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Making the Megaproject: Water Infrastructure and Hydrocracy at the Public-Private Interface in Peru

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ABSTRACT: To meet an increasing industrial and urban demand for water in a context of water scarcity in Peru, the state has invested heavily in hydraulic megaprojects to ensure water supply to citizens and corporations. The Majes Siguas Special Project (PEMS) in the Arequipa Region is an example of such a water infrastructure project. While the first stage of PEMS, built in the 1980s, was financed and run by the Peruvian government, the second stage that is currently underway is being co-financed and built by a private transnational consortium that will run the infrastructure for 20 years. This can be understood as a process of temporary commodification of the water infrastructure and places the hydraulic megaproject at the heart of tensions between seeing water infrastructure as public utility and seeing it as private provision. This article asks how this tension between public and private is played out in practice within the hydraulic bureaucracy and examines ethnographically how the Majes Siguas Special Project is made over time by way of the everyday practices of experts. The study finds that these experts anticipate the potential political effects of temporary commodification of water infrastructures to be both a risk and a distinct possibility. The article argues that building, maintaining and managing hydraulic megaprojects are far from straightforward processes, but should instead be understood as open-ended experimental reconfigurations that the hydrocracy deals with through contingent practices of knowledge.

KEYWORDS: Megaprojects, water infrastructures, public-private partnerships, build-operate-transfer (BOT) model, temporary commodification, hydrocracy, expertise, Majes Siguas Special Project, Peru

INTRODUCTION: HYDRAULIC MEGAPROJECTS AS A LENS TO UNDERSTAND CONTEMPORARY WATER GOVERNANCE

Water scarcity is a historical problem in the arid coastland of Peru where the majority of the country's population lives, and contemporary climate change threatens to exacerbate this situation. To make things worse, continued urbanisation and the growth of the mining and agricultural industries increase the demand for water. To meet these challenges and ensure water supply, the Peruvian state has not only implemented new water legislation since 2009 but has also developed new hydraulic megaprojects and extended existing ones. One such megaproject is the Majes Siguas Special Project (PEMS) in the south of Peru. It is an irrigation infrastructure that was first built in the 1980s and is now being extended, which captures water in a dam in the highlands and brings it via canals and tunnels through the Colca and Siguas valleys to the Majes and Siguas plains near the coast, where it irrigates farmland.

Water megaprojects thrive in Peru (Mills-Novoa and Taboada, 2017) and in the rest of the world (cf. Crow-Miller et al., 2017; Boelens et al., 2019). Historically, they formed the basis for state formation and centralised power (Wittfogel, 1957). They were initiated and provided by the state as a central part of nation-building and modernisation processes, and were enacted by experts on water infrastructures who together constituted a hydraulic bureaucracy, what Molle et al. (2009) have labelled a 'hydrocracy'. Governments around the world have long considered the need for regulation of the common good of water to be justification for a strong state role in water management and investment (Meinzen-Dick et

al., 1997: 18, cited in Benedikter, 2013: 12). However, hydropower and irrigation megaprojects became deeply controversial in the late 20th century because of their negative social and environmental impacts and due to disputes among proponents and opponents. Nevertheless, despite international criticism and a drop in funding for water infrastructure at the time (Molle et al., 2009: 338-339), hydraulic megaprojects have currently recaptured their prominence worldwide. Rising awareness about climate change and the desire to find paths towards a new green economy have contributed to this resurgence of hydropower facilities, helping to frame hydraulic megaprojects as greener alternatives to other forms of energy production (Boelens et al., 2019: 4-5). In Peru, hydraulic megaprojects are especially relevant in the context of irrigation and drinking water provision, not least in dry areas like the Arequipa Region. While the megaproject is a particular contemporary form of water provision, Peru has a long history of providing water through hydraulic works that have been propelled by public, corporate and community actors (cf. Bakker, 2007). The Inca Empire and even earlier civilisations are famous for their sophisticated canal networks, which took advantage of the numerous rivers and glacial lakes, and of gravity resulting from the vertiginous drop of the Andes (Regal, 1970; Reyes-Knoche, 2012). The building of dams with mortared stone walls had already begun in colonial times (Priale, 2003), and in the 19th century, modern concrete water infrastructures consisting of dams, tunnels, canals, weirs, traps and inlets were designed and built for irrigation, hydroelectricity and drinking water services, often – as in the rest of the world – by private actors (cf. Molle et al., 2009; Benedikter, 2013: 15). By the 20th century in Peru, as elsewhere, government had taken over building hydraulic infrastructures, and numerous public works were built throughout the country (Priale, 2003). With the 2009 water law, the Peruvian state has begun actively encouraging the participation of the corporate sector in public water megaprojects.

A megaproject refers to any large-scale, long-term, complex and high-cost infrastructure for services such as transportation, telecommunications, energy or water supply. Their particular features include material construction that physically impacts their surroundings, planning and construction over the course of many years, the requirement of large economic investment, and being publicly initiated by governments (Altshuler and Luberoff, 2003). However, unlike earlier megaprojects that were publicly funded and operated, today they are increasingly created and managed through so-called public-private partnerships (PPPs). One type of PPP is the build-operate-transfer (BOT) model in which private actors build the infrastructure, operate it for a number of years, and then transfer it to the state that commissioned it. I argue that the hydrocracy is shaped in various ways by the BOT model – a process which involves 'temporary commodification' of infrastructures during which they exist as owned assets that are publicly traded, before finally being transferred to the public authority that commissioned them. In the past, when hydraulic megaprojects were publicly funded and operated, the hydrocracy was made up of public experts. Today's megaprojects (developed as PPPs) now also engage experts from the private sector as concessionaires and supervisors, involving them at all phases of the project from funding and design to the actual management. This makes for a more heterogeneous form of hydrocracy. I base the argument on a study of the PEMS that involves three public and private actors: 1) the public agency AUTODEMA (*Autoridad Autónoma de Majes*), 2) the transnational private consortium Angostura Siguas SA, and 3) an independent consultancy firm called Nippon Koei LAC. The public agency AUTODEMA was set up by the Peruvian Government in 1982 to run the PEMS and operate its infrastructure built in the first phase. Since 2004 AUTODEMA is governed by the Regional Government of Arequipa. The second phase is now being developed in collaboration with the second actor, Angostura Siguas SA. This private firm will build the extension of the infrastructure – including a new dam, a new tunnel, and new canals – to irrigate additional land. It is estimated that the construction will take four years, and that once the extension is finished the consortium will take over the daily operation of the entire infrastructure and run it for 16 years before transferring it (back) to the Regional Government of Arequipa. Nippon Koei Ltd, the third actor, is supervising this public-private collaboration. Contemporary hydrocracies are thus more diverse than they have been in the past.

