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ABSTRACT

Over the last two decades, the Moroccan state has had to deal with some deeply uncomfortable knowledge regarding mounting water scarcity. This presents governing actors with a difficult dilemma. On the one hand, this knowledge is politically disturbing as it could undermine prevailing hydro-agricultural policies, which are based on the promise of unlimited irrigation expansion. It could also corrode the dominant social alliance built around these policies. On the other hand, accurately quantifying water resources has long been essential for establishing the technocratic legitimacy of the state.

This paper investigates how the state manages uncomfortable numbers that it has either produced or endorsed: an issue rarely addressed by social studies of quantification, but increasingly consequential in the current ecological crisis. Drawing from a literature on the production of ignorance, we highlight contradictory processes of knowledge production and ignorance. We show that Moroccan state hydrologists have dealt with uncomfortable figures by keeping them fragmented in space and time. They have continued to produce innumerable measurements of water scarcity. However, they have done so in an increasingly scattered manner, both spatially and temporally, while studiously avoiding integrating these fragments into updated national estimates.

This uneasy compromise between "seeing" and "not seeing" like a State has so far helped reproduce the "modernizing" social alliance forged around large hydraulic projects. However, its durability is doubtful. Our case study thus raises a number of hypotheses about what the ecological crisis could do to state quantification in many places and in the near future.

1. Introduction

By the summer of 2022, there was growing consensus that Morocco was facing "its worst drought in history[1]". At the end of July that year, the average filling rate of the country's largest dams did not exceed 29 %, compared to 45 % at the same time the previous year. Yet this serious "rainfall shock" (World Bank, 2022: 18) was by no means an isolated occurrence. The Kingdom of Morocco had already experienced two successive years of drought in 2019 and 2020.

To many observers, the three-year rainfall deficit merely confirmed what an abundance of data had shown for at least two decades, namely that "droughts were becoming more frequent, and gradually converged to a quasi-permanent condition" (World Bank, 2022: 15). The World Bank, among others, emphasised that water stress was set to worsen with climate change, given the evapotranspiration caused by a projected increase in mean annual temperatures (1.5–3.5 °C by mid-century) and a decrease in precipitations (by 10–20 percent, and even up to 30 percent in some regions). Alongside international organisations, the Moroccan state itself has been actively producing, over the last two decades, disturbing evidence of the increasing intensity and frequency of droughts, which confirms a more structural water scarcity.

This evidence is politically disturbing because it could easily fuel criticism of the dominant hydro-agricultural policies of the last fifty years, which are based on the promise of unlimited irrigation expansion. In so doing, it could weaken the dominant social alliance forged around these policies. This article therefore investigates how the state manages politically uncomfortable numbers, i.e. figures that the state itself has produced or endorsed, but that can potentially undermine established social compromises and hierarchies.

This question has remained somewhat of a blind spot for social

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[1] *La libre Belgique*, "Le Maroc fait face à la pire sécheresse de son histoire", 08/07/2022.

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studies of quantification, especially critical studies of water quantification. This field of inquiry has tended to adopt a broadly Foucauldian line of thought, by suggesting that the State only produces, essentially, the knowledge it finds useful to govern (Birkenholz, 2009; Ward, 2013). The claim that states only fabricate the knowledge they need to steer and control society, while ignoring 'local', 'vernacular', or 'indigenous' knowledge frameworks has been at the core of Scott's (1998) famous thesis on how the modern state essentially "sees" nature and society by simplifying and homogenizing both, in order to better control them. This is also in line with a contemporary literature on the "manufacture of ignorance", which Proctor and Schiebinger (2008) have dubbed "agnotology". In all these approaches, state knowledge only encounters resistance as *external* resistance from subaltern groups who may feel misrepresented and marginalized by State objectifying and universalist framings (Vos and Boelens, 2018).

However, over the past fifteen years, another strand of research has argued that the erasure of knowledge could also involve less deliberate and clear-cut strategies on the part of State actors (see for instance: McGoey, 2016; Pestre, 2013). This literature speaks of a -practical- "production of ignorance"rather than a -strategic- "manufacture of ignorance". Here, ignorance emerges out of more or less improvized practices that attempt to cope with what Rayner (2012) has dubbed "uncomfortable knowledge". Uncomfortable knowledge undermines the ability of institutions to pursue their goals, but cannot be easily ignored or undermined. As such, it typically presents institutions with a difficult *dilemma* (Best, 2022).

In accordance with this latter line of thinking, we consider that the accumulation of data on water scarcity can best be described as some deeply uncomfortable knowledge for Morocco's political rulers and state hydrologists. Rather than a body of knowledge to be self-evidently ignored or suppressed, it presents them with a difficult dilemma. On the one hand, quantifying scarcity may challenge the dominant hydro-agricultural policies in the kingdom. Since the 1960s, these modernization policies have been aimed at the continued expansion of irrigation, through large-scale schemes decided, financed and controlled by the State, and the supply of highly subsidised water. They have proved to be a key political instrument to make rural notables, and more recently a new group of urban-based agricultural investors, one of the most solid social bases of the Moroccan monarchy (Leveau, 1985; Hammoudi, 2001). This social basis, and its hegemony over broader groups of farmers, is predicated on the promise of unlimited expansion of irrigation (Swearingen, 1987), or what Adams (1991) has called the ideology of "irrigationism". It could come under renewed criticism if there was proof to show that the country has now reached its hydrological limits.

On the other hand, however, credibly quantifying water resources has always been important for establishing the Moroccan state's authority over its society. Quantifying less, or producing manifestly erroneous figures, would run the risk of undermining this technocratic legitimacy built up over many decades, which forms the basis of the professional ethos of many state hydrologists. How, then, can governing actors continue to claim expert legitimacy, which involves producing credible figures, while seeking to avoid the politically destabilizing effects of these same figures?

Our paper foregrounds a rather messy process whereby state hydrologists *simultaneously* produce both realistic and fanciful figures. We show that state hydrologists have dealt with uncomfortable figures mostly by keeping them *fragmented* in space and time. They have continued to produce innumerable measurements of water scarcity. However, they have done so in an increasingly scattered way. Fragmentation has occurred both spatially (with many estimates of declining rainfall, declining reserves stored in dams, over-exploitation of individual aquifers) and temporally (a seasonal drought, a past period, future projections…). Meanwhile, State actors studiously avoided integrating these disjointed fragments in a coherent manner. With this "politics of scale", the overall water estimates, which provide the basis for water planning at the level of large watersheds and are the most instrumental in supporting the dominant hydro-agricultural policies, have remained unchanged. As a result, they have drifted, for their part, into increasingly unrealistic and fanciful overestimates.

The remainder of this article is organized in five parts. First, we briefly survey how critical water studies have traditionally approached the political role of quantification, and how one of their blind spots may be addressed by the literature on the production of ignorance. Second, we trace the historical synergy between an increasingly realistic quantification of water and the hydro-agricultural modernization policies in Morocco, until the early 2000s. Third, we chart the proliferation of uncomfortable evidence of water scarcity from the 2000s onwards, and how it has been kept fragmented through four types of practices. Fourth, we briefly illustrate the political productivity of this fragmented production by analysing the case of a major state-run irrigation project on the Saïss Plain, in northern Morocco. Finally, we conclude by discussing the relevance of the Moroccan case with respect to the production of ignorance in times of ecological crisis, and by outlining some possible scenarios for the future of water quantification in Morocco.

The methodological approach used in our case study is based on three distinct types of sources. First, we carried out a detailed analysis of 18 documents, which include assessments of freshwater resources nationwide since the 1970s. These documents fall into four categories: national planning and/or evaluation documents published by Moroccan government agencies (7); planning documents for a specific watershed, namely, that of the Sebou River Basin, which is where the irrigation project we analysed is located. In our view, these documents are representative of planning documents from other watersheds (3); studies from bilateral and multilateral cooperation agencies (4); and scientific papers (4). All of them were selected for their influence, which was measured by the number of times they were quoted in other official documents and in the media. The Sebou planning documents were selected to illustrate the overestimation of water resources at the scale of a large watershed and to show how this overestimation allows to depoliticize water management (see section 4).[2]

Secondly, we conducted 12 semi-structured interviews between April and July 2021. They were carried out with experts directly involved in water quantification at both the watershed and national levels (Moroccan consultancy firms and cooperation agencies), and with scientists in the field of hydrology and hydrogeology with extensive experience in Morocco. Together, they have enabled us to assess what has become, in times of scarcity, of the traditional ethos of water bureaucrats, which used to deeply value quantification. They have also helped us to identify the various neutralisation practices used to keep measurements of scarcity fragmented.

