonal, monthly, weekly, daily patterns) is therefore scarce. The growing use of smart water meters may help, but only if frequent readouts occur and hotels instal multiple decentral water meters.

The other three research clusters pertain to the larger water system in the tourism area and address tourism's contribution to water scarcity issues, options to increase water supply, and ways to model water demand in tourism regions. Including these clusters in the analysis may seem arbitrary, because they are not all tourism specific. Water infrastructure to increase water supply, such as dams, reservoirs and pipelines, for example, is usually not built for exclusive use by tourism. However, our analysis focuses on mass coastal tourism areas, where tourism dominates economic life and is responsible for a large share of water consumption. In these areas, tourism is therefore a major driver of investment in water systems, either to increase supply or to manage demand. The relationship between water and tourism often exceeds the limits of the coastal locations, which requires analysis at the scale of the regional water supply system. However, despite the importance of the regional scale in the water–tourism nexus, these first three research clusters often show more provisional or speculative results and less robust methodologies. To improve the results of these research lines from a prospective perspective is vital involving all the stakeholders involved in water management and governance, including tourist ones. In this way, it will be possible to identify new management and governance options in water supply systems, and improve hydrological models, and propose new methodologies that allow the development of new tools for modelling social behaviour and its effect on water consumption.

When taking a bird's eye view of the literature and the field's development, it can be observed that the centre of gravity has gradually shifted. Pioneering studies, many of them predating the period studied here, focused on agenda-setting, using secondary data in retrospective analyses to problematize tourism's role in water scarcity issues and suggested potential solutions. Once the relevance of the water–tourism nexus was

established, the focus shifted to understanding tourism's role in water scarcity issues in specific areas. Through surveys among hotels and tourists, complemented by interviews, much is now known about the determinants of water consumption and water-saving measures, as well as about tourists' attitudes towards these issues. Building on this solid knowledge base, the third generation of studies focuses on informing hotel managers regarding the effectiveness of water-saving measures, and local and regional governments regarding water management and governance challenges. They depend on stakeholder involvement and collaboration for information on local experiences and timely input from water managers, hoteliers, and tourists (Roxas et al., 2020). Notwithstanding their logical sequence, the three research waves greatly overlap in practice.

While the shift in focus is clear, the three research waves share one important feature: in a fundamental sense, they all approach the water–tourism nexus from the water side. Water scarcity is framed as an environmental problem. Tourism's relevance for it is clear (wave 1), and the determinants of tourism's contribution to the problem and of the drivers of water-saving action are clear (wave 2), which makes it possible to inform tourism stakeholders about how to act (wave 3). Despite the increasing involvement of stakeholders, this water-centric approach remains partly out of sync with the needs of hotel managers, who face complex challenges regarding sustainability, water autonomy, and climate change resilience (Santos et al., 2022; Zafeirakou et al., 2022).

Many so-called 'environmental' problems are in fact societal problems, which are deeply rooted in our society's economies, institutions, cultures and behavioural patterns. Challenges related to the water–tourism nexus, then, are strongly connected to institutions and culture, and to the way in which tourism is organized. To effectively address them, knowledge of the water system and stakeholders alone is not enough: what is needed is stakeholder action (see also Warren & Becken, 2017). To support this, approaching the water–tourism nexus from the tourism side is essential: framing the challenges in the context of the economic, social and institutional landscapes and realities that the stakeholders in tourism and other sectors operate in. Effectively addressing the tourism–water nexus challenges can only happen by reconciling the water realities and the stakeholders' realities.

The hydrosocial cycle approach constitutes a promising avenue towards achieving this. It recognizes that water challenges are strongly shaped by social aspects, such as power relations and human behaviour, and adds these impacts to the traditional hydrological cycle approach (Arahuetes et al., 2018; Wesselink et al., 2016). In the context of the tourism–water nexus, the hydrosocial cycle approach takes account of tourism's increasing interference with the natural flow of water resources. It connects water scarcity, a macro-level problem with regional and local particularities, with water consumption, a micro-level pattern conditioned by the behaviour of tourists, tourism operators and other stakeholders. Whereas the hydrosocial cycle approach focuses on the relative positions of stakeholders and the relationships, interactions and interdependencies between them, approaches such as concept mapping reflect the perspectives of individual stakeholders (Eden, 2004). Concept mapping is a participatory co-creation method to elicit stakeholders' visions on the structure and functioning of the complex tourism–water system they operate in. In an interview setting, individual stakeholders describe and portray their own perception of the system and map it out on a piece of

paper, indicating the central components ('concepts') and the relationships between them (Trochim & McLinden, 2017). Creating concept maps helps to understand a stakeholder's perspective on the nature of any problems in the system, the causes of these problems and possible solutions, as well as their own position in the system (Garrod et al., 2013). Typically, stakeholder representations of the same tourism–water system differ greatly between stakeholder categories, but also within stakeholder categories.