The growing prominence of public-private hydraulic megaprojects in Peru as a response to the country's water crisis warrants an empirical investigation of their social organisation under the premise of temporary commodification. This article uses the PEMS as a case study to examine how the hydrocracy – with its multiple actors – plans and manages this large-scale water infrastructure through their daily practices. It also makes sense of the megaproject at the interface of the state and the market in the provision of water to the public.

A hydraulic megaproject can be conceptualised as a material and organisational infrastructure that enables water to be captured, transported and delivered to its users. From a political-ecological perspective, hydraulic megaprojects are approached as a matter of power relations and water (in)justice, and are seen as being founded on what has been termed the 'Dark Legend of UnGovernance', or 'UnGov Legend' for short (Boelens, 2015; Boelens et al., 2019). This refers to a modernist narrative of the megaproject as development and progress of the nation. In order to become compelling, water authorities not only frame megaprojects as coherent and benevolent solutions to deep crises, but also depict local water users and their ecologies as disorganised, irrational and unproductive. According to this theory, the UnGov Legend enables national and international mega-hydraulic policies and state- and market-based water laws that neglect the existence of multiple hydrosocial territories and the realities and practices of local populations. Rather than designing their mega-hydraulic plans to meet the needs of the water users, the hydrocracy – that is, the experts who run the project – force water users to adapt to their projects (Molle et al., 2009; Benedikter, 2013). The top-down imposition of such plans tend to produce continuous 'disencounters' between experts and water users instead of mutual resonance and shared understanding of the issues at stake (Stensrud, 2019). While this perspective brings relevant light to the social and environmental effects of the asymmetry in the power relations between experts and water users, it does not tell us much about hydraulic megaprojects as such. My research thus offers a distinct vantage point from which to understand the nature of hydraulic megaprojects by studying them ethnographically, that is to say looking at them from within and from the actors' points of view, and thereby unpacking the relations of interdependence between the public and private actors that constitute this hydrocracy. Thus, instead of taking the infrastructure and its expertise as a given, I argue that they are socially made through everyday discursive and material practices enacted by both public and private experts. I will draw on anthropological literature that explores infrastructures as being sociomaterial rather than objective facts, that considers hydrocracies as dynamic realms rather than homogeneous entities, and that sees experts as individual agents shaped by their professional background and personal views rather than rational and neutral actors.

The ethnographic material on which this study is based stems primarily from fieldwork within the realm of the PEMS, conducted over three months in 2016 and 2017. I studied the social history of the project, its current management of the existing infrastructure built in the 1980s (PEMS I), and the planning of the extension that is yet to be built (PEMS II). I undertook participant observation among public authorities and at sites of the actual and planned water infrastructure and conducted 19 semi-structured interviews and numerous unstructured conversations with public and private experts working on the megaproject. I also carried out archival research in the archive of the public agency AUTODEMA and in three private archives of former workers at the PEMS. During the entire period of the research (2016-2018), I followed events to do with the project through email correspondence with interlocutors and through mass-media reports.

In this article I propose an anthropological perspective on hydraulic megaprojects in order to understand how they work from within and what this implies for Peru's water crisis. I do this by depicting three empirical cases within the PEMS, in which I analyse the responses of experts to the multiple challenges related to this infrastructure and its management. The first case focuses on time, and on how the PEMS strives to materialise 'historical futures' and long-standing dreams of prosperity in the region. The second case deals with planning and describes how the experts 'make way' for the forthcoming extension of the water infrastructure and its concession through the organisational practices of meetings

and documentation. The final and third case addresses uncertainty, and how the experts manage 'tunnel trouble', that is, how they operate and maintain existing infrastructure that has deteriorated over 35 years of use. Given the scale and complexity of this kind of megaproject, I make no claims to being exhaustive in the choice of case studies. I want to argue, however, that each of the three cases demonstrates important aspects of hydraulic megaprojects and is worthy of attention. Focusing empirically and theoretically on the hydrocracy's making of contemporary large-scale water infrastructures will enhance our understanding of megaprojects as emergent phenomena at the public-private interface, and of their implications for Peru's water crisis. In what follows, I will develop my theoretical stance.

ON INFRASTRUCTURES AND HYDROCRACIES

Infrastructures are commonly defined as the basic material structure of an organisation that is necessary for its operation. Modern infrastructures also inform contemporary social organisation and are thus anthropologically relevant objects of analysis from which ethnographic scrutiny of their everyday material practices that constitute them can speak to larger issues in society (Lowrie, 2014; Harvey et al., 2015: 1; Anand et al., 2018: 4; Hetherington, 2019: 6). As Appel et al. (2015) suggest,

> By attending to the formation, maintenance, and breakdown of roads, water pipes, or electricity grids in everyday life, we can ask how infrastructure helps us to theorize key anthropological questions about aspiration and imagination; about modernity, development, and temporality; and about the production of states and markets, the public and the private.

From an anthropological perspective, infrastructures are approached as sociomaterial relations of connectivity (Larkin, 2013; Strang, 2016), and are analysed by way of 'infrastructural inversion', an idea developed by Bowker (1995). The latter term suggests a figure – ground reversal, that is, to bring the infrastructure – often considered to be the hidden backdrop to social action – to the foreground in order to study what it does to social action. This analytical approach draws attention to the everyday hidden and unnoticed work done by infrastructures. Harvey et al. (2015: 3-4) have pointed out that this inversion can become analytically less productive in cases where infrastructures are all but hidden and unnoticed because they suffer regular breakdown, have collapsed, or are presented as political spectacles because then they are already at the foreground and noticed (cf. Larkin, 2013). However, as these scholars underscore, infrastructural inversion refers mainly to mundane daily operations, while infrastructure-as-spectacle is about display to society. Based on the case of the PEMS, I would add that the same infrastructure can be simultaneously in the background and the foreground, albeit at different scales and degrees depending on whose vantage point and at what moment. When ordinary people in Arequipa talk about the Majes Siguas, they normally are referring to the hydraulic megaproject as a whole, which is a result of the government's publicising of it for decades as a spectacular development project in and for the region. Local water users living along the existing tunnels and canals in the highlands and those at the receiving end of the infrastructure in Majes plains, see it as the backdrop to their daily irrigation activities and refer to it simply as the Majes Canal, the Majes Siguas irrigation project, or simply Majes (cf. Brandshaug, This Issue; Paerregaard, This Issue; Stensrud, This Issue, 2016) Similarly, to the people in the highlands who have recently received offers to sell their land to the Regional Government to make way for the extension of the infrastructure, or those who have applied for jobs in its construction, the 'Majes project' is not yet a tangible infrastructure, even though it is positioned in the foreground of their lives because of the multiple material and social ways it already affects them. To all these categories of people, the *making* of the megaproject and of its infrastructure is taken for granted and hence placed in the background as long as it works and makes water run smoothly and abundantly. Even in extraordinary times, when the hydraulic infrastructure is threatened by breakdown and thus comes to the foreground because the water supply is at risk, neither the water users nor the citizenry at large have access to the entire infrastructure or appreciate its full complexity. By contrast, to the experts who are the focus of this

