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Governance and Sustainability Challenges in the Water Policy of Morocco 1995–2020: Insights from the Middle Draa Valley

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Abstract: Since the UN Water Conference in 1977, international debates have centered on global water scarcity and achieving sustainable development. In 1995, Morocco introduced a water policy to strengthen the country's socio-economic development through irrigated agriculture, while ensuring the long-term sustainability of water resources through integrated water resource management (IWRM). Empirical research, however, reveals decreasing groundwater levels and increasing inequalities around water access. The purpose of this article is to shed light on the challenges this policy provokes for achieving sustainable development, the limitations it faces to implement IWRM, and provide insights on how the policy is linked to the increased pressure on water resources as reported in the literature. We conducted a content analysis of ten key water policy documents and thirty-seven in-depth semi-structured interviews undertaken between 2020 and 2021 with governmental actors and inhabitants of the Middle Draa Valley (south Morocco). We found that sustainability and social-inequality problems unintendedly triggered by the policy were linked to three factors: the use of a disciplinary approach for policy formulation and its limitations to encompass the complexity of the water-related problems, the compartmentalization of government sectors hindering the development of sound solutions to water-related problems, and the neglect of social, economic, and political factors affecting actual access to water.

Keywords: Morocco; Middle Draa Valley; water policy; sustainable development; IWRM; access to water

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1. Introduction

Since the UN Water Conference in 1977, international debates have increasingly focused on the risks arising from water scarcity at a global scale and on finding ways to achieve sustainable development [1]. With many developing countries facing the challenge of water scarcity, the associated narrative became the foundation for promoting the Integrated Water Resources Management (IWRM) [1]. During the last three decades, the adoption of this paradigm has had an important influence on the way water policies have been formulated in these countries. The main prescriptions of IWRM include the Dublin principles: Fresh water is a finite and vulnerable resource, essential to sustain life, development, and the environment. This calls for a holistic approach linking water and land uses, social and economic development with the protection of ecosystems. Water should be managed within the boundaries of river basins, and it should be treated as an economic good to deal with its competing values and promote economic efficiency in its use. Participative approaches should be applied in water development and management, and the role played by women in the provision, management, and safeguarding of water must be recognized. In addition, IWRM proponents proclaim that governments should focus on demand management policies rather than on increasing water supply. The ultimate goal of IWRM is to maximize the economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems [1,2].

Today, IWRM is the dominant water policy paradigm around the world, yet its hegemonic positioning is more the result of discourse coalitions and the popularity of the concept than of any proof that it can achieve more sustainable outcomes [2–4]. Critics of this paradigm point to internal inconsistencies that make it unimplementable [5,6], as well as to a lack of clarity on how to achieve integration of water management into other fields [7]. Consequently, IWRM is interpreted and deployed by different actors in different ways in accordance with prevailing political interests and ontological and epistemological frameworks [2]. The need to find effective ways to connect water management to the management of other environmental resources, human health, economic growth, and social equity, is well-illustrated in [8–10]. The efforts made in the water sector to find better ways of assessing progress on the Sustainable Development Goals' targets [11] is also a manifestation of the limitations of the IWRM paradigm. This debate highlights the fact that there is still no certainty on the requirements for sustainable and integrated water governance [9].

Despite growing criticism of the IWRM paradigm, governments around the world continue to turn to this paradigm as a framework that proposes concrete courses of action to deal with water scarcity. In Morocco, water scarcity is framed by the government as a major obstacle for achieving socio-economic development. As population growth and economic development increase the demand for water, the Moroccan government foresees even greater pressure on both groundwater and surface water resources in the coming decades [12,13].

To enable the country to adapt to changing water conditions and meet a sustainable socio-economic development in the long term, the Moroccan government launched a water law in 1995 that announced the implementation of a new national water policy [14]. The 1995 water law reformed the country's legal framework and declared the adoption of the Integrated Water Resource Management (IWRM) paradigm. This new water policy also contributed to a consolidation of the transition started in the 1980s from a hierarchical and state-coordinated water management model to one in which management and maintenance responsibilities are partially transferred to water user associations [15]. Nonetheless, an important continuity with past water policies is the commitment to further constructing large-scale water infrastructure to increase the country's water supply [16,17], which is in direct contradiction with the water demand management approach suggested by IWRM.

Despite the efforts made to improve the water management in the country, the situation regarding water in Morocco has been described as critical [17–19], and some authors argue that the water policy has placed even heavier pressure on water resources, particularly on aquifers [20–23]. For instance, Molle [22] points to a contradiction between Morocco's agricultural policy (Green Morocco Plan 2008–2020) and its water conservation policies. The author concluded that incentivized expansion of groundwater-based agriculture through a highly subsidized production process results in the further depletion of water [22] (p. 17). Other authors show how aquifer depletion in Morocco is linked to the flourishing of a groundwater economy from the 1980s [21,24,25]. Stimulated by expanding agricultural markets, ambitious agricultural policies, and the reduced costs of well drilling, pumping, and irrigation equipment, "hundreds of thousands of private tube-wells" were created at farmers' own initiative [21] (p. 587). These different studies indeed illustrate how current water use trends in Morocco have placed greater pressure on existing resources in the country.

This article aims to identify the challenges the water policy of Morocco during 1995–2020 provokes for achieving sustainable development and the limitations it faces to implement IWRM. To this end, the article first analyzes how water policy documents frame water-related problems, goals, and solutions. Second, the article analyzes the key water governance challenges identified by water managers and water users in the Middle Draa Valley (MDV). In this way, the article helps to better understand how this policy contributes to the increased pressure on water resources reported in recent years in the literature. The MDV is one of the driest regions in the country and faces problems of water scarcity [12,13]. Therefore, it brings important insights on the interactions between national policies and everyday local

dynamics of access to water that can be useful not only for better understanding the case of Morocco but also other semi-arid and arid regions in the world.

The MDV is located in the Anti Atlas region, south of the Central High Atlas Mountains and north to the Saharan Desert. It covers 15,000 km^2 and is composed of six river oases. Zagora is the main city of the MDV and contains around 39,987 residents [26]. The climate of the region ranges from arid to hyper-arid [27], presenting an annual rainfall average of around 70 mm at the meteorological station in Zagora [28]. The average potential evaporation goes up to 3000 mm [29]. In 1972, the government built El Mansour Eddahbi Dam to regulate the water flow of the Draa River. Among the canals used for distributing the water of the dam along the MDV, the government distinguishes three hierarchical levels: "main canals" (210 km), which are the responsibility of the Regional Office of Agricultural Development—Ouarzazate (ORMVAO), "connection and secondary canals" (150 km), which are the responsibility of irrigation water user associations (WUAs), and "traditional seguias" (1160 km). These traditional canals transport water from secondary canals to the territory of each village and are managed in a traditional system implemented by the canal users (interview Gov.01, 25 February 2020). The effects of climate change are reducing reservoir inflows [30] and siltation has reduced the water storage capacity of the reservoir from 583 million m^3 in 1972 to 428 million m^3 in 2020 (interview Gov.01, 25 February 2020). In combination, these processes have forced governmental dam managers to reduce the number of dam water releases during normal years from seven to four (interview Gov.01, 25 February 2020). Consequently, farmers increasingly rely on groundwater and report a reduction in their agricultural yields.

The paper is divided as follows. Section 2 introduces our methodology, and Section