www.water-alternatives.org Volume 15 | Issue 2

Aubriot, O. 2022. The history and politics
of communal irrigation: A review.
Water Alternatives 15(2): 307-340

AWARE Annual Water Alternatives Review

The History and Politics of Communal Irrigation: A Review

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ABSTRACT: Communal irrigation or user-managed irrigation – also long referred to as indigenous or traditional irrigation – has been the focus of interest for two main complementary reasons: 1) from a perspective of development practice (to learn lessons from customary management of these irrigation systems); and 2) from a theoretical perspective (to explore the relationship between irrigation and society). This paper reviews the main discourses through which the category of 'communal irrigation' is politically constructed. This is done through an historical reconstruction of the three main phases during which communal irrigation was the subject of discussion – namely, in the 19th century, the 1950s to 1980s, and from 1990 onwards. The review shows that while the definition of this category has evolved over these three periods it has always served the way the state positions itself in relation to the policies to be implemented. It underlines the adaptation, resistance or decline of the systems in the present context of growing competition over water, increasingly restrictive legislative frameworks, and more wide-ranging societal change. Finally, the review argues that the normative perspective and the universalistic principles that undergird most water policies conceal the diversity of knowledge and potentially weaken customary rules and historical communal systems.

KEYWORDS: Communal irrigation, indigenous irrigation, traditional irrigation, farmer-managed irrigation systems, common-pool resource, collective action, development paradigm, water user association

INTRODUCTION

All observers of so-called indigenous or traditional irrigation systems have underlined the collective management of water. They have been fascinated by the customary rules and social organisation that are involved in the management of both collective infrastructures and common-pool resources (Geertz, 1972; Chambers, 1980; Lansing, 1987; Pradhan, 1989; Ostrom, 1990; Mabry, 1996). These collective dimensions have been the focus of interest for two main, but overlapping, reasons. First, from a development perspective, studies have been carried out to draw lessons from these long-lasting systems for the sake of improving state-implemented irrigation networks (Aymard, 1864; Coward, 1980; Ostrom, 1990); at another point in time, they have been studied with the aim of optimising their hydraulic efficiency (Shivakoti and Ostrom, 2002). Second, consideration has been given to communal irrigation to explore the relationship between irrigation and society and, more specifically, the interplay between technology, ecology, and social and political organisation.

Water is indeed an element around which multiple threads are woven, linking technical, social, economic, political and cultural aspects (Mosse, 2003a; Barker and Molle, 2004; Barnes and Alatout, 2012; Casciarri and van Aken, 2013). This interplay raises questions about how we should understand water and by which criteria it should be studied, since any specific focus entails setting limits on the complexity of existing water situations. Broadly speaking, the criteria selected depend on specific

meaning systems and may even contribute to the structuring the meaning-making of the world (Jessop, 2010). Irrigation water can be seen as a physical element that is brought to plants via technology or as an economic asset that is mobilised to increase agricultural production. It can also be viewed, however, as a relational resource that permeates various social spheres. Each of these viewpoints refers to different water-related meaning systems. In the context of increasing competition over water, which viewpoint and which criteria should be privileged in the analysis? How do we account for the interaction of these different spheres (technical, social, economic, political and cultural) and for the sociotechnical interdependence that is now called water – society co-construction? The debates that animate research on irrigation have a bearing on the way these broader questions are addressed. Distinguishing the category of communal irrigation contributes to the way one understands irrigation – in contrast to other conventional categories such as state or individual irrigation – and emphasises the collective aspects of management. Academic debates are therefore concerned with the role of communities in this management, their autonomy, as well as the weight of history and social relations that help understand the dynamics of irrigation systems and distinguish communal irrigation.

This review aligns with the scholarship that considers communal irrigation as a 'political construction'. It presents the main discourses that lay out the arguments for analysing these systems and for state intervention in them. By doing so, it explores this political construction and the diversity of actors involved. We will see that irrigation systems themselves have evolved over time and that the policy and academic perspectives about them have as well. From an analytical point of view, however, it is not always easy to distinguish between the changes that have affected irrigation systems, the academic and the policy realms because of how these three influence each other. This review sets out to show how a specific type of perspective and knowledge is privileged in policy-making and how it impacts (positively or negatively) these irrigation systems. It also aims to explain why the image of independent communities has prevailed in the indigenous irrigation or communal irrigation category, even as states are increasingly interfering in the water sector.

Given that communal irrigation became a subject of discussion as far back as the 19th century, we follow a more or less diachronic presentation that is structured into three main phases, which constitute the three sections of this article. During the 19th century, Western states began to take an interest in communal irrigation, either because of their interest in irrigation systems in their colonies, or because of the restructuring of state bodies and their respective assignments, or – especially in France and Spain – in response to a legal vacuum. The years from 1950 through to the end of the 1980s are a period that presented new development paradigms. During the first phase of that period – the late 1950s and 1960s – states ignored communal irrigation while, simultaneously, a virulent scholarly response followed the 1957 publication of Wittfogel's book *Oriental Despotism*, which discussed the place that irrigation occupies in state construction. Reactions to this work revived academic interest in the diverse forms taken by irrigation management throughout the world. This was followed by a second phase which extended from the end of the 1970s through the 1980s. This period saw a revival of states' interest in communal irrigation; it arose from their efforts to increase staple grain production through irrigation and, later on, from the financial disengagement that was part of structural adjustments. It was during this stage that the founding principles to support the next phase were established. This third phase, from the 1990s onwards, has been marked by decentralisation, participatory management, and efficiency paradigms and, later, by the involvement of private actors. Scholars have analysed the adaptation, resistance or decline of communal irrigation systems when confronted with intervention projects that are aimed at improving their performance or when faced with various environmental and/or societal changes (legal, political, technical or socio-economic).

This historical reconstruction highlights the colonial heritage of the dichotomy of categories – traditional vs modern – that are used to characterise communal irrigation. It shows how the definition of this type of irrigation has evolved over the three time periods yet has always served the way the state

positions itself in relation to the policies being implemented. The communal irrigation category thus appears to be part of a 'colonisation project', in the sense that ideas elaborated upon in Western countries and/or in legislative and donor spheres are used to impose a way of understanding the sharing of, and control over, water. This conceals the diversity of water knowledges and locally developed relationships with water, and thus can undermine indigenous rules and the irrigation system itself.

DICHOTOMY OF CATEGORIES, LEGACY OF THE COLONIAL ERA

What is communal irrigation?

Communal irrigation refers to irrigation systems with a collective infrastructure that is, along with water, commonly managed by users. Some systems have even been conceived and built by the local population. Communal irrigation systems can be of various sizes; they can cover part of a village area or can spread over hundreds or even thousands of hectares. (Not included here is the new category of 'farmer-led irrigation', which often refers to individual technologies that are owned and operated by a single farmer; see Woodhouse et al., 2017; Veldwisch et al., 2019).

Communal irrigation mainly pertains to the diversion of streams, to surface water storage, or to underground galleries. Canals that divert streams or springs are common in mountainous areas such as the Andes, the Atlas Mountains, the Alps, and the Himalayas; they are also common in the East African or Southeast Asian mountain ranges, as well as on various plains such as in the Mediterranean and in Asia, most notably in cases of spate irrigation (cf. Steenbergen et al., 2010). Water wheels have been used in some areas to lift water from a stream to the main canal (de Miranda, 2004), after which the water flows by gravity along the canal. Old lake reservoirs that store flowing water are very common in India and Sri Lanka where these seasonal, partly dammed water bodies are referred to as 'tanks'. Underground galleries that tap an aquifer can be found in regions across North Africa, Turkestan and China. They are referred to as *qanat* in Iran*, karez* or *kariz* in Afghanistan and Turkestan*,* and *foggara* or *khettara* in North Africa (Beaumont and Bonine, 1989; Balland, 1992). All these collective infrastructures are (or were initially) gravity systems that distribute water via a network of canals that extends over the irrigated area. Indeed, as a fluid, water must be contained, and for water to be collected, transported and 'trans-poured',[1] it needs 'containers' (Leroi-Gourhan, 1943); rivers, dams, canals, water pipes, and dikes can play this role. Many observers have expressed their fascination with the ingenious technology of infrastructures such as huge hidden underground galleries (Beaumont and Bonine, 1989) and long canals perched on a mountainside (Crook and Jones, 1999; Kreutzmann, 2000), with the diversity of systems within a country (Agarwal and Narain, 1997), and even with the sophisticated sharing of water (Capot-Rey and Damade, 1962; Bédoucha, 2002).

Though the expression 'communal irrigation' has been adopted in this article, it is not entirely satisfactory and, indeed, none of the terms found in the literature fully portray the multitude of characteristics related to this type of irrigation. The use of a single word to categorise a diversity of situations, techniques and activities necessarily privileges certain of its elements over others. Indigenous, traditional, small-scale, minor, local, community and communal irrigation, as well as customary, smallholder, user-managed or farmer-managed irrigation systems (FMIS), all refer more to their technical aspects or to their geographical or organisational patterns. Table 1 summarises this diversity of terminology and the elements highlighted by each term. It should be noted that this is an intuitive analysis, not one based on a statistical study of the terms used. All terms implicitly express an opposition to modern irrigation; for example, indigenous techniques that have been established empirically over time are often (for engineers and bureaucrats) set against modern techniques that are based on

[1] This is a translation of the term *transversement,* which was coined by Leroi-Gourhan (1943), the father of cultural technology studies.

mathematical calculations. This dichotomy, which originated in the colonial era, has persisted and some types of irrigation are still described today according to the following dichotomous categories: traditional (indigenous, customary, or local) vs modern, or community vs state or bureaucratic, and small-scale vs large-scale.[2]

Table 1. Criteria covered by the diverse terms defining 'non-modern' irrigation.