study and who make the megaproject work, the infrastructure in its different parts and dimensions is at the centre of their everyday practices, both in ordinary times and at times of crisis. At the same time, the particular scale and complexity of a contemporary hydraulic megaproject such as the PEMS places certain dimensions of the project in the foreground for every one of the actors. By conducting an infrastructural inversion and examining the experts' practices and encounters as constitutive of the infrastructure of the PEMS, this study sheds new light on the way hydraulic megaprojects enable the supply of water as a form of temporary commodification.

For these purposes, I draw on the conceptual definition of infrastructures as "extended material assemblages that generate effects and structure social relations (…) through engineered (…) or non-engineered (…) activities", as elaborated by Harvey et al. (2015: 5). The differentiation between engineered activities (planned and purposefully crafted) and non-engineered activities (unplanned and emergent) points to a tension that is relevant in the context of hydraulic infrastructures. Hydraulic works – that is to say, most modern infrastructures – are tightly coupled and highly interdependent systems that are intrinsically embedded in particular landscapes and are made of constantly deteriorating materials (cf. Carse, 2014). The design, planning, projection and building of infrastructures are never straightforward and are seldom undertaken from scratch. New designs must consider existing configurations, and infrastructures are rarely used and operated as planned (Harvey and Knox, 2015; Jensen and Morita, 2017). Plans are re/produced by new actors, and track records of past plans are lost. Jensen and Morita (ibid) have begun to conceptualise the material assemblages to be open-ended experimental systems. By using the terms open-ended and experimental they want to highlight the element of surprise and the unplanned consequences of any infrastructure. They also want to draw our attention to the emergent character of infrastructures from design to building and their forms of use due to the complex interaction of historical, geographical, political, economic and technical conditions, resulting in "a largely unpredictable set of infrastructural reconfigurations" (ibid, 2017: 619) that need to be dealt with through contingent practices of knowledge (Harvey and Knox, 2015: 90-100). As we shall see in this article, the PEMS is a good example of infrastructural reconfigurations on a long-term and large-scale level of the megaproject as well as in the daily micro-practices of management.

As mentioned in the introduction, hydraulic infrastructures give rise to hydrocracies (Molle et al., 2009; Benedikter, 2013) – or "work-site animals" as Ribeiro (1994) labels them – that is, particular epistemic communities of experts who are in charge of designing, negotiating, planning, building, operating and maintaining such infrastructures. As members of epistemic communities, they enact their expertise through practices of socialisation, authentication and institutionalisation (Carr, 2010; Boelens et al., 2019: 11), as much as through abstract reasoning, material engagements with nonhuman elements, and social interaction with other epistemic communities (cf. Carse, 2014; Harvey and Knox, 2015; Anand, 2017; Whitington, 2018). The hydrocracy concept often refers to engineering expertise (cf. Molle et al., 2009; Wester et al., 2009; Benedikter, 2013). This profession, for obvious reasons, abounds in such settings and consists of many different branches ranging from hydraulic and structural to chemical and environmental engineering, which creates epistemic diversity and a range of different skills within the profession. In the making of the PEMS, large numbers of experts representing many different professions are mobilised and thereby constitute the hydrocracy of this particular megaproject. The experts range from high-ranking officials to construction workers, all of whom are experts and carriers of particular skills. These include architects, economists, lawyers, sociologists, biologists, environmental scientists, human resource specialists, communication managers and secretaries, as well as technicians, drivers, mechanics, and guards. While many of these experts have worked on the PEMS for decades, there are also plenty of staff who only are temporary hires who do specific tasks, both in the daily operations of the existing water infrastructure and in the planning of the PEMS II. The latter constitute a form of precariat (cf. Standing, 2014) within the hydrocracy of the PEMS. AUTODEMA has technical staff stationed at different sites of the existing infrastructure, that is, at the Condoroma Dam and the Tuti and Pitay intakes in the highlands and at the irrigation grid on the Majes plains. The three principle organisations

involved in the current development of the second stage of the project, the PEMS II, have their staff placed at different sites. The consortium's headquarters is located in Peru's capital of Lima while its main office, where their technical, legal and economic experts are based, is in Arequipa city, conveniently close to the administrative and technical offices of AUTODEMA and to the offices that the supervising company Nippon Koei rents in the historical Cayma District. This description of the PEMS professional profile serves to underscore the diversity that characterises its social world and to show that this megaproject is assembled in many different public and private realms which shape it in different ways. In the following three sections, *Historical futures*, *Making way*, and *Tunnel trouble*, we shall see how this hydraulic infrastructure is made by way of rituals, legal documents, knowledge practices and social interactions at the public-private interface.

MAKING THE MAJES SIGUAS SPECIAL PROJECT

Historical futures

The *Proyecto Especial Majes Siguas* is a hydraulic infrastructure and a long-standing regional development project in the Arequipa Region that has been declared to be of national interest. Already in the early 20th century, engineers and politicians envisioned transferring river water from the Colca River watershed to the Siguas River and using this water to transform the desert plains of Majes and Siguas into fertile land which would spur economic growth and progress for the country (Stensrud, 2016: 573). Detailed studies were undertaken in 1912, concrete project plans were carried out in 1946, and new studies and plans were made in subsequent decades. The first feasibility study for the project was originally prepared by the US-born Peruvian engineer Carlos Sutton in 1964, and was followed up by geological and hydrological surveys by the Majes Irrigation Commission and local consulting firms (Maos, 1985). The Italian firm Electroconsult, of Milan, prepared detailed plans in 1968. The project was framed as an Integrated Regional Agricultural and Energy Development Project with the objective mainly of stimulating the regional economy. The idea was studied and analysed several times, but it did not materialise until the 1970s when the military government of Juan Velasco Alvarado (1968-1975) created what was at the time one of the world's most expensive irrigation projects, with a total investment of US$630 million, 35 percent of which was financed by the Peruvian state and 65 percent through international loans (Stensrud, 2016: 573).

