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Accounting for Water

Questions of Environmental Representation in a Nonmodern World

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Abstract

This chapter discusses new science policy initiatives that involve water in terms of environmental representation: who represents, what is represented, for what purpose (equity, sustainability). One such initiative, Water Accounting, adheres, at least on paper, to a modernist treatment of science and politics (and nature–society) as being distinct and distinguishable. The effect of this is that particular water "facts" (e.g., the water consumed per unit of land, or the crops produced per unit of water) appear as the (only or most) objective starting points for improving water management and governance; other "facts" and other possible ways of representing water come to be seen as less true or important. Typically modernist claims of neutrality and independence also make it difficult to recognize how water accounting representations, measurements, and calculations derive from specific epistemic and policy communities, whose members have specific concerns, are part of specific knowledge traditions, and pursue specific societal projects of betterment. Inspired by social studies of science, it is suggested that water accounting and other attempts to speak for water or represent the environment become more useful and honest when efforts are made to address, more explicitly, the entanglements between science and politics. This abandonment or relaxation of modernism includes embracing diversity, plurality, or multiplicity as well as acknowledging, accepting, and reconciling the existence of many different ways to engage with, relate to, and account for water—many different versions of water. It also includes replacing the aspirations of transcendence, integration (or universality, commensuration), and inclusion (consensus) with equally difficult to attain, but more modest and pragmatic, ideals of situatedness, translation (mediation), and contestation (or dissent).

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Introduction

On the face of it, the reframing of water as an environmental question has been very successful. The water resources literature is replete with alarmist references to the closure of river basins, the depletion of aquifers, or the disappearance of wetlands. Most agree that water can no longer be simply considered as something to be captured and made available for societal purposes, arguing that it should instead be treated with caution. The widespread recognition of water as a global environmental concern coincides with a surge in international initiatives to speak differently—more ecologically or environmentally green—about water. These often combine large-scale attempts to count, measure, map, and predict changes in the globe's water resources with proposals for new ways to appreciate, valuate, and account for them. Focusing on water used in agriculture, initiatives such as the World Water Assessment Program, the Water Foot Print, and Water Accounting share the ambition of making science's abilities of accurate representation available and legible to water decision makers to support them in their efforts to use and allocate water in more environmentally conscious ways. Water Accounting, for instance, as explained below, aspires to become "the standard reporting and planning system" for water, helping "managers to manage water consumption more tightly (following certain well-defined targets) and to understand which flows to manipulate by means of retention, withdrawals and land-use change" (Bastiaanssen et al. 2015). Initiatives such as Water Accounting and the Water Footprint share the objective to measure and calculate water consumption (of a crop, but also of a consumer, farmer, company, chain, community, or nation) to allow (economic) valuation and comparison.

The enthusiasm with which these initiatives are embraced, developed, and sponsored by a wide variety of actors suggests that they offer an attractive and powerful way to express environmental concerns in water. In this chapter, we discuss whether this enthusiasm is justified. We do this by examining which, and whose, concerns are addressed by these new science–policy initiatives and by exploring how they are addressed.[1] Engaging with the larger aim of this book, we are particularly interested in their ability to address and combine concerns of sustainability with those of equity and diversity. Speaking for/about water is a question of environmental representation in two senses of the word:

1. Representation as an operative term within political processes that seek to extend visibility and legitimacy to the environment as a societal concern, thus creating political and societal support for institutional or technological interventions to help conserve or protect it

[1] Politics is as much about who has the authority to speak as about what is spoken and how. For elaborations of this for water, see Boelens and Zwarteveen (2005) as well as Zegwaard et al. (2015). For a more general discussion of so-called ontological politics, see Mol (1999, 2002).

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2. Representation as the normative function of language, which either reveals or distorts that which is assumed to be true about the environment

Hugely oversimplifying, and following Latour (2004), one could say that modern societies, at least ideally, have delegated these two forms of representation to specific societal realms: political representation happens (or is supposed to happen) in the realm of political decision making, whereas representation in terms of revealing what is real belongs (or is supposed to belong) to the realm of science or academia. The assumption of a fundamental divide between nature and society both mirrors and, importantly, feeds this separation.

Here we show that new international policy initiatives in water, at least on paper, seem faithful to this modernism in how they present, promote, and discuss the knowledge they produce. One clear effect of this is that the cultures and identities of the producers of knowledge and their particular social projects disappear from the water facts presented, as do many of the assumptions, stories, and labor (the semiotic and physical work) used to measure, calculate, and compare waters across times and places. In addition, because of their categorization of water as something natural to anchor their truth claims, initiatives such as Water Accounting and the Water Footprint make waters appear the same irrespective of where and how they are accessed or used, by whom or for what purpose, and irrespective of the social relations (of ownership and labor) and meanings of which they form a part. These waters thus come to appear as similar, or even as the only possible versions of water. These "natural order" versions of water are those to which—by modernist agreement and tradition—only scientific experts have access.

By granting some waters universal status, this distinctly modern way of knowing water may foreground some concerns while neglecting (or making it more difficult to see and address) others. We also fear that by implicitly delegating contentious allocation decisions to scientists, these initiatives may short-circuit processes of political and democratic decision making (cf. Blok and Jensen 2011). Thus, we make a plea for the project of environmental representation to abandon or relax modernist claims and languages. Inspired by a rapidly expanding body of scholarly work in the social studies of science, science and technology studies, and feminist technoscience studies, which calls into question the divides between politics and science (and by implication between nature and society),[2] our arguments here entail an invitation to all who are engaged in environmental representation to reflect on their practices. We suggest that attempts to represent water will be more successful if they (a) acknowledge that science and politics are, and will always be, deeply

[2] We have been particularly inspired by Donna Haraway (1991, 1997, 2008), Bruno Latour (2004), and David Harvey (e.g., Haraway and Harvey 1995). For water, Erik Swyngedouw's various writings (e.g., Swyngedouw 1999, 2009, 2013) are noteworthy and influential. In his writings on "modern water," Jamie Linton also provides important ingredients to this discussion (e.g., Linton 2010; Linton and Budds 2014). See also Zwarteveen (2015).