The co-creation of individual concept maps allows for an even more critical step: confronting the stakeholders in the same water–tourism system with each other's maps. Seeing the various perspectives and discussing about specific concepts within them tends to lead to much more appreciation for each other's standpoints (Bisung & Dickin, 2019). Stakeholders acquire a broader and more complete understanding of the shared system's challenges and the roles of the various actors in it, fostering awareness and collaboration. Social learning with and among tourists, the tourism industry, policymakers and societal actors is essential to foster stakeholders' mutual understanding, stimulate the co-creation of system innovations, and improve water governance (Ricart, 2020). This type of transdisciplinary research, in which stakeholders and researchers engage in a process of social learning and co-creation of innovative solutions is urgently needed (Amelung et al., 2016), but still relatively rare in water–tourism nexus research (Warren & Becken, 2017).

Transdisciplinary research needs interfaces where the input from stakeholders and the various disciplines can be integrated and where paradigmatic differences can be negotiated and reconciled (Khoo-Lattimore et al., 2019). Researchers from different disciplinary backgrounds and stakeholders often do not speak each other's 'language' and therefore need to develop some common ground at the interface of their respective realms. These so-called boundary objects (e.g., Van Bruggen et al., 2019) can take many forms. In one of them, scenarios, researchers devise a set of coherent and plausible futures, based on the development of environmental and societal factors beyond the stakeholders' control, after which local stakeholders develop possible responses and evaluate them in terms of water risks and the ability of the tourism sector to fulfil tourists' water needs (e.g., Hyytiäinen et al., 2022). This process of 'gaming out' response options can also take the form of serious games.

Agent-based models are more quantitative boundary objects, which are well-suited for modelling the dynamic behaviour of complex socio-ecological systems by simulating agents' interactions and tackle governance and management challenges (Qiu et al., 2016). They allow for the representation of environmental processes as well as the direct representation of individual stakeholders, including their differences, individual perspectives and mutual interactions (Nicholls et al., 2017). While agent-based models lack the richness of serious games and other forms of interactive stakeholder processes, they can benefit from both quantitative and qualitative data and can be informed by theory during the model development process (Baktash et al., 2022). Likewise, they help evaluate the effectiveness of many more public and private intervention options in many more potential futures, and therefore contribute valuable information about the robustness of response options (Student et al., 2020).

Conclusions

Using a systematic literature review of 65 publications on the tourism–water nexus in coastal mass tourism areas in the Mediterranean, this paper set out to take stock, identify knowledge gaps and formulate a list of priorities for further research. The analysis shows that the body of literature in the field has expanded substantially over the past two decades, with an acceleration starting around 2015. While the topics have become more varied, the literature remains well integrated, with the exception of a small pocket of less connected research on non-conventional water sources. With more than 150 authors identified, the community involved is substantial and growing, even though the large majority of authors was involved in only one publication. The field is dominated by a handful of researchers, most of whom are affiliated with Spanish universities. We identified six clusters of research, of which three are related to water systems in tourism regions: one on tourism's contribution to water scarcity issues, one on options to increase water supply, and one on options to monitor water demand. The other three clusters are related to water consumption in tourism accommodations and destinations: one on determinants of water consumption in hotels, one on determinants of tourist behaviour regarding water and one on options to reduce water demand.

The research of the past two decades has yielded much new knowledge, ranging from tentative and/or speculative (such as analysis of how tourism impact water supply systems) to well-established and robust (such as the determinants of water consumption in hotels). Key knowledge gaps remain, however. First, data availability on water consumption remains severely limited. Data are not readily accessible and only gathered for individual case studies. In addition, hotels tend to have only one single water meter, so that the contribution of different water uses (e.g., shower, toilet, laundry service, kitchen) cannot be established. Smart water meters may help improve data accessibility. The dominant position of Spanish case studies constitutes a second, spatial knowledge gap: studies from other European Mediterranean countries are less common, and studies from the Levant and North Africa are very rare. Some Spanish findings may resonate in other Mediterranean regions, but the peculiarities of some of the resorts studied, such as Benidorm, with its dominance of high-rise hotels ('Spanish Manhattan') and its dependence on reservoirs for water supply, may make results less relevant for other destinations. A third knowledge gap is the relative lack of social science research, in particular on perceptions and power, which is important for successful sustainability transitions. Connected to this is the lack of interdisciplinary integration and systemic approach, knowledge gap number four. There is much potential for learning by connecting and integrating the insights from the six clusters of literature, and by integrating the literature on nonconventional resources into the field's mainstream literature. The fifth and final major knowledge gap that we identified is the limited stakeholder involvement. Solving the complex and often 'wicked' water availability issues requires the active participation of societal actors throughout the research process, from problem framing and data collection to the design, implementation and evaluation of solutions.

In light of these knowledge gaps, we identified two priority issues for future research: (1) social science research on the perceptions, power, and politics associated with the tourism–water nexus, for example, through hydrosocial cycle analysis and concept mapping; and (2) more systems thinking and transdisciplinary approaches to integrate

disciplinary insights and individual case study results, and engage stakeholders, for example, through agent-based modelling and serious games. Strengthening research activity in non-Spanish tourism destinations and increasing the availability and accessibility of water consumption data are important supporting goals.

The shift from disciplinary to problem-based, integrated and transdisciplinary research is necessary to confront the many complex socio-ecological challenges today's society faces. Different research traditions and epistemological, ontological, and axiological positions must be reconciled to support Mediterranean tourism's transition from being an exploitative sector to being a conscientious sector that lives up to its responsibility in a water-constrained society.

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