

# Challenges on European Irrigation Governance: From Alternative Water Resources to Key Stakeholders' Involvement

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### Research Article

Volume 3 Issue 2

**Received Date:** March 11, 2019

**Published Date:** April 05, 2019

**DOI:** 10.23880/jenr-16000161

## Abstract

Europe's freshwater resources are under increasing stress in several regions, with a mismatch between demand for, and availability of, water resources across both temporal and geographical (spatial) scales. Human pressures have encouraged more active consideration of alternative water sources as a strategic option to supplement water supplies and protect natural resources. Recognition of the potential role of water reuse in such a strategy is now well embedded within both European and national policy communities. However, a lack of governance in decision-making processes focused on the benefits of using alternative water resources can motivate frustration to farmers and the public. In order to address this gap, the provision of water governance tools, strategies and policies are key issues than simply finding technical (or technocratic) solutions for matching, in space and time, and in quantity and quality, water demands and (alternative) water sources. The promotion of Constructed Wetlands (CWs) and Alternative Water Exchange Consortiums (AWECS) can be positive to ensure irrigation governance in the Anthropocene.

**Keywords:** Wastewater; Desalination; Water management; Irrigation; Stakeholders

## Introduction

Water resources management has taken many different forms and directions since the dawn of civilization [1]. Humans have long sought ways of capturing, storing, cleaning, and redirecting freshwater resources in efforts to reduce their vulnerability to irregular river flows and unpredictable rainfall [2]. Choices for agricultural water management include a

large range of technical, infrastructure, economic, and social factors [3,4]. Irrigation systems, as examples of complex social-ecological systems, deal with both the uncertainty of ecosystem dynamics and the interdependencies resulting from Anthropocene complexity. The Anthropocene marks our time as one in which Earth's form and functioning has become inextricably entangled with the workings of human societies [5]. This concept suggests that such

collaboration, perhaps based initially around a global spatial database of Anthropocene impacts, is not an impossible dream [6]. The need for environmental scientists to communicate increasingly more effectively with political and business leaders, as well as the general public, is another shared theme of the Anthropocene literature, reflecting the recognition that humans activities are at the core of both the problems and solutions [7,8]. One of this activities is irrigation because water-agriculture nexus is context-dependent, socially constructed and technically uncertain, and it should be analysed as a hydrosocial cycle, which likewise takes into account the inseparability of social and physical aspects of water systems. Irrigation systems have been under pressure to produce more with lower supplies of water [9]. Agriculture water needs must be supplied in a context of diminishing availability, due to environmental awareness, population growth, economic development and global change [10,11]. As a consequence, water management for agriculture is interrelated not only to traditional water resources management, but also to food production, rural development, and natural resources management [12].

European irrigation practices have traditionally consisted of gravity-fed surface irrigation systems [13]. In these cases, the water is conveyed from surface sources (primarily rivers or reservoirs, both natural and artificial) and is distributed to the individual fields through a network of canals of different sizes, relying on gravity as the driving force [14]. The European rural mosaic is based on a combination of ancient irrigation systems and modernised or new irrigation projects, which were promoted based on the guarantee of water efficiency and food security [15]. In both contexts, hydraulic constructions have played a central role in the attempt to dominate water and land resources, where the agrarian plains have played a key role in developing irrigation [16]. Water management options have typically been categorized as either supply management or demand management [17]. The former is focused on enlarging the amount of resources available, while the second focuses on reducing the amount of needed for consumptive purposes [18]. Historically, civil and water engineers have focused on large-scale supply augmentation infrastructure projects, while economists and environmentalists have tended to advocate for efficiency improvements and conservation oriented policies typically associated with water demand management [19]. Each approach has its relative merits. Supply-side policies enlarge the pie, promoting possibilities for increased economic activity and avoiding the difficult social and political obstacles involved in such demand-

side options as cutting water quotas or increasing prices [20]. Demand management options are often cheaper, more economically efficient, and have less negative environmental impacts than supply augmentation [21].