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intertwined and (b) abandon the modernist idea that there is only one correct way to know and represent water.[3] We thus propose to replace or perhaps complement attempts to commensurate very different waters in one overarching language, or set of values, with efforts to explicitly accept and support different ways to engage with, relate to, and account for water—different versions of water. This implies replacing transcendence, integration (or universality), and inclusion (consensus) with the equally difficult to attain but more modest and pragmatic principles of situatedness, translation (mediation), and contestation (or dissent) as guiding values. Water accounting initiatives do not have to be given up in the process. However, rather than assuming and asserting that many waters (or watery realities) can and should be expressed and calculated in water accounting terms, it becomes important to specify more clearly and delineate the types of questions that water accounting representation can answer, and for what (political or societal) purposes. As well as toning down universalist claims and ambitions, this includes efforts to accept and acknowledge that there are other ways of imagining and speaking for water, including nonscientific ones.

Three notions emerging from the social studies of science are particularly important for our argument. The first concerns the treatment of knowledge as performative; that is, the idea that knowledge—in our case knowledge about agricultural water—does not simply *describe* but also tends to *enact* realities into being (Law 2009). Considering (scientific) data as "facts" is based on the widely held assumption that reality has a definite form that is independent of the tools that are used to measure or count it. We propose a different and less accepted view of scientific knowledge in treating it as performative: rather than unambiguously emanating from some preexisting reality, knowledge actively helps produce reality.[4] Concepts (scientific) divide, map, and categorize; they are a way to help make sense of complexities by creating order. They demarcate, define, delineate, and indeed proactively establish and produce the boundaries between what matters and what can be ignored. Considering science and knowledge practices as performative also means that

[3] We are not the first to make this argument. Recent pleas for nonmodern ways of knowing and engaging with nature include Castree (2014) and Haraway (2008). Scholars who have made this argument for water include Linton (2010), Linton and Budds (2014), and Swyngedouw (1999, 2009, 2013).

[4] This view is not incompatible with philosophical realism or the preservation of an empiricist-realist belief in a world that is independent of the knower. In fact, we, along with others (e.g., Latour and Haraway), remain committed to accurate accounts of reality. Haraway argues for situated "knowledges" which maintain a strong commitment to objectivity (learning to see well) while denying that everyone will see in precisely the same way. For Haraway, "seeing well" is not just a matter of having good eyesight: it is a located activity, cognizant of its particularity and of the accountability requirements that are specific to its location (Haraway 1991:191). In situated knowledge-making projects, embodied knowers engage with active objects of knowledge whose agency and unpredictability unsettle any hope for perfect knowledge and control.

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differences between research findings—accounts of realities—produced by different methods or in different research traditions can no longer be treated as different *perspectives* of a single reality: they become, instead, the enactment of different *realities*. This implies a move from assuming that the world is one—a uni-verse—to accepting the existence of multiple worlds that are produced through diverse social and material practices and relations. These worlds need not necessarily be disconnected. There may be resonances or overlaps between them (Law 2009).

The second notion follows from the idea of Bruno Latour that realities (and knowledge of realities) "depend on practices that include or relate to a hinterland of other relevant practices" (Law 2009:241). Sustainable knowledge rests in, and reproduces, more or less stable networks of relevant instruments, representations, and the realities that these describe. This is what makes realities—together with the techniques and representations that enact them—seem stable, durable, and reliable (Law 2009:241–242). This also means, and is the third notion, that realities are only real within particular networks (of people, devices, funds) or systems of circulation. Truths, therefore, are not universal (Law and Mol 2001): they are only "realized" in definite form within the networks of practices that perform them. The question of how this happens then becomes important: this is a question of power, interests, traditions, and culture.

By exposing how water accounting initiatives can fall into the trap of modernism, our aim is not to expose these initiatives as wrong, or to accuse their developers. To the contrary, some of us directly collaborate in water accounting efforts and subscribe to its aspirations of using water in wiser and greener ways. We also find the idea of using freely available remote-sensing data for improving the democracy of water decisions attractive. However, we are concerned about the close affinity that water accounting has to particular policy networks and societal projects of betterment, and fear that if the "facts" produced by water accounting come to be seen as the only possible truth, this will lead to the privileging of some waters (and associated uses and users) over others. In particular, as we discuss below, water accounting foregrounds efficiency and productivity as concerns, thereby risking to eclipse concerns of equity or diversity. Hence, by showing that water accounting is not that modern after all, our aim is to improve sensibility to how the production of water accounting measurements, maps, and sheets may help structure relations of dependence and power.

Below, we first establish how water accounting can be characterized as modern. Its implicit appeal to a natural and global order as the foundation of knowledge—an order that can be exposed or discovered through the rigorous methods of science—is distinctly modern. In addition, its active cherishing of a specific form of objectivity—one that is anchored in the idea that it is possible to see (and know) from an undetached and unmediated position—belongs to a modernist repertoire. After this discussion, we focus on whether, or to what

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extent, water accounting meets or can ever meet its own implicit modernist claims. We demonstrate that water accounting facts are more compatible with some versions of reality (and some political projects of improvement) than others. When using a modernist approach to science, it becomes difficult or even impossible to discuss this. Finally, we end with a discussion of whether and how water accounting tools can be used in less modernist ways. This discussion explores what would be needed for water accounting tools to support not only greater productivity or efficiency, but also goals of equity or diversity.