Lastly, in order to understand the political reasons for overestimating water resources, we drew on previous studies conducted in the Sebou Region to investigate the ongoing development of a large irrigation scheme on the Saïss Plain, which is supplied by the M'Dez Dam (see Del Vecchio and Mayaux, 2017; Benchelih, 2021; Del Vecchio, 2023).

2. The state and the discomforts of quantification

Social studies of quantification, and their development by critical water studies, have not frontally addressed the issue of uncomfortable data, and the associated dilemma it poses for governing actors. After briefly reviewing this literature and highlighting this blind spot, we will show how the literature on the production of ignorance can be put to use to fill it.

[2] This section owes much to the research carried out by Paulė Steponavičiūtė, to whom we are grateful. See: Steponavičiūtė, P., 2021. "Measuring water scarcity in Morocco: the social-political dimensions of a scientific process", Master's thesis, Sciences Po Paris.

2.1. Social studies of (water) quantification: The blind spot of the quantification dilemma

Beyond the environmental field as such, social studies of quantification have long highlighted that the construction of modern states was intimately connected to the development of quantification. Quantification helped States design general policies, while also assisting them in identifying and handling particular cases. Throughout his work, Desrosières (1998) famously sought to historicize government statistics as (evolving) forms of objectification of society. In his view, "large numbers" legitimized state sovereignty and state authority over a delimited territory, as well as the state's role in governing the economy and society at a distance. By defining what is worth measuring and how to properly measure it, quantification transforms a messy reality into an object with stable properties. In this process, the state and its bureaucrats choose to count only what ultimately suits them in their drive to control and modernise their society, and to advantage some particular groups to the detriment of others. Inconvenient knowledge, then, is simply ignored or expunged.

Within the field of critical water studies, many analyses of quantification have built on this overarching approach. They have shown that the design of hydraulic infrastructure was based on the classification, standardization, abstraction and normalization of water resources (Fernandez, 2021). Through quantification, local and highly irregular watercourses are transmuted into national resources, whose millions of m^3 can be commensurated and added up within a national territory. By constructing an imaginary of national water, water quantification helped craft nation states, for example, Israel after World War II (Alatout, 2008) and post-colonial Mozambique (Rusca et al., 2019). It also helped states regain their lost legitimacy after deep political crises, as in the case of Spain after the country had been deprived of its last colonies at the end of the 19th century (Bellés, 2014).

Correlatively, many studies have shown the extent to which knowledge deemed inconvenient by modernizing elites was ignored, expunged and made invisible. In the case of the San Lorenzo Dam in northern Peru, Barbara Lynch (2019) showed that the planning staff deliberately ignored the potential impact of water diversion on peasants and herders, which resulted in a devastating social and cultural impact of displacement caused by the Project. Similarly, based on the empirical research in the new hydropower hotspots in the Eastern Himalayan region of Northeast India, Amelie Huber (2019) argued that a blind eye to environmental risks, which she calls strategic ignorance or manufactured production of risk, facilitates unequal distribution of benefits accelerating the process of social marginalization. As a result, epidemic contestation involves clearly antagonistic coalitions, who mobilize profoundly heterogeneous knowledge. In this spirit, Dukpa et al. (2019) examined how in India's Eastern Himalayan state of Sikkim, indigenous local communities have successfully contested all proposed hydropower projects and sustained anti-dam opposition in their home region. They argue that the traditional system of self-governance—"vernacular statecraft"—known as Dzumsa, prevalent among indigenous Bhutia communities, played a central role. This form of self-organization mobilized people's attachment to their place and the corresponding notions of territoriality, in order to forge "agonistic unity" against large dams.

These works are broadly consistant with a rapidly expanding literature, that of the "manufacturing of doubt" (Proctor 2011; Oreskes and Conway, 2010). This looks at how powerful actors seek to suppress and deligitimize inconvenient knowledge. Overall, this body of literature would lead us to hypothesize that Moroccan rulers have sought to suppress or conceal uncomfortable data on water scarcity, cast doubt on its validity, or organize alternative expertise to fuel confusion and controversies.

However, for governing actors, evidence of water scarcity is not just threatening knowledge, to be suppressed by any means necessary. Rather, it presents them with a difficult dilemma. To take the full measure of this dilemma and its consequences, it is worth turning to the literature on the production of ignorance.

2.2. The production of ignorance: Beyond the knowledge/ignorance dichotomy

Social studies of quantification, and the aligned literature on the manufacture of doubt, tend to posit a rather clear-cut dichotomy between knowledge and ignorance. They also tend to posit a dichotomy beween actors interested in manufacturing ignorance – State elites for the most part – and those resisting this erasure, with varying degrees of contradiction and success. As such, they provide valuable insights into the different knowledge regimes around water, and the epistemic conflicts between them. However, their main consepts appear ill-suited to grasping the political *dilemma* that the quantification of ecological limits poses to governing actors, and to Moroccan state hydrologists in particular, as they find themselves torn between strong incentives to quantify ever more precisely, and equally strong incentives to slacken their efforts to do so.

On the one hand, quantifying scarcity threatens to raise questions about the viability of the prevailing hydro-agricultural model and the social alliances it supports. On the other hand, however, it does not suppress the appeal of quantification as a means of legitimation, for at least two reasons. First, quantification is deeply rooted in the professional ethos of water officials. The meaning of their job is closely associated with the production of "accurate" measurements, whatever the political implications of these. Second, coming up against ecological limits actually *increases*, in some ways, the appeal of quantification. This is particularly true in the field of forecasting. Here, quantifiers have the opportunity to fashion the image of a far-sighted state. This makes them appear as scientific masters of the long term and guarantors of the general interest. They can portray themselves as being up against the short-sightedness of their population, in particular farmers (Andersson and Prat, 2015). Forecasts based on credible figures also enable what Beckert (2016) calls "defensive decision-making". Decision-makers can hope to cushion the discontent induced by their policies by pointing out that they were based on widely accepted forecasts. Therefore, to see or not to see, to quantify or not to quantify, is definitely the question for Moroccan state hydrologists.

This dilemma invites us to build on other currents within agnotology, which have sought to go beyond the knowledge/ignorance dichotomy. They have focused on how state quantifiers deal with what Rayner (2012) has dubbed "uncomfortable knowledge". Uncomfortable knowledge is knowledge, which, if revealed, presents a danger to institutions because it could potentially undermine institutional principles, arrangements and goals. At the same time, however, it is knowledge that is produced as part of the ordinary workings of an institution, and is therefore not easily suppressed. This is why it tends to result in what Rayner calls "clumsy solutions". Clumsy solutions are satisficing (as compared to optimizing) social arrangements which allow 'different sub-sections of a society or organization to rub along with each other by not questioning each other's motivations and worldviews too deeply'.

In the case of pesticide regulations, for example, Dedieu et al. (2015) have shown that State agencies in both France and California could integrate disturbing epidemiological knowledge, while simultaneously mobilizing resources that domesticate and disarm this knowledge. In this case, it was the very organization of monitoring systems that paradoxically reduced the perceived danger of pesticides. Statistics had the effect of rendering some pathologies less visible, even when policy mechanisms existed to compensate those afflicted by these pathologies, indicating that policy-makers had some interests in reducing them. By operating a fragmented monitoring system with scattered prerogatives, French bureaucrats, in particular, could ultimately "ignore what they know". Thus, pre-existing routines and blind spots ended up being reinforced, despite the pressures brought on by the accumulation of new

evidence (Dedieu and Jouzel, 2015). This finding fits broadly within the claims of the "new political sociology of science", which argues that knowledge gaps are not necessarily the product of a neat and deliberate strategy, nor a purely involuntary organizational effect. Instead, they may result from a certain "politics of knowledge" and expertise, produced through practices of bricolage and improvisation (Frickel and Moore, 2006).