CRITERIA		IRRIGATION				
		Traditional indigenous	Local	Small-scale	Farmer-managed, user-managed	Communal, community-managed
TECHNICAL	Old	++				
	Local materials	++	++			
	Local knowledge	+	++	+	+	
GEOGRAPHICAL	Small-scale	+	+	++	+	+
REGULATION	Customary rules	++	+	+	++	+
SOCIAL	Endogenous	++	+	+	++	
ORGANISATION	Community			+	++	++
	Collective management	+			++	++
Some authors using the term		Geertz (1972); Pérez et al. (2011); Yabes et al. (2015)	Trottier et al. (2018)	Pascon (1984); Mabry (1996); Harrison (2018)	Coward et al. (1987); Pradhan et al. (2015)	Hunt (2007); Cox et al. (2014); Boelens et al. (2017)

Note: ++ = main criterion in the terminology used; + = criterion also taken into account but secondary, or implicit, in the terminology.

In Table 1, 'traditional' and 'indigenous' irrigation are grouped together since they both refer mainly to a presumed age (from centuries-old networks to approximately 50-year-old networks) and to local materials, customary rights or laws, and endogenous organisation. Small-scale irrigation is distinguished from local irrigation because the latter can be large. Examples of large local systems are the *subak* (Lansing, 1987), the network of surface holding structures called 'tank cascades' (Mosse, 2003), some *zanjera* systems (Yabes and Goldstein, 2015) or the Chhattis Mauja canal irrigation system (Yoder, 1994). Recently built small irrigation systems, on the other hand, often rely on imported materials, such as the village hillside reservoirs in Turkey that were studied by Visage and Kuper (2019). The 'farmer-managed irrigation system' seems to be neutral but, as we shall see, it is closely linked to specific water policies.[3] 'Communal irrigation', as Hunt (2007) points out, has at least two meanings or two forms of social organisation: a territorial unit of local government (such as a village), and an organisation that includes all water users (as in an irrigation community). The term 'community' itself is polysemic and is a source

[2] Pascon (1984), for example, had difficulty in defining small-scale hydraulics; he finally categorised as such all irrigation infrastructures that are not large waterworks.

[3] In French, the term *systèmes paysans* (peasant systems) is used to express indigenousness and collective management (Aubriot, 2004a; Ruf, 2013); it does not have the link to policy that 'farmer-managed irrigation systems' has. *Peasant irrigation* is also used by Boelens et al. (1998).

of controversy. It is often used in Latin America where communities are officially recognised (Gelles, 2012) and usually referred to as villages; in countries like India, however, it is associated with caste and therefore has a different connotation. The expression 'communal irrigation' is frequently used in countries like the Philippines where this type of irrigation is institutionalised (see, for example, Inocencio et al., 2016) and such systems are called *communals* (Coward and Levine, 1987). In the present review, 'communal irrigation' is used as an umbrella term because it refers to collective management by a group of users.

Table 1 shows that each of the terms contains a number of implicit meanings, reflecting the diversity of irrigation itself. It also shows that these terms are practically synonymous insofar as they share a majority of the criteria (technical, geographical, regulatory or organisational). Only one of the expressions, 'communal irrigation', conveys neither age-related nor farmer-initiative aspects, nor does it convey local dimensions related to its technology and organisation (such as local materials, local knowledge or endogenous organisation). This expression can therefore integrate current transformations that irrigation systems have been undergoing (this will be further reviewed below).

It is nevertheless interesting to note that dichotomies such as traditional vs modern and large- vs small-scale are still pervasive in the development domain even though their soundness is debatable. Indeed, it is not possible to oppose scientific knowledge and indigenous knowledge (Diemer and Slabbers, 1992; Agrawal, 1995), and irrigation systems can be of variable sizes. Techniques have also been modified or combined over time and do not neatly relate to either tradition or modernity, while some modes of institutional organisation have been imposed. In sum, a hybridisation process has taken place. I now go back to the 19th century where these dichotomies originated.

19th century questions of laws and models

The 19th century was a turning point in terms of Western states' interest in water issues, particularly regarding their legal and technical aspects. This can be explained by the context of that time, which included colonialism and the restructuring of state bodies. It was also motivated by the legal vacuum left in France after the abolishment of feudal rights during the 1789 Revolution (Ingold, 2014), and in Spain where the 1811-1873 liberal revolution attempted an anti-feudal restructuring (Swyngedouw, 1999).

The debate among engineers and administrators about water management during the 19th century focused on local rules and institutions and on standardising regulations, especially given the emergence of 'scientific irrigation' that was based on flow calculation as it applied to large-scale networks. Indeed, it was in that century that state technical and administrative bodies in many Western countries were assigned a more important function, when technoscience became a tool of governance (Carroll, 2012); this occurred in France (Ingold, 2014), Italy (Ingold, 2011), Spain (Swyngedouw, 1999), and the United States.[4] In France, this created opposition between state administrations. On the one hand, civil and hydraulic engineers argued that the interests of all should prevail over individual rights and that irrigation should be controlled by a state authority. They defined their domain of competence over water according to purely technical elements, exempt from any political dimension. This allowed them to support a *naturalised* vision of water, that is, one devoid of social and historical dimensions (Ingold, 2008). On the other hand, field administrators, agronomists and technicians defended a definition of water whereby it was regarded as a common good shaped by practices and rules that were socially constrained. They advocated for the governance of water by the users themselves (ibid). Opposition between the viewpoints of these professional groups derives from a difference in work ethos but is also related to the struggle for access to decision-making power (Graber, 2007). This tension can also be seen in the context of the development of the market value of water. Water became a highly coveted resource in the 19th

[4] Even though the US Bureau of Reclamation was formally established only in 1907, it dates back to the 19th century (Carroll, 2012). In Britain there were only military engineers, whereas in India British hydraulic engineers were organised into a professional corps during the second half of the 19th century (Weil, 2006).

century due to the increasing number of attempts by industry, agriculture and cities to appropriate the use of running water (Haghe, 1998).

In France, one of the most influential members within the second group of actors was François-Jacques Jaubert de Passa (1785-1856). He was an agronomist who published various works on communal systems of 'waterings' in the south of France in 1821, in Spain (including that of Valencia) in 1823, and throughout the world in 1846. He advocated for the recognition of local water management institutions that had been shaped by time and for the governance of water according to the diversity of customary rules. He also underlined the autonomy of user communities. He was opposed to any state, administration, or law that attempted to homogenise, centralise or standardise regulations governing irrigation water management. His writings certainly influenced the enactment of the 1865 French law that grants local governance of agricultural water to all landowners of a collective irrigation system (Ruf, 2001). This law has nevertheless placed these associations under administrative supervision (Ingold, 2015), not unlike what would happen globally to water users associations in the 1990s. This similarity is hardly surprising since E. Ostrom (1990) – whose influence on policies will be discussed below – was inspired by the work of Glick (1970), who described Valencia's communal systems based on Jaubert de Passa's writings (Garrido, 2014). Other 19th century authors also greatly influenced the idealisation of communal irrigation. Joaquin Costa, for instance, was one of the key protagonists of the *regeneracionismo* movement that aimed at modernising the Spanish economy, particularly after the loss of its last colonies in 1898. Costa promoted scientific – technocratic hydraulic engineering and watershed management, but also local management by farmers. He drew attention to local knowledge systems and to customary laws and practices. His thinking greatly influenced 20th century Spanish politicians and professionals and thus the shaping of Iberian territory by hydraulic works (Swyngedouw, 1999; Duarte-Abadía and Boelens, 2019).

The second driving force behind a number of 19th century studies was colonialism.[5] English and French engineers carried out studies in Spain, with the aim of researching European models that could be replicated in their colonies; similarly, Americans conducted studies in Europe for application in California (Glick, 1970). European hydraulic knowledge was renowned in and of itself; however, it had its foundation in the Roman heritage of urban hydraulics and in Dutch drainage or polder techniques that date from the 12th century (Bethemont, 2000). Agricultural hydraulics were part of Arab water knowledge, and thus reached Spain as early as the 8th century (Pérennès, 1993) and Sicily in the 9th century (Todaro et al., 2020); such knowledge, however, was lacking among European hydraulic experts until the 19th century (Pérennès, 1993). Colonial engineers from northern Europe were thus confronted with technical challenges that were due to the unfamiliar environmental conditions for which their hydraulic models – designed for temperate climates – were unsuitable. As stated by Aymard (1864: 2-3), "If these models exist somewhere, they are to be found in Spain" (my translation). These engineers were indeed fascinated by the local governance of Spanish irrigation[6] (El Faïz, 2004; Garrido, 2014) and by the diversity of its water tenures which were either distinct from land ownership or 'married' (that is, associated) to it (Glick, 1970). These colonial engineers also had to address the legal aspects and issues of territorial sovereignty. This led them to study the institutions in charge of managing irrigation in order to incorporate them into their governance structure, to implement homeland laws in the colonies (for

[5] This turning point in 19th century colonial imperialism barely concerned Spain which, from the 16th century onwards, had already transformed the hydraulic landscape of Latin America, imposed its water laws (Ruf, 1999; Zimmerer, 2000), and even imported *qanat* technology (Beekman et al., 1999).