The Modernism of Water Accounting

Many emerging science policy initiatives concerned with the agricultural use of water utilize the exciting new possibilities of satellite imagery to measure water use changes and water footprints from a distance, in the hopes that such measurements will add rigor to policy discussions about how to best use and allocate water across competing uses and users. Water accounting initiatives, based on the idea that there is much water to be gained (or saved) in agriculture by more efficiently matching water gifts to crop requirements, are a case in point. This idea combines the oft repeated statement that most fresh water is used in agriculture, with the widely held belief[5] that much of this water is used inefficiently (see, e.g., Postel 2000; Gleick 2002). Important objectives of these initiatives include identifying where water can be used more efficiently, finding ways to hold users accountable for their irrigation practices, and making consumers aware of how much water went into the production of the fruits and vegetables they buy in the supermarket.

A foundational premise of water accounting is that the availability of accurate knowledge about sources and uses of water is a crucial precondition for achieving these objectives. Water Accounting (2016), for instance, states:

> Water problems around the world are increasing; however, information useful for decision makers within the water sector and related to the water sector seems to be decreasing. Solving water problems requires information from many disciplines, and the physical accounts (describing sources and uses of water) are the most important foundation.

The idea is that water is in need of representation by science in ways that are usable in policy and decision-making processes. This reflects a particular, yet implicit, view of the science–policy interface and posits one particular version of water and logic of water use. First, the assumption seems to be that water

[5] By calling this a belief, we are not suggesting that water is not used inefficiently. We are referring to how definitions and uses of efficiency terms are not uniform or agreed upon within the community of irrigation scholars, with claims about efficiency often being inappropriately used outside the contexts to which they apply, leading to false estimates of water savings at the basin scale (Perry 2007; Lankford 2012a, b; van Halsema and Vincent 2012).

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decision making happens in clearly identifiable spaces by known actors who are rational and accountable to their words and deeds. This corresponds poorly to actual practices. In this neoliberal and globalizing world, water governance is controlled by an ever-increasing number of actors, only few of whom are identifiable or identify themselves as water decision makers. These actors have widely differing perspectives, influence, and interests; operate in different overlapping domains; and draw on different rationalities, values, resources, norms, and legal repertoires to articulate, frame, and defend their positions (Franks and Cleaver 2007). The environments in which they operate and strategize is complex and difficult to predict. Actual decisions about water uses and allocations are only partly informed by what would be considered as scientific knowledge: they occur through often messy, multilayered, and multiple negotiations (Zwarteveen 2015). Second, water accounting focuses on the water used as an input for agricultural production (or economic profits) and stipulates efficiency or productivity (e.g., expressed as units of water per quantity of crop or profit produced) as the main concern. Because the Water Accounting initiative adheres to modernist ideas of objectivity, these waters and the logic behind them risk being perceived as the only possible or true ones, as we will explain.

Like many international science–policy initiatives in water, water accounting speaks to an emergent policy consensus that water problems are (or should be treated as) global in nature. Water Accounting, for instance, refers to the need for assessing planetary boundaries or states that "a system of water accounting has so far been missing as an important element in the emerging system of global water governance" (Bastiaanssen et al. 2015:10). Texts also make use of global projections of population growth, by stating that "producing enough food to meet the demands of a global population of 9.1. billion people by 2050 require levels of food production in 2007 to be increased by approximately 60%, and doubled in sub-Saharan Africa and parts of South and East Asia" (Bastiaanssen et al. 2014:6) or that annual agricultural water use will need to increase from approximately 7,100 km3 globally to between 8,500 and 11,000 km3 in order to meet projected food requirements in 2050 (de Fraiture et al. 2010). The reference to water problems as "global problems" not only draws useful attention to global connections and interdependencies, it also—in our opinion much less usefully—suggests the need for and possibility of one coherent global view, which is also one that only (some) scientists can express and articulate. It is a small step from the articulation of environmental problems and solutions as global problems to the claim that the world is a "universe": that there is only one correct way of knowing this world. In other words, there is a risk that a preference for the global also feeds beliefs in the existence of the universal. Such beliefs erroneously posit the "global" as the larger whole, of which "the local" is a subsystem or a specification. "Globalness" then comes to signify (the existence of) one overarching order, the one that scientists first need to unravel and discover before policy makers can intervene in it.

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The belief in such a global universal order underlies the aspiration that water accounting shares with many other science–policy initiatives in water: that of integrating all available knowledge on "water flows, fluxes, stocks, and the services and benefits related to water consumption" in one all-encompassing database or overarching map. Water Accounting (2016), for instance, states:

> Solving water problems requires information from many disciplines….The information has to be coherent and synchronized in order to provide an integrated picture.

In a paper explaining water accounting, Bastiaanssen et al. (2015:2) express the hope that it "should be adopted by environmentalists, agronomists, economists and lawyers alike," thereby indeed functioning as a common, integrative language; a language that commensurates different waters and either reflects or establishes one single water order:

> The working hypothesis is that by having an approved central database on water-land-ecosystems at the negotiation table with standard nomenclature and clear data, confusion becomes minimal, and trust among parties will get to a higher level.

Thus, water accounting appears to be guided by the conviction that there is, or should be, one correct or right way of representing water.

Water accounting makes use of satellite-produced earth observations and aerial photographs to produce maps that cannot be established from the ground: a single image presents (proxies for) the distribution of evapotranspiration, biomass growth or water productivity for large areas. The attractiveness of this way of knowing water flows and stocks, especially when on-the-ground measurement stations are few, is clear. Yet, our concern is with how the use of earth observations tallies with (and further nourishes) ideas of transcendence: ideas that it is possible to see and control water from a detached and unmediated position, a global vantage point or eye in the sky.[6] Such ideas match with a modernist interpretation of objectivity as consisting of being detached and unconnected, with independence as its central feature. Water Accounting (2016) states that it "is a multi-institutional effort from international knowledge centers (IWMI, UNESCO-IHE and FAO) that are neither politically nor geographically connected to a given river basin...[and] provides independent estimates of water flows, fluxes, stocks, consumption and services, that in the near-future becomes certified." It is thus guided by the assumption or desire to produce facts more or less independently from wider policy contexts. The possibility to do this is anchored in the unequivocal placement of water on the nature side of the well-known and typically modernist society–nature dichotomy. Hence, the "white paper" defines water management as an interference in natural flow processes

[6] For a critical feminist analysis of Earth Observation Satellites, see Litfin (1997); for a discussion of the dangers of using pixels to represent the commons, see Lele (2001).