In this paper, we show that Moroccan state hydrologists also manage to "ignore what they (actually) know" by fragmenting evidence of water scarcity. In so doing, we present a nuanced vision of the intermingling of knowledge and ignorance within a state faced with contradictory imperatives. We begin by tracing the gradual crystallization of a dominant social alliance around supply-oriented, large-scale infrastructure, in order to grasp exactly what social order has been thoroughly destabilized from the 2000s onwards, and with what effect.

3. Modern water quantification and the hydraulic mission in post-colonial Morocco (1960s–2000)

Between the 1960s and the turn of the 21st century, the quantification of national water resources was a key feature of large-scale, supply-side water policies. Quantification was by no means a purely scientific endeavour. In the words of the first comprehensive report on national water resources, it served to estimate the country's "hydraulic potential", i.e. the total volume of water that could effectively be harnessed by development policies (Kingdom of Morocco, 1971: 14). Beyond this direct objective, it contributed to the broader legitimation of the post-colonial Moroccan state. In fact, by upholding the promise of the unlimited expansion of irrigation – which Adams (1991) has called the ideology of "irrigationism" – national water quantification helped sustain the monarchy's social bases. After underlining the close historical relation between water quantification and developmental policies, we will highlight the broader effects of quantification on political legitimation.

3.1. Quantify and modernize: unveiling the nation's hydraulic potential

The subordination of quantification to modernization has been clearly expressed, until now, in the structure of the Moroccan state itself. Since 1966, over and above some minor changes in terminology, water quantifiers have had posts in the Water Resources Division (DRE,[3] now the Water Research and Planning Division – DRPE), which is integrated into the General Directorate of Hydraulics (DGH), in charge of water infrastructure.

Water engineers from the DRE/DRPE embarked on the first systematic national water survey, published in three volumes in the 1970s, with the support of French experts. Their ethos was that of senior civil servants dedicated to the edification of a modern technocratic state. Like their many counterparts in France and other Arab countries, they played a crucial role in crafting a political developmentalist legitimacy (Longuenesse, 1990). Two emblematic figures among the state "quantifiers" were Meziane Belfkih and Mohamed Jellali. Belfkih (1944–2010) was a civil engineer who graduated from the prestigious *École Nationale des Ponts et Chaussées* in France, in 1970. He began his career by supervising the construction of dams on the Tessaout River, east of the city of Marrakech, producing hydrological data on the Oum'R'bia Basin in the process. In the 1990s, he became Secretary General of the Ministry of Public Works and later Minister of Public Works. Jellali (1944–2014) was a water engineer, who graduated from the French *École Nationale Supérieure de Géologie Appliquée de Nancy* in 1968. He spent his career characterizing and measuring aquifers, first with the Moroccan Geological Bureau (*Bureau de Recherches et de Participations Minières*) and then at the Ministry of Public Works from 1971 to 1999. There, he headed the DRPE (1982–1992) before becoming head of the DGH (1992–1999). Throughout this period, the main executives of the DRPE, and more broadly of the DGH, had a similar profile (Mokhtar Bzioui, Mustapha El Haiba, Mohamed Aboufirass, Moulay Hassan El Badraoui, who took over as head of the Division in the early 2000s). After obtaining a degree in hydrology or hydrogeology in France, they spent most of their careers with the DGH, often combining it with additional consultancy work for international organizations, such as FAO, International Fund for Agricultural Development (IFAD), and the Arab Organization for Agricultural Development (AOAD).

Until the 1990s at least, they were supported in their efforts by foreign -mostly French- experts, such as Jean Margat (1924-), a French hydrogeologist. During the 1950s, Margat worked for the geological service of what was then the French Protectorate of Morocco. When he returned to France in the early 1960s, he joined the French Geological Bureau (*Bureau de Recherches Géologiques et Minières*) and went back to Morocco in this capacity. There, his activities and his team's activities were partly funded by UNESCO's International Hydrological Decade (1965–1974), later followed by an "intergovernmental hydrological programme" that continues to this day.[4]

Thus, in the early 1970s, the DGH estimated total "renewable" water at 25 billion m^3 (Bm^3) and "exploitable" volumes at 16 Bm^3 (Kingdom of Morocco, 1971). These estimates, which would be adjusted over the following decades (more on this below), were both modern in themselves and modernizing in their ambition. Their authors claimed that these modern numbers were as realistic as possible, given the available resources. Assessments of water reserves were based on a national measuring network, which increased from 35 hydrometric stations in 1956 to 300 in 1985, complemented with 80 climatological stations estimating evapotranspiration (HCP, 2006). In this way, Moroccan hydrologists operated within the paradigm of the prevailing hydrological science, which considered (rain)flow regimes as fundamentally stable entities that were knowable (and controllable) "once and for all" thanks to increasingly efficient measuring devices, long-term metrology and statistical instruments. This paradigm would later be profoundly destabilised by the structural decline in available water resources, particularly as a result of climate change and the overexploitation of groundwater.

These national estimates also had an actively "modernizing" effect because they highlighted the magnitude of the country's water potential (owing to the Atlas Mountains), compared to their less well-endowed neighbours, such as Algeria or Tunisia. The conceptual distinction between renewable and exploitable water resources reflected the close subordination of global quantification to modernization. Although it lacked a firm scientific base (as the definition of an exploitable resource depends on economic, social and technical evaluations which are inherently debatable), it showed that the political role of global quantification was to estimate the country's "hydraulic potential", i.e. the water that development policies could effectively mobilize.

Water quantification efforts were given a renewed impetus in the 1990s. Internationally, this decade was marked by the salience of growing water scarcity. Multiple organizations, including the FAO,[5] the World Resources Institute (WRI), the Consultative Group on International Agricultural Research (CGIAR), the International Water Management Institute (IWMI), and the International Food Policy Research Institute (IFPRI), were busy quantifying water scarcity worldwide (Fernandez, 2014). In Morocco, Jean Margat (1992) and Mohamed Jellali (1997) broadly agreed on estimates that were significantly higher than previous figures: 29–30 Bm^3 for renewable water resources and 21 Bm^3 for exploitable water resources. Renewable water resource estimates were based on a 30-year average of rainfall and

[3] All the acronyms for the Moroccan state bodies provided in the text are the French acronyms.

[4] See: https://en.unesco.org/themes/water-security/hydrology.

[5] See the database AQUASTAT, established in 1994.

evapotranspiration, between 1960 and 1990, combined with estimated infiltration and runoff coefficients (HCP, 2006). The average precipitation was estimated at 150 Bm^3, of which 121 Bm^3 was expected to be lost through evapotranspiration. There was also a broad agreement that the ratio between surface and groundwater resources was around 2/3 (between 20 and 22 Bm^3) and 1/3 (between 6 and 10 Bm^3). Variations in specific estimates mostly depended on how to consider double accounting – due to transfers between groundwater and surface runoff (Margat, 1992). However, these differences disappeared when it came to exploitable water: it was unanimously agreed that, of the 21 Bm^3 exploitable water resources, 16 Bm^3 were from surface water and 5 Bm^3 from underground water.

For many decades, then, Moroccan state has been strongly committed to achieving the most realistic quantification of water resources possible, in order to better plan its major hydraulic infrastructures. The use of numbers by State hydrologists was very much in line with that of the 'engineering State' as highlighted by Alain Desrosières: it measured physical units (m^3 of water) with the direct aim of maximising the quantities to be produced (in this case, infrastructure). In return, and according to a mechanism of mutual reinforcement also well highlighted by Desrosières, this use of quantification consolidated the authority of the Moroccan state.

