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The moralization of hydraulics: Reflections on the normative-political dimensions of water control technology

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ABSTRACT

Strongly dominated by natural science disciplines (as civil and hydraulic engineering, irrigation studies, hydrology, climatology, and soil sciences), conventional thought characterizes water control technology as morally and politically 'impartial' – a tool to be used, a means to a desired end. In this paper we challenge this view by showing how technological artefacts are scripted or coded by human agency, social norms on right and wrong, and power relationships, and how they, in turn, 'structure' or 'mediate' the moral actions and decisions of human beings. We discuss at length what technology is, how its designs are inherently social, and how the social co-ordination of labour as well as technology's replicability are central for it to emerge and exist. Through a case study about tank irrigation in India, we demonstrate how the moral agency of maintaining a certain social order in the tank-irrigated area was delegated to technological designs of sluices, waste weirs, and other discharge structures, but also to the layout of canals, and the landscape of the command area. Precisely this delegation of the reproduction of social order to material structures allowed the sustaining of differentiated power relations over a long period of time. In conclusion, we claim that our argument has much larger relevance for the politics of water control technology, even for mega-technology such as large dams. We claim that engineers and planners not only shape material designs of water control structures but that they implicitly 'materialize morality'. In that sense, re-organizing water rights and re-distributing water resources is not merely a matter of redressing institutional policy frameworks but equally involves re-moralizing and re-politicizing the very material technological artefacts.

1. Introduction

It is a common-sense understanding that humans are social beings who think and act intentionally and morally, who have values and principles and who act based on certain understandings of right and wrong, whereas technological artefacts are objects that are passive, a-moral and instrumental. In this view, normative action and morality pertain to the domain of the human where human beings define the means to the ends, while technology as a means is merely instrumental and developed to functionally serve humankind's means. In his article "*Morality and Technology: The End of the Means*" (2002) Bruno Latour questions this classic divide – related also to modernity's dichotomist separation (purification) of society/culture and nature/technology, while he also questions the discontinuity among humans and things (Latour, 1992). In different ways, authors as Achterhuis (1995, 1998, 2001), Borgmann (1995), Ihde (1983, 1990), Winner (1980, 1993), Magnani (2007) and Verbeek et al. (2009), Verbeek (2011) have argued for the need to engage with the debate on the moral role(s) of technology itself. They ask to go beyond the modern postulate that claims that artefacts are neutral and that denies the agency and moral contents of technological systems or, as Latour (2002:255) frames it, "technologies-that-are-neither-good-nor-bad-but-will-be-what-man-makes-of-them". At the same time, they also question the simplistic assumption in the opposite direction: the threat of self-intentional futuristic technologies ("technology-that-becomes-crazy-because-it-has-become-autonomous-and-nolonger-has-any-other-end-except-its-goalless-development", Ibid.).

Some scholars argue that things themselves have morality and that

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human beings, rather than only moralizing each other, should start understanding and even directing the moralization of technology instead. Other schools argue that this is a tricky issue because of the difficulty to ascribe morality to things and artefacts that do not have mind, free will, or consciousness. The pertinent questions, however, are: how to conceptualize the moral significance of things? How to understand the ways in which technologies mediate, create, shape moral decisions and political actions of humans? The related question then is: How do designs of technology involve (include, steer and concretize) ethical/moral and political decisions? As Paul Verbeek (2011) writes in his work on *Moralizing Technologies*, "… both the use and the design of technology involve ethical questions that are closely related to the moral character of technological artefacts. How can users deal with the ways in which technologies mediate moral decisions and help to attribute responsibilities and instil norms?" (Verbeek, 2011:2).

Placed in this literature, the aim of our paper is to not only engage with how artefacts have politics – how technological designs incorporate structures of power and determine who benefits and who loses – but also how these designs have norms and morals. This is, we inquire how the distribution of power facilitated by artefacts is based on a specific social order which in turn is based on what is considered as right or wrong. By morality we mean the ensemble of intentions, decisions and actions that distinguish between proper and inappropriate, between good and bad. It refers to codes of conduct based on a body of standards or principles derived from religion or culture. Charles Taylor, in his pioneering work on the morality and sources of the selfhood, refers to the work by Wittgenstein to argue that all interpretations of rules draw upon a tacit background. Wittgenstein calls this background "forms of life" (Taylor, 1989). Our aim in this paper is to discuss how "forms of life" are technologically mediated through technologies that are shaped by and in turn shape our moral decisions and actions.

In this paper we discuss the issue of 'materialized morality' in the field of water control technology. Strongly dominated by natural science disciplines (as civil and hydraulic engineering, irrigation studies, hydrology, climatology, and soil sciences), conventional thought in these fields characterizes water control technology as morally and politically 'impartial' – a tool to be used, a means to a desired end. Problematic effects, for example of hydropower dams or certain irrigation technologies, are commonly attributed to either dysfunctional design, its non-adaptation to local realities, the social (e.g. exploitative) relationships in which the technology is used, or to the (mis)use and mismanagement of the artefact. Fundamentally, water control technology is often seen (by natural and life sciences) as a set of technical tools designed rationally and with practical functionality (or dysfunctionality) for humans, and (by social sciences) as technologically neutral means of production that are operated and owned by (or deprived of) humans in accordance with prevailing power structures and distributions of responsibilities, burdens and benefits. Characteristically, the political and moral contents of water technology and artefacts are not seen and remain unquestioned.

We argue that technology itself needs to be viewed differently. Illustrated by his fieldwork in irrigation schemes in the 1980s in Sri Lanka, Bryan Pfaffenberger argued that technology, beyond systems of material tools, is simultaneously "a social object endowed with sufficient meaning to mystify those who become involved with its creation or use. Technology, then, is essentially social, not 'technical'. When one examines the 'impact' of a technology on society, therefore, one is obliged to examine the impact of the technology's embedded social behaviours and meanings …" (Pfaffenberger, 1988: 241). Since then, a number of scholars have studied how water technological artefacts and hydraulic systems are not neutral intermediaries but actively codetermine normative morality, political structures and social differentiation in the water world (e.g., Shah, 2003; Bijker, 2007; Veldwisch et al., 2009; Bakker, 2012; Harris, 2012; Boelens and Vos, 2014; Menga, 2015; Hommes et al., 2016, 2019; Mollinga and Veldwisch, 2016; Crow-Miller et al., 2017; Swyngedouw and Boelens, 2018) and have examined the moral perceptions, behaviours, experiences and lives of water users, engineers, officials, and others (e.g., Kaika, 2006; Meehan, 2013; Perreault, 2013, 2014; Rodríguez-de-Francisco and Boelens, 2015, 2016; Strang, 2016; Sanchis-Ibor et al., 2017; Dupuits, 2019; Stensrud, 2019). For recent debates, see e.g. Melsen et al. (2018), Rusca and Di Baldassarre (2019), Hommes and Boelens (2018) and Ross and Chang (2020).

In this article we scrutinize how moral-normative and political relations among humans shape and how they are in turn shaped by water infrastructure. We claim that technical designs have 'built-in' social morals and norms that structure, among others, the ways in which systems can be operated and maintained, the way they are controlled, and the ways in which they make it possible for the water to be accessed and distributed. We engage with how water technology in turn structures organizational forms, management norms, water rights and property relations and even contributes to creating and maintaining social order. We aim to demonstrate this iterative relationship between social norms and morals and designs of technological artefacts.