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and refers to the physical, quantitative understanding of hydrological processes as the basis for such interferences (Bastiaanssen et al. 2015).

In all, the Water Accounting initiative—just like many other international science–policy initiatives in water—is clearly built upon a modernist onto-epistemological scaffolding. The rest of our discussion will reflect on this scaffolding, first in terms of whether it meets its own modernist claims and then in terms of how it addresses questions of power, inequality, and politics in its analysis of water problems. We continue by discussing the possibility of using the tools, methods, and maps of the Water Accounting and other science–policy initiatives in less modernist ways, in support of the production of political-scientific representations of, and interactions with the environment that are more accountable to equitable, diverse, and sustainable forms of living.

Networks, Affinities, and Waters

A first way to test the modernism of water accounting initiatives is to question their independence or neutrality by tracing their origins: Through which networks do they happen and circulate? This is not a difficult exercise as these initiatives bring together old epistemic friends who share a long history of developing and actively promoting and circulating a particular body of water knowledge. This body of knowledge is one that is closely linked to water management interventions in developing countries, funded by development cooperation money and dominated by the disciplines of engineering and economics (see Goldman 2001, 2007). Indeed, water accounting initiatives bring together a very particular group of international water experts—the International Water Management Institute (IWMI), the FAO (World Food Organization), the World Bank, and more recently IHE-Delft—and provides them with the opportunity to use advanced technological means (remote sensing and modeling) and a contemporary grand challenge (global water scarcity) to breathe new life into an old and very familiar project: that of measuring and mapping consumptive uses of water in order to improve its productivity (e.g., IWMI 2007).

The many collaborations and overlaps (in ideas and people) between the international water policy network (development cooperation donors, UN agencies, the World Bank, and regional development banks) and international centers of scientific expertise (FAO, IWMI, IHE-Delft) produce a close circularity between how water is scientifically understood and how it is enacted in policy proposals for regulating and controlling it. It is no coincidence that the very donor organizations (e.g., USAID, the Asian Development Bank, the African Development Bank, and the World Bank itself) that finance development of the new water accounting tools and indicators are also the ones most interested in the river basin scans, maps, and water resources assessments that they facilitate (Bastiaansen et al. 2015). Water accounting initiatives are thus less independent or objective than they hope or claim to be: they exist and

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circulate (obtain funds, legitimacy, and credibility) thanks to and because of a particular network of scientists, policy makers, and donors. Viewed another way, water accounting initiatives thus far seem to have been more convincing and effective in mobilizing funds for their projects than in supporting actual water decision-making processes with their tools. One could even speculate that much of the modernist language used serves primarily the purpose of mobilizing support, rather than expressing deep epistemological convictions

One possible implication of this is that the maps and measurements produced by water accounting initiatives do not produce a universal water, but rather one very particular version of it.[7] We suspect that this version exists and circulates precisely thanks to its affinity with specific communities of practice, citation circles, projects, and flows of funding. If true, knowledge of water accounting is deeply situated: it is attached to, and depends on, specific people (bodies) with particular institutional, financial, and political affiliations, helping them achieve *their* water ambitions. It may even be that it is because of these attachments and affiliations that knowledge of and tools for water accounting become mobile, durable, and eventually "true" or at least effective.

The Water Accounting Version of Water as Efficient, Quantifiable, Valuable

We have suggested that water accounting belongs to a particular epistemic tradition in agricultural water science, one aimed at efforts to improve the effectiveness of water projects and water policy reforms funded and supported by development cooperation and loans. Inspired by optimistic beliefs that development happens through technological progress and economic growth, the overarching problem diagnosis of this body of work was, and still is, that there is a gap between the potential (determined on the basis of results obtained in virtual or real-life laboratories, experiments, and pilot plots) and actual performance of water delivery systems (variously expressed in terms of poor efficiencies, water productivities or yield gaps). Articulating water problems in this way frames the search for solutions as consisting of ways to close this gap and, in the process, (re-)formulates the water problem as primarily one of efficiency or productivity. Efficient or productive water use, in turn, tends to get defined as the precise matching of water deliveries to crop water demands, or the avoidance of waste or losses of water when conveying it from the source to the root zone of plants.

[7] Sletto (2008) provides another clear example of how environmental knowledge is produced as part of specific institutions. He shows that the production of environmental knowledge is central to the institutional cultures of environmental planning agencies and shaped by political-economic processes, dominant narratives, and particular institutional desires to produce "conservation" landscapes.

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This is a very particular framing or enactment of the water problem, one that emphasizes water as an input for the production of crops, or perhaps more accurately profits. The water that counts, and that needs to be accounted for, is the water that produces a particular (quantifiable and marketable) kind of value, for only when this value is produced can returns to investments (in infrastructure, reforms) be expected (Gilmartin 1994, 2003; van Halsema 2002). This version of water is particularly compatible with approaches to the regulation, management, and control of water that are optimistic about the possibility to combine economic growth with efficiency and environmental conservation; that is, modes of resource regulation that aim to deploy markets as the solution to environmental problems, based on the conviction that sustainability depends on maintaining natural capital (Bakker 2004, 2007; Ahlers 2010; Robertson 2012).