### The Role of Alternative Water Resources

Europe's freshwater resources are under increasing stress in several regions, with a mismatch between demand for, and availability of, water resources across both temporal and geographical (spatial) scales [22]. In addition to the traditional sources of water, two alternative sources of water are available: water reuse and water desalination. The first is not an additional water source but rather a product that needs to be tailored to the intended uses. It differs to supply augmentation measures such as seawater desalination, which in effect includes a new input to the water cycle [23]. Both concepts, water reuse and seawater desalination, are limited by different key barriers: 1) Their management is more complex than the management of conventional resources; 2) Their cost is more expensive than the cost of conventional resources due to conveyance, storage and distribution in dedicated network; 3) They are perceived as being riskier and expensive than beneficial (especially in the case of wastewater); and 4) Their use is conditioned by food products growth regulation and trade barriers [24,25]. Addressing the last two barriers are not solely related to technical issues, but to social issues. According to this and irrespective of scientific and engineering based considerations, farmers' opposition and public rejection has the potential to cause water reuse and water desalination projects to fail, before, during, or after their execution [26,27]. Reuse and desalinated water schemes may face public opposition resulting from a combination of prejudiced beliefs, fear, attitudes, lack of knowledge and general distrust, which, on the whole, is often not unjustified, judging by the frequent (and highly publicized) failures of wastewater treatment facilities worldwide.

### Policies and Partnerships

At regulation level, different strategies and policies have been defined in recent years. For example, the Strategic Implementation Plan of the European Innovation Partnership on Water, proposed in 2012, in which water reuse and recycling has been identified as one of the five top priorities of the EIP Water, and the Blueprint to Safeguard Europe's Water Resources, promoted by the European Commission, published in the same year, in which maximization of water reuse was a

specific objective, with a proposal for the development of a regulatory instrument for water reuse by 2015. Both documents are fixed by the Water Reuse report, published in 2013 by the Water supply and sanitation Technology Platform (WssTP), who notes that “although investors and water utilities are becoming increasingly enthusiastic about water reuse (...) the capability of Europe’s water sector to deliver reuse projects is being compromised by a lack of suitable regulation, skills and public understanding”. This report also notes that “with appropriate investment in people, knowledge, and technology, Europe could be a global leader in this rapidly developing market”. A year later, in 2014, the Joint Research Centre published the document untitled Water Reuse in Europe: Relevant guidelines, needs for and barriers to innovation, in which wastewater reuse potential was fixed for each European country. A recent document published in 2017 by the World Bank and titled Beyond Scarcity: Water security in the Middle East and North Africa claims for a real challenge to generalize and accelerate positive innovations throughout the Region by establishing a “new water consciousness” amongst citizens which recognizes that moving beyond scarcity is everyone’s responsibility be they a farmer, business, public agency, or as individuals. All these documents aim to cope with the management of benefits and risks associated to alternative water resources. In fact, the use of treated wastewater in agriculture benefits human health, the environment and the economy. This use represents an alternative practice that is being adopted in different regions confronted with water shortages and growing urban populations with increasing water needs, especially given the decline in surface and groundwater resources caused by climate variability and climate change. The availability of water resources is also affected by wastewater-sourced pollution, as such water is not always treated before reaching surface channels, and by associated aquifer pollution. The use of treated or untreated wastewater in agriculture is not exempt from adverse effects on the environment, especially on soil. A review follows on the effects of wastewater reuse in agriculture and the impact on physicochemical parameters such as pH, organic matter, nutrients, salinity and contaminants, as well as on microbial diversity.

### Public Participation and Stakeholders’ Involvement

Recent decades have witnessed a growing desire to integrate social discourse in the decisions of *general interest*, and this has led to a rise in participation as a justifiably essential component for promoting good

governance [28]. Public participation in the management of topics linked to the territory or its natural resources has always been controversial [29]. Just two examples can be highlighted: how to justify public participation as a suitable mechanism for promoting agreements between disparate interests, and how to identify stakeholders who represent antagonistic discourses. Participation has been defined as an exchange forum organized to facilitate communication between government representatives, stakeholders, groups of interest and the whole of society. That is, it is a feasible framework for generating new ideas, theories, methods, techniques and a favorable context for the review, verification, adjustment and redesign of existing knowledge. Although much of the literature tends to mix both concepts interchangeably, there are those who consider society and the public (the set of individuals who are generally without structure and organization) to be clearly distinct from stakeholders (organized groups of people who share common interests and a decisional system) [30]. It is important to clearly define who is meant by “stakeholder”. A wide body of literature proposes different ways for defining stakeholders. Some approaches are more pragmatic, attempting to classify stakeholders according to a set of attributes [31]: those who affect an action, and those who are affected by an action, or those whose involvement is a “pragmatic requirement” to achieving a successful outcome, or whoever causes a problem needs to be considered as a stakeholder and co-owner in the process of addressing that problem [32].