Before elaborating upon the case study, in the next section we first present our methodology, followed by a section that outlines our conceptual journey. The latter discusses the notion of morality in and of technology, starting with some basic issues: what is technology; how are technological systems designed; and how are moral and political contents incorporated and expressed in the making of the technology. This will help to develop a better understanding of the role of water control technologies in co-shaping or mediating social order. This is illustrated with an Indian tank irrigation case study in the fourth section. In the final section we present our discussion and conclusions.

2. Methodology

The research is based on academic and grey literature research, participatory observation, semi-structured interviews with water users, hydraulic engineers and water governance officials. It uses 'technography' to understand how technology shapes everyday life and serves a certain purpose (cf. Jansen and Vellema, 2011). In terms of methodology, before, during and after our case research we have extensively examined the academic, grey and policy literature on the social and political contents of technology. This included a revision of the conceptual debates on the politics of water and of hydraulic infrastructure, and extended to the (inter-)disciplines of political ecology, governmentality studies, science-and-technology studies, anthropology of technology, political geography, and the fields of natural resource governance and interactive technological design. After laying the first literature-based groundwork, we engaged with our conceptual questions through a case study of small dam ('tank') irrigation technology in South India. Our first extensive field research on this case was done in the years 2000–2002 for 3 months twice, totalling 6 months. We had extended follow-up fieldwork periods shorter in duration in the years 2010–2011 and 2017–18. In these periods, fieldwork consisted of numerous open-ended conversations, semi-structured interviews, and focus group discussions with all key actors in the tank command area that comprised farmers from all social groups – including the elite and landed farmers of Hindu religion and higher caste and the marginal farmers from Lambani and Muslim background. We had also extensively interviewed farmers holding land in different parts of the atchkat, including in the wet land in the head and middle parts and in the tail end– this is explained further in the paper. We had multiple interviews with several present and past members of Irrigation Committee and Irrigation Organisation. The fieldwork also comprised of extended on-the-location observation of technical artefacts on a regular basis. In addition, regional policy-makers and hydraulic engineers from Minor Irrigation Department and PWD were interviewed several times. During these fieldwork periods, ethnographic and participatory observation and notepad annotation was our permanent practice. The fieldwork was followed by new state-of-the-art literature research, and drafts of this article were discussed with academic peers: to scrutinize and develop, in particular, the recent theoretical debates on the social and political construction of technology.

3. Conceptual background: technological designs and moralizing scripts

In this section we present a conceptual frame to understand the meaning of technology in the first place, and then show how technological artefacts are designed and, in the process, 'moralized' by incorporating norms and standards that support particular forms of social life.

3.1. The notion of technology

There have been many attempts and perspectives to develop a more comprehensive definition of technology separate from science. Generally, three layers of meaning have been attributed to technology. At the most basic level, technology refers to sets of physical objects or artefacts. Secondly, technology is referred to as human activity as much as an object. Thirdly, technology refers to what humans know (knowledge and skills) as well as what they do; hence technology is knowledge of the practical arts (MacKenzie and Wajcman, 1985, 2-3). Definitions that include an anthropological perspective relate technology to material activities. For instance, Pfaffenberger (1992, 497) provides two definitions of technology, one restricted and the other inclusive of social dimensions. The restricted definition ("technique") refers to technology "as a system of material resources, tools, operational sequences and skills, verbal and non-verbal knowledge, and specific modes of work condition that come into play in the fabrication of material artefacts", similar to MacKenzie and Wajcman's extended notion. The inclusive definition of technology for Pfaffenberger, which he calls the sociotechnical system, refers to "distinctive technological activity that stems from the linkage of techniques and material culture to the social coordination of labor" (1992: 497). In this understanding, techniques and artifacts are an integrated material component of the social coordination of labour in shaping human adaptations to the natural environment. Hence, he suggests that the social anthropology of technology should include all three aspects: techniques, sociotechnical systems and material culture. In this definition, technology is inherently social as without the social coordination of labour it cannot come into existence. Complementary to this understanding is how the social construction of technology occurs whenever one set of meaning gains dominance over the other and wins expression in the technical content of the artefact (Pfaffenberger, 1988, 240). A technology is thus, "hardened history or a frozen fragment of human and social endeavour" (Noble 1986 as quoted in Pfaffenberger, 1988: 240).

Sigaut (1994: 424) presents a related anthropological perspective when defining techniques "… first of all as actions, next they are material actions in the sense that they all make a material change in something, and finally, they are not simply material, they are intentionally material" (Sigaut, 1994, 424). Again, the intentionality involved in the materiality of technology makes it inherently social. We follow Pfaffenberger and Sigaut in their description of the technology-society relationship. However, technology is not only made of social coordination or labour, but it exists because it is replicable. As Pfaffenberger (1988: 241) points out, "no technology can be said to exist unless the people who use it can use it over and over again". That means that technology exists because it is reproduced and associated technological behaviours replicated. A similar point is also reflected in Sigaut's definition of technology. According to Sigaut, technology, by definition, exists to make a material difference in something. In Sigaut's definition materiality does not only centrally constitute technology but also human intentions. Human intention to produce material change is what shapes and defines technology. The materiality and intentionality in Sigaut's definition firmly embeds technology in social action. Finally, Noble's definition of technology in which technology is formed when the dominant meaning finds an expression in the content of the technology, attributes social and power relations a pivotal role in shaping technology.

What already becomes clear in such understanding of technological systems is that they are neither material, social or symbolic only but all at once rendering the common boundaries among 'nature', 'technology' and 'society' obsolete. These boundaries, in fact, need to be seen as products of human minds, social conventions and actively constructed reality (Goldman et al., 2010; Harris, 2012; Swyngedouw, 2015; White, 1995). In technology, natural, material and social orders do not simply 'influence' each other but mutually *constitute* each other as also argued by other scholars (for example, technology as hybrids (Anders, 1988), as actor-network (Latour, 1991, 1994), as naturecultures (Haraway, 1991), and as seamless web (Hughes, 1990, 1983)).

3.2. Designs

In engineering disciplines, conventionally, design is defined as an idea about an artefact non-textually represented, for instance through a drawing or a set of equations, a visual or mathematical expression (Ferguson, 1993). In this concept of design, an idea about an artefact precedes the artefact. Although in the real world design may not always be done by expressing an idea on paper, what is nevertheless important about this definition is that a certain degree of 'imagination' of an artefact precedes the making of the artefact. The conventional conceptualisation of designing is also reflected in Papanek's (1997: 4) somewhat unconventional definition of design as: "the conscious and intuitive effort to impose meaningful order. The conscious and intuitive effort may involve imagining an idea about an artefact and representing it. But what Papanek calls "imposition of meaningful order" through designing is what makes designing a purposive and intentional action aimed at solving a problem or achieving an outcome. However, as Ferguson (1993: 3) comments, the intentionality behind a design as well as underlying choices, judgements and assumptions are often times concealed in the conventional engineering representation of design on a drawing board. This can be problematic when considering that designers usually intend to solve a problem "that has no single right answer but many". Hence the act of designing involves making choices and taking decisions based on certain assumptions and judgements about the world. The process of designing, thus, involves an idea and a non-textual representation thereof, as well as specific choices, decisions and judgements.