This further underscores the point that water accounting is deeply social and political in that it belongs to specific policy networks and is more suitable to support some societal projects of betterment than others. The projects that water accounting seem to favor are those closely aligned with market-based solutions to problems of development and sustainability. As noted, it may well be that it is partly because of this affinity with dominant policy models that the maps and measurements of water accounting obtain authority. It may also be that it is precisely their resonance and alignment with powerful funding, policy networks, and ideologies that enables their exposure and makes them popular, legitimate, and indeed true, as much, or more, as the accuracy with which they represent water.

The Water Accounting Version of Water as Natural

Water Accounting treats, defines, and analyzes water as something that is, in essence, "natural," the behavior of which can be explained through reference to a universal natural order or logic. This has two effects: First, it suggests that water can be rather straightforwardly read off actual realities "out-there," as if these realities unequivocally exist prior to being mapped, measured, or known. This conceals the hard, and often messy, work involved in water accounting science-in-action: producing measurements, maps, and sheets entails engaging in the repetitive, laborious, and painstaking activities of labeling, marking, repeating, cleaning, numbering, noting, interpreting, and controlling. This work is partly performed by different technologies, machines, algorithms, and computer programs through advanced tools of registration, classification, aggregation, measurement, and calculation (for an example of what this entails for water accounting, see Bastiaanssen et al. 2014). Whereas a modernist account would use these tools to help uncover the pre-given order of things, a social studies of science account has it that tools themselves help produce this order. Accordingly, observed phenomena do not simply depend on certain material

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instrumentation; they are *thoroughly constituted by the machines and apparatuses that make them appear* (cf. Latour and Woolgar 1986; Blok and Jensen 2011:32). The point is that science requires work and an enormous amount of laborious, meticulous, and routine manipulation of artifacts: facts are indeed literally produced. Accepting this prompts the need to rethink what is true, shifting the discussion about objectivity and representation from just one of accuracy to one of the *translations and alliances* needed to mediate (move, displace) a phenomenon or substance into a textual or visual fact.

The second effect of ontologically defining water as natural is that it makes the water accounting version of water appear almost as if it moves and circulates by and of itself: it situates the power to change water flows in the hands of "decision makers," who themselves remain rather opaque and anonymous. The human labor, technologies, institutions, and funds required to (organize water's) access and transport, and indeed "own" it, do not enter into the analysis, nor do the specific social relations through which this labor and funding are mobilized become visible. The particular water use configurations shown on Water Accounting maps thus reveal little or nothing about the historical or contemporary struggles over water's access and control; the social arrangements in place to share, care, or control it; or the multiple ways of engaging with and making sense of water that help explain how it "behaves" and moves.

To give but one example, consider the water accounting maps produced for an irrigation scheme in Sudan (e.g., Figure 11.1). These maps clearly show circular patches of high water productivity next to smaller rectangular spaces where water productivity is much lower and displays greater variation. The highly productive circles represent the areas that were irrigated by the center-pivot irrigation sprinkler systems introduced a decade ago. On these colorful maps, these circular areas are the places where most value per drop of water is produced. The maps suggest, therefore, that these areas should be appreciated and encouraged. The particular abstractions through which this valuation exercise happens, however, leave many things out of the equation. Hidden (and thus eliminated from the public policy deliberations that water accounting hopes to inform) are the highly unequal deals, sharing arrangements, and favors that have produced this seemingly homogenous and highly productive space. The maps, for instance, do not tell how the Sudanese company that owns the sprinkler pivots and exploits the scheme succeeded in cheaply negotiating access to this land, water, and infrastructure in 2006. Prior to this, in 1990, people in the investment area had agreed with Kuwaiti and Sudanese public investors to construct a smallholder irrigation scheme, which would have provided them with opportunities for engaging in the cultivation of irrigated crops as well as water and fodder for their cattle. In 2006, however, the Kuwaiti government sold its share, which consisted of the main irrigation infrastructure, to this Sudanese company. The Sudanese government allowed this company to lease the land of the smallholder scheme for 25 years. The company subsequently fenced off the area and bulldozed away most of the

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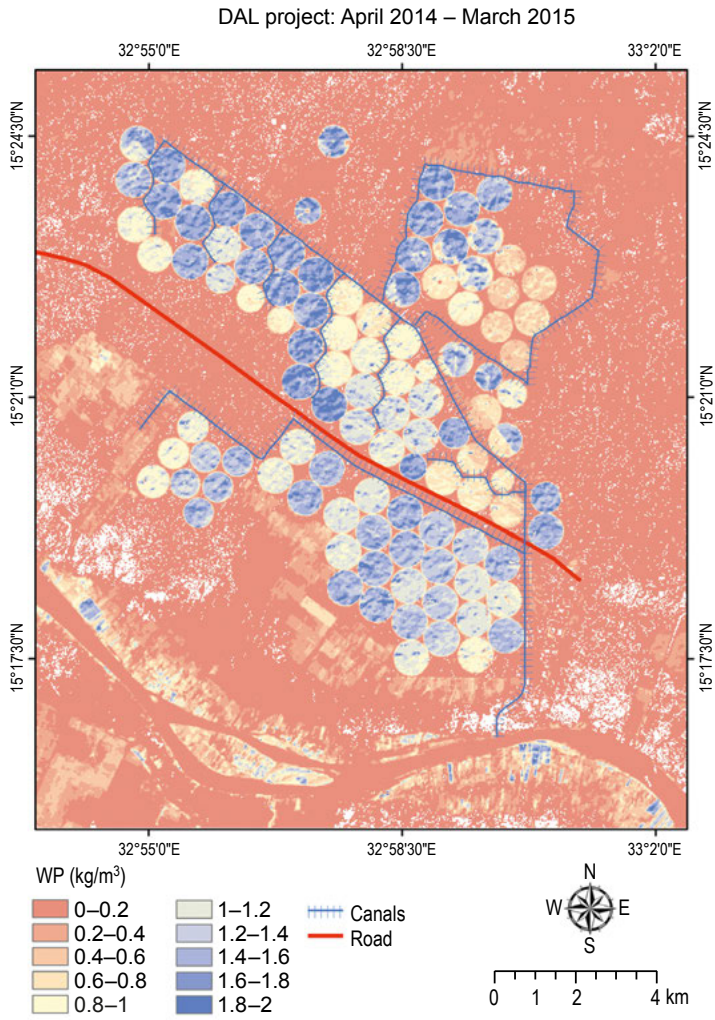