3.2. National quantification and state legitimation

Investment in metrology legitimized the "dam policy", which was officially launched on 18 September 1967, with a speech by King Hassan II. The policy's objective was to irrigate some 1 million hectares by the year 2000. This involved increasing storage capacity from 1.5 Bm^3 in 1956 to 16 Bm^3 in 2000 (Swearingen, 1987). As a result of this policy, by 2021, 149 large dams had been built, with a storage capacity of around 19.1 Bm^3 (Kadiri, 2021). More generally, water quantification legitimized policies promoting hydro-agricultural modernization, whereby the state directed agricultural development through massive investments in infrastructure to store and convey surface water to agricultural plots. There was tight supervision of farmers' irrigation practices, control of food prices and subsidies for farm inputs. These investments both reflected and reproduced the hydro-agricultural social bases of the monarchy, which Houdret and Amichi (2020) have described as the Moroccan "rural social contract".

The dominant social base was made up of large landowners. It operated, first, through the preferential distribution of irrigable land, which the Moroccan state had gradually recovered from former French settlers in the 1960s. An official assessment drawn up at the end of the 1980s showed that over 320,000 ha of land were distributed to about 24,000 beneficiaries, less than 2 % of the population of farmers recorded at the time (Ministry of Agriculture, 1987: 17). Of this total, some 150,000 ha would later be irrigated. Swearingen has shown how the "old landed elite" took the lion's share of the distributed land, along with "military officers, government officials, large urban merchants and other wealthy Moroccans". Ultimately, the distribution of land through clientelistic lines would consolidate "a powerful force of 8,500 to 9,500 large landowning families (…) owning some 2.2 million hectares, or around 30 % of agricultural land, including most of the modern sector and areas irrigated with modern methods" (Swearingen, 1987: 51). This dominant social base was also bolstered by agricultural subsidies, particularly for fruit and vegetable production for export, and advantageous access to credit.

A wider, but also less dominant social base was made up of a broader base of small-scale irrigators, aspiring irrigators and related businesses in both upstream activities (public works, sale of seeds, irrigation equipment, etc.) and downstream activities (storage, marketing, processing, etc.). Several hundred thousand households benefited from state-led hydro-agricultural policies. In exchange for privileged access to irrigation water from the dams, which the state built and managed, the rural "notables" had to maintain social peace across rural areas, by ensuring that at least some of the accrued benefits went to poorer farmers as well (Leveau, 1985; Mayaux, 2021).

Beyond these privileged social bases, the quantification of water had wider legitimizing effects on the Moroccan population as a whole. It allowed the Moroccan state to claim a monopoly on scientific knowledge over water resources within its bounded territory. It expressed how, as Moroccan sociologist Paul Pascon (1984, p. 20) stated at the time, "knowledge today is essentially technical knowledge and technical knowledge is the monopoly of the administration". The Moroccan state asserted its monopoly regarding expertise on water in relation to other potentially autonomous knowledge centres in society, such as universities or farmers unions. In addition, it affirmed its expertise in relation to foreign agencies in an era of burgeoning "Official Development Assistance" (ODA). However, the Moroccan state's relative autonomy in terms of expertise did not prevent its rulers and bureaucratic engineers from tightly embedding themselves in transnational networks with the World Bank, the FAO and, above all, French post-colonial experts in the Cold War context (Longuenesse, 1990).

Overall, the national quantification of water resources rendered several scientific uncertainties invisible. The estimation of renewable resources is inherently subject to various approximations that the production of stable figures erased. Some are of a practical nature, related to the limitations of the measuring, statistical and modelling instruments used. Others are more epistemological and relate to assumptions regarding social processes, such as land and water uses, which depend on future, and necessarily uncertain, social and political choices, including levels of public and private investment. In particular, calculating exploitable resources is based on multiple assumptions regarding a wide array of heterogeneous variables, such as: the state's financial capabilities; soil erosion, which affects the reservoirs' storage capacity; and the nature and extent of engineering capacities and skills. All these uncertainties were rendered invisible by a state that claimed to enjoy a panoramic view of water resources.

From the 2000s onwards, the synergy between quantification and development of water resources came to a halt. Uncomfortable data began to proliferate, showing that demand for water now structurally exceeded available supply. How was the state going to deal with this new situation?

4. Uncomfortable evidence and the fragmentation of water quantification

From the 2000s onwards, evidence that exploitable water resources were being severely eroded proliferated. At the central level, it was produced and circulated by the DRPE. The DRPE compiles the data it receives from the water basin agencies (ABH) which were created by the 1995 Water Act. The ABH, of which there are now nine, have replaced the former Regional Water Directorates, and are formally more autonomous than their forbears. They enjoy a wide range of formal prerogatives that include developing and implementing river basin masterplans that define objectives and investment programs; authorising water abstraction and discharge; and monitoring both the quality and quantity of surface water and groundwater. The ABH represent an effort at 'integrated' water management, in a policy domain long dominated by the Ministry of Agriculture.

However, the new evidence of scarcity put forward by ABH and DRPE was of a very particular kind. Quantifiers related to these two institutions set out to quantify scarcity in a disjointed way, across numerous disconnected compartments. In so doing, they have studiously avoided synthesising these dispersed and heterogeneous measurements into an overall downward revision of the country's exploitable water. We present some of the inconvenient, scattered evidence in Section 3.1., before describing the main tactics that have been used to keep it fragmented in Section 3.2.

Diagram 1 below presents the timeframe of the main national estimates of water resources, the main actors and organizations involved in

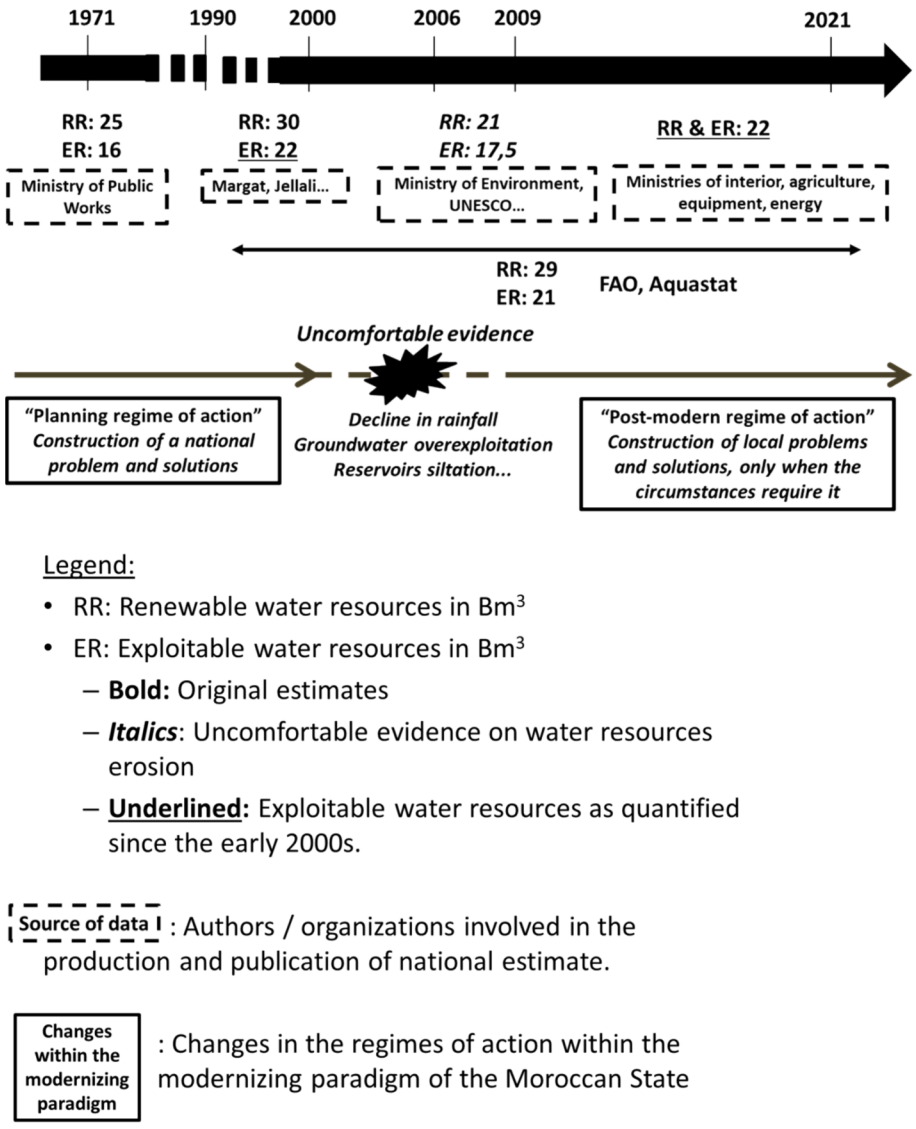


Diagram 1. A timeframe of water quantification in Morocco (Source: authors).

their production and the types of quantification.