[6] Due to a colonial and European-centric ideology, several authors have striven to attribute the advantages of irrigation in Spain to the Spanish, not to the Arabs, in order to limit the amount of space given to contributions from Arab-Muslim civilisation (El Faïz, 2004). Other authors, on the other hand, saw the Arab heritage as having spanned centuries (Garrido, 2014).

example, the French in India),[7] or to create specific laws (the British in India[8]) that placed the associations and/or the infrastructure under administrative supervision.

Just as social scientists influenced the thinking of this period, during this time the imperial context also influenced scientific production (Deprest, 2017). This is the case of J. Brunhes, who is considered to be one of the founders of human geography. His PhD (1902, published in 1904) is a major contribution to knowledge about irrigation systems and hydraulic societies in Mediterranean countries. It is based on case studies from Spain, Algeria, Tunisia and Egypt. In Spain, Brunhes was in contact with the *regeneracionismo* movement and lauded the work of Costa on agrarian collectivism, and in Algeria he was in contact with the military and colonial administrators (Deprest, 2017). Knowledge was thus produced within a complex network of actors. It was circulated within empires, moving between the metropolis and the colonies and between different empires (ibid). With regard to irrigation, Brunhes attached great importance to collective organisation and he credited these admirable "hydraulic communities" (1904: 436) with the prosperity of arid zones. He grasped the social dimension of water-related practices, postulating that "it is the use of water that maintains the social bond" (ibid: 75). He also showed the importance of environmental conditions in explaining the diversity of water management, but did not apply environmental determinism.

By the end of the 19th century, scientists, engineers, administrators and political leaders were thus travelling between various countries (Spain, France, Italy) and different trans-colonial spaces (including Algeria, Australia, Egypt, the United States, India, Tunisia, Russia and Argentina). They were questioning the transferability of technical and legal solutions from European Mediterranean countries to the colonies[9] (Ingold, 2008; Deprest, 2017). In the end, these models were not applied, as the following section explains.

Neglect of local knowledge, but the making of communities

Colonial engineers and administrators decided that, in fact, little from the Spanish models could be directly used in the colonies. The British, for example, were envisaging volumetric pricing, but were disappointed that they could not find any such solution in Spain; they therefore judged its water-sharing and maintenance systems to be unfair (Garrido, 2014). In India, however, it was not until the 1880s that, with progress made in mathematics, engineering was able to 'subdue' nature using scientific methods. Until that point, engineers who were members of the military and who had little specific hydraulic knowledge, had worked by trial and error (Gilmartin, 2003). 'Imperial science' helped organise the productive control of nature based on universal scientific principles. In 19th century India, this gave birth to large irrigation systems that were created through river diversion schemes. These systems were built by neglecting, or even destroying, existing local systems in Punjab or Bihar (Gilmartin, 1994; D'Souza, 2006; Ali, 2014). Such was also the case in Indonesia (Ravesteijn, 2002), in Morocco, and in Algeria (Marié, 1994). This 'imperial science', which aimed at imposing a form of political control over populations in concerned areas (Gilmartin, 1994; El Faïz, 2004), went hand in hand with the 'hydraulic mission' to develop modern technology (Molle et al., 2009) and to test the technological expertise of engineers in the colonies (Marié, 1994). In India, however, science played contradictory roles. In the colonial context, imperial science was constrained by the 'science of empire', which crafts and sustains political hierarchies and administrations by linking elites and the colonial state. This science shaped the discourse on local

[7] The 1865 French law on *Association Syndicales Autorisées* (ASA), which put associations under administrative supervision, was applied in Pondicherry (Aubriot, 2013a).

[8] From the mid-19th century, tanks in South India came under the Public Works Department and various legislative measures were passed (in vain) to force cultivators to undertake the maintenance work of the infrastructure; the Madras Compulsory Labour Act of 1858 was the first of these (Agarwal and Narain, 1997: 246). A separate cess was also levied for the use of irrigation water (see Tamil Nadu Irrigation Cess Act, 1865; http://www.bareactslive.com/TN/tn643.htm).

[9] For the British colonial context, such 'travelling' of knowledge and discussions of irrigation governance are reported in Scott-Moncrieff (1868), Tignor (1966), and Cookson-Hills (2013); for Australia and South Asia, see Deakin (1893).

social order based on 'communities' (Gilmartin, 1994). 'Local knowledge' was therefore caught between two realities: the need to be recognised by administrators, and its neglect by colonial engineers who relied on imperial science (ibid). Imperial science eventually prevailed, while local knowledge failed to serve as a model.

During this colonial period, the definition and characterisation of 'local communities' was particularly subjective. According to the anthropologist Mosse (1999), colonial rulers did not want to take the path of establishing strong, autonomous, self-governing local entities, despite an administrative discourse on the autonomy of village institutions. Describing water management as *traditional, communal* or *indigenous* is in fact the corollary of a centralised state. In South India, for example, the administrative system needed an institutionalised and formalised conception of local practices that was anchored in the assumed 'customary' and 'traditional' legitimacy of the maintenance of tanks, since the administration did not have enough manpower or the financial means to maintain these infrastructures (Mosse, 1999, 2003a, 2008). Gilmartin (1994) shows how the definition of "local communities" shifted from the need of British officials to manage taxes on agricultural revenues to the need of irrigation engineers to manage large volumes of water. The administrators defined these communities according to categories such as kinship and rights over common resources; however, these 'communities' did not necessarily align with the structure of the irrigation networks that were set up by engineers. Their contours therefore had to be redefined to correspond to a logic that was in keeping with the structure of irrigation canal networks and with the scientific discourse of an 'efficient' control of nature.

As mentioned above, in 1823 Jaubert de Passa describes the democratic management of Spanish irrigation systems by the irrigators themselves, a description that was reiterated later by various authors. The historian Garrido (2014), however, questions this idea, showing that these systems were in fact run by a few large landowners or by the municipality. He speaks of the myth of the democratic management of Spanish systems – a myth that has influenced the very way that these systems have evolved. In India, similarly, D'souza (2006) does not entirely support the distinction made by Sengupta (1980) between traditional or indigenous irrigation systems and modern irrigation systems that are based on a participatory setup. Sengupta's distinction is between cooperation among users versus formal centralised bureaucratic management; however, according to D'souza (ibid), this conveys the impression of democratic decision-making while ignoring caste differentiation practices and the forced labour that has been used in repair and maintenance work.

At the beginning of the 20th century, colonial geographers and agronomists ended up clashing with public works engineers. The latter were in favour of large concrete reservoir dams (a technology that had emerged at the turn of the century) and of large irrigation systems, while the former denounced their environmental and social effects (Gobe, 2017). In the 1920s, the debate was settled due to pressure from dam construction companies that were at the forefront of technical progress (ibid) and of the adoption of large-scale hydraulic systems.[10] From then on, irrigation followed a logic that was based on calculation of the flows to be delivered and on the application of the industrial model to agriculture (Marzouk, 1989), that is, on 'scientific irrigation' (Molle et al., 2009). The growth of this technocracy was accompanied by the minimisation and suppression of local knowledge (Weil, 2006).

The early 20th century was thus characterised by the valorisation of the technology that belonged to engineering science (as opposed to indigenous techniques) and its "civilising mission" (Weil, 2006). Engineers perceived themselves to be agents of technical progress and vectors of 'modernisation'. They considered their solutions to be based on objective facts (Gobe, 2017) and they believed technology to be neutral and apolitical (Ingold, 2008). At that point, native systems – marginalised in science as well as in policy-oriented discourses – had barely been studied; this did not change until the controversy raised by Karl Wittfogel.

[10] In India, in contrast, a virulent polemic started in the mid-19th century between proponents and opponents of embankments to solve flood issues; this debate persisted and hindered a number of projects (Mishra, 2008).

SECOND HALF OF THE 20TH CENTURY: REDISCOVERY (OR REINVENTION?) OF COMMUNITY IRRIGATION

During the first postcolonial decades (1950s and 1960s), social anthropologists, historians and archaeologists carried out a number of studies on communal irrigation systems in reaction to Wittfogel's 'hydraulic society' theory. This renewed interest focused on the irrigation-society relationship and discussion was mostly conducted in the academic sphere. A second phase, in the 1970s and 1980s, was decisive in producing concepts that had been inspired by the study of these systems and in the setting up of paradigms that became the basis of development practice.