Figure 11.1 Water accounting map that shows water productivities in the area irrigated by a Sudanese company; circles represent the lands irrigated by the efficient center-pivot irrigation schemes.

existing scheme infrastructure to transform it into a highly mechanized pivot irrigation scheme. It started a profitable farming enterprise to produce fodder (alfalfa) for export to dairy farms in Saudi Arabia.

What the maps do also not reveal is what happened to the smallholders who were thrown out of the 1990 irrigation scheme to make place for the company farm. Many were no longer themselves involved in the hard labor on the farms; instead, they hired laborers from South Sudan, Darfur, and Nomadic tribes

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in the area. Yet, they protested fiercely when their ability to farm was taken away. Security forces had to be called in to quash their revolt. Village leaders benefited from the deal that was reached and played a key role in allocating the 4,000 *feddan* left for smallholders. Laborers left the area after the company began operations.

None of this is visible when observing the pivots quietly moving around to complete 12- or 24-hour irrigation cycles. These imported pivots make perfectly round wetted areas to produce a solid 18 tons of alfalfa per hectare. Water accounting maps support the story of the company scheme as a highly productive and efficient one, by positively contrasting the circular company "islands of high water productivity" to the less productive rectangles of smallholder farms. What would be the effect of this representation if it were actually used to inform water allocation decisions? The existence and mapping of productivity differences might suggest that those who are less productive are less deserving of support and encouragement. It could also provide arguments in favor of more pivot irrigation schemes. Water accounting representations may thus help convince those responsible for water allocation decisions to sell or rent out other smallholder schemes to private investors. At another level, the narrow focus of the maps on plot-level productivities may divert policy and political attention away from the question of whether it is better to use water to grow food for the Sudanese market rather than to use it to produce fodder for mega-dairy farms in Saudi Arabia. While both the Ministry of Agriculture and the business plans of the company, since the 1970s, have repeatedly referred to Sudan as a bread basket of the world to justify their actions, an ironic effect of the maps may be that they mark the smallholder farms instrumental in producing this "bread" as inefficient, thus creating the risk of cutting them off from new investments or support.

This example demonstrates how dangerous it is to present water accounting measurements and maps as the only possible reality, or as unequivocally representing (speaking for) "nature" or "the environment." To do so shelters them from political debate (thereby directly clashing with the stated ambition of water accounting initiatives to contribute to water democracy) and renders invisible the deeply social and political relations and processes through which this "nature" has come into being. The situation of irrigation schemes along the Blue Nile in Sudan is not unique in that it is one where all available water has been allocated. This means that interventions that intend to change (improve) uses or users inevitably entail reallocations and often dispossessions.

Dealing with Difference: From Commensuration to Connections, Translations, and Contestations

As discussed, the science of water accounting, just as all of science, is replete with culture and politics: it comes from particular epistemic communities,

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emerges from distinct successor science projects, and becomes true and obtains legitimacy through (associations with) particular policy and funding networks. The maps and measurements produced by water accounting do not describe the world as it is, but instead produce one particular version of it. This version is easier to align with some societal and political projects of betterment than with others. To our knowledge, water accounting maps and assessments have not yet been directly translated into, or informed , interventions or water allocation decisions, nor have they been used to legitimize or promote specific investments. We fear, however, that their use of a modernist objectivity allows them to be captured, interpreted, and used by those who promote a certain logic of calculation and efficiency as the only, preferred, or most important one in talking and deciding about agricultural water uses or about wise water uses in general. Although presented as a new and green logic, this water accounting logic is the same logic that has long dominated agricultural water science, particularly in debates about irrigation efficiencies.[8] It is a logic that makes some uses and users appear productive and/or efficient, thus qualifying them for support and approval. Others, in contrast, appear as wasteful or environmentally destructive, which sets them up to become candidates for sanctions or for projects of improvement, training, or awareness raising. It is also a logic that can easily be made compatible with larger efforts to use pricing or valuation for the regulation, management, and control of water, such as payments for ecosystem services.

The high water use and delivery efficiencies or water productivities favored by water accounting appear (are made or become real) on farms where farmers have the desire and (technological and financial) means to indeed optimize the drops of water used against yields or incomes obtained. Perhaps there are industrialized farms or commercial plantations in desert areas for which this is the case. However, as the example of the Sudanese company farm illustrates, the crop per drop or income language does not show how rights to water or land were obtained in the first place (through which negotiations and deals), thereby eclipsing historical investments in technologies or infrastructures for accessing water. Thus, we maintain that the language used in water accounting is not the only possible, best, or true language, nor is the water this language enacts (i.e., water as an input to the cultivation of marketable crops) the only possible or true version of water. Farmers and others concerned about water may be interested in many more things than just optimizing crop or income per drop. Farmers may, for instance, aspire to use water for improving the ease of farming operations or to spread risks. They may take pride in their own particular variety of crops, nurturing it partly for its own sake and cultivating it

[8] This logic is far from straightforward, as the many ongoing discussions within irrigation expert communities about how to best define and operationalize efficiency demonstrate (see, e.g., Lankford 2012a, b; van der Kooij et al. 2013). The familiarity of this logic in this particular epistemic community may explain why water accounting initiatives generate enthusiasm, support, and funds here.