4.1. Four well-documented sources of decline in exploitable water resources

Published in 2006, the Kingdom of Morocco's "Fiftieth Anniversary Report" provided a telling overview of how state agencies documented and acknowledged multiple sources of decline in exploitable water resources. The authors of the report on the water sector, Ali Agoumi and Abdelhafid Debbarh, were both professors and bureaucrats with very similar social profiles to the state hydrologists described earlier,[6] which made their critique even more significant. Their report is worth summarizing in detail because it sets out the main themes and scale of the Moroccan water crisis and provides the basis for numerous subsequent official documents. It highlighted four separate dimensions of water scarcity, without integrating them: the decline in average rainfall and, therefore, of rainwater runoff into surface water and infiltration into aquifers; the rise in average temperatures, which increased evaporation; the silting of dams, which drastically reduced the effective storage capacity of reservoirs; and water table drawdown that led to the long-term depletion of aquifers.

Their report began by stating, first, that "rainfall has shown a general downward trend in all regions of Morocco" (Kingdom of Morocco, 2006: 346). It highlighted that of the seven droughts the country had experienced since 1955, five had occurred since 1975 and they had lasted longer and were more severe on average than previous droughts. Second, the report indicated that the country had experienced an average warming of at least 1 °C over the past 50 years, which had caused a sharp increase in the rate of evaporation from reservoirs, although precise figures were not provided.

Third, the report went on to note that "the silting of dams recorded annually reaches 75 million cubic metres (Mm^3), equivalent to the retention of an average dam and to a volume of water sufficient to irrigate more than 10,000 ha". It also pointed out that "soil degradation, erosion and deforestation will have an increasing impact on reservoir storage capacities in the future" (Kingdom of Morocco, 2006: 208). Lastly, it highlighted the rapid drawdown of groundwater, which "would already have disappeared" without the intensive and concomitant mobilization of surface water (Kingdom of Morocco, 2006: 363). It documented massive drawdowns at various locations in the country: in

[6] Ali Agoumi is a professor at the Hassania School of Public Works. Abdelhafid Debbarh was Director of Executive Training at the Department of Higher Education (2004–2007) and former Director of the National School of Agriculture in Meknes (1999–2004).

the south (−17 m for the Souss Aquifer between 1969 and 1994); in the centre (−40 m for the Saïss Aquifer between 1980 and 1994); but also in the supposedly less affected northern part of the kingdom (−17 m for the Beni Mathar Aquifer).

This report was subsequently taken up and updated in a large number of official documents. They all continued to measure scarcity in disjointed fragments. Published in 2009, the National Water Strategy highlighted the magnitude of the downward pressures on water resources. Using data from the National Meteorological Department, it pointed out that water inflows to dams had decreased by 20 % when comparing the period 1970–2006 to a longer period 1950–2006. It also forecast a reduction in rainfall, compared to the 1961–2000 period, of 10–15 % by 2020 and 25–40 % by 2080 (Kingdom of Morocco, 2009: 27). Furthermore, it indicated that 75 Mm^3 of water was "lost" annually through siltation, in addition to the resource that was lost because of eutrophication in dam reservoirs due to nutrient leaching. Lastly, it estimated the total exploitation of groundwater at 5 Bm^3 per year, compared to a renewable volume of 4 Bm^3, amounting to a level of over-exploitation of 1 Bm^3. It stated that the drop in piezometric levels had caused "a significant decrease of average river discharges, reducing water inflows into dams, and also a drying up of springs and of natural lakes connected to aquifers" (Kingdom of Morocco, 2009: 32).

The accumulation of all these measurements clearly revealed the permanence of a scientific, quantifying ethos among state hydrologists. As one former Water Department official, who still works closely today with his former colleagues as a consultant, put it to us: 'I think the data is accurate. Because otherwise, if the data is wrong, I don't think we'll be able to manage the water for years to come. We're always going to have a problem if we don't have accurate data from the outset. How are we going to manage the data all the following years? (…) The information must be checked at national level to ensure that it is reliable and standardized[7]'. Another former member of the Water Department, who also now works for a consultancy firm, highlighted the continuous improvement in quantification techniques, particularly as a result of remote metering: 'Morocco is now in remote management mode. The whole of Morocco is in the process of converting all its piezometric, hydrometric, hydrological and climatic stations in general to remote measurement networks. The idea is to be able to centralise the data at the level of the DRPE, so that the data can be transmitted in real time, and the assessments can be updated instantly (…) We can no longer react, we no longer have the luxury of waiting a year to take stock and redo the planning. Because in a year of drought, we have to be very reactive and see what measures we should be planning. So, ideally, we want to have instant information so that we can react to it very quickly[8]". Being a good water bureaucrat still means, in 2024 as much as it did half a century ago, being able to produce reliable and credible measurements of the water available, and increasingly even in real time.

Over the following fifteen years, the many heterogeneous figures that have been produced were reiterated in numerous official and scientific documents (see for example: El Badraoui and Berdai, 2011; EESC, 2014; MEMEE, 2014; Kingdom of Morocco, 2018). They put additional pressure on the already fragile legitimacy of developmentalist policie, as they no longer highlighted the country's hydraulic potential, but rather underlined the severity of the water crisis and, potentially the futility of large infrastructure. We will now look at how state hydrologists have kept the data fragmented, avoiding aggregating it into coherent new global estimates.

4.2. Four practices of fragmentation

The wide array of evidence mentioned above has not been incorporated into national water estimates. On the contrary, assessments of exploitable water resources have remained remarkably unchanged since 1990, oscillating between 20 and 22 Bm^3, with no discernible downward trend. Table 1 below provides an overview of this striking stability over the last three decades.

As we can see, these increasingly unrealistic figures are not only put forward by Moroccan bureaucracies. They are also taken up and disseminated by international organisations such as the FAO and the World Bank. The reason for this is that donors simply use the data provided by individual countries. They are reluctant to confront them by questioning their figures, which are seen as an essential attribute of their sovereignty. As an FAO consultant explained to us: "For data on water withdrawals, it's almost exclusively data that comes from the countries (…) The idea is for it to be country driven[9]".

Four main neutralizing practices were used to to maintain these figures despite the many bits of evidence of water scarcity: taxonomic games; the use of long-term averages; the systematic non-updating of hydrographic data; and the foregrounding of "new" water resources, despite the major uncertainties surrounding them.

The first practice was to play with taxonomy. Its most emblematic illustration was the erasure of the previously central distinction between renewable and exploitable resources. This meant, at least implicitly, that all renewable resources were now considered exploitable, which contradicted the former realism. The erasure was effected in the 2009 National Water Strategy, which no longer included the category for renewable water. The only category that remained was that of "exploitable" water, estimated at slightly over 22 Bm^3 (18.195 Bm^3 for surface water and 4.067 Bm^3 for groundwater). Merging the two water categories allowed the authorities to acknowledge the decline in total volumes of renewable water -a widely documented fact- while simultaneously neutralizing the political ramifications of this decline by considering that all remaining resources could, after all, be effectively harnessed.

The second practice, specifically used for surface water, was to base water planning on long-term averages. Officially, the move was justified by the need to smooth out high inter-annual variability, a well-founded argument in itself.[10] However, in this case it was conveniently used to ignore the recent downward trend in water resources. It also meant that the issues of future climate change, and the increasing decline in water resources of around 30 % forecast for 2050, were kept off the agenda.