Power relations in question

K. Wittfogel's theory (1957) stipulated that state-building is induced by the need for centralised control over irrigation. This fuelled a rich debate on the relationship between hydraulic systems and power relations – a debate that still rouses some interest (Lees, 1994; Davies, 2009; Wilkinson, 2010; Bichsel, 2016; Obertreis et al., 2016). Wittfogel focused on large-scale irrigation networks of "hydraulic societies" but, in doing so, reinforced the dichotomy with small-scale systems. Interestingly enough, this led to field studies that were conducted between 1958 and 1961; these were undertaken by a number of social anthropologists who showed the diversity of water management methods throughout the world and the role of local communities. Leach (1959) demonstrated how, in Sri Lanka, kinship plays a role in controlling access to land and water; Million (1962) compared seven case studies, including his fieldwork in Mexico, concluding that water allocation management can be either centralised or strongly or partly decentralised, depending on the case; Gray (1963) concentrated on villages in East Africa where water is managed by hereditary ruling groups; and Fernea (1970) illustrated the capacity of communities in Iraq to manage water even when the political regime had undergone major change. The case studied by McC. Netting (1974) in the Swiss Alps is astonishing because none of the users was able to explain how the entire system was working. Maass and Anderson (1978: 4), on the basis of six case studies, emphasised the ingenuity of Spanish and American irrigation system users in having invented "operating procedures that avoid centralised and despotic power". All these authors demonstrate the absence of a systematic relationship between irrigation and centralised authority; they thereby make clear the capacity of users to manage and control water by themselves.[11]

From the 1970s onward, studies on the irrigation-society relationship went in two main directions. One of these was related to the importance of environmental factors – notably water scarcity – in understanding the sophisticated organisation of resource management (Downing and Gibson, 1974; Wade, 1979; Louis et al., 1987). Geertz (1972), however, used two contrasting examples to show that aridity does not necessarily determine how water is managed. In Bali's wet environment, irrigation is technologically complex, highly collectively organised, and associated with religious calendars; in arid Morocco, on the other hand, where the variability of the climate is high, irrigation is structurally very flexible and is governed by elaborate codes of rules and individual property. Maass and Anderson (1978) discussed Brunhes' theory (1904) and, although embarrassed by his use of the concept of a psychological state of uncertainty, they recognised that similar natural environments would not necessarily produce similar irrigation systems and that cooperation between users is an influential factor in that it helps to adjust to the natural environment. More recent studies have also taken a stand against ecological determinism based on aridity. A meticulous sharing of water resources can, for example, be observed in regions where water is abundant (Wateau, 2002, for Portugal; Aubriot, 2004a, for Nepal); conversely, in the oases of Ladakh in the Indian Himalayas, where water is scarce, the means for sharing it lack

[11] This is not to mention archaeologists and historians who questioned the excessive determinism of the historical relationship between large-scale irrigation and state-building or between it and changes in state political organisation (Adams, 1960; Mitchell, 1973; Meyer, 1990).

sophistication (Labbal, 2001). Such determinism tends to be based primarily on a false opposition between nature and culture (Kelly, 1983).

The second direction taken in the studies is an examination of political and cultural dimensions of water management. The geography of an irrigation network does not necessarily correspond to the geography of politically defined territorial units. The studies attempt to unravel the link between the two. Robert Hunt and Eva Hunt, through a study conducted in Mexico and an analysis of the literature they carried out on local organisation (Hunt and Hunt, 1974,1976), showed that irrigation is linked to major features of the social organisation, which is in turn closely connected to power hierarchies. Indeed, critical activities of irrigation (maintenance, allocation, conflict resolution) are not homogeneously distributed among the population, and the elite is often involved in control of the social aspects of the irrigation system as well as of the local government apparatus. Water management gives rise to roles that often appear to be embedded in a set of functions related to the social and political life of the water-using community. "Wealth, social class, hereditary descent group membership in aristocratic lineages, and ascription to political roles which imply control of other resources may correlate with rights within the irrigation system" (Hunt and Hunt, 1974: 133). Other studies confirm this point of view. Kinship ties, for example, often shape the logic of water distribution, as observed in, for example, North Africa (Berque, 1955; Bédoucha, 1987; Kilani, 1992; Ftaïta, 2006), Sri Lanka (Leach, 1961), Nepal (Aubriot, 2004a), and Madagascar (Hall, 2008). In these cases, kinship groups have been charged with managing conflicts and water-sharing; each group thus receives water in their turn, according to a rotation system. Some other studies report strong hierarchical distinctions according to age groups, as in Tanzania (Potkanski and Adams, 1998) and Kenya (Fleuret, 1985), or according to socio-economic class, as in Mexico (Millon et al., 1962; Hunt and Hunt, 1974) and Ecuador (Apollin et al., 1998). Depending on the case, this type of organisation has repercussions on access to water and/or on the institution in charge of water management. Religion has also influenced the modes of water-sharing and distribution, as highlighted in studies conducted in Tunisia (Bédoucha, 1987), Oman (Le Cour Grandmaison, 1984), and Bali (Geertz, 1972; Lansing, 1987). Many scholars who address power relations in communal irrigation (Mosse, 2003a; Shah, 2003) have pointed out that communities are not homogeneous and that "water is the friend of the powerful", to paraphrase Bédoucha (1987). For Kelly (1983), many of these studies tended towards one of two polar positions: water users' autonomy over irrigation management, or control over it by an elite. According to this author, a differentiation should be made between the centralisation of irrigation roles within the irrigation system and the articulation of the system to political authorities. Finally, Hunt and Hunt (1976) noticed that many of these case studies refer to "small localities, usually communities" whose definition is often taken for granted and not necessarily discussed, while in fact these 'communities' exhibit vast structural diversity.

Renewed interest linked to development issues: Founding principles in the making

The studies of the 1970s and the 1980s inaugurated the start of a new phase that was to be decisive for developmental intervention in communal irrigation. A new 'participatory' paradigm of irrigation development was established, which then developed into the irrigation management transfer (IMT) policy approach. It was at this point that communal irrigation studies moved from being primarily of academic interest to directly supporting irrigation development interventions and recommendations.

Disengagement of the state

At the end of the 1970s, while funding agencies were already reflecting on the structural adjustment and financial disengagement of states, large-scale hydraulic projects were being systematically decried as failures – economically unprofitable structures – in Asia (Wade and Chambers, 1980) and in Africa (Fleuret, 1985 for Kenya; Adams et al., 1994 for Tanzania). The focus then shifted to studying peasant systems that had been in existence for decades and even centuries (Coward, 1980; Ostrom, 1992; Mabry, 1996). The aim was to develop irrigation but also to learn lessons about irrigation from 'indigenous

knowledge' (Coward, 1980; Adams et al., 1994) that could be applied to IMT in state irrigation systems. UNESCO also launched a programme in 1980 to inventory small-scale hydraulic networks (Chiche, 1984).

Spotlight on the sociotechnical complexity of communal irrigation

Social scientists realised that they did not know how to fully explain the complexity of the sociotechnical dimensions of irrigation in diverse environments (Coward and Levine, 1987). They further realised that they had to take environmental and technical issues into account, just as engineers needed to integrate social processes (Chambers, 1980; Yoder and Thurston, 1990; Diemer and Slabbers, 1992). In their seminal work – which reviewed more than 130 references and cases studies from around the world – Coward and Levine (1987) noted that their 10 years of cumulative knowledge about farmer-managed irrigation systems was mainly based on descriptive studies and on very few analytical ones. The Cornell Irrigation Studies Group in Ithaca, USA,[12] to which these scholars belonged, played a major role in the multidisciplinary intellectual production of the late 1970s and 1980s. Its members identified key themes (water rights, regulations, conflicts, institutions, cooperation) and developed analytical grids (Chambers, 1980; Uphoff, 1986a). As consultants, they supported pilot projects on participatory management, including the first USAID-funded pilot project in Sri Lanka in 1980 (Uphoff, 2015). Scholars were recruited by the International Irrigation Management Institute (IIMI),[13] which was created in 1984 and served as a platform for debates but also compiled results in accordance with the advice given to funding agencies. This institute (and thus the Cornell group), thanks to its own research programmes and its policy of funding conferences and disseminating results, has played a crucial role in orientating research towards communal irrigation.

Efficiency and performance

Technical efficiency and performance are, respectively, an engineer's and an economist's notion, based on technical and production logics. Since the 1980s, they have been used to study peasant irrigation (Wade and Chambers, 1980; Lam, 1996; Shivakoti and Ostrom, 2002). These notions do not refer to the social links or the symbolic dimensions that often undergird peasants' irrigation practices (Bédoucha-Albergoni, 1976; Boelens, 2014), which are discussed below. Efficiency is not emphasised in communal systems logic (Coward and Levine, 1987) and is rarely explicit in Valencian community objectives (Maass and Anderson, 1978). Community system users and development scientists or administrators clearly follow different management logics. Maass and Anderson's work (ibid) pioneered simulation programmes that were developed to estimate the efficacy of various management procedures. The notions of efficiency and performance were then used to compare types of irrigation and to support the idea that farmers are more capable of managing irrigation systems than are state agencies (Vander Velde, 1982; Ostrom, 1992; Lam, 1998). This helped to assert the validity of the IMT paradigm that was developed in the 1980s.

Since earthen canals, which lose water through seepage, came to be seen as retrograde technology, the notion of efficiency also contributed to reflections on the rehabilitation of infrastructures using modern technology or materials (cf. IIMI et al., 1987). Pilot rehabilitation projects were undertaken in the 1980s (cf. IIMI, 1986; Adams et al., 1994; Shukla, 2002; since 1982 in the Philippines, cf. IFAD, n.d.) to test new paradigms (participatory, IMT, efficiency). In countries such as the Philippines, Sri Lanka, India, Morocco and Mexico, the existence of small-scale irrigation systems had already been recognised by the state. In India, for example, tanks came under a state department's responsibility and were categorised

[12] The Cornell Irrigation Studies Group was made up of economists, engineers and sociologists; it included Walter Coward, Norman Uphoff, Gill Levine, Randy Barker and Dany Sisler, all of whom had worked in various Asian countries.