The Majes Siguas Special Project (PEMS) was divided into two stages. The first stage of the project, the Majes Siguas I, or PEMS I, was built between the years 1974 and 1982 by the international Majes Consortium (MACON), which comprised engineering firms from Sweden, Spain, South Africa, Canada and England. Between those years, MACON built the Condoroma Dam, the Tuti and Pitay intakes, and the Colca-Siguas adduction (101 km of tunnels and canals) that lead the water from the highlands to the Majes plains, as well as the irrigation grid that is used by its farmers. In addition, the consortium built roads and camps, some of which are still in use. Conceived and implemented at the time of Peru's land reform (1969-1979), the purpose of the Majes Siguas project was to spur development for the whole region. Hence, it was framed as a project that would create employment and economic activities based on agricultural and industrial production. It focused on the development of small-scale agriculture, offering plots of land to families from the region who settled in the desert, so-called *colonos*. PEMS I was completed in 1982 and, once the water began to arrive at the pampa of Majes, these first colono settlers started to work the land that had been allotted to them (Stensrud, 2016: 574). Today, 15,000 hectares of the Majes plains, irrigated through the Majes Siguas system, produce a variety of crops, mainly alfalfa that is used as fodder for cattle and dairy cows in the region (Stensrud, 2016: 578). Crops like aji pepper and artichoke are also grown for export, and potatoes, corn and legumes are produced for the regional market (Pacheco, 2009: 24). Currently, 120,000 people are estimated to live in the town of El Pedregal and in the entire Majes District (Stensrud, 2016: 582). Since the inauguration of the water infrastructure

in 1982, it has been operated and administered by AUTODEMA, which was for many years an autonomous public agency under the Ministry of Agriculture until it was passed to the Regional Government of Arequipa in 2004.

Figure 1. Layout of the *Proyecto Especial Majes Siguas* I and II (source: Portalfruticola.com).[1]

Due to economic and political problems in the country, the second stage (Majes Siguas II or PEMS II) – which is now underway and promises to double the water supply capacity – was not actualised until 2006, by which time the premises of the project had changed. Still considered a regional development investment project in the interest of the Peruvian nation, it was now framed as an agro-energy project oriented towards high-tech agribusiness and hydroelectric production. The focus was no longer on small-scale farming, but rather on the production and exportation of industrially grown crops and hydropower. The PEMS II comprises the extension of the existing water works, and is to be built in two phases, first the Angostura Dam and the derivation tunnel in the highlands, and then the irrigation grid that will enable the development of 38,500 hectares of new land in the Siguas plains and 7000 additional hectares in the Majes plains. In addition, two hydroelectric components are planned, as well as roads and services to support the future city on the Siguas plains that is also envisioned (Field notes, January 2016, August 2017).

In contrast to the first stage, the PEMS II is organised as a public-private partnership. It will apply the build-operate-transfer model, which, as described above, is a concept of privatising infrastructure that was introduced already in the 1970s (Tam, 1999: 377). In general, it implies that a private actor – a concessionaire – is responsible for financing, constructing and operating an infrastructural facility to

[1] https://bit.ly/2iWVLER

supply the public. In return, the concessionaire has the right to generate revenue from the facility for a specific period of time until the facility is transferred to the grantor (normally the state). In line with this model, the PEMS II was launched through public procurement in 2006. The transnational consortium Angostura Siguas, comprised of the Spanish firm Cobra and the Peruvian firm Cosapi, tendered a bid and won the contract. The contract was signed on 9 December 2010, and has been amended several times. According to this agreement, the Peruvian government and the private consortium are to share the investments fifty-fifty. The consortium will be paying off the investment through the collection of water fees from users over 16 years of operation, starting once the extension is in place. In contrast to PEMS I, the economics of the second stage are based on the premise of industrial agriculture for which big land lots of at least 200 hectares have been planned. The Peruvian state currently auctions off these land lots in the Siguas plains to finance the government's loans for the project. At the time of the agreement in 2010, the megaproject was estimated to cost approximately US$400 million. By May 2018, however, the estimated cost had increased to over US$600 million due to various technical changes made by the consortium to optimise profits, and because of the delays caused by the project's many political, juridical and organisational issues. Social and political protests in the neighbouring region of Cusco led to an international court case, which paralysed the development of PEMS II until 2013 (Stensrud, 2016: 570). In addition, the process of clearing the land where the dam and the tunnel are to be built has taken much longer than expected due to legal problems of land ownership. In 2016 and 2017, the project was halted by social protests in the highlands where the new parts of the infrastructure are to be built, and by inhabitants' claims for employment and economic compensation for losses of land and the negative impact on their livelihoods. Corruption scandals in recent years have also affected the project. Brazil's massive Car Wash Operation,[2] which started in 2014, has uncovered an unprecedented web of corruption in Latin America in the bidding for, and building of, public works. Sparked by this investigation, Peruvian prosecutors have been looking into accusations of bribe-taking by Peruvian construction companies for such contracts. The cartel, the so-called Construction Club, involves the Peruvian building firm Cosapi, one of the companies in the Angostura Siguas consortium. PEMS II has not been identified as a corrupt megaproject in this sense, however the firm Nippon Koei Latin America – Caribbean Co. Ltd (the independent supervisor of PEMS II) plus general political pressure caused Cosapi, in 2018, to finally sell its shares to its partner Cobra and completely leave the project. Finally, what initially appeared to be a mere technical problem turned into a political conflict, which resulted in the suspension of the PEMS II work on the highlands site. In 2017, the consortium suggested a change in the plans for the irrigation system in the Siguas plains from a gravity-fed open canal system (like in the Majes plains) to a pressurised system of pipes, arguing that the latter is more efficient (Field notes, 22 August 2017). This change implies a cost increase of US$110 million that the Regional Government of Arequipa would have to bear. While the then governor Yamila Osorio was willing to have her government assume this cost, she did not get the necessary support from the representatives of Arequipa in the national congress and therefore could not sign the thirteenth amendment to the contract. On the other hand, the recently elected governor, Elmer Cáceres Llica, has declared that this cost should be the responsibility of the private consortium, but that he and his government are willing to study the options.