### The Context of the Anthropocene

Through the History, humans have long sought ways of capturing, storing, cleaning, and redirecting freshwater resources in efforts to reduce their vulnerability to irregular river flows and unpredictable rainfall [33]. The highly positive impacts of a reliable water supply on economic productivity (which requires waterworks like dams, irrigation, and interbasin transfers) [34], means that the water cycle will increasingly be controlled by humans for decades if not centuries to come, a hallmark of the new geological epoch called the ‘Anthropocene’ [35]. This term is currently used informally to encompass different geological, ecological, sociological, and anthropological changes in recent Earth history. The origins of the concept of the Anthropocene, its terminology, and its sociopolitical implications are widely discussed [36]. This is a consequence of the hydrocentric approach that emerged over the past two decades [37,38], which focused on managing water resources as a natural water environment that needs to be protected. The evidence suggests, however, that what are needed are

rather hydrosupportive approaches in which water management is performed to achieve social goals, which may include sustaining environmental functions [39]. The concept of the Anthropocene, attributed to Paul Crutzen, is focused on how the effects of humans on the global environment have escalated. Noting the impact of anthropogenic emissions of carbon dioxide on global climate, he suggested assigning the term 'Anthropocene' to the present, in many ways human-dominated, geological epoch [40]. According to different authors [41-43], proposals for marking the start of the Anthropocene have included (i) an 'early Anthropocene' associated with the advent of agriculture, animal domestication, extensive deforestation, and gradual increases in atmospheric carbon dioxide and methane levels thousands of years ago; (ii) the New World species associated with colonization of the Americas; (iii) the beginning of the Industrial Revolution; and (iv) the mid-20th century as the 'Great Acceleration' of population growth, digitalization, and mineral and energy use. Taking into account the transdisciplinary nature of the concept, human-water interactions throughout the Anthropocene requires a fundamentally new type of collaboration, which must simultaneously explore the geophysical, social, and economic forces that shape an increasingly human-dominated global hydrologic system [44]. It will also require dissolving the distinctions between the natural sciences and the humanities and between the traditions of scholarship that emphasize quantitative information and those that emphasize narrative approaches [45,46].

## Discussion

Global climate change is already exacerbating this situation with projections indicating significant and widespread impacts over the medium to long term [47]. These developments will inevitably lead to growing competition between different water using sectors, with high quality resources being protected and reserved for drinking water production [48]. Human pressures have encouraged more active consideration of alternative water sources as a strategic option to supplement water supplies and protect natural resources. Recognition of the potential role of water reuse in such a strategy is now well embedded within both European and national policy communities. Indeed, recent years has seen a sense of urgency in calls for water reuse to become more widespread. It is, in fact, the top listed priority area in the Strategic Implementation Plan of the European Innovation Partnership Water which drew attention to 'limited institutional capacity to formulate and institutionalize recycling and reuse measures, a lack of financial incentives for reuse schemes, and poor public

perceptions towards water reuse' [49]. In a similar vein, maximisation of water reuse is a specific objective of the European Blueprint for Water with a proposal for development of a regulatory instrument on standards for water re-use anticipated by 2015. According to this, further efforts are also required to explain the benefits of reusing water and using water desalination in order to stimulate public, commercial, and government enthusiasm for water reuse [50]. How to address this gap?

From the reviewed literature conducted in Tran QK (2017) [51], it has long been recognised that the main challenges to more effective water management are largely socio-institutional rather than technical, with institutional fragmentation, limited long-term strategic planning, lack of project demonstration, and inadequate community participation. Cognitive factors such as the Law of Contagion and the Law of Similarity may explain many of the cultural perceptions that people may have about alternative water resources [52]. The first one suggests that once water has been in contact with contaminants, it might be psychologically very difficult for farmers (as producers) and citizens (as consumers) to accept that water has been purified. Secondly, the 'appearance' of a substance's condition or status is psychologically linked to perceptions of reality. Combined, both factors can create mental barriers to accepting alternative water resources as a source of pure water. Thus, there is an ongoing challenge for water service providers to constructively engage with diverse societal concerns and to build support for both the principle of water reuse and individual projects [53]. An original strategy proposed by Tran QK (2016) [54] and later recovered by Baumann D (1974) [55] focuses on converting water reuse programs on pleasant things that both farmers and key stakeholders approve of. According to both authors, if you are able to put the alternative water resources in an attractive setting and invite both farmers and the public to look at it, sniff it, picnic around it, fish in it, and swim in it, it will be easier to promote their use for production and consumption. An example was conducted in Italy, at the Milano Nosedo wastewater treatment plant –the largest wastewater plant in the region, treating approximately 150 million m<sup>3</sup>/year of wastewater–, in which managers promote open days to invite stakeholders and the general public to participate in the activities of the plant to favour acceptance and understanding the benefits of alternative water resources. This will not only favour the implementation of new projects but will also support the development of financial incentives for reuse schemes based on circular economy principles [56,57].