Whereas in the disciplines of industrial engineering or architecture designing is generally carried out by a group of professionals, more commonly and widespread designing may actually be carried out by other, non-expert actors. This is certainly true in the case of water control technology like the small water control dams (irrigation tanks) discussed in this paper, a majority of which were not only constructed several centuries ago, but moreover largely constructed, used and managed by local artisans and farmers. In such a context, designing does not involve a straightforward process of translating an idea into an artefact. Rather, it is the outcome of complex, extended sociotechnical processes of trial and error where the imagination of an artefact is in many cases based on already existing artefacts. As Pfaffenberger (1992:500) observes, "any sociotechnical system shows the imprint of the context from which it arose, since system builders must draw on existing social and cultural resources" – resources that they modify to face new challenges. Therefore, designs are not one-time effort, they emerge, change and evolve over a long period.

Concerning the process of designing, we consider the following issues of importance here. First of all, the act of designing that puts technology together is intentional. It implies devising to produce material difference in order to serve a function, to achieve an intended outcome or to impose an order. This human intent to shape the material makes the process of designing inherently social. Secondly, designing involves a process or an act that translates an idea about an artefact into an artefact. The translation requires several judgments and choices to be made based on several assumptions. Thirdly, the process of designing generates patterns of outcomes such as an artefact with certain physical properties, along with a rule or a certain type of social arrangement that ensures a certain use and management of the artefact and consequently reproduces it. In the process of reproducing the technological designs, the rules, roles and social arrangements are also reproduced. Thus, technology exists because it is reproduced. And fourthly, designing involves applying various types of knowledge that are socially generated and held – technical and scientific knowledge generated and held by professionals as well as other types of knowledge such as those generated by local artisans, farmers or water user communities (Geels and Kemp, 2007; Shah, 2008, 2012; Obertreis et al., 2016).

3.3. Technological script or code and the morality of water control technology

The concept of technical code, associated with Langdon Winner (1986, 1993) among others, and the notion of script used by Latour (1992) and Akrich (1992), can further help decipher the causal link between social relations of morality and technological designs. Akrich (1992: 209) states that, "the world inscribed in the object is the world described by it." This means that for Latour and Akrich technologies are products as well as producers of social life. Devices and artefacts for Latour are non-human characters delegated to discipline humans and/or perform tasks. Devices and artefacts do not simply replace human labour or effort but also take over the task of ordering, guarding and ensuring the moral and ethical aspects of human behaviour, which in the absence of the device or artefact would have to be in the form of verbal or textual instructions (Latour, 1992: 225-34). In the absence of devices performing certain tasks, a morally loaded textual or spoken message would be needed to make humans confirm to such intended behaviour. For instance, imagine the type and extent of textual information that would be needed in the absence of a traffic light at a busy juncture to regulate traffic. The devices thus confirm the moral behaviour of users and create an order. Latour compares devices with text that builders and/or users inscribe in a similar way to how authors and/or readers script a story. By scripting a device, the builders/users delegate the task of maintaining a certain order to non-human characters/devices. Devices do thus not only contain delegated functions but also duties, ethics and values (Latour, 1992: 232). This is what Papanek (1997: 4) meant by saying that designing imposes an order. This delegation of ordering tasks to technological systems of artefacts and prescribed uses is often an automatic and silent process, concealed and naturalised. One of Foucault's understandings of "governmentality" stems from this thinking about sociotechnical ordering: "Government is the right disposition of things… …. the complex composed of men and things..." (1991:93. See also Lawhon and Murphy, 2012; Boelens et al., 2019; Hommes et al., 2019).

That artefacts are coded to (re)produce a certain social order is also argued by, for instance, Langdon Winner. In his now famous article "Do artefacts have politics?" (1980) he showed how the bridge to access Long Island was designed with a lower height to keep away the buses that would have transported especially black and poor people. The design was thus coded with racial prejudice. The technological code silently took over the political and moral task of discriminating between who should or should not be allowed on the beach. Despite critiques challenging deterministic codes and suggesting alternative uses of coded artefacts (e.g., Woolgar and Cooper 1999; Joerges, 1999) and technology's "interpretive flexibility" (Bijker, 2007), Winner (1993) convincingly argued that the process of technological development is inherently political because it determines who is allowed to co-design and who is excluded. For water control, this made Mosse (2008:941) observe that "… technologies of water control of all kinds are 'political technologies' – that is, ways of social ordering that themselves influence how people work, relate or produce over long periods" (see also Jasanoff, 2006; Boelens and Gelles, 2005; Mollinga and Veldwisch, 2016; Aubriot et al., 2017; Paerregaard, 2017; Paerregaard and Andersen, 2019; Wesselinck et al., 2017; Menga and Swyngedouw, 2018).

Therefore, we focus on how the task of maintaining social order is delegated to artefacts whose designs are coded in a certain moral fashion and how reproduction of the coded designs helps reproduce the social order. This makes it crucial to analyse the technology design process, which takes place under conditions of social interactions, institutional interests, and political contradictions, guided by extending networks of human and non-human 'actors' and the inscription of norms and 'codes'. As Latour argues, artefacts do not just 'reflect' society, "they are in large part the stuff of which the social fabric is made" (2000:109). Clearly the 'mission' of the technology (what it *should* do once it is put into operation) bears a significant moral cargo. Moral design or the moralization of design relates to this Latourian idea of delegating human morals to artefacts and technological networks.

As is the case in any sociotechnical system, also water control artefacts do not just facilitate or replace human labour but also replace people's textual or verbal instructions for how to 'manage' a water system in the 'right' way. Morally loaded messages are inscribed in the water technological designs to create social and political order: hydraulic engineers, economic planners and irrigation system builders make choices, judgements and assumptions and by that means delegate functions, duties, ethics and values to the water management artefacts. Moral obedience acquired through 'scripts' (Latour, 1991), 'codes' (Winner, 1980) or the 'mode d'emploi' (Lacroix, 1981; Van der Ploeg, 2020) and the implicated power relations are, however, often concealed. The politics of water system design and management are naturalized. Artefacts or sociotechnical assemblages, as 'hardened morality', aim to enforce particular ethical and political behaviour. As Callon argued, "engineers transform themselves into sociologists, moralists or political scientists at precisely those moments when they are most caught up in technical questions" (Callon, 1991:136).

Irrigation system design is a moralization process *par excellence*. For example, designers' canal layouts establish where to conduct the water to and who *not* to give water; canal capacities and gate openings establish maximum water flows allowed to be taken and create norms that reward top-enders and harm tail-enders; the design of control structures, cross regulators, gates, keys, distribution boxes and anti-robbery locks aim to prevent stealing and automate proper distribution; and hydraulic blocks and schedules require particular forms of organization and distribution. In short, through its designs the technology has built-in water rights, management forms and water control norms that create and maintain social order and reproduce social relations.

Water control technology, indeed, is and fosters a set of normative meanings and political behaviours but renders this social facet largely invisible, as if it were 'just' material tools. The moral messages and social relations from which the technology arises, in which it is embedded and which the technology in turn produces and stabilizes, are hidden behind a veil of neutrality. This lends particular force to how intervention schemes and modernization projects may seek to governmentalize diverse territories. Since the standards that determine how irrigation systems should function are not based on any existing universal truth but on historically and politically driven morality, making technology's moral contents 'natural' and 'invisible' through technological scripts hides and potentially strengthens relations of power and domination. As Pfaffenberger remarked: "Behind the neutralizing veil of technological modernization, parachuting new, externally-developed socio-technological systems induces not only new artefacts, but also a new world of social relations and myths in which definitions of what 'works' and is 'successful' are constructed by the same political relations the technology engenders…. Creating a 'successful' technology also requires creating and disseminating the very norms that define it as successful" (Pfaffenberger, 1988:249-250).