Signboards placed close to the construction sites of the PEMS II dam and tunnel in the highlands say: "Majes Siguas II is now up and running". Others placed in the still-desert lands of the Siguas plains say: "Special Project Majes Siguas Phase II: Angostura [dam] [made] Reality: Majes [plains] – Exporter [of goods]". Messages like these convey to the public that the hydraulic megaproject, which was envisioned as a regional development project already in the 19th century and the first phase of which was built in the 1980s, is coming close to completion. The second phase of the project has thus been inaugurated several times in sod-turning ceremonies, by the then Peruvian president Ollanta Humala in 2014 and by

[2] The so-called *Operação Lava Jato* is an ongoing Brazilian criminal investigation of corruption in the public works building sector throughout Latin America, involving numerous large building firms and high-level politicians.

the former regional governor Yamila Osorio in 2015. On 5 November 2017, governor Osorio and the then president Pedro Pablo Kuczynski held yet another inaugural ceremony at the actual construction site of the new tunnel in the highlands (4800 metres MASL). Together they enacted the reception and the symbolic blessing of the tunnel boring machine (TBM) that had been assembled in China, shipped over to Peru, and transported to the highlands the month before. In all their speeches, the politicians referred to the long history of the project and the promises of progress and development for Peru and for Arequipa that it carried, and ensured connectivity to global markets. The dream was finally coming true after 40 years of waiting, and the future was finally here! As of April 2019, however, only the workers' camp, some roads, and some minor tunnels to support the PEMS II had been built. The huge TBM is still waiting to perforate the Andes. As such, the more-than-40-year-old project materialises a historical future (Harvey and Knox, 2015), articulating "past desires and future imaginaries" (ibid: 15) and harbouring hope, ambition, promise and expectation (Anand et al., 2018; Hetherington, 2014) both for the population in the Arequipa Region, for Peru as a whole, and for the many people working on the project. Here, infrastructures as open-ended and experimental material assemblages – a notion developed by Morita and Jensen (2017) – becomes clear as the PEMS has been reconfigured over time from one which supplies water within the context of land reform and small-scale agriculture in the 1970s to one of large-scale agriculture for exportation and hydropower production in the 21st century. From this long-term temporality, I shall turn in the next section to how processes of reconfiguration also take place at a micro level in the everyday planning and management of the first and second stages of the megaproject.

Making way

A transnational megaproject worth millions of dollars could be imagined as having its headquarters in a skyscraper in a metropolitan financial district. By contrast, the headquarters of AUTODEMA, the public agency administering and operating the PEMS, is located in a small compound of a dozen single-storey wooden buildings along a short internal street shaded by jacaranda trees, in a quiet area of upper Cayma District in Arequipa. At the small entrance, staff and the occasional visitors must announce and identify themselves with guards. On an ordinary day, staff sit around their computers and talk on their cell phones, visit other offices to leave or fetch documents and reports, and attend innumerable meetings. To visit or inspect any point of the infrastructure in the highlands or the Majes plains, the staff goes out from the AUTODEMA headquarters in Cayma in special vehicles. The offices of the PEMS II unit in charge of the second stage of the megaproject are located in a small building called Module 6. The walls are papered with maps and photos of the first and the second stage. This is also where all the relevant documentation, such as feasibility studies, legal documents, maps, reports and plans of this second stage are kept, not only in staff computers, but also stored in binders and on bookshelves, and filling boxes on the floors of offices and in the narrow corridor.

In 2016, the front meeting room of one of the buildings doubled as a collective office for numerous temporary staff members of the PEMS II unit. Among these was a group of young environmental scientists hired to do the environmental impact assessment of the planned construction. There was also a pair of young lawyers sitting there who had been hired by AUTODEMA to solve the matter of acquiring land for building the Angostura Dam in Pusa Pusa and the tunnel in Tarucamarca. According to staff members of AUTODEMA, the matter of territory had been largely omitted by the government when setting up the public tender in 2006. By 2015, when the project actually started, the acquisition of property had become a major obstacle to the proceedings. Property owners no longer lived in the scarcely populated highlands as many had migrated to Arequipa and, in order to buy the land, it was necessary to first locate the actual owners. When the Condoroma Dam and the tunnels and canals of PEMS I were built in the 1970s and 1980s this was not a problem, according to AUTODEMA staff who has worked on the project since the 1980s (Field notes, 25 February 2016). They recalled that at that time most peasants still lived on their land, and what was then DEPEMA simply offered those affected by PEMS I a plot of land in the Majes

plains. Once they had accepted the offer and moved, MACON started building without major conflicts. In PEMS II, by contrast, the concession contract stipulates that the concessionaire will not start the building of the Angostura Dam and the tunnel until all the land affected by the infrastructure has formally become state property and has been conceded in one single act to the consortium for the time of concession.

The matter of land ownership is revealing of the process of temporary commodification and the public-private interface of the PEMS. Central to private companies is the right to private property and, in the same vein, ownership is key to commodification. While the PEMS I was a public venture for which the public authorities at the time simply acted according to the logic of land-as-commons, the private actor involved in PEMS II refused this logic. AUTODEMA thus had busy days finding out who were the owners and convincing them to sell their land. In the case of the peasant community landholdings, this procedure was even more complicated due to the lack of individual title deeds and, in a couple of cases, due to legal conflicts between peasant communities. To resolve this situation, AUTODEMA offered to community members that, if they agreed to sell, AUTODEMA would undertake all the paperwork to formalise their title deeds in the SUNARP Public Property Register. In legal terms, selling communal land is possible only if at least 51 percent of the community members accept. The task of the young lawyers working for the PEMS II unit was thus not only to manage the cases through the legal-bureaucratic maze but, together with the staff sociologists, to negotiate with community members and convince them to sell in the first place. In 2017, only 40 of the total 52 land plots had been acquired, and the consortium kept deferring the actual building start, much to the annoyance of AUTODEMA. These and many other matters were constantly being discussed in project meetings.