[13] In 1992, the International Irrigation Management Institute joined the Consultative Group on International Agricultural Research (CGIAR); in the late 1990s, IIMI became the International Water Management Institute (IWMI), expanding its scope to water and land.

as 'minor irrigation' (Mosse, 2003a; Shah, 2003), and in Morocco communal irrigation came under the category of '*petite et moyenne hydraulique* that is small and medium hydraulics (Pascon, 1984). In some other countries, however, it was only in the 1980s that they began to feature in national statistics for irrigated areas (Fleuret, 1985, for Kenya; Pradhan, 2010, for Nepal).

Self-governed and autonomous farmer-managed irrigation systems

Self-governance of communal irrigation systems was systematically emphasised in the governance discourse (Coward, 1980; IIMI, 1986; Uphoff, 1986a, 1986b; Merrey et al., 1988) and studies were therefore undertaken to fully grasp this notion. Coward (1983, 1986), for example, shed light on the process of "hydraulic property creation", that is, the relationship between water rights and investment in the creation of the irrigation network (followed by a renewal of water rights through investment in maintenance). In other words, those who invested in the construction of a network (including their heirs who would have the responsibility of maintaining it) are recognised as having the right over a defined share of water and are thus regarded as legitimate holders of these water rights. This key relationship supports self-governed irrigation systems and, in the long term, explains the confirmation of rights, the maintenance of infrastructures, and the strengthening of the organisation (Boelens and Vos, 2014).

A new expression was coined, that of 'farmer-managed irrigation systems', which supports the logic that farmers were more adept than state agencies at managing irrigation systems. Since the 1980s, the acronym FMIS has been commonly used in literature on irrigation in South Asia, the Philippines and Indonesia.[14] Its dissemination was clearly promoted by IIMI through publications and in the course of conference proceedings (IIMI et al., 1987; Yoder and Thurston, 1990; Manor and Chambouleyron, 1993; Lauraya et al., 1994), and through the establishment of an FMIS network (cf. Abernethy's preface in Yoder and Thurston, 1990). FMISs were thus doubly institutionalised, both on the level of irrigation systems themselves and on national (or, in India, state) level through FMIS networks. The expression 'farmer-managed irrigation system' derives from a set of discussions developed since the end of the 1970s by the Cornell Irrigation Studies Group. The sociologist Uphoff (1986a: 4), stated that, "in practice, there is a continuum between agency-managed and user-managed systems, with a middle range of joint management as the most common mode". IIMI's papers, on the other hand, introduced a more marked dichotomy between state- and farmer-managed irrigation systems (Pradhan, 1989; Pant et al., 1992); this was, in turn, relayed by other scholars (see for example Shivakoti and Ostrom, 2002). This simplification arguably makes the FMIS category more 'operational' as it classifies any historical farmer-managed system as a FMIS. This designation (as well as 'traditional' or 'indigenous') has the disadvantage of minimising or even overlooking the role of the state in framing the management mode for these systems (through incentives, legal frameworks, etc). It also implicitly makes them autonomous and independent of the state.[15]

This idea of autonomous irrigation communities resonates with broader debates on peasant autonomy. Indeed, peasant studies, which emerged in the 1950s and attempted to define what a peasant society was, portrayed peasant communities as relatively autonomous and independent of the state. In Europe, this took place in a period when the number of peasants was declining and they were being replaced by agricultural producers whose operational model was dependent on development policies (Mendras, 2000).

It is worth noting that state institutions and scholars involved in development studies showed a particular interest in peasant systems when, for example, they planned to intervene in peasants' lives,

[14] The term 'farmer-managed irrigation system' first appeared in Martin and Yoder (1983) in the literature I perused for this review.

[15] For their part, Coward and Levine (1987) did not necessarily minimise the role of the state in FMISs. In their agenda of future research to improve policies and programmes for public intervention in FMISs, they proposed an analysis of the articulation between the local context and a broader one, including the relationship with the state.

either to change the production model or to formalise peasant water management institutions. This is reminiscent of the French state's historical control of irrigator communities in the 19th century, especially when it was trying to reform irrigation associations (Ingold, 2015).

Commons managed by communities

Another line of research, that on common-pool resources, has contributed importantly to the renewal of studies on communal systems. This research has also helped promote IMT and has highlighted the existence and importance of collectively managed common property. This school of thought was developed in the 1980s, most notably at Indiana University Bloomington, and applies to, for example, grazing land, irrigation water and fisheries. In 1988, its leader, Elinor Ostrom, was commissioned by USAID to review the literature on community-based management and to carry out field trips (Locher, 2016), the results of which are included in her seminal book (Ostrom, 1990). She compared various common-pool resource systems (including many irrigation systems) in order to arrive at a list of conditions explaining the cooperation between individuals and a long-standing viable institution to govern these resources. She thus proposed a third option to the state/market binary: community-based management of commons, a notion that has become ubiquitous in the most recent phase, which began in the 1990s and extends to the present.

In summary, the 1970s and 1980s saw the advent of notions that were inspired by the functioning of communal irrigation systems. Discussions were dominated by the elaboration of concepts (self-governance of communal irrigation, FMISs, commons) and paradigms (state disengagement, management efficiency, community autonomy, users' participation). These were developed by two main schools of thought, the Cornell Irrigation Studies Group and the Bloomington common-pool resources group. They represent the core principles that went on to support the next phase, that is, the post-1990s development policies of decentralisation and the generalisation of participatory management.

FROM 1990 ONWARDS, A CONTEXT OF COMMUNITY-BASED MANAGEMENT POLICIES

The 1990s and 2000s represent the golden age of studies on communal irrigation insofar as the number of studies on this subject saw a sharp increase. Elinor Ostrom's Bloomington workshop on Political Economy and IASC (International Association for the Study of the Commons) contributed significantly to this. Economists acquired certain power by influencing the way legal and development policies were framed. They provided justification for participatory management policies through the idea of creating formal irrigator associations. These new paradigms of decentralisation and participatory management have been largely applied in policies, either in state irrigation systems via IMT, or in development projects whose scope covers the rehabilitation or the revival of 'traditional' systems, or in community-based natural resource management (CBNRM) programmes. Consequently, many studies have examined the impact of the formal institutionalisation of irrigation management on the adaptation, resistance or decline of communal systems. Some studies have also explored new forms of local irrigation.

Enhancing the visibility of communal irrigation

Communal irrigation as a commons

As we have seen, community-based management became the solution promoted by pilot development aid projects in the 1980s, not only regarding irrigation but also other shared resources. Theoretical framing using institutional economics (Ostrom, 1990, 1992) resonated with funding agencies and development institutions because it proposed the implementation of a set of clear rules as a self-contained kit. Decentralised and participatory management has thus been incorporated in a neoliberal narrative that served as a basis for development policies, as well as for a number of water laws that were enacted throughout the world in the 1990s under pressure from funding agencies.

Some time went by before the common-pool resource (CPR) approach began to be criticised. While wondering why outsiders such as development experts were so interested in the commons, Goldman (1997) presented the commons theory as a new form of social control through the knowledge it produced. He argues that because CPR approaches do not take institutions of power into account, the theory undermines the commoner's position to control this knowledge. One of the harshest criticisms of CPR approaches came from the anthropologist D. Mosse (2003a, 2003b). In his point of view, social models used by CPR theory are synchronic, ahistorical and do not address change. They are established with a very utilitarian and economic vision of water use, separating water management from other aspects of social and cultural life. Moreover, they present local resource negotiations as being independent of the state. We may add that social groups are poorly differentiated, power relations are difficult to integrate into the model and the approach does not allow us to grasp the social dynamics at play. For Agrawal (2003), a political scientist, this school of thought puts too much emphasis on local groups and ignores external factors, especially social and political contexts (demographic change, market penetration and state policies) and also technological developments. Researchers who adhere to the socio-ecological system (SES) framework have filled these gaps by exploring the concepts of social-ecological resilience, institutional robustness, and the sustainability of 'traditional' collective irrigation systems. They analyse the way these systems react to external threats such as typhoons, a change in a country's political regime, the construction of large dams (Yabes and Goldstein, 2015), to the introduction of new techniques by new resource users (Pérez et al., 2011), or to cumulative disturbances such as climate change or a tourism-fuelled labour market that displaces farming (Schoon and Cox, 2012). Some economists (Baron et al., 2011) have shown that theoretical anchors of the CPR theory, such as methodological individualism, can be contradictory or limiting when attempting to understand structural effects, the interlocking of scales and the functioning of power mechanisms within collectives, which are all essential dimensions for comprehending collective action. One of the most constructive criticisms from a conceptual point of view comes from the critical institutionalism movement championed by Cleaver (2001, 2002) and her concept of 'institutional bricolage' presented below.

Farmers' rationality, logic and knowledge

Other studies also contributed to improving the visibility of communal irrigation systems. They focused on understanding farmers' rationality and their operating logic from a sociotechnical point of view. Two main schools of thought followed this line of research in Europe: the Wageningen irrigation group and the French 'Social Water Management' (*Gestion sociale de l'eau*: GSE) developed in Montpellier.