Table 1
The stability of national water resource estimates in Morocco, 1990–2021 (Source: authors).

Year	Source	Total exploitable water, Billions of m^3
1990	FAO (Aquastat)	20
1992–1993	World Resource Institute (source: Margat, J.)	
1995	UNESCO	21
1997	Jellali, M.	21
1998	World Bank (Water Resource Management Project Staff Appraisal Report)	20
2006	Agoumi & Debargh	20
2006	High Commission of Planning	20
2008	Margat, J.	20
2018	State Secretariat for Water and GIZ (CREM report)	22
2019	National Water Plan	22
2021	FAO (Aquastat)	22

[7] Interview, Rabat, May 5, 2021.
[8] Interview, May 17, 2021.
[9] Interview, videoconference, May 18, 2021.
[10] The National Water Plan, promulgated in 2020, estimated that annual exploitable water resources could range from 3 Bm^3 (in 1992) to 48 Bm^3 (in 1961) (PNE, 2019, p. 47).

For example, the 2019 National Water Plan was based on an average estimate of surface water resources for the entire period 1945–2018. Therefore, the estimate for surface water could be maintained at about 18 Bm^3 (18.157 Bm^3).

The same tactic was used to quantify water resources at the level of large watersheds. For example, the 2012 Master Plan (PDAIRE) for the Bouregreg-Chaouïa Basin (which includes Rabat, the capital city), was based on two long-term hydrological averages for the periods 1939–2005 and 1972–2005, respectively. This downplayed the documented decline in water resources which only began in the 1980s and increased in the 1990s. Ultimately, only the longer period of 1939–2005, with its higher estimates, was actually retained as a basis for planning decisions (see Table 2).

The third practice was the systematic non-updating of public data. The legal framework facilitates this tactic because it does not impose any specific periodicity for the quantitative assessment of water resources.[11] This practice was also aided by the fact that, despite what the 2016 Water Act (36–15) mandates, there is no genuine, up-to-date and accessible national information system on water. Yet establishing such a "SNIE" was declared a national priority by the 2009 Water Strategy, the 2016 Water Act and the 2019 Water Plan. Its absence was more recently deplored by a panel of experts (Groupe de l'Eau, 2022: 18) in a report drafted in 2022.[12] Thus, in the 2019 Water Plan, groundwater withdrawals could still be estimated at 5 Bm^3, a volume exactly identical to that already estimated in the 2009 National Water Strategy. Thus immutability raises legitimate doubts, given the "anarchic and uncontrolled exploitation of groundwater, with increasingly deep drillings", which has been well documented by the State itself throughout the same period (Groupe de l'Eau, 2022: 17). More generally, the expert panel pointed to "a lack of data, and uncertainty about the reliability of the data that is available" (p. 18). In 2018, the Moroccan Court of Auditors also noted a "lack of assessment of water resources in the context of climate change" (Cour des Comptes, 2022: 29).

Similarly, at the level of large watersheds, complete and accessible versions of the water plans (PDAIRE) have not been made available since the early 2010s. With the 2016 water act, the state officially permits this kind of delay. Although the 1995 water act stipulated a revision of the PDAIRE every 5 years, the 2016 water act made the revision optional and extended the time frame to 10 years. As a result, in 2024, the last wave of fully completed PDAIRE dated back to the 2007–2012 period.

At the same time, the 2016 water act states that the PDAIRE must only provide an 'overview [*synthèse*] of the current quantitative situation'. This limited 'overview' does not amount to any obligation to carry out a new, systematic measurement campaign. Consequently, as an expert from a consultancy involved in drawing up several of these plans pointed out to us, 'When a PDAIRE process is launched, we come with a battery of data that has already been pre-established (…). The PDAIRE doesn't come in to redo this work; the PDAIRE comes downstream to say: here's the data that exists'. When we enquired whether "in fact, then, the consultancy firms are simply summarising the data that already exists?', our interviewee replied, embarrassed: 'Yes. Absolutely, well, of course… no'; before adding, thinking he was putting things into perspective, that 'PDAIREs are only internal documents, bureaucratic documents anyway[13]'.

Fourth, official reports have introduced "new" water categories, even though their status is scientifically highly ambiguous and debatable. Quantitatively, the most important of these resources are "saved" water resources. They emerge from improving irrigation efficiency, for example by converting from a sprinkler or gravity-fed system to drip irrigation. In this spirit, in 2007, the National Program for Water Savings in Irrigation (PNEEI) set out to convert some 550,000 ha of land to drip irrigation. The expected outcomes included water savings ranging from 30 to 50 %, amounting to a total of around 1 Bm^3 of "saved water".[14] In the 2009 National Water Strategy, the potential for water savings in the irrigation sector was inflated to no less than 2.5 Bm^3 by 2030, again mostly by converting to drip irrigation (2 Bm^3/year), now combined with improved conveyance efficiency, volumetric pricing and awareness raising campaigns. The same figures were repeated seven years later by the CESE (2014), and again in 2019 by the National Water Plan. The latter indicated that drip irrigation would allow some 1.4 Bm^3 of water use reduction, with a further reduction of 1.1 Bm^3 largely due to the modernization of pipes and networks.

The "saved water" category followed the logic adopted since the 1990s under the umbrella term of "water demand management". However, this approach has come under mounting criticism, particularly with respect to the expected benefits of drip irrigation. Scholars have pointed to a number of reasons why the potential water savings brought by drip irrigation might be illusory. For example, farmers could over-irrigate (compared to theoretical standards) because of inertia in their farming practices and risk aversion; drip irrigation may reduce return flows at the aquifer or watershed level; agricultural intensification might bring changes in cropping patterns and/or crop densification; and lastly, as drip irrigation is less labour-intensive, many farmers may use their additional revenues to expand their irrigated area – a classic example of the "Jevons paradox" or rebound effect (for a recent review see Perry and Steduto, 2017). For all these reasons, intended savings may well be mere "paper savings", amounting to a reallocation of water across space and between users, rather than a genuine reduction in water use (Molle et al., 2010). It is highly unlikely that the Moroccan authorities are unaware of this extensive evidence, and therefore of the fact that far less than 2.5 Bm^3 will actually be "saved".

National policy documents also promote another type of 'new' water resource, namely, "unconventional" water. In the case of Morocco, it includes desalination and the reuse of treated wastewater. Official figures estimate the volumes used today at 164 Mm^3 for desalinated water and at around 65 Mm^3 for wastewater reuse (Cour des Comptes, 2022). The National Water Plan projections for 2050 show figures of 1 Bm^3 of desalinated water and 340 Mm^3 of reused wastewater. Although the goals for desalinated seawater may be physically realistic, they are quite implausible given the magnitude of capital costs, as well as operating costs related to the amount of energy required. The intended volumes of treated wastewater are even more questionable, not only for economic reasons, but also on a biophysical level. In most areas, particularly those located some distance from the coast, treated wastewater contributes to river flows. It is already used downstream and plays an important role in the functioning of aquatic and riparian ecosystems, especially in the context of river basin closure that is prevalent in Morocco. In these areas, any new water use corresponds to a reallocation of resources.

To summarize, since the mid-2000s, water scarcity has been measured in a fragmented and scattered way. Taken together, the various neutralizing tactics have generated fuzziness, uncertainties and a systematic overestimation of national water resources. However, they also have enabled state hydrologists to continue to legitimise themselves through quantification, while avoiding the political problems that such quantification could pose. Water bureaucrats appear anxious not to call into question the 'numerical narrative' of 20–22 Bm3 of available water.

[11] The 1995 water act, supplemented by the 2016 act, only specifies that this assessment is the responsibility of the basin agencies.

[12] Describing themselves as a "group of graduates of the Hassan II Agronomic and Veterinary Institute", one of the kingdom's two most prestigious agronomy schools, most of these experts had held responsible positions in the field of irrigation within the Ministry of Agriculture, in addition to often prestigious international careers.