In January 2016, I participated in one of the PEMS II project meetings held in the large meeting room of the AUTODEMA headquarters. Twelve men and two women attended, representing the public and private actors. Representing the concessionaire were two Spanish and two Peruvian engineers from the private international consortium Angostura Siguas. Several engineers, an architect, a lawyer and a secretary represented AUTODEMA as the grantor. Finally, three engineers and one legal expert from Nippon Koei participated as supervisors, one of whom acted as chairperson of the meeting. The agenda that day included about ten items for discussion regarding documents, authorisations, studies and time frames. Each of the two parties (concessionaire and grantor) requested information from the other, complaining about their tardiness in sharing documents and reports. During the meeting, some issues were seemingly not controversial and therefore quickly sorted out such as, for example, the status of the environmental impact assessment. Other matters – one of which was the landholding problem – generated much tension and rather harsh exchanges of words between the representatives of AUTODEMA and those of the consortium. AUTODEMA claimed that the changes in the construction plans undertaken by the concessionaire had unexpectedly increased the amount of land needed for the project. Another issue was the archaeological assessment on the construction site that was required by Peruvian law. While the concessionaire argued that this study had already been done, AUTODEMA staff claimed that the assessment needed to be more comprehensive in order to get the final CIRA certificate that guarantees that a specific area has no archaeological remains. Yet another controversial matter that was discussed was the geographical placement of the workers' camp (whether it should be in Pusa Pusa or in Tarucamarca), the number of workers to be employed, and the level of their salaries. The concessionaire accused AUTODEMA of having created unrealistic expectations about thousands of highly paid employment opportunities, which they would not be able to meet. At the time of PEMS I in the 1980s, AUTODEMA had become a major employer in the region and even in the country, fulfilling expectations about public provision of employment. Drawing on these experiences, when framing the second phase of PEMS II the stakes and expectations were initially set high by AUTODEMA experts promising "thousands of jobs" in the region. In the last two decades, however, the process of building dams, tunnels and canals has largely been automated and is carried out with minimal human labour. The private consortium thus considered employment of un- or low-skilled labour as an unnecessary cost.

Throughout the meeting, the chairperson and his supervisory colleagues – who had the final say in these disputes – tried to mediate between the opposing parties. After two hours of intensive and exhausting discussion, the meeting ended. The minutes, written by an AUTODEMA secretary during the meeting, were sent around the table and signed by all the participants. The representatives of the concessionaire then left, leaving the representatives for the grantor and the supervisor in the room in a kind of ad hoc post-meeting. The AUTODEMA public servants now spoke out and disclosed some information that had not been revealed in the meeting, and complained openly to the supervisors that the private concessionaire was not complying with the agreements but rather was only obstructing and delaying the process. One of the supervisors asked why the concessionaire would want to delay it, to which the AUTODEMA representatives replied that the agreement stipulates that if the Peruvian state cannot meet the project time frames they would have to pay high fines to the consortium. This and all other details in the agreement between the Peruvian government and the consortium are stated in the concession contract, which was constantly referred to during the meeting. The contract can be seen as materialising the tensions between the private rights and public obligations mentioned above. These tensions had an additional postcolonial dimension. In contrast to the case of the urban hydraulic infrastructure of Mumbai in India that is shaped by the fact that it was commissioned, built and managed by colonial powers in England (Anand, 2017: 14), the PEMS was granted by the Peruvian state to a private consortium which included a Peruvian firm but, more importantly in this context, comprised also a company from Spain. In this latter case, the affective sense of nationalist pride and modernist dreams that imbued the hydraulic megaproject was undermined by the fact that one of the players which would contribute to the fulfilment of this dream was not only foreign, but was from Spain. Days after this meeting, members of AUTODEMA staff expressed to me that they did not trust "the Spaniards", meaning the representatives of the Spanish firm Cobra. Because infrastructural forms are shaped by the social and political context in which they are assembled (Hughes, 1983), it is symbolically significant that the second phase of the PEMS was being undertaken by Peru's former colonial power. The postcolonial memory looms large, including in hydrocracies, and operates emotionally among its members as a "structure of feeling", referring to the different ways of thinking that vie to emerge at particular points in history (Williams, 1979).

Meetings such as the one described above and other types of meetings are characteristic of megaprojects like the PEMS and are where the interface of the public and the private takes place. This is where there is sharing, contestation and negotiation of the terms of agreement (and disagreement) between multiple expert categories that are differentiated by their public and private stakes and nationalist feelings. As cultural forms that discipline individuals and control the epistemic boundaries of a given organisation (Schwartzman, 1989; Shore et al., 2011), meetings work as rituals of legitimation (Thedvall, 2006, 2008) in which the performance of rules and regulations makes decisions valid and the project trustworthy (Nyqvist, 2015; Sandler and Thedvall, 2017: 6). In addition, the PEMS experts produce and handle an innumerable number of different types of documents including land deeds, contracts, subcontracts, calendars, memos, maps, reports, manuals, minutes and certificates. This large variety of documents makes clear that such "artefacts of modern knowledge" (Riles, 2006) create what Hull (2012) has termed a political economy of paper. In combination with meeting practices, these documents constitute as much a legal as a performative power that enables the making of the megaproject. In the process, the infrastructure is thus constantly reconfigured both as an idea and as a material form (cf. Harvey and Knox, 2015: 87).

Tunnel trouble

From the previous section, it would seem that daily management of an infrastructure deals more with meetings, documents and emotive negotiations than with the actual water infrastructure. While this is partly true in a megaproject such as the PEMS, the everyday work of the infrastructure also involves both close and abstract engagements with the materiality of the hydraulic megaproject. The example that

follows deals with what might seem to be an extraordinary practice of creating an infrastructure, yet, in environments of late industrialism, ageing and deteriorating materials are becoming more common (cf. Fortun, 2012).