Some recommendations should be taken into account for ensuring the promotion of alternative water resources in line with key stakeholders' and farmers acceptance. For example, to develop the Ecology of Games framework (EGF) focused on multifunctional irrigation systems. According to Gu Q, et al. (2015) [58], the overarching hypothesis of the EGF is that the institutional complexity of a system—i.e., the presence of multiple independent, but functionally interdependent, forums that constitute the system—affects stakeholders' interactions and their strategies for advancing in decision-making processes, as well as the collective and individual outcomes these interactions produce. In order to address this gap, this approach proposes forum participation on key stakeholders' perception as a mechanism to identify alternative water resources barriers and benefits. Another proposal could be the promotion of constructed wetlands (CWs) as part of the hydrosocial cycle, with the aim to recognize, reflect, and represent water's broader social dimensions [59]. CWs are cost-effective treatments able to remove a broad range of contaminants (chemicals such as organic substances, metals and metalloids; and biological organisms, such as bacteria, viruses, and parasites) from municipal and domestic wastewater [60]. Compared to conventional wastewater treatment plants, CWs have a lower visual impact and are particularly interesting to treat alternative water resources from small and rural communities because they can operate with low energy consumption and do not need highly qualified operators. In addition, some measures to ensure institutional support and regular training on experiences about the agricultural use of alternative water resources should be promoted by Alternative Water Exchange Consortiums (AWECS) able to manage alternative water exchange between agricultural and urban-tourism activities in those geographical contexts limited by water scarcity and water disputes. This water exchange promotes cost savings when being compared with the cost of pumping groundwater or diverting freshwater from a river or water-delivery canal, and this also reduces water scarcity by ensuring a regular water provision throughout the year [61,62]. Both strategies (CWs and AWECS) needs for the collaboration between technicians and social scientists. Engineers can provide the best, safest, and efficient solutions to ensure water quality standards, whereas social scientists can facilitate better understanding of the reasons that explain rejection or acceptance from farmers and the public perception to alternative water resources for agricultural use [63]. Furthermore, managers can take profit of this coupled

technical-social approach to promote integrated and participated water resources management [64].

## Conclusion

Irrigation systems, as complex social-ecological systems, deal with both the uncertainty of ecosystem dynamics and the interdependencies resulting from Anthropocene complexity. Debates over irrigation management and governance have increasingly been framed in relation to social, economic, environmental and cultural impact, stimulating policy framework changes at different scales. Furthermore, the water-agriculture nexus is context-dependent, socially constructed and technically uncertain, and it should be analysed as a hydrosocial cycle, which likewise takes into account the inseparability of social and physical aspects of water systems. Water resources management in semi-arid areas calls for solutions able to provide responses to the decrease of available resources as effect of, among others, climate change and to ensure the sustainability of water uses, mainly in agriculture. In this perspective, reuse of treated wastewater is recognized as a key component for its ability to satisfy the increasing demand while mitigating environmental pollution. Although wastewater treatment technologies are available, many countries have experienced public and farmers' resistance to the adoption of alternative water resources for agricultural purposes. In order to address this gap, the provision of water governance tools, strategies and policies are key issues than simply finding technical (or technocratic) solutions for matching, in space and time, and in quantity and quality, water demands and water sources. Farmers' acceptance is indeed crucial to locate, finance, develop and operate any wastewater treatment plant while public participation is essential to meet the particular needs, channel local knowledge to improve the design of the project, and build vital institutional trust to address water scarcity. Moreover, a lack of involvement of key stakeholders in decision-making processes can be cause of frustration between the theoretical aims about farmers and public participation and realistic engagement promoted by the official agenda. In addition, any decision-making process has to provide a team of facilitators able to determine and adapt the participation process to reconcile confronted water interests. The Anthropocene is an ideal framework for promoting irrigation governance approaches that take seriously physical and social issues in combination with the promotion of natural and social sciences collaboration as an approach attentive to manage alternative water resources from governance principles.

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