[13] Interview, Rabat, May 17, 2021.

[14] More precisely, the PNEEI project document had a water saving target of 826 Mm^3/year, including 514 Mm^3/year in large-scale public irrigation schemes ("reconversion") and 312 Mm^3/y in individual groundwater-based irrigation.

Table 2
The long-term averages of the Bouregreg-Chaouïa Master Plan (Source: PDAIRE, 2012).

Period			1939–2005		1972–2005	
Hydrographic region	Surface (km^2)	Site	Inflows (Mm^3)	Inflows/region (Mm^3)	Inflows (Mm^3)	Inflows/region (Mm^3)
Bouregreg	9524	SMBA	650.7	674	480.6	498
	563.5	Akrach	23.3		17.3	
Atlantic coast	350.7	Yquem	22.2	155	21.9	139
	2640	O El Malleh	76.7		65.1	
	830	N'fifikh	25.1		21.4	
	284	Hessar	8.6		9.2	
	700	Cherrat	22.1		21.8	
Chaouïa	272.8	Bouskoura	8.2	23	8.8	24
	630	Tamdrost	1.8		2.3	
	197.2	Merzeg	5.9		6.4	
	70	Touijine	0.9		0.9	
	183	Oued Mazer	2.3		2.2	
	166	Boumoussa	2.1		2.1	
	173	El Hamer	2.0		1.6	
Total				852		662

An official from a European funding agency highlighted the discrepancy, on the part of basin agency directors, between quiet criticism and official conformism: 'When the atmosphere is informal, they can get carried away about the contradictions of water with agriculture and so on. But as soon as things become institutional, they become bland[15]'. We will now highlight the positive effects of this overestimation in terms of legitimacy, by examining the case of a mega infrastructure project, and the way in which the fragmentation of quantification has contributed to shield it from criticism.

5. The usefulness of fuzziness: sustaining the promises of water for all in the Saïss Plain

The Moroccan state has used data fragmentation to prevent water scarcity from being socially defined as a structural, and unsurpassable, condition. In so doing, governing elites have been able to manage water-related social tensions on a local, case-by-case basis. They have been broadly successful in preventing a wider (re)politicization of the dominant agricultural model, which is based on the paradigm of "irrigationism". In this way, they have maintained the modernizing social compromise between the state and irrigators, which was established after independence.

A good illustration of the political usefulness of fragmented data is the hydro-agricultural development project on the Saïss Plain. Covering over 200,000 ha between the cities of Fez and Meknes, the Saïss Plain is one of the country's main fruit and vegetable production areas. Since the 1980s, it has witnessed a massive development of irrigated agriculture, fueled by a "boom" in groundwater extraction (Fofack et al., 2015). The number of wells and boreholes on the plain increased from around 900 in 1980 to more than 10,000 in 2015 (Bouignane and Serrhini, 2015). The whole process has caused an acute over-exploitation of the water table: today the overdraft is estimated at about 100 Mm^3 per year. To remedy this, 125 Mm^3 of water is to be transferred from a new dam, the M'Dez Dam, still under construction in 2024. The idea is that the surface water from the dam, which could supply up to 30,000 ha, will be a substitute for the "excessive" groundwater that is currently being pumped and, in so doing, will help bring the aquifer back into balance. Thus, the project is justified by a discourse of water security, which frames it as an urgent, and therefore indisputable, way of "safeguarding" the Saïss aquifer. As in many other contexts, water scarcity legitimizes the need for major hydraulic works, thanks to a rhetoric of securitization (see: Alexandra and Rickards, 2021).To achieve this stated objective, water from the dam will only be allocated to current well owners. Meters will be installed at their wells to allow the state services to monitor whether the substitution is effective (see Map n 1).

The assumptions underlying this substitution project appear extraordinarily optimistic in the light of available data. Overestimating water resources, both surface water and groundwater, has been made possible by some of the tactics identified in the previous section.

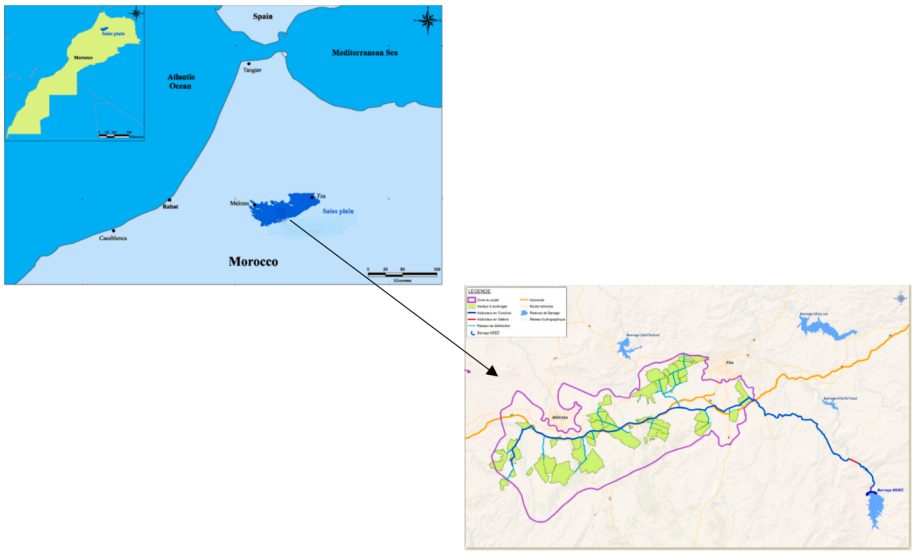
First, in the 2011 Master Plan for the large Sebou Watershed (PDAIRE), within which the Saïss Plain is located, estimations of surface water inflows are based on a long-term average, covering the period 1939–2009 (Kingdom of Morocco, 2011). The authors of the PDAIRE themselves note that taking a shorter reference period, that of 1973–2009, would have produced a 23 % lower estimate (3,856 Mm^3 versus 4,984 Mm^3). An even shorter period, starting in the 1980s, would make the decline in water inflow even more pronounced. Similarly, groundwater measurements, including that of the Fès-Meknès Aquifer, are based on the period 1939–2002. Consequently, it is highly likely that their estimated recharge (1,572 Mm3 per year) is greatly overestimated, as is their actual capacity to replenish wadis and outflow springs (878 Mm3). In contrast to these optimistic estimates, lower inflows have resulted in the gradual emptying of existing dams throughout the watershed since at least 2015. For example, the Idriss 1er dam, which will be mechanically deprived of some of its water by the M'Dez dam, has already seen its storage rate decline sharply.[16] Furthermore, the agricultural uses of the water stored in the M'Dez Reservoir will compete with domestic uses, such as the supply of Fez (36 Mm^3) and other neighbouring cities. These domestic uses will have legal priority over agricultural uses. Finally, and by definition, long-term averages do not take into account the effect of future climate change, although water inflows are expected to decline by a further 20 % in the watershed, according to the National Meteorological Agency (IAV Group, 2022: 14). Therefore, the state plan to fill the M'Dez Dam by the end of 2025, in less than a year, appears highly uncertain.

Second, the figure for over-exploitation (100 Mm^3) has not been officially updated since 2011. Diagram 2 below is still used in official documents today.

However, this figure is out of date. For example, a more recent study

[15] Interview, Rabat, March 19, 2019.

[16] In November 2022, for example, the dam was only filled to 22 % of its capacity.



Map n 1. Location of the Saïss project.