Over time, the material state of the canals, tunnels and dams becomes another dimension that needs to be handled by the experts in abstract as well as concrete terms. The existing 35-year-old PEMS I infrastructure was built in the seismic environment of the Andes. Materials like iron and concrete age and deteriorate, just as water wears out the material through friction, and as a result several stretches along the infrastructure have become vulnerable. Infrastructures are human assemblages, but are embedded in landscapes and thereby give rise to what Carse (2014) calls "demanding environments" that require constant maintenance and work as "they can produce different experiences of control over or separation from the nonhuman world, while increasing vulnerability to its variability" (Carse, 2014: 219-220). Today there are many cracks and fissures in the canals and tunnels that were built during the PEMS I stage, and these pose an imminent threat of collapse of the entire infrastructure and a resulting interruption of the water supply. During my fieldwork, the infrastructural damage at a site called Canal 9, located close to the district of Achoma in the Colca Valley, was intensively discussed both within AUTODEMA, and in their meetings with representatives of the private consortium. It was also discussed in the meetings held in the Colca-Siguas Multisector Coordination Committee that water users in the area also attended.[3] Already in 2013, AUTODEMA technicians had announced that this particular canal and tunnel were in very bad condition, not only leaking constantly but the leakage also possibly leading to major damage. In 2015, a minor quake occurred in southern Peru that separated the canal from the tunnel. Agustin, a civil engineer at AUTODEMA's PEMS II unit, told me that a geological fault line runs just above the tunnel and that when seismic movement occurs everything in its surroundings is likely to move. Water users downstream also criticised upstream water users for building their own reservoir on the slopes above the tunnel, saying that the water from this dam would leak into the tunnel causing further deterioration. Provisional repairs were undertaken but the problem remained and, in 2016, AUTODEMA built a temporary canal just outside the entrance in order to bypass the part of the canal that most needed repairs. The work required the water to be cut off for a couple of days, to which the water users were strongly opposed. On 14 August 2016, a 5.2 magnitude earthquake occurred whose epicentre was close to the tunnel, killing nine people and injuring 40. Afterwards, an inspection by AUTODEMA revealed that the quake had left Tunnel 9 severely damaged and in danger of collapse. Repairs would take time and water supply would need to be cut off for several days, which would jeopardise crops. A collapsed tunnel that would take a long time to repair being a much worse prospect, the water users in the Majes plains demanded that AUTODEMA take the matter seriously and undertake immediate repairs.

In a conversation with Luisa, one of the AUTODEMA agronomists, in August 2017, I asked her what had been done to solve this problem. She explained that except for the provisional repairs that AUTODEMA had carried out in 2016, no major repairs had as yet been undertaken despite the imminent risk of collapse. A technical assessment of the state of the existing PEMS I infrastructure had been planned for the previous year for an estimated cost of S/10 million (US$3 million), its high cost due to the multiple professionals such an assessment would need, including geophysicists and hydraulics experts. The public tender for this assessment had been withdrawn, however, allegedly due the lack of budget. In view of the major complicated operation required to repair the tunnel, many of the AUTODEMA staff I spoke to were rather pessimistic about their own possibilities of achieving this, both because of the lack of money and the farmers' resistance to the water supply being cut off even for a few days; another reason for their pessimism was the scant expertise available in the country. AUTODEMA's budget, staff and room for maneuvering have been increasingly cut since it was downgraded in 2004 from an autonomous

[3] The *Comité Multisectorial de Coordinación* (Multisector Coordination Committee) is a network of stakeholders in the Colca-Siguas water basin. They hold monthly meetings attended by representatives from the local and regional public water agencies and from the water user organisations in the area.

national agency to one that was dependent on the Regional Government of Arequipa. AUTODEMA, therefore, expected that the experts would be brought in by the international consortium. In interviews, many of the AUTODEMA experts expressed distrust of the private consortium and alleged that they were merely interested in the revenues, but they were also aware of the advantages in terms of access to technology and resources that these big private corporations could provide. While they knew that AUTODEMA had the responsibility of handing over if not a perfect at least a functioning and operating infrastructure to the concessionaire once the extension was finished, they reckoned that if they could patch up the cracks and fissures then the private consortium would, once they took over, have the technical and financial capacity to make the thorough repairs required by the ageing infrastructure of PEMS I. This example relates to what Harvey and Knox (2015: 90-100) have called the "as long as" philosophy, which they have found to pervade Peruvian road engineering practices. This philosophy, or epistemology as it were, refers to putting abstract knowledge about facts and figures into practice as long as that works, and to be pragmatically aware of the contingent nature of these practices: "If mathematics is important to engineering it is because it is the means through which that contingency can be managed; it is the best of all possible solutions given the constraints, rather than a truth that is incontestably correct" (ibid: 108). The parallel can be made to Luisa and her colleagues at AUTODEMA, who see their practices of repair and maintenance of the infrastructure as doing as much as possible given the material, economic and social constraints, which can also be seen as an 'as long as' logic. While one political effect of the temporary commodification of the PEMS is the neo-liberal assumption that the private actor appears as a saviour when it comes to solving public problems, the public experts at AUTODEMA understood the temporary dimension of concession precisely as an 'as long as' solution that could benefit the state of the infrastructure.

In a similar way, but in a different vein, representatives of the water users organisations in the region told me that although they also expected the management of the water infrastructure to improve once the private consortium took charge of the PEMS, they were afraid of losing the possibility to negotiate fees and water quotas that they to some extent enjoy now with AUTODEMA and other public water authorities in the above-mentioned Colca-Siguas Multisector Coordination Committee meetings (Field notes, 29 January 2016). On the other hand, Luisa, at AUTODEMA, told me that such negotiations with water users was often a headache in her work because the water users would insist on higher water quotas even though her and AUTODEMA's task is first and foremost to ensure that the water supply lasts until the next rainy period and that, in the meantime, there is enough water to satisfy the needs of all water users. What AUTODEMA staff considered to be efficient management and fair distribution of the region's water was constantly questioned and pushed by social claims, economic interests and political pressure.

While the claims and negotiations for higher quotas took place within the hydraulic bureaucratic realm, other claims were more public and political. Examples of this are the public protests in the neighbouring region of Cusco in 2010 regarding the environmental impact of the project, the social protests in 2017 in Caylloma Province (where the Angostura Dam and the new tunnel are to be built) against the alleged insufficient economic compensation to the local population, and the political proposals (since the election campaign in 2018) to reduce the size of the land lots in the Siguas plains so that local farmers could also invest in them. This illustrates on a societal scale how knowledge and politics are deeply entwined phenomena in the field of water governance in Arequipa (cf. Andersen, 2014, 2017; Stensrud, 2016; Paerregaard et al., 2016), in Peru generally (cf. Oré and Rap, 2009), and elsewhere (cf. Anand, 2017; Björkman, 2015). More importantly for the purposes of this article, this section also reveals how public experts within the hydrocracy have a multidimensional understanding of the potential political effects of temporary commodification of water infrastructures, and how the politics of knowledge is entangled with the logics of the market. They are aware of the risk of losing influence as a public agency, but also of the prospect of not having to take responsibility for the maintenance of a crumbling large-scale infrastructure or the endless struggle to achieve fairness in the provision of water.