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not just to maximize profits, but also for reasons of taste, beauty, and heritage to mention just a few.[9] There may be trade-offs between water and labor (e.g., when farmers over-irrigate to reduce weed growth) or between water and fertility (e.g., when farmers sequence their water gifts to allow the roots of their fruit trees to grow deeper, thus allowing them to make better use of the soil's fertility) (Domínguez Guzmán et al. 2017).

Moreover, water accounting measurements—like all representations of water—are deeply scale sensitive. There are places in the world where the optimization of water use does not occur at the level of the farm or of a single crop over a single season, but involves sophisticated social and political mechanisms—which may have become more or less fixed in infrastructure—of sharing available waters across larger areas (watersheds or river basins), or over time, among different users. These mechanisms may have evolved historically as part of the collective investments in the construction or maintenance of infrastructure, to form wider social fabrics that govern the organization of socionatural relations. Indeed, living with water in specific places for generations often has yielded intricate ways of looking after and caring for or protecting it, or the infrastructure constructed to transport it, for future generations. Such forms of living with and caring for water come with their own ways of expressing or enacting water: with their own ontological definitions and logics, and their own repertoires for making water real (Boelens and Hoogendam 2002; Boelens and Gelles 2005; Domínguez Guzmán et al. 2017). In other words, there are many ways of "doing" water that differ from how emerging policy–science initiatives like water accounting "do" it. Different waters have their own specific bodies of knowledge and communities of knowers. They are also associated with their own words and systems of meanings, and embedded in their own practices (e.g., of accessing and transporting water, of assessing and classifying quantities and qualities, of irrigating crops, of sharing and distributing it, of making decisions about it, and of conserving and protecting it).

The modern way to address the simultaneous existence of multiple waters is to try and commensurate and integrate them. Can the waters embodied in the above-mentioned practices, however, be (more or less accurately) expressed in water accounting terms and somehow be shown on maps? Can concerns (e.g., of equity and diversity) that these waters highlight be integrated in calculations, so that the decision makers they are supposed to support can also be held accountable to values other than productivity and efficiency? We have tried to grapple with this latter question in a recent project, the Nile Water Lab (nilewaterlab.org) in which we explored how water accounting maps compare with more ethnographic attempts to understand changing water uses and flows. One tentative conclusion is that there are indeed many values and measurements

[9] Jan Douwe van der Ploeg's long list of publications about farming styles and the persistence of family and smallholder types of farms is insightful here.

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beyond those of productivity and efficiency which can be expressed in water accounting terms and that can be shown on maps. Whether, how, and to what extent the information and data required to produce these values and measurements can be (just) obtained from remote-sensing data is, however, doubtful. Water security, for instance, would require detailed information about (changing) property relations, information which may be difficult to gauge from aerial photographs. Another conclusion is that the grid-like Euclidian spatialities of water accounting waters are less suitable for expressing the mutual interactions (and indeed co-constitution) of water flows and people, and thus for explaining why differences between watery places and people came about in the first place. For generating such explanations other forms of representation are more suitable, such as historic narratives or pictures.

The question of how and whether remote-sensing tools can be used to address a range of different realities is one that has also been addressed by others. One suggestion that originates from their attempts is using and answering such questions playing around with a variety of temporal and spatial scales and categories (e.g., of land cover or use) to inform the production of maps (Guyer and Lambin 1993; Jiang 2003; Walker and Peters 2007). They propose that it is necessary to compare and contrast explicitly the measurements, classifications, and values used by different scientists with those used by irrigators or water users, to make the resulting differences the topic of conversation and discussion. What happens when water is *not only* a natural resource but is, for instance, also a relative or a goddess? Most exercises of this kind conclude that the modernist approach for dealing with the existence of multiple ontologies (i.e., multiple versions of reality) tend to result in positing some ontologies as superior (see, e.g., Robbins 2003; Zubrow 2003; Comber et al. 2005; Turnbull 2007). This is because a modernist treatment would usually consist of attempts to make different waters fit one overarching scientific logic. The history of irrigation development is replete with examples of the effects of such a modernist treatment, examples of the sometimes violent destruction and erasure of existing ways of living and ways of using water in favor of more scientific and therefore supposedly more efficient, rational, and productive modern irrigation schemes (Boelens 2015). "Local" and "other" waters then get treated as informed by, or merely consisting of, tradition and culture, placing them in contradiction to the universal and global modern waters of scientifically informed policy experts (see Robbins 2003; Bonelli et al. 2017).

Our proposal for addressing multiple waters is different: rather than trying to find a singular currency that allows the commensuration of all differences, or devising a singular grid on which all different waters can be mapped, we suggest that there is merit in finding ways to acknowledge and live with many different orders, repertoires, registers, languages, choreographies, and idioms that express or do water. Importantly, this requires acknowledging that culture and politics are inherent to *all* forms of knowledge, including scientific ones. Robbins described one attempt to do this for an environmental

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mapping exercise in Rajasthan, India. Although not specifically focusing on water, his conclusion is insightful: he argues that the simultaneous expression of a variety of knowledges—those from "experts" as well as local "laymen"—creates a level playing field that allows comparing and contrasting them to see whether and how they resonate or clash with each other (Robbins 2003:239). Robbins's example illustrates how all "categorical imaginations" (based on forestry typologies, ecological classifications or hydrological units) are inevitably partial, preliminary and situated. They may clash, but they may also usefully converge.[10] Robbins suggests that exploring such clashes and convergences is useful to elicit legitimate disagreements; this can draw attention to how proposals which change uses or allocations of environmental resources may benefit some but not others, creating contestation and sometimes conflict. The simultaneous existence of different waters, in other words, reflects not just how disparate groups of people engage with, depend on, or interfere with water, it also shows that there are likely to be disagreements and clashes over access, rights, and futures that specific water decisions and investments help enable.