We now discuss a case study from South India to illustrate this general theoretical discussion on the moralisation of water technology.

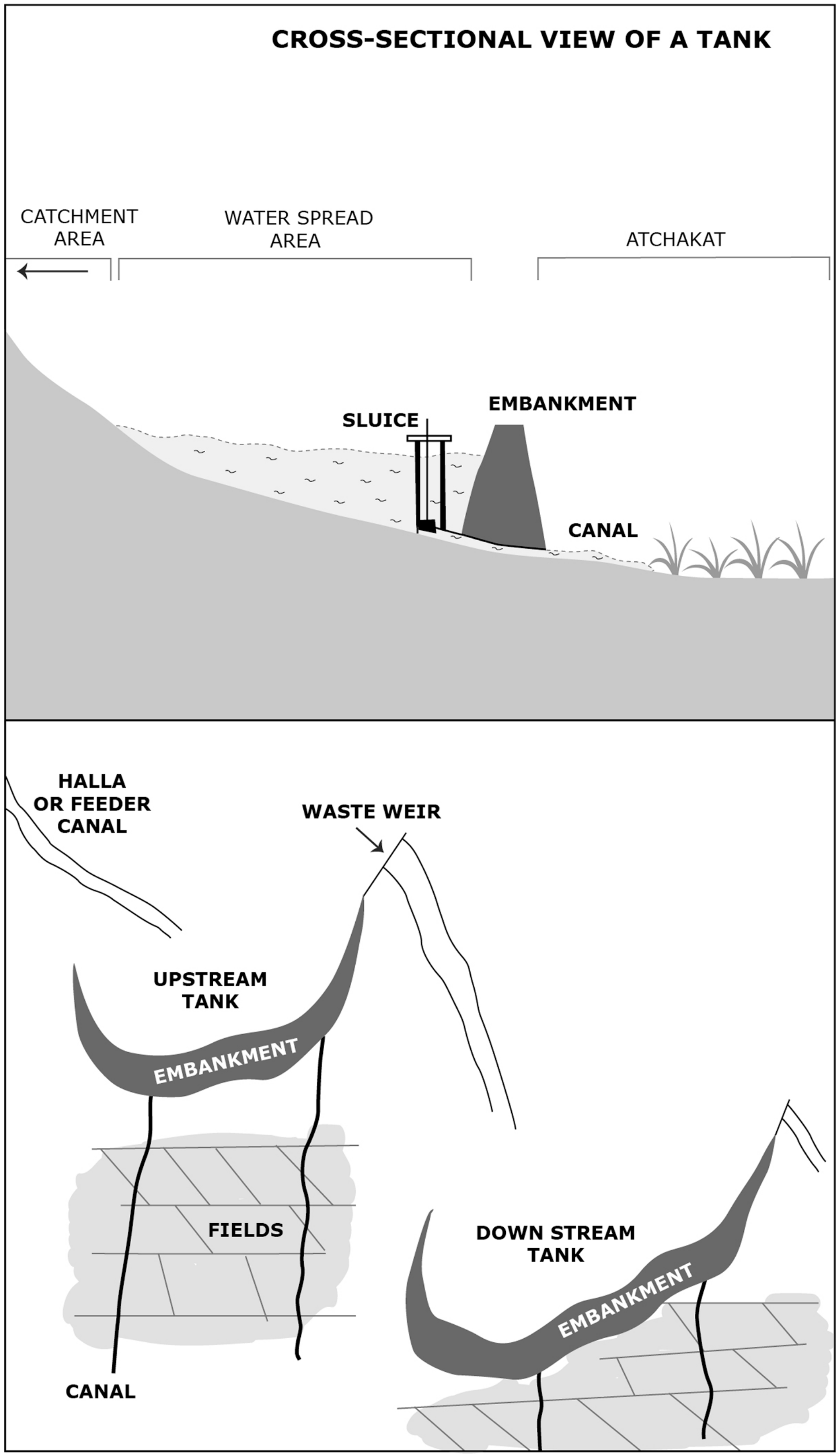

Fig. 1. The Technical Principle of Tanks (not to scale).

4. Morality of technology: a case study of tank irrigation in South India

4.1. The context

We aim to further explain the moralization of technology through the exploration of a case study of a particular tank located in the state of Karnataka in South India. Technically, a tank can be described as a miniature version of a large dam. Water is impounded behind an earthen embankment to be released through sluices into canals to be further distributed to irrigated lands. Excess water from a reservoir is allowed to escape through waste weirs. Fig. 1 gives a schematic diagram of the technical principle of tanks. Tank embankments are usually semi- circular or irregularly curved in shape. They could be a few hundred meters to a few kilometers long depending upon the shape and size of the valley they are bridging. Tanks usually receive water from a seasonal drainage channel (locally known as *halla*), a seasonally flowing tributary or a canal supplied from a river. They are almost never constructed directly on perennial rivers.

Tank irrigation in south India is a several centuries old technology Tanks are known to have existed even in 300 B.C., but large scale tank construction activity in south India dates back to around 700 A.D. (Gurukkal, 1986). Scattered all over south India there are thousands of tanks, irrigating anywhere between 10 and 1000 ha. The number of tanks built in the British and post-independence periods is almost negligible compared to the number of tanks constructed during the previous centuries. For instance, the majority of existing tanks in a federal state as Karnataka - approximately 38,000 – are several centuries old. In the current context, they irrigate roughly 19 per cent of the state's net irrigated area and hence are a significant source of irrigation especially in the dry regions where no other form of irrigation is available (Vaidyanathan, 1998: 6–7).

A considerable policy and academic interest in the tank irrigation and practices started to emerge in the 1980s in India as a part of the larger debate on the merits of modern vs pre-modern water management practices and technologies. This happened in relation to the much wider critique of the model of development adopted in India since independence. To put this in the wider historical context: in the first two to three decades after independence in 1947, India was put on the path of modernity based on the belief of first Prime Minister Nehru that the dream of Indian progress, high-tech way, was realizable. Nehru famously called large dams and nuclear power plants the modern temples of India (see also Khagram, 2004; Boelens et al., 2019; Shah et al., 2019a). In the first two-three decades after independence India thus adopted a policy of high-tech infrastructure-driven, centralized water management policy through the construction of large dams and canals that were also created to support the newly introduced high-input driven green revolution agrarian paradigm (Mollinga, 2003). The dream of high-tech modernity started to be shattered in the 1980s in the times of widespread political unrest. The rise of anti-nuclear energy and anti-large dam movements raised serious questions regarding increased inequality and injustice caused by the adoption of such high-tech modernity as development model.