MAKING WATER INFRASTRUCTURES AT A DYNAMIC PUBLIC-PRIVATE INTERFACE

Despite the critique of hydraulic megaprojects in earlier decades with regard to their social and environmental impacts, they are nowadays increasingly considered to be a way to deal with the tension between growing water demand and increased water scarcity, and they are thus on the rise again in countries like Peru. If we want to understand how social actors respond to Peru's current water crisis, it is relevant to scrutinise ethnographically how such contemporary hydraulic megaprojects are organised and made sense of as they unfold. Taking the Majes Siguas Special Project (PEMS) in the Arequipa Region as a case in point, this article has taken an anthropological point of view, problematising prevailing understandings of hydraulic megaprojects and their hydrocracies as monolithic top-down managed institutions pervaded by modernist narratives of national progress. PEMS is a particularly compelling empirical case because of its long-term nature, which reveals the transformation of hydraulic megaprojects in Peru. While the first stage (PEMS I), built in the 1970s and 1980s and targeting small- and medium-scale farmers from the region, was funded through international loans and has been operated by the Peruvian state since its completion, the premises have changed for the second stage (PEMS II) that is currently underway. Due to financial constraints, increasing neo-liberalisation and climate change in Peru during the first two decades of this century, the government has, in the case of PEMS II (as in other cases), opted to follow the public-private partnership and build-operate-transfer models for concluding the hydraulic megaproject, aiming in this way to confront an increasingly critical water situation and nurture postcolonial dreams of progress.

At present, PEMS is thus a megaproject at an overlapping and dynamic public-private interface: the existing infrastructure (PEMS I) is still run by the public agency AUTODEMA, while the planning and development of the forthcoming stage (PEMS II) is undertaken in collaboration with, and through joint funding by, the Peruvian AUTODEMA and the transnational private consortium Angostura Siguas. The latter will eventually – once the company has finished the building of PEMS II – take over and run the entire infrastructure (PEMS I and II) for a concession period of 16 years, at which point it will transfer it all (back) to the Peruvian state. I have suggested that this shift in the making of water infrastructures can be seen as a form of commodification. My point is that if commodification refers to the process of making an object of economic value out of something that was previously not available for exchange or trade, then such PPP hydraulic megaprojects imply more specifically a temporary commodification of the water infrastructures they finance and operate, as much as the water that they supply.

To understand this phenomenon and how it plays out in practice, this article has unpacked the hydraulic megaproject by conducting an infrastructural inversion, that is, by bringing the *making* of the infrastructure to the analytical foreground. In this vein, I have also argued for the need to problematise our notions of the hydrocracy as a homogenous entity and the experts as mere rational technocrats. The results show that contemporary hydraulic megaprojects in Peru are infrastructures that encompass public and private logics in dissonant but also overlapping and ambiguous ways, which challenges their realisation as much as our conceptual understanding of them. By analysing the PEMS infrastructure in both its phases as an open-ended and experimental material assemblage (Harvey et al., 2015; Jensen and Morita, 2017), I have tried to convey the emergent character of the PEMS infrastructure by depicting its social history and by paying ethnographic attention to the diversity of the types of expertise that constitute its hydrocracy, the daily practices and social interactions by which the infrastructure is made, and the multidimensional understandings of the experts' roles as water managers. In the process, the article proposes a more nuanced picture of how a hydraulic megaproject is organised.

Since its inception, the PEMS has been situated in the past, the present, and the future of Arequipa and Peru (Love, 2017). It indexes a postcolonial sense of longing for modernity and progress – a discourse that is very pervasive in Peru and in other Latin American countries. It is in this sense that the water infrastructure materialises an imaginary of Peruvians and Arequipeños that enables a spatial connection between the highlands and the arid plains, and a temporal articulation that connects a glorious past with

the hope for and promise of a benevolent future (cf. Anand et al., 2018). However, far from being a linear (modernist) process of planning, building and operating – that is to say, of 'progress' – I have shown how the imaginary of the infrastructure's purposes and the premises of its production have been reconfigured over the decades from being a public utility to becoming a private provider, and how it has become framed as a private solution to public challenges. This open-ended reconfiguration of the infrastructure is also manifested at the micro levels of the infrastructure's making, through multiple legal, political and social, engineered and non-engineered, practices. The public-private collaboration that structures PEMS II is a realm imbued with tensions between the public and private logics of management and the possible commodification of water that these logics entail. Rather than a linear process, the planning that involves AUTODEMA, the Angostura Siguas consortium, and the supervisor Nippon Koei LCA is a punctuated process of exchanging information, negotiating stakes, and complying with regulations and agreements. Meetings, maps, reports, certificates and land deeds constitute objects through which the megaproject is legitimised and the temporary commodification made possible. Ageing building materials, unstable geological forces and politicised interests also pose a constant challenge to the infrastructure and its experts, both in terms of resources and competence, and social and political pressure. To sort out such challenges, experts resort to what I have called an 'as long as' logic, drawing on the work of Harvey and Knox (2015). This implies a pragmatic awareness of the limits of their capabilities and of the potential benefits of the scenario being proposed. Thus, from the AUTODEMA experts' point of view, while the temporary commodification implies a loss of influence in the water management of the region and a sense of being recolonised by more powerful market actors, at the same time it constitutes a possibility of gaining otherwise unavailable resources, technology and skills to apply to the infrastructure. To them, the premises of the Majes Siguas Special Project in this second phase are thus a window of opportunity to the future.

CONCLUSION

What are the implications of this case for the ways in which Peru's water crisis is understood and handled? It is too early to say how temporary commodification will affect the actual provision of water by PEMS, since the second stage is yet to be built and therefore the Angostura Siguas private consortium is not yet running the infrastructure. It is therefore difficult to venture whether contemporary hydraulic megaprojects offer a socially and environmentally sustainable water alternative or are but an illusion that private solutions can solve public challenges. What can be implied from this study is that the shift towards commodification of water infrastructures – temporary or permanent – that is driven by technical, organisational, political and financial forces, creates contradictions and tensions between state and market logics, as well as additional uncertainties and unplanned consequences that experts deal with through contingent practices of knowledge. This insight can help in the planning of megaprojects that are already at the public tender stage and can prevent and mitigate conflicts between stakeholders along the way. It can perhaps also serve the public at large to know that far from being a straightforward process, making and managing water infrastructures at the public-private interface can be as challenging as taming water itself.

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