The Wageningen school clarified the sociotechnical approach (Vincent, 1997) without focusing specifically on peasant irrigation systems. However, some scholars from this school, such as Boelens (1998, 2012; with Roth 2005; with Zwarteveen 2005), have continued to do so, addressing questions of equity and water rights. Benda-Beckmann (1995, 2000) studied how legal pluralism helps to understand various situations, since customary or even religious rights are prevalent in historical irrigation systems that are also subject to national law. Shah (2003) examined how tank technology in India is linked to social, economic and political relations and how global changes in society interact with changes in technology and local social relations.

The French school was characterised by its adherence to a diachronic approach by looking at the moments of rupture in the history of these systems in order to grasp the societal or technical context that explains the changes that have occurred. GSE highlights the social dynamics of water management which is considered to be a social construct, historically produced but never fully immutable, and which often involves collective rules and a social organisation (Sabatier and Ruf, 1992). This school of thought inherited the results and methodology of a line of research that emerged in the 1970s and studied agrarian systems and peasant knowledge (Cochet, 2011). GSE initially focused on peasant systems (Ruf, 1993, 2001; Molle and Ruf, 1994; Labbal, 2001; Aubriot, 2004b; Hall, 2008; Bédoucha and Sabatier, 2013) without providing a critical approach to either the 'communal irrigation' or 'peasant irrigation system'

categories, and therefore reinforced the dichotomy with large hydraulic systems implemented by the state.

The work of other researchers, mainly social anthropologists and geographers, can also be grouped into this category of study on farmers' knowledge and the social dynamics of water management. Wateau (2002) studies 'conflict' as an element of social structuring in a system in Portugal, while Gentelle (2003) analyses the 'water imprint' of hydraulic infrastructures to study ancient systems in collaboration with archaeologists. Kreutzmann (2000, 2011) highlights the complexity of interrelationships between natural, social and institutional factors in the Karakoram mountains, while Trawick (2001) hypothesises an egalitarian Inca model of water-sharing in the Andes, which he conceptualises as a moral economy of water, i.e. the interaction between a moral model of how the society ought to be and its material expression (here in the case of water sharing), involving a dialectical approach to nature/culture relationships. Note that historians who question irrigation management and study the factors that explain the evolution of old networks work mostly in Europe (Cressier, 2006; Ingold, 2009; contributors in Fournier and Lavaud, 2012; Garrido, 2014; Leibundgut and Kohn, 2014). They show how research focusing on conflicts – and defining the moments when rules are changed – can help illuminate the social context.

The 1990s-2000s therefore constitute the period of peak visibility of these systems through two main types of research: studies about institutional economics that support development policies, and sociotechnical approaches that point out the complexity of the interaction of social, technical and environmental aspects.

Crafting formal water user associations (WUAs)

The irony of formalisation for historical systems

Development policies frequently stipulate that any collective irrigation network benefitting from state aid has to create an irrigators' association and to register it with the legally recognised government body, whether the given network is an FMIS or a network managed by a state agency. This primarily concerns surface water as most groundwater is pumped by means of individual infrastructures. Moreover, groundwater is rarely considered a common resource (as in India, cf Landy et al., 2021), especially when the law defines the right of access to this resource in terms of land ownership (as in the case cited). The irony of the situation is that communal irrigation systems, which served as examples to build the discourse on promoting decentralised participatory management, and which were recognised in this very discourse as benefitting from well organised institutions, also have to set up a formal water users' association. And in most cases, their informal secular institution is not taken into consideration. The collective organisation invented by the state is resolutely formal and, by registering these institutions, the state becomes one of their stakeholders.

Proponents of 'traditional system revival', mainly NGOs, (see for example Agarwal and Narain, 1997 for India) readily accept this formalisation of water management institutions at the village level. As Mosse (2003a) found in the case of India, these actors lay the emphasis on local knowledge and heritage. Their discourse shares elements with the discourse that supports state participatory management policy: 'autonomy' of 'communities'. However, neither of the two discourses discusses or questions the implication of states or NGOs in the revival and rehabilitation of these irrigation systems. Formal associations, supervised by NGOs and/or administered by a state department, have been created.

Some researchers question the relevance of 'reviving' these irrigation infrastructures, especially tanks, because population density is high and reservoirs occupy a lot of space while offering short-term water storage, and thus little security (Von Oppen and Rao, 1987). When village institutions totally lose interest in the irrigation function of tanks, assigning them the function of recharging groundwater would seem more appropriate (Palanisami and Easter, 2000). Since the late 1990s, in many places this has become a

default function or has resulted from programmes aimed at evicting encroachers, given the importance attributed to groundwater recharge by the Indian government. Furthermore, some tank associations (headed by tube well owners!) have decided not to use tank water for surface irrigation but for groundwater recharge. This decision can be regarded very cynically when one learns from hydrogeologists that the aquifer used here by these irrigators is not recharged locally by their tank but rather miles away (Aubriot, 2013b).

Issues linked to formalisation

This formalisation of water management institutions in communal systems has prompted several questions, as alluded to in the title: *Is formalisation the answer?* (Reddy and Reddy, 2002). Four issues linked to formalisation can be identified in the literature. One relates to the scale of the imposed social unit: the village community. Mosse (1999, 2003a, 2003b) has extensively deconstructed this notion for tank management in South India while showing that isolating resource management from its particular historical and social context denies the importance of political relations and of the cultural construction of natural resources. In Tanzania, the formalisation of a management institution has led to recognising the 'traditional' part of the irrigation system only if it is 'improved' and integrated in a formal bureaucratic system; hence, a customary institution and informal water uses have not been recognised (Harrison and Mdee, 2017). This type of informal organisation can even be dismantled due to the formalisation process. For example, in the High Atlas (Morocco) and the Eastern Pyrenees (France) – in addition to the village organisation involved in water management – there existed an informal organisation encompassing several hamlets on the scale of a 'socio-hydraulic territory' (Riaux, 2006, 2009). This level of organisation, with only shared rules and no chief nor specific organisation, is not included in the principles defined by Ostrom. Nor is it recognised by water policies and development projects. The imposed scale of the formalised water user association consequently makes invisible or even destroys such informal social units.

The second issue, which is not specific to irrigation, is associated with the definition of 'user' in a community-based management programme and pertains to the social embeddedness of access to and use of resources. It is usually related to unequal access to government aid. In some countries, development projects are allocated according to a demand-driven principle (Shukla, 2002). The formalisation of participatory management implies that farmers establish contact with the administration in order to keep abreast of available support and to have more chance of benefitting from the latter which often lies in the hands of the wealthiest (Mosse, 1999; Khanal, 2003; Agrawal and Gupta, 2005; Harrison and Mdee, 2017). This process excludes people or communities who do not possess the social codes for development. This formalisation and bureaucratisation of irrigation consequently favours the most powerful. Women are often not recognised as WUA members. However, in some irrigation systems, as in the Chhattis Mauja in Nepal, they take advantage of this situation by ignoring the rules of the organisation to obtain more water (thus becoming free-riders rather than victims) (Zwarteveen and Neupane, 1996). Because common-pool theory oversimplifies the project context and the commons reality, project expectations remain unfulfilled (Saunders, 2014). In the Chhattis Mauja case, the lack of women's participation in maintenance impacts the irrigation system's performance (Zwarteveen et al., op. cited).

More generally, the *critical institutionalism* line of research recommends that project interventions be based on a socially informed analysis of the contents and effects of institutional arrangements rather than on institutional form alone (as per institutional economists such as Ostrom). Firstly, a diversity of roles and functions indeed exists in society, and those promoted by formal institutions may reproduce existing patterns of inequity. Secondly, people draw on existing social and cultural arrangements to shape institutions. Some 'institutional bricolage' takes place that is an active, conscious creative process of adapting norms, values and social arrangements to fit new purposes, while also reflecting and being shaped by deeply embedded unconscious principles (Cleaver, 2002; Merrey and Cook, 2012). For these

authors, the dichotomies of traditional/modern, formal/informal, economic/social are not useful since they do not assist in understanding the plurality of social arrangements that shape institutions. The latter results from a rather dynamic hybrid combination of elements taken from 'bureaucratic' and 'socially embedded' institutions (Ibid).

The third issue is concerned with power relations and raises the following questions: has the introduction of formal institutions changed power relations or created new political openings since it set out to promote more equitable water access? Does it provide the opportunity for a complete shift of power or the emergence of a new elite (Pangare, 2002; Aubriot and Prabhakar, 2011)? Or has a certain continuity been observed? These questions arise in any type of irrigation system: some external investment by the state in communal irrigation systems may jeopardise the functioning of irrigation and reshape power relationships among stakeholders (Mathieu et al., 2001). In large systems in South Asia, local elites 'capture' associations, as per the cases of Mollinga et al. (2001) or Reddy and Reddy (2005) or Valadaud (2021). In the case of the large irrigation systems in Morocco studied by Kadiri (2010), associations proved to be arenas for political competition. In many cases, participatory management policy has gradually evolved towards a political process: from social groups to political manipulation, with political parties tending to impose their structure on the WUA (for examples in South Asia: Menon et al., 2005; Aubriot and Prabhakar, 2011) and some WUAs not being specifically concerned with water management issues. In the case of Indian water tanks, formal tank management institutions have often been set up to only manage irrigation, but tanks are places with multiple functions (fishing, grazing, irrigation) and producing several resources (fish, fodder, palm, various trees, etc) (Reyes-García et al., 2011). This leads to conflicts with the informal tank management institution, or with local administrative units that also try to recover revenue from these locally auctioned resources (Prabhakar, 2013).