In agreement with Robbins, we propose that the question of how to address different waters is not mainly one of integration, standardization, or commensuration. It also concerns travels, connections,[11] translations, or networks between many different, sometimes contingently, emerging orders and forms of patterning. Rather than explaining away the waters that do not fit dominant patterns or orders, or forcefully reshaping and normalizing them to make them fit, we propose to combine the water accounting methodology with other ways of knowing and representing water. In this way, water accounting can become a useful starting point to compare and contrast different waters, as well as to help elicit the logic, values, and futures that inform them. Rather than only mapping and accounting for the waters that fit one universal logic, this would also highlight those that do not fit, and provide a potentially useful way to bring accepted normalcy into relief as an entry point for discussing or perhaps to challenge them (for further discussion, see Leigh Starr 1990; Law and Mol 2002).

To reach practical decisions about how to most wisely deal with and allocate water in specific situations, it is clear that some procedure is needed to handle, combine or merge multiple ideas, interests, and opinions. We suggest

[10] This proposal is not new, but derives directly from what many of the science and technology scholars cited here (e.g., Law, Mol, Haraway, and Latour) suggest. For elaborations and specifications of the argument for the particular case of mapping, see Turnbull (2007) and Zubrow (2003).

[11] Turnbull (2007:140) makes a similar argument to address multiplicity in the production of maps by "reconceiving mapping and knowing performatively and hodologically...through focusing on the encounters, tensions and cooperations between traditions and utilizing the concept of cognitive trails—the creation of knowledge by movement through the natural and intellectual environment....differing modes of spatially organized knowledges can then be held in dialogical tension that enables emergent mapping."

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that a pragmatic discussion of what works, and for whom, provides a more interesting guide than modernist beliefs in the possibility to assess water in an objective, nonpolitical way (see also Latour 2004, whose ideas were inspired by Dewey's pragmatism). Rather than integration or commensuration, the task then becomes one of forming strategic alliances; that is, learning to translate from one language to another and communicate in ways that can surpass disciplinary, ethnic, and other such boundaries (Haraway and Harvey 1995).

Conclusions

Emerging science–policy initiatives in water can be used to rethink the question of the political-scientific representation of the environment and the politics of scientific knowledge production. How can these be democratically organized? How can "universals" (durable, mobile, and stable knowledge; insights, tools or technologies that can travel between places and times) be produced without simultaneously causing dangerous elite concentrations of knowing? How can novel and stronger forms of accountability be created for what Haraway calls "livable worlds."

Water accounting initiatives have grounded our discussion, as these epitomize a contemporary surge in science–policy initiatives in water that combine adherence to a modernist conception of science with advanced remote sensing and computing powers to produce the "facts" supposedly needed to govern, manage, and use water in wiser ways. Although we share the enthusiasm of the developers of water accounting and similar initiatives about new possibilities of producing and making available advanced and detailed geo-referenced information about water stocks, flows, and services, we are worried by the distinctly modernist ways in which this information may be captured and used to obtain legitimacy and funding. In particular, we are concerned about how this modern treatment makes the particular versions of water that water accounting produces, appear to be the only possible ones. The distinct social and political origins of these waters disappear, also making the specific societal projects of betterment that they promote appear as the only or best ones.

In this chapter, we have tried to demonstrate that water accounting maps are as much a reflection of the specific networks and communities of those who produce them, as of the hydrosocial features of the areas they represent. In our view, this does not necessarily discredit them as useless or faulty. Instead, we have used the example of the deep situatedness in water accounting to call for a different way of interpreting and treating the maps and measurements produced. We argue that the usefulness or value of water accounting knowledge does not depend on strong (claims of) detachment and universality. To the contrary, water accounting will become better—truer, more useful—when these modernist claims are replaced with nonmodernist ones.

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What does this mean? Instead of modernist detachment, we suggest that there is merit in actively cherishing and acknowledging different forms of rootedness or situatedness. Here it helps to reconsider the idea of scientists as engaged in uncovering universal or global orders, replacing it with one that imagines the task of researchers as modestly intervening or carefully tinkering. Rather than being only about representional accuracy, the question of environmental representation then becomes also one of (organizing forms of) permanent critical scrutiny of why and how some knowledge travels (obtain legitimacy, durability) and some does not. This includes asking uncomfortable questions about the implications of geographical distance between centers of knowledge production and those of knowledge application, especially when this distance also marks, and is maintained by, differences in economic and political power. The production of nonmodern forms of knowledge warrants continuous investigation of how produced knowledge helps "order society" by performatively sparking communities, authority, and reality into being, thereby also disciplining and normalizing "others" (creatures, spaces). This must be accompanied by a different organization of accountability in research, one that makes researchers more visible socially, culturally, and politically.

Admittedly, this is rather theoretical and idealistic, and seemingly far removed from the urgent task of producing answers to pressing problems of water scarcity, pollution, or floods. Yet, much of it may be, above all, a *practical* matter related to a rethinking of how research is funded in relation to how accountability for produced research results is organized. It may start rather humbly by simply acknowledging what many researchers actually do in their everyday work with water, instead of focusing on what they say they do. It involves the relatively straightforward task of clearly situating knowledge production efforts in the specific political decision-making efforts or imaginations of futures of which they always form a part. Pragmatic proof of effectiveness, which works to help achieve a particular goal, then becomes necessarily part of the evidence needed to establish the value of produced knowledge.

Perhaps more difficult, the reconstruction of water policy–science initiatives on a less modernist scaffolding requires that researchers (and by extension their financial and political supporters) move away from modernist truth claims and hopes for total information, transparency, and control (to know and steer from a relatively invisible, global and detached position) and instead learn to accept that knowledge will always be local, tentative, preliminary, and partial, and that solutions are clumsy and temporary.

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