In this political context of the critique of modernity, a considerable policy and academic interest in the pre-modern and pre-colonial (also known as traditional or indigenous) water management practices started to emerge. During this period, a large number of studies documented these practices (e.g. Agarwal and Narain, 1997). It is in this discourse of hailing pre-colonial and pre-modern technologies as hegemonic alternative to modern technologies that the pre-colonial irrigation technologies of tanks were praised as a commendable example of the cultural and environmental superiority of traditional knowledge (Mosse, 2004; Shah, 2008). Retrieval of this lost tradition and rejuvenation of community institutions to manage tanks became central pillars of the policy and practices of tank rehabilitation and development programme highly funded by the World Bank and European Union. Among critiques of the violence of modernity, the concepts of local, indigenous, traditional, pre-modern, and Eastern knowledge found wide currency. These forms of knowledge and practice were claimed to be substantively, epistemologically, and contextually superior to modern science and technology. At the same time, scholars also freely associated them with other desirable traits, such as decentralization, democracy, bottom-up planning, egalitarianism and even self-organizing spontaneity (Shankari and Shah, 1993; Sengupta, 1993; Reddy, 1991; Mukundan, 1996).

These policy and academic discourses, however, uncritically made pre-modern knowledge systems and artifacts into reified objects of virtue irrespective of their social and historical location. We show, however, how tank technological designs may have been constructed by relations of power in both pre-modern and modern socio-cultural contexts (see also Mosse, 2004; Shah, 2003, 2008; Bijker, 2007; Hidalgo-Bastidas and Boelens, 2019). This paper studies one such tank located in the semi-arid region of the state of Karnataka to show how the designs of tank technology inculcated morals and political choices made by the different actors involved.

4.2. Morally scripted water control technology: tank designs in Karnataka

The hydro-technological tank development of the case we discuss here started around 600 years ago. Now, it is one of the important tanks in the state of Karnataka, India located in a semi-arid environment with an average annual rainfall of 600–650 mm (See Fig. 1). The tank provides irrigation to at least 560–600 ha; because it is located in a hard rock area there is no other form of surface or ground water irrigation available. Farmers here formed an Irrigation Organisation which appointed its Irrigation Committee in charge of water management.

The land irrigated by the tank is owned by individual farmers from different caste and ethnic backgrounds. As we discuss in detail later, historically the higher caste Hindu farmers have owned the best cultivated land whereas farmers from the castes of Lambani and Muslim religious backgrounds have owned inferior land in the command and tail-end areas. This land tenure pattern, however, is now changing and farmers with lower socio-economic backgrounds have come to outnumber land owners due to farmers from higher caste and socio-economic backgrounds moving out of agriculture. The cropping patterns are mixed and shift from year to year; main crops grown are sugarcane and paddy for both consumption and commercial purposes. Also dry crops such as groundnut and millets are grown again for both consumption and selling in the market.

The tank embankment is 2625 m long with a maximum height of 7.96 m. The water-submergence area is 404 ha. The tank receives water from a combined catchment of roughly 120 square kilometres. The tank has very simple water discharge structures that in fact have maintained a sophisticated regime of water regulation over a long historical period – the reason why this tank is an insightful case for studying the morality of technology.

The tank has five waste weirs and two sluices marked as W1-5 and S1 & 2 respectively in Fig. 2. The way these waste weirs and sluices are designed and located in the embankment ensures automatic regulation of water discharge that does not need much of human intervention: as we discussed in the introductory section these designs are coded or 'scripted' with intentions (Akrich, 1992; Latour, 1992; Winner, 1980). To understand this moral scripting, we need to look at two separate scenarios: 1) when the tank has received water beyond the full-tank level, 2) when there is not sufficient water in the tank. The way in which the technological assemblage of the waste weir and different sluices function largely determines how irrigation is organised in the command area. Below is a detailed description of the technological designs and the purpose they serve and how they impose meaningful order (Papanek, 1997:4).

When the tank has received much water and overflows, two waste weirs on the extreme edges (W1 & W2) discharge water at the same time. Next, two other waste weirs (W3 & W4) start functioning if the

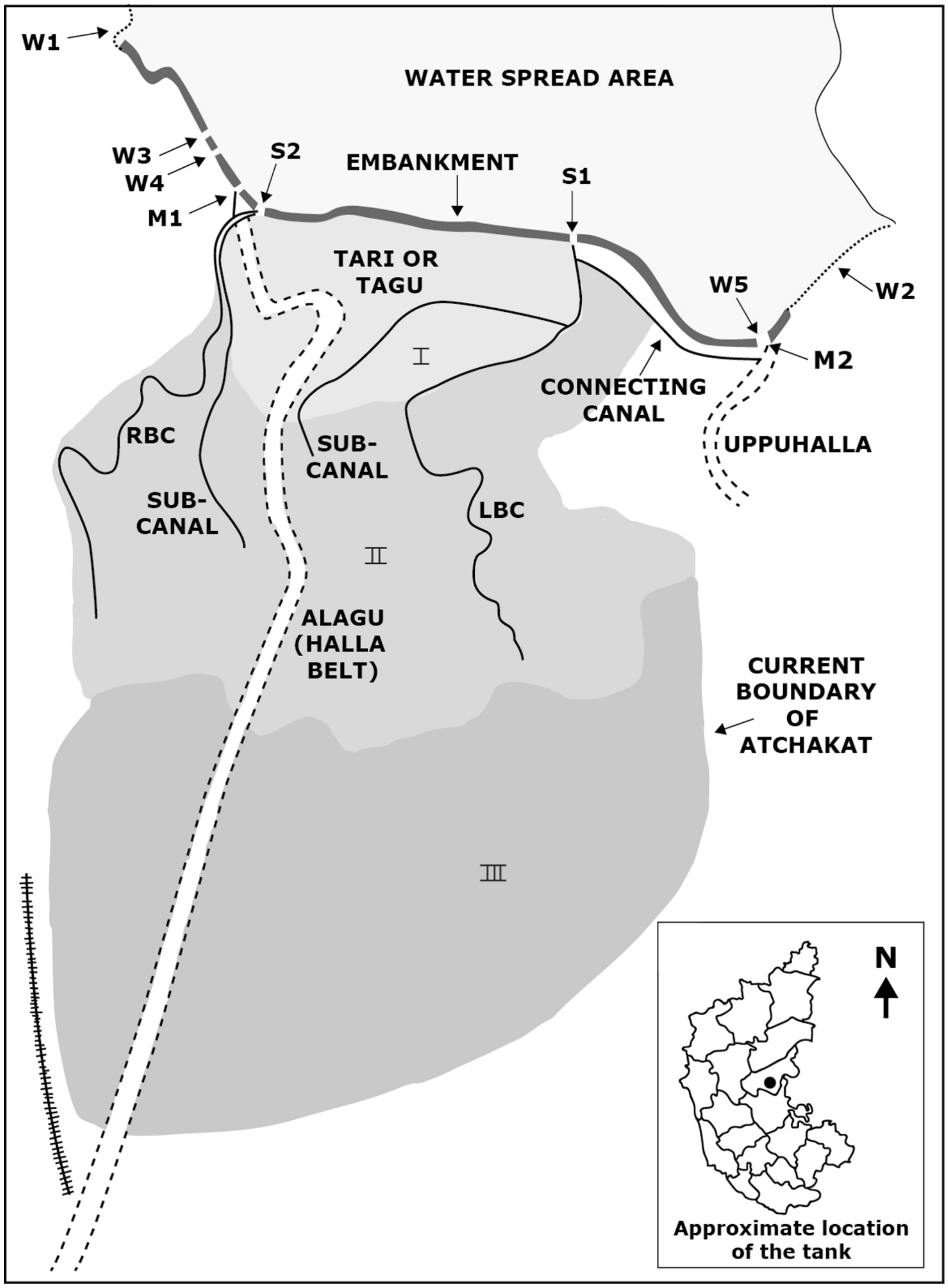

Fig. 2. A schematic map of the atchakat and approximate location of the tank.