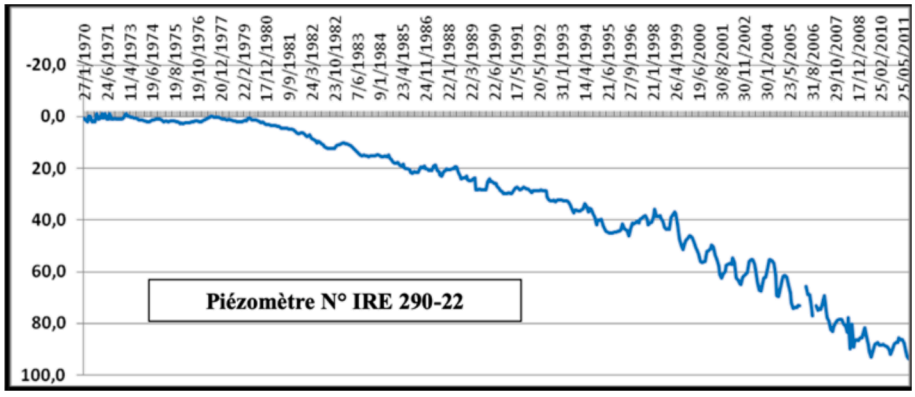


Diagram 2. The non-updating of overexploitation figures for the Saïss aquifer, as of 2023 (source: PDAIRE – Sebou, 2011). Legend: "Piézomètre" = piezometer.

conducted in 2018 estimated over-exploitation levels at −182.5 Mm^3 (Sinan, 2018: 121). However, this "interim report" was never officially endorsed. It was announced several times in the national press that a new version of the PDAIRE was being approved, but this version has yet to be made public.[17] In other words, even if the dam could be filled as planned, its storage capacity would not be sufficient to bring the water table back into balance.

Finally, the state expects to save some 40 Mm^3 of water by converting 20,000 ha to drip irrigation (Kingdom of Morocco, 2011). As discussed in the previous section, however, these expected savings hardly seem plausible in light of the numerous research studies that have shown that potential water savings brought by drip irrigation were likely to be illusory. Furthermore, the Moroccan state has a poor track record when it comes to effective monitoring of water consumption.

This selective "blindness" is politically useful, however. It reproduces the fictitious narrative of a "substitution project" aimed at halting groundwater over-exploitation. This narrative is widely communicated to the general public, disseminated through the media and put forwards in leaflets presenting the project. It is also vital for the project's international donors: the European Bank for Reconstruction and Development (EBRD); and the Green Climate Fund, a financial mechanism of the United Nations. Both organizations support infrastructure projects on condition that they make a positive contribution to "sustainable development", rather than worsening the over-exploitation of scarce resources.

For the farmers concerned, the inflated volumes of water that are announced help sustain the promise that there will always be enough water for them. The state promises future contracts that will guarantee access, for every farmer, to some 4,000 m^3 of water/ha/year. This promise makes it possible to postpone difficult questions of social justice, which would necessarily arise if the overall amount of available water was significantly reduced. Will fewer farmers than announced be actually allowed to access water from the dam? What will the state do if it fails to supply the guaranteed volumes of water? Will it allow farmers to pump the water they need from the aquifer, which would go against the commitments made to international donors, to the general public and to other groundwater users? Inevitably, also, filling the dam will sharply reduce the river flow rate immediately downstream, affecting the farmers and livestock breeders who have been using this water and who are not included in the project.

The state uses data fragmentation and overall fuzziness to buy time. In so doing, users' grievances can be addressed on a case-by-case basis, if and when they arise. How they are precisely managed will depend on the specific nature of the issue, and on the bargaining power of the rightholders who happen to be disadvantaged. Meanwhile, the legitimacy of the project as such will remain unchallenged. Governing actors can continue to maintain the fictitious narrative that modern irrigation

[17] The 360, "Un nouveau plan directeur du bassin du Sebou", 13/02/2023.

policies, and the social compromises that they sustain, can be reproduced indefinitely. The systematic "downscaling" of negotiations and of the solutions which are put forwards (a new reservoir, a new intake in a dam, a desalination or demineralization plant, a wastewater reuse project, etc.) helps perpetuate the promise that there is still some room for manoeuvre and some hope of water access for every farmer, even in a "closed basin" where all the water has in fact already been allocated (Molle et al., 2010). As a result, the large estimates that guide water policy and planning are increasingly removed from the biophysical reality that they purport to describe.

6. Conclusion: The politics of (selective) state blindness

The study of how the Moroccan State, over the last two decades, has been quantifying water scarcity, highlights the deeply ambivalent nature of quantification. In contrast to what critical studies on water have highlighted in many contexts, quantification is not necessarily, in a binary perspective, either 'favourable' or 'unfavourable' to State interests. Rather, as Boudia and Jas (2014) have shown in the case of toxic substances in water, quantification can be both indispensable and feared.

By bringing the literature on the production of doubt to bear on the issue of water quantification, we have provided a nuanced view of the relation between knowledge and ignorance. The Moroccan state is neither a "merchant of doubt" nor a "post-truth politician" (Lockie, 2017) which would actively seek to obscure climate change and its impacts, conceal the downward trend in rainfall, or downplay the silting up of dams. It does not deploy "alternative numbers" and counter-expertise on these issues. Instead, it is a state ridden with contradictions because its structural relation with its society are deeply at odds with ecological limits. On the one hand, state hydrologists continue to believe that a modern state should produce reliable data. On the other hand, however, they are fully aware of the political risks that may arise if this data were aggregated nationally. As a result, they have continued to produce uncomfortable data, but kept it studiously scattered in an attempt to neutralize its political significance. This is an emblematic example of those "clumsy solutions" identified by Steve Rayner.

This ambivalence echoes other findings, such as Alexandra's (2020) on Australia's Murray Darling Basin. While the social and political situation differs in obvious ways from that in Morocco, the legacy of large-scale water infrastructure development, and the ecological limits it is now running up against, are broadly similar. In Australia, local bureaucrats confirmed that the failure to reform water allocation in the wake of the "millennium drought" from 1996 to 2001 was primarily related to the political risks this entailed. Until now, much like in Morocco, planning has repeatedly ignored scientific warnings about the overall drying trend in the watershed, even though it has continued to produce a great deal of local data, for example on individual dams (Alexandra and Rickards, 2021).

Our finding is also consonant with Frickel and Kinchy's general proposition (2015) that the definition of scales, both spatial and temporal, generates forms of ignorance. The Moroccan state has spatially fragmented its knowledge, and has selected convenient periodisations, to invisibilize et depoliticize water scarcity. Correlatively, aggregate figures now used for planning purposes at the scale of large watersheds and at national level have drifted into pure fiction. The endlessly repeated estimates of 20–22 Bm^3 of available water contrast with a rare independent study in 2022, which evaluated water resources at only 10.4 Bm^3 for the 2015–2021 period, compared to 21.7 Bm^3 for 1945–1980; an astonishing reduction of 52.1 % (IAV Group, 2022).

The question remains as to the political viability of this approach to regulating conflicts. How long can the state keep up this 'clumsy' compromise between seeing and not seeing? It is hard to imagine that these contradictory practices will be able to persist for long, as they are the source of strong cognitive dissonance for state hydrologists. What, then, are the most plausible developments? One possible scenario would be for the Moroccan government to measure less, or simply stop communicating key figures, i.e. to engage in more active manufacturing of ignorance. This scenario seems unlikely however, given the central role that quantification continues to play in political legitimation. Another option would be to revert to long-standing, modern practices and reintegrate quantification. This return to realism would be politically offset, and rendered manageable, by the promise of 'new' water resources, especially seawater desalination. In our view, this is the most likely scenario in the short-term. However, there are major uncertainties surrounding the capacity of this technological fix to balance, in the longer term, the "water gap" created by decades of "irrigationist" policies. In this scenario, contradictions between quantification and modernization would likely re-emerge sooner or later.

A third scenario, normatively more desirable, would involve an explicit admission that national water resources have permanently diminished. It would rely more on public debate to manage tensions between scientific and political modes of veridiction (Barbier et al., 2020). A fundamental rethink of hydro-agricultural policies would be set on the agenda. It would contemplate a break with irrigationism and a possible transformation of the dominant social alliances. Will the water crisis in Morocco end up fuelling a genuine public debate around water numbers? Will it lead to a more pluralistic approach to quantification and, ultimately, to different modes of water allocation? Only time will tell.

CRediT authorship contribution statement

Pierre-Louis Mayaux: Conceptualization, Data curation, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing. **Sara Fernandez:** Conceptualization, Data curation, Investigation, Methodology, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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