The fourth issue relates to the political agenda of this formalisation in the sense of how politics frames this type of association. What is the political construction in this phase of community-based management policies? The various examples mentioned in the present review confirm the statements made by Dressler et al. (2010) that community-based resource management has done less to support indigenous rights to resources than to facilitate intervention in keeping with free-market principles. This may be one aspect of the political construction of such policies. Through the formalising process (mandatory when infrastructures are renovated), funding agencies also attempt to bring together elements defining modernity, in keeping with Latour's (2004) objectivity, efficiency, profitability and formalism. However, this ideal of modernising water governance – with the constructions of a material, symbolic or even normative nature it embodies – has to be compared with the arrangements (as suggested by critical institutionalism), adaptations and resistances that it actually produces. The comparison therefore sheds light on what is left unsaid about development projects, about practices that are marginalised or, on the contrary, used to legitimise politics or power relations (Auvet, 2018). Through the three issues mentioned above – scale of the social unit, exclusion process and political dimension of WUAs – it is evident that 'communal irrigation' is not only a way for governments to wield a form of control over local affairs but it also defines the scale and structure of this control, as well as the type of local interlocutors for government departments. It is also a way "to avoid or subordinate alternative ways of undertaking water management" (Boelens et al., 2012: 330). From the users' perspective, there are three main reactions: those who adapt, those who don't, and those who resist. Those who adapt to this formalisation do it in various ways (including the political means seen above in the third issue). Those who do not fulfil the conditions to create a formal association then see their system collapse. One might say in a relatively simplified way that communal irrigation systems have to cherish formal participation because otherwise they perish. Thirdly, there are those who are resistant to official models. This resistance has been particularly active and has been studied in the Andes where farmers and communities defend their own ways of being and doing (Boelens et al., 2012). There is clearly a form of identification and control at stake in the formalisation process from a government perspective, but also from the users' perspective. Communal irrigation is, as it was in previous periods, an element that enables a government to shape

systems of belonging, identification, and to consolidate its authority (see also Gelles, 2012). The state's perspective thus remains the same: to control the people who manage communal irrigation systems. However, the use of normative tools based on universalistic principles can undermine indigenous rules and thus modify or destroy the irrigation systems or generate resistance among users.

Societal and environmental change: Adaptation, resistance or decline of communal irrigation systems

Since the 1990s, various changes (technical, environmental, administrative, legal, economic, social) have occurred that have had repercussions (both positive and negative) on communal irrigation systems. Several studies have investigated the way communal systems have adapted, resisted or declined when confronted with these changes. These can be categorised in three ways (given that irrigation systems may be confronted with a combination of these changes).

The first category concerns changes in development policies. These include rehabilitation policies or programmes based on participatory management that aim to formalise water management institutions (see above). There may also be projects to expand networks, creating opportunities for a change in the balance of power and wealth among the various stakeholders (Mathieu et al., 2001). Reidinger (1974) and Wade (1978) demonstrated the influence of water distribution and sharing on the choice of crops, and thus proposed irrigation as a policy instrument for changing cropping patterns. Conversely, policies advocating a type of agriculture or crop may alter the irrigation calendar, as well as irrigation practices and the relationship between stakeholders (Shah, 2003; Lansing, 2007). These various studies show the interaction between the management of crops and irrigation, and highlight the fact that irrigation management has to be studied in its broader context of agriculture and of social relations.

With the multiplication of water uses, water diversions and powerful new techniques for water extraction, the issue of water availability is no longer necessarily dependent on local management. In other words, water management problems cannot be solved at the local level alone. The integrated water resource management (IWRM) approach, which tends to promote efficient, equitable and sustainable management of water at basin level (and to cope with conflicting demands on this scale) should help, but discussion of this is outside the scope of this review. We can, however, see some of IWRM negative consequences on customary rules. For example, the European Water Framework Directive, which places at its heart the preservation of aquatic ecosystems, deeply impacts age-old irrigation systems. Indeed, in the Cévennes in France, the future of secular canal irrigation systems has in the last 10 years been challenged by the IWRM inspired water laws based on quantitative and economic logic. This leads to the idea that these canals extract too much water from the river compared with the agricultural results they provide and with the water needs in the downstream plain, without even measuring the water returning to the river. Consequently, the quantity of water they can draw from the river has been substantially limited. This case study reveals that a hierarchy exists in the various types of knowledge about water, especially between empirical hydrological knowledge and expertise using models (Collard et al., 2021). It also shows how a law based on good intentions (to prevent rivers from drying up) can negatively affect customary rights. Another example is the management of collective water bodies used for fishing in Nepal. The water policy authorises their management to be contracted out to a single person, thus preventing villagers from having access to the services provided by these ponds and undermining their informal rules, except in those villages that oppose this individual appropriation of the resource (Sarrazin, 2020). More in general, legal pluralism research shows that informal water tenures have difficulty surviving alongside formal ones (Hodgson, 2016).

The second group of changes refers to competition between sectors over a resource, and to competition between resources, especially between surface water and groundwater. Competition over water is specifically detrimental to communal irrigation when companies working in sectors such as hydropower, mining, etc.; are involved (Budds and Hinojosa, 2012). Competition between resources is a

major issue in many countries, especially where policies have facilitated the use of groundwater by means of individual pumps. An example is the huge increase of groundwater extraction in India (Shah, 2009; Unesco et al., 2015), India being the country with the largest area irrigated by groundwater. This individual pumping allows farmers to be free of many constraints of collective systems. The downside is often the wealthy farmers' disinterest in the collective irrigation system and thus gradual difficulties for users of the collective system in managing it. Pumping groundwater, or water in rivers and streams, therefore undermines collective irrigation systems (Aubriot, 2013b; Dessalegn and Merrey, 2015). A second effect of the extensive use of groundwater (by farmers or companies) is the lowering of the water table,[16] which induces a lack of groundwater availability for irrigation and also for domestic use. Such lowering dries up springs (Ayeb, 2012) or underground galleries (Mustafa and Qazi, 2007) which used to supply oases: it therefore destroys communal irrigation schemes. In all these cases, equity and access to water are impacted and challenged.

The third group of changes relates to economic and social contextual factors that contribute to modifications in management or even to the decline of community systems. These may include: economic change, such as the market-oriented economy (Cohen and Pearson, 1998; Bastakoti and Shivakoti, 2008) combined with a reorientation of the function of the water infrastructure (for example, tourism as in Reynard, 2002); population growth and changes in agriculture (Potkanski and Adams, 1998); and the development of roads with the intrusion of the market in the local economy (Kreutzmann, 2000). For some researchers (Agarwal and Narain, 1997; Palanisami and Balasubramanian, 1998), the decline of tank management institutions in India is due to the loss of social cohesion among irrigators, while for others, such as Mosse (2003a), the reason is to be found in the state-community relationship. Reasons to explain the decline or, conversely, the durability of communal irrigation systems have fuelled the entire literature.

Some systems have managed to survive, maintaining or adapting their own water distribution and network maintenance rules, while appropriating the formalism of WUAs. They have reorganised their institutions to meet institutional criteria for development (Aubriot, 2004a; Ftaïta, 2006; Riaux, 2009; Hillbom, 2012; Trottier and Perrier, 2018; Idda et al., 2021). Others have also resorted to technological innovations that came alongside a co-evolution of institutions (Badenoch, 2009; van der Kooij et al., 2015). Conversely, some communities have put up resistance and have prevented local water management from being controlled by rural elites or state actors (Boelens and Gelles, 2005). Many systems have failed or had difficulty rallying collective action, and have therefore collapsed: they are often situated in regions where they cannot compete with the use of groundwater (Ayeb, 2012; Aubriot, 2013b) or they cannot resist major changes in the socio-economic context (Cohen and Pearson, 1998; Shivakoti, 2000).

All these various water-related studies are of a multidisciplinary nature, taking into account different factors and combining technical and social dimensions,[17] and sometimes also symbolic (cf. Boelens, 2014) or religious dimensions (Cox et al., 2014). In the 2000s, several of these authors moved closer to the political ecology school of thought (Budds, 2009; Linton, 2010) which emphasises the place of politics in environmental issues, with the idea of going beyond the nature-society dichotomy. For water, the political ecology literature has coined the notions of 'hydrosocial cycle' and 'hydrosocial territory'[18] (Linton and Budds, 2014; Mollinga, 2014; Boelens et al., 2016), and 'territorial pluralism' (Hoogesteger et

[16] This environmental issue has a social impact because tube wells that tap groundwater need to be deepened (Janakarajan and Moench, 2002; Benbabaali, 2005; Prabhakar, 2013) or wells need to be closed (Jouili et al., 2013)

[17] Schoon and Cox (2011), who distinguish four types of disturbances in a SES (flow, parameter, network and connectivity), also note that biophysical and social factors are involved in each of them.

[18] The "hydrosocial territory" can be compared to the "socio-hydraulic territory" of Riaux presented above. The "socio-hydraulic" vocabulary is used by people who work alongside hydrologists, while the "hydrosocial" vocabulary relates to a longer tradition in social sciences of scholars who do not necessarily work in interdisciplinary fields but who see water as both natural and social (Wesselink et al., 2017).

al., 2016) to analyse spatially bound socio-material constructs with their process of domination and exclusion from decision-making. From a political ecology perspective, which assumes the co-construction of water and society, researchers explore the interface between globalisation and grassroots forms of resource tenure.