tank collects more water than can be discharged by the W1 and W2 waste weirs. At this point – when the tank is overflowing – none of the other discharging mechanisms (including sluices) are operated and both Right Bank and Left Bank canals receive water only from the waste weirs. In the next possible scenario – the tank is not overflowing but still has received water up to the full tank level – the two flood gates located in the structure of the waste weirs come into operation: the fifth waste weir (W5) has a floodgate (M2), known as *madaga* in the local language, which is connected with the Left Bank Canal, and another one (M1) located on the other side of the embankment is connected to the Right Bank Canal. When the tank is full but none of the waste weirs are discharging water, i.e. at the full tank level, both sluices are submerged. At that time the *madagas* – the floodgates – can be lifted to supply water to the Right Bank and the Left Bank canals. Both sluices are operated after the *madagas* stop discharging water. So the sequence of water supply in the irrigated command area from the full to the lower tank level is as follows: when the tank is full first the waste weirs W1-2 on the extreme edges without flood gates discharge water; at a lower level of water in the tank the waste weirs W3-4 become operational. At the water level lower than that, the waste weir W5 is operated by lifting the flood gate to supply water to the Right Bank Canal (RBC), just as the flood gate *madaga* M1 is lifted to supply water to the Left Bank Canal (LBC). Next, both sluices become operational only after the water in the tank is lowered further. These designs of tank discharging structures ensure automatic functioning, which, fundamentally, codes and organizes the expected moral behaviour of the cultivators (Verbeek et al., 2009; Verbeek, 2011).

As we already mentioned, the tank supports mixed cropping of paddy, sugarcane and groundnut during the main irrigation season that begins in November or December. Mixed cropping implies a discrepant need of quantity and timing of irrigation water and hence is more likely to create conflicting situations. The crucial question that arises is who is permitted to cultivate which crop when water is enough only for some to cultivate paddy or sugarcane. Surprisingly, it is not the Irrigation Organisation and Irrigation Committee that establish the collective's moral-political water distribution rules. Instead, these moral decisions are embedded in the designs of the hydraulic infrastructure of the tank and the cropping pattern (Verbeek et al., 2009, Winner, 1980).

The tank generally receives water up to full tank level between early July and mid-October or latest by November and December. According to farmers, the tank overflows once only in three, four or even seven years. The cropping pattern in the command area is adjusted according to three possible scenarios of water availability in the tank: 1) If the tank fills up to a level which results in waste weirs and *madagas* overflowing, irrigation is invariably provided to everyone. 2) If the tank fills up only to the full tank level, water is enough for cultivation of partial wet and semi dry crops for a period of nine months. The Irrigation Organisation then becomes active and irrigation is provided according to the rules laid down for mixed cropping of paddy and non-paddy crops. This is the only instance where the Irrigation Organisation becomes active. 3) If the tank receives less water than that of the full tank level, water is not released for irrigation. The tank usually receives water every year for the mixed cropping for the period of three to six months. This means that rather complicated decisions about which cropping pattern can be followed have to be carried out every year depending on the storage maintained from the previous year and the level of storage received in the current year.

During one of the initial discussions we had with the members of the Irrigation Committee, they explained that if by the second week of December the tank would be at least half full, a meeting of all farmers is called and as per the rules each farmer would be given instructions about the cropping pattern and rotation schedule. They also informed that there was a high degree of rule adherence in the irrigated area (known locally as *atchakat*) and that conflict free water distribution was achieved for more than two decades, as they would say, 'because of the management by the Irrigation Committee and Irrigation Organisation'. Members of the Irrigation Committee also informed that rules about water distribution and cropping pattern were even written down.

On hearing this, we requested them to show the written rules. We were hoping to read at least a couple of pages of written rules with a number of contingent conditions. It was an anti-climax when after a couple of days of searching, the members showed a one-line written in the Irrigation Organisation's minute book of 1992. The sheer length and simplicity of the rule was astonishing given the fact that we had expected a labyrinth of rules dotted by a complex combination of 'ifs' and 'buts' given the complicated rotation schedule that might be necessary for the mixed cropping pattern in the *atchakat*. The magic line in the minute book read, "all farmers are allowed to grow whatever they want, but paddy would be given water once in 8 days, sugarcane once in 15 days and groundnut once in 15–20 days." Later, several farmers told us that there was nothing new about this rule except that it was penned down. The elderly farmers recalled that the rule had been in operation for at least two generations and many surmised that it must have been applied for many more generations.

The written rule did not provide much insight into how a certain mixed cropping was sustained in the command area when the tank did not receive enough water for all farmers to grow wet crops. Since the rule allows all farmers to grow whatever they want, all farmers simply may plant paddy or sugarcane and demand irrigation once in eight days for which the tank would not have enough water. The rule, therefore, looked as if it was insufficiently framed to cover all possibilities of cultivation in the tank command area. Nevertheless, it eventually proved key to understand how one line can make everything (seemingly) fall in place: the morality of the rule and its adherence were scripted on the technology, and imprinted on the landscape of the command area – not written on paper. The particular social and historical context had shaped the command landscape layout in such a fashion that a one-line rule was enough for an 'orderly' water distribution and rotation pattern that determined the morality of water control – who should or should not receive water. Below we show how scripted designs of the technology not only took over the moral task of maintaining order in the *atchakat* but that the same designs also reproduced social relations of power in the tank area over a long period of time. A technology is thus not only the earlier cited "hardened history" or the "frozen fragment of human and social endeavour" but it is an outcome of extended social and technical processes (Pfaffenberger, 1992: 500).

4.3. The landscape of the command area has a history

The following table gives an overview of the land ownership, cropping patterns and irrigation practices in the command area, discussed in the text:

Name of land	Type of soil	Irrigation Need	Cropping pattern	Land-owning pattern	Irrigation charges
Alagu	Fine upper crust, sticky, clayey soil suitable for paddy	The whole command drains in this part so a higher degree of moisture is always available	Two or three crops of paddy + sugarcane	Historically this part of the *atchakat* is owned by high caste Hindu farmers	No irrigation charges are levied
Tagu or Tari land	Sticky clayey soil suitable for paddy	Receives sub-surface moisture and always receives irrigation	Paddy + Sugarcane	Historically this land is owned by higher caste Hindu farmers but farmers with lower socio-economic background are numerically now dominant	No irrigation charges are levied
Valadi or Bagadi land (Khushagi land)	Red sandy soil	Requires irrigation every day	Groundnut + Hybrid millets	Mixed landowning pattern, with Lambani (a lower caste) and Muslims (marginal socio-economic background) are numerically dominant	Irrigation tax is paid to the Irrigation Organisation and also to the Minor Irrigation Department

Various parts of the *atchakat* are known by different names; each refers to a distinct type and nature of soil and level of fields. As shown in Fig. 2, the middle patch in the *atchakat*, marked as II in Fig. 2, is called *alagu,* which is the original path of the seasonal rivulet that supplies water to the tank. Around 20–24 ha are *alagu* land. This part remains under water when the waste weirs are discharging. The entire *atchakat* drains into the *alagu*. Hence, it always has seepage cum drainage water when the *atchakat* is irrigated. Even when the tank has not overflowed for several years, this part may still have enough moisture to cultivate sugarcane by lifting water manually from small dug out ponds. Farmers with land in this part of the *atchakat,* invariably cultivate two or three crops of paddy when irrigation is provided for one season and sugarcane when irrigation is not provided. Practically no other crop can grow here. During the irrigation season, the lands in this part do not need irrigation as drainage from both sides of the *atchakat* would be more than necessary. Hence, these lands are not part of the rotation schedule imposed by the Irrigation Organisation, nor do the landowners here pay any irrigation charges collected by the Irrigation Committee.

The land situated at higher level than the *alagu* land is called *tagu*, which means (paradoxically) lower level land – this is marked as I in Fig. 2. This land receives sufficient seepage from the canals when irrigation is being provided in the *atchakat* and during the time of heavy rain. When the tank has water at full tank level, this part stays wet; i.e. it receives subsurface moisture. Otherwise, it receives irrigation once in eight days as per the rules, but in reality more often than once in eight days (as discussed later). The landowners of this type of land pay irrigation charges to the Irrigation Committee. The type of soil here is sticky clay, which is considered especially suitable for paddy. The nature of the soil in this part – upper crust fine, black and clayey – compared to red and mixed sandy soil in the other parts of the *atchakat*, suggests that paddy must have been cultivated here for a long period, perhaps for several centuries. This type of land is also called *tari* or paddy land. Much of this land is located close to the embankment, although some patches exist all over the *atchakat*. There is around 100 ha of *tagu* or *tari* land.

The *atchakat* slopes from the sides towards the middle. LBC and RBC run on the higher contour at the edges of the *atchakat*. The land in the tail end of the LBC was brought under cultivation about several decades ago. A group of farmers displaced by a dam constructed nearby – mostly Lambanis (a lower caste that historically do not own land) and Muslims (another socio-economically marginal community) – extended the then existing left bank and right bank canals, cleared the land and started cultivating it. This type of land marked as III in Fig. 2 is called *valadi* or *bagadi* land which is at a higher level than tagu or tari and alagu land. This type of land has red sandy soil. Water cannot stand for more than a day on this land and hence this land is considered suitable only for groundnut and hybrid jowar (a local millet). Irrigated paddy is rarely grown on it because it would need water almost every day, which the rotation schedule does not support. The Minor Irrigation Department and the Irrigation Organisation call this land as *khushgi* land (marked as III in the Fig. 2) and charge a higher amount of tax than for the tagu and alagu land. That is because as per the official position of the Irrigation Organisation, khushgi land is the land for which no payment of water tax to the Revenue Department is made. The Irrigation Organisation charges a higher rate for this land because the MID does not recognise it as 'localised' or 'naturalised' atchakat. The localised atchakat is that part of the actual atchakat that is officially recognised by the Revenue and Minor Irrigation Departments. The landowners of the localised atchakat are registered with the Revenue Department and are supposed to pay water tax.

The riddle of how mixed cropping is managed in the atchakat with the help of a one-line rule can be partially solved now. The privileged, continuously wet alagu and tagu or tari land (which is part of the localised atchakat, the most favoured land historically), is the finest quality of paddy land in the atchakat located close to the embankment in the head reach and receives considerable seepage and irrigation, (officially) once in eight days. This land has become suitable for paddy cultivation because it was favoured for irrigation during all the previous historical regimes. This land can cultivate paddy with less frequent irrigation compared to other land in the atchakat. Paddy cannot be grown on valadi or bagadi land if irrigation is not provided every day. Jowar and groundnut are grown on this land, which receive irrigation once in 15–20 days. The khushgi land, as the in-between category, is prone to a serious identity crisis. Lower level tari (tagu) land belonging to the khushgi category exists in the tail end of both RBC and LBC. Although this land should, according to the rules, receive irrigation once in eight days, tail end farmers on the LBC side have to go through several rounds of negotiation among themselves and with the Irrigation Organisation in order to receive adequate supply of water during the peak season.

These historical scripts are also the codes that moralise the technology because they support and reproduce historically contingent landowning patterns and access to irrigation, and correspondingly create and maintain agrarian structure and order in the socio-technical context of this tank. This is how technological codes takes over the task of maintaining the social order (Jasanoff, 2006; Winner, 1980). If we look at the landholding pattern in the atchakat: Out of the 71 higher caste farmers holding totally 42 ha in the localised atchakat of 203 ha, 58 (82 percent) hold 26 (62 percent) hectares of prime paddy land located either in alagu or in tagu. That means that the majority of higher caste farmers hold prime paddy land – and this is going on for several generations. However, we found in the last two field work visits in 2011 and 2017 that the lower caste farmers increasingly not only possess, in aggregate, a higher amount of land in the localised atchakat than higher castes, but they also now possess a higher amount of land even in tagu and alagu. That means that numerically they dominate landholding in the tagu, tari and alagu – the prime paddy land in the atchakat, which is not a sign of power relations shifting in the atchakat, but related to the fact that the higher caste farmers are increasingly moving out of agriculture making it possible for the lower and disadvantaged class farmers to acquire more land. Putting it differently: almost all higher caste farmers own prime paddy land, whereas the numerical strength of lower castes farmers owning prime paddy land has been increasing over the last decade. In other words, most of the favourable paddy-growing patches belong to a majority higher caste and some lower castes farmers, whereas the non-favourable, non-paddy patch is entirely owned by lower castes.

Whose agendas then influence the formation and functioning of the Irrigation Organisation and Committee? Actually, the paddy growing farmers – historically from the upper castes, but now also from the lower and backward castes – are favoured by the technological scripts and by water distribution practices. Even the rotation schedule during irrigation seasons is implemented by keeping the need of paddy growers at the forefront. Paddy growers from various caste and class backgrounds share the best part of the atchakat, benefiting from the water distribution rules. These benefits are morally legitimized because they are entangled with the material technology. Paddy growers emerge as a particular script-favoured category, now cutting across traditional caste and class boundaries. Technology has thus dissolved traditional boundaries that determined resource distribution and has created its own. This is why we think that creating institutions with higher representation of marginal groups, though necessary, may prove insufficient to ensure democratic utilisation of the resources. Discriminatory distribution practices are also mediated and institutionalised through technology. We argue that a fair and just distribution of the resource can hardly be achieved unless the designs of the technology are understood and, if needed, adapted or transformed to support correcting the bias.

4.4. Key-spanner and night irrigation

As we discussed above, technology not only organised rule adherence but also created conditions for a relatively conflict free environment. One can hardly blame the physical structures for being partial. And if the scripted designs are inherited through generations, it is even more difficult to do so. This, however, does not mean that designs do not change or cannot be re-scripted. As per one of the definitions of technology we discussed, social construction of technology occurs when one set of meaning gains dominance over the other and wins expression in the technical content of the artefact (Pfaffenberger, 1988: 240). This shift in the dominant meaning by which the designs are scripted also signifies a shift not only in the moral social order so maintained by the technology but in the power relations of the social organisation. This imposition of meaningful order makes designing purposive and intentional action (Papanek, 1997; Verbeek, 2011). We discuss below how this scenario of change occurred once the key-spanner was introduced to operate sluices in the tank.

The operating mechanism of the sluice was reconstructed in the 1970s by the Public Works Department (PWD). The plug and pole type of sluice (in which a plug attached to a long wooden pole was used to seal the sluice aperture) was replaced with an operating mechanism fitted with a gearbox, and a threaded iron rod was provided for a precise opening of the sluice. Prior to that, the sluice was opened only with the permission of the influential farmers of the village and after some social and religious rituals were performed. During the irrigation season, at that time, the technology did not permit easy lifting of the sluice. The water-watchman and other skilled farmers had to dive to lift the plug under considerable water pressure when the tank was full. At that time, the operating mechanism of the sluice had a social lock and key. Although technically it was possible to open the sluice even when it was socially not permitted – apparently, two people can lift the handle of the pole from one side and insert a stone in the plughole to partially open the plug – this operation was fairly tricky and risky and cannot be performed easily without a large number of people knowing about it.

After the PWD replaced the plug and pole type of sluice, opening the sluice became as easy as turning a spanner, i.e. the key, in order to lift the rod located in the gearbox. This iron artefact, now, embodied power and was scripted with different morals than the one supported by the previous design of the sluice. The key-spanner now holds the place of power. There have been disputes about where the key spanner should be kept at the end of the irrigation day. The balance of recognition of power in the village has to some extent been inverted with the entry of this technological artefact. Now, whoever acquired the possession of the key-spanner attained a recognisable status in the village. This elevation of status may not stop only at a membership in the Irrigation Committee; it may possibly result in acquiring a party ticket for the local village level (panchayat) election too.

The change in the recognition of power is not the only change the key-spanner has brought. The provision of the gearbox and rod type of sluice-operating mechanism with a key-spanner theoretically made it possible and provided the opportunity for anyone to open the sluice easily and candidly. The possibility that the sluice can be easily opened presented an opportunity to those who are at the receiving and marginal end and not favoured by the layout of the atchakat and the distribution canals. This new design of the sluice was scripted with an opportunity to challenge the power-laden moral order maintained by the previous design of the sluice. Here, one type of social order established with one form of moral technology was countered or challenged with another – potentially threatening the entire social order.

The latter illustrates how designs and artefacts of tank technology changed and performed within the web of tension generated by relations of power, authority and discrimination. The above discussion further shows that when a particular, historically specific form of rule formation supports and perpetuates unequal distribution of power and resources through a certain set of technological designs, their moral authority is not without contestation (Winner, 1993; Bijker, 2007; Duarte-Abadía et al., 2019).

5. Conclusion

In this paper we have argued that water control technology does not play a neutral role but artefacts are scripted or coded by human agency, social norms, practices and power relationships. Therefore, we sustain that technological designs of water control technology are also political-legal and social designs at the same time. “Any behaviour that is technological is also, and at the same time, political, social and symbolic. It has a legal dimension, it has a history, it entails a set of social relationships and it has a meaning” (Pfaffenberger, 1988:244). To put it differently, as Verbeek (2011:16) argues, “in our technological culture, humans and technologies do not have separate existences anymore but help to shape each other in myriad ways…”.

Technological artefacts are thus scripted or coded by human intentions and therefore they, in turn, ‘structure’ or ‘mediate’ the moral actions and decisions of human beings. They provide ‘material answers’ to the moral question of how to act. As we demonstrated in our case study, the moral agency of maintaining a certain social order in the tank-irrigated area was delegated to technological designs of sluices, waste weirs, and other discharge structures of the tank, but also to the layout of canals, the atchakat landscape and cropping patterns. This social order shaped by differentiation in power relations persisted over a long period of time because the agency to reproduce them was delegated to the material structures. As David Mosse describes it, “… influential or richer farmers can ensure that it is their rights that are fixed in permanent concrete structures, such that the technology itself (the design of weirs, sluices or field layouts) is able to do the work of social differentiation…” (Mosse, 2008:944 referring to Shah, 2003).

We therefore argue that technological objects must be seen as part of the moral community in the sense that they help to shape morality. This means that the moral agency is a matter of human-technology hybrids rather than an exclusively human affair (Verbeek, 2011:42, 17). We propose to move beyond the predominantly modernist understanding of the relations between subjects and objects in which subjects are active and intentional and objects are passive and mute. We show not only that human intentionalities can be operative ‘through’ technologies but also that, in many cases, ‘intentionality’ needs to be located in human-technology associations—and therefore partly in artefacts as well.

However, we must also clarify that we do not intend to argue that technologies are moral agents in themselves. Following Latour and Vermeer, ‘in themselves’ entities are quite meaningless in any case—they are given a script, a code, a design – a moral character – in relation to and as part of the human social organisation in which they function. And at the same time, they help to constitute this social organisation and its social relations, in specific sociotechnical configurations—enabling and supporting the moral character of our actions and decisions. The technological artefacts are then also the arena for struggle and negotiation. Technical design criteria of technological artefacts are tools to defend, modify, contest, challenge, to attain a set of social relations and social order that will favour or not a specific set of interests of a specific societal group. As we demonstrate in our case study, installing a new design of the sluice that can be easily operated with a key spanner redefined, facilitated and reconstituted an entire set of social power relations in the local agricultural and irrigation context.

The illustration also shows that the scripting of the moral designs of the artefacts is not ‘set in stone’. They are sites of contestations, and vehicles or articulations of choices made by dominant actor groups in particular socio-technical networks. Struggles and social change often lead to re-scripting and redesigning this set of meanings so inscribed on the artefacts, configuring a new social order. In other words, technology designed or imposed by a particular dominant group in a particular socio-historical context is not an omnipotent force.

Our argument also has a much larger significance for the politics of water control technology, even for mega-technology such as large dams. We argue that engineers and planners not only shape material designs of water control structures but that they implicitly ‘materialize morality’. For instance, different from ‘traditional’ small dams or tank systems, mega-dams are commonly designed, constructed, and implemented under top-down governors’ rule, technocrats’ knowledge, and capitalist investment practices. Such hydraulic infrastructures are characteristically presented as if based on monolithic technical consensus and unidirectional engineering. However, Atkins (2018), Boelens et al. (2019), Duarte-Abadía et al. (2019), Hoogesteger and Verzijl (2015) and Hidalgo-Bastidas and Boelens (2019), among others, show how those who are affected by these water interventions, and eventually governed by the changes brought by them, often dispute the forms of knowledge, norms, morals, and operation and use rules embedded in mega-hydraulic engineers’ designs. They discuss a number of cases of large dams from all over the world to illustrate how social movements’ protests may deeply influence the moralization of large dams’ technological artefacts. They conclude how large dam designs are shaped by the power interplay among those who govern and those who are governed (Shah et al., 2019b).

In the end, the study of how water technology is actively moralized in terms of contents and process offers important understandings for the struggle to re-orient water policies or even to de-colonize the symbolic and political orders of water governance. It appears that re-organizing water rights and re-distributing water resources is not merely a matter of redressing institutional policy frameworks but equally involves re-moralizing and re-politicizing the very material technological artefacts.

CRediT authorship contribution statement

Shah and Boelens: Theoretical design and conceptualization. **Shah:** Fieldwork. **Shah and Boelens:** Analysis and manuscript writing.

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