New communal irrigation programmes and new categories

Government projects based on the construction of small-scale and new (modern) collective irrigation infrastructures are emerging. They follow rules set by the state, as for example in Turkey (Le Visage and Kuper, 2019) or in the Philippines.[19] Here, the commons are entirely created by the state, which also defines the technology to be used and the institutions or the rules to be applied. Continuity with the concept of communal irrigation lies in the presence of a collective organisation of the community around a jointly managed infrastructure (which integrates local and community organisation dimensions as in Table 1). It no longer refers to the other aspects (use of local material and technical knowledge, customary rules, indigenous institution) involved or implicit in the other designations of Table 1. These development agency-promoted and -funded projects are part of a neoliberal era that facilitates public-private partnerships.

Some studies highlight the multiple uses of some collective water bodies that are not necessarily used for irrigation. This is the case, for example, of small reservoirs which are relatively recent (their number has increased in the last 50 years) and dot the rural landscape of sub-Saharan Africa (Venot et al., 2012; Saruchera and Lautze, 2019). Focusing on the diversity of livelihood benefits and strategies – and not only on their irrigation function or on the infrastructure – sheds light on the benefit of strengthening future investment in small reservoirs.

The ways in which binary categories (like traditional vs modern) shape irrigation policies and development projects without acknowledging the complexity of irrigation expansion is also emphasized by researchers who speak of 'farmer-led irrigation' (FLD). This expression defines the process whereby farmers are the driving force behind the establishment, improvement, and/or expansion of irrigated agriculture, often in interaction with other actors (see Veldwisch et al., 2019). Many states promote market-oriented agriculture for which irrigation is needed. In sub-Saharan Africa, many small-scale farmers invest in various types of local irrigation (furrow irrigation, shallow groundwater use, pumping from water bodies, using waste water). Until recently, these initiatives were ignored by the main irrigation development agenda (Woodhouse et al., 2017), with the World Bank now promoting FLD.[20] In Nepal, small-scale initiatives have also drawn the attention of researchers (Pradhan et al., 2015). In this new category, we note a shift towards a paradigm that values the investment of private actors and farmers' initiatives, whether individual or collective. This means that this type of irrigation is not necessarily communal (but can be) and always includes some hybrid forms of collaboration that are not purely private, public or communal (Woodhouse et al., 2017: 225). Because scale-based, community-based or state-based categories render farmer-led systems invisible, these authors suggest avoiding this polarisation and to, instead, focus on the process at work, notably who is the driving force behind the investment and innovation initiative.

Hybridisation as a common feature... and a common future?

Through this review we have seen that initially communal irrigation was defined as an indigenous and collective system with local materials and customary rights being managed by informal institutions. Then, through the colonial period and into more recent times, materials and technology changed and systems evolved. In the Andes, the long history of Spanish colonisation had modified irrigation systems even

[19] See https://www.pna.gov.ph/articles/1145179

[20] https://www.worldbank.org/en/topic/water/brief/farmer-led-irrigation-development-flid

before the 19th century (Gelles, 2012). Since the 1980s, under the influence of donors and funding agencies which impose development conditionalities to governments, village irrigation institutions had to be formalised in order to receive government assistance. Thus, the so-called state disengagement remains relative as engineers are still involved in state-implemented irrigation systems and intervene in so-called farmer-managed irrigation systems. Most communal irrigation systems therefore rely on a hybridisation process, i.e. new technology used alongside local techniques, where both communities and the state are involved[21] and have certain responsibilities (to varying degrees, according to the countries and cases). Changing the technology necessarily has implications for the institutions, as in the case of Spain when gravity systems adopted sprinkler or drip irrigation (Garcia-Mollá et al., 2020; Sanchis-Ibor et al., 2021). Hybridisation can also involve private companies, with a diversity of situations possibly emerging. Garcia-Mollá et al. (2020) show the different paths of hybridisation observed in four different cases, ranging from complete privatisation to the permanence of communal control.

Even if hybridity is a common feature, the indigeneity of historical communal irrigation systems is generally still visible in the rules (water allocation, water distribution, and/or infrastructure maintenance) and in the design of the system, even when the latter is not immutable and has evolved with society (see Shah, 2003). The social organisation (i.e. the way various functions are organised and attributed) has often changed to adopt the WUA format. For instance, in rehabilitated large-scale communal irrigation systems and large-scale state networks, the WUA structure and the new technology for diversion dams/weirs and lined canals are now quite similar. The distinction between these two types of irrigation is blurred with regard to the technical and social-organisational aspects, but the rules governing water distribution and infrastructure maintenance may still differ and leave farmers some room to apply their own logic.

Another specificity of historical communal irrigation is the sociability that has been created through water and that gives value to water sharing and use (Hoogesteger et al., 2016; Collard et al., 2021). This is based on the historical links that have been woven and negotiated over time. Indeed, water rights rely on negotiations and relations between people who appropriate the resource. But these social relations are dynamic and water rights are therefore never granted in perpetuity (Bruns and Meinzen-Dick, 2000). In the growing competition over water, water rights can be challenged, especially with current water laws that give more weight to the state, and impose a scale of management that tends to cause the decline of informal organisations.

CONCLUSION

Communal irrigation – a category rooted in the colonial era – was initially defined according to its local technology, informal institutions and customary management. Since the 1980s, it has undergone a formalisation process of its water user institutions which has allowed government to intervene not only to improve infrastructure but also to define the structure of water user associations and ways of overseeing them (recalling some 19th-century processes). This formalisation and bureaucratisation of institutions have transformed social relations not only within the groups of water users but also between the community and the state. Although communal systems are presented as self-governing, the state is in fact present, especially when it intervenes to rehabilitate irrigation networks or to define the framework of new communal irrigation programmes. It may also intervene on a legal basis – for instance, in the regulation of the volume of water allowed to be diverted into canals when certain conditions are laid out, as in the case of the European Water Framework Directive. Nowadays, the management of community irrigation systems is constrained by various laws that obscure the diversity of knowledge on the subject as well as local norms for water use and control, and the cultural relationship to water.

[21] These systems might have undergone a hybridisation process in the past, for example in their implementation, but this is not necessarily present in the collective memory and is often concealed by the FMIS category.

Multiple situations have emerged, with communal irrigation systems falling into three main groups. First, there are those that no longer function or are declining. Their users have not succeeded in coping with social (migration, urbanisation), economic (farming is no longer essential), financial (the burden of maintenance cannot be shouldered), technical (in particular, competition with individual groundwater pumping) or environmental transformations (the resource is no longer available). This does not necessarily mean that farmers can cope without their irrigation system and indeed some of them may have been left by the wayside when the communal system was abandoned. Determining who has benefitted and who has lost out due to the present series of changes in access to the resource, is an important issue. Researchers should explore the alternatives to recovering water access in the most egalitarian way possible – ideally within a participatory process alongside villagers, especially those who no longer have access to water. As pointed out by de Vos et al. (2006), the challenge is to generate a creative, proactive capacity for water management through and within local organisations.

In some historical irrigation networks users have been able to adapt to the various constraints. Some did so through technical improvements, consent to the formalisation of WUAs, acquisition of knowledge about the conditionalities (and acceptance of them) to gain access to state funding, and institutional bricolage. By contrast, others showed strong resistance to the norms established by water laws or development projects in order to protect their water rights. Within the last decade, there has been a marked decrease in the number of studies on communal irrigation. Yet it remains important to analyse how social norms and values that characterised the relationship to water in historical communal irrigation have been affected by the formalisation of the institution and the norms imposed on users, in order to understand the resistance process as well as the cultural and social elements upon which the agency of water users is founded. Moreover, since water management is always imbued with politics, studying in greater depth the local political processes involved should be useful for making policy recommendations.

Finally, some new systems are set up via development programmes and established with formal associations and imported materials. However, alongside these collective infrastructure systems, many other collective solutions are also emerging, thanks to local or external (state, NGO, via cooperation) initiatives, although they may be on a smaller scale and not necessarily integrating the whole 'community' (e.g. all the farmers in the area). Competition for water prompts farmers everywhere to find solutions to access water, either on an individual or small-group basis (often by the wealthiest farmers), or on a collective basis, which is more likely to encourage a more equitable access to the resource. Some new practices are emerging but have not yet been thoroughly analysed (with the exception of some studies on small reservoirs in Africa). Some water bodies (such as small ponds) are also relatively invisible in the literature either because they look perfectly ordinary or because – being multifunctional – irrigation is not their main purpose. Many grassroots initiatives have taken place for collective action in protecting, sharing or recharging aquifers. Some have been analysed by Zwarteveen et al. (2021) who advocate accepting (and working with) the diversity of knowledges and conceptual vocabularies. All of these technologies and practices could be further explored to gain an even better understanding of the way villagers collectively strive to adapt to their ever-evolving environment.

ACKNOWLEDGEMENTS

I would like to thank Peter Mollinga and François Molle for inviting me to contribute to this issue, which is the result of an interesting process of exchanges, notably a fruitful collaborative session where all the authors discussed the papers and provided each other with constructive criticism (many thanks to all the participants for their helpful remarks). I would also like to thank M. Kuper for his comments on a previous version of my paper. And I am very grateful to the two anonymous reviewers, as well as to Peter Mollinga, for their sharp-sighted and valuable comments that helped me to improve the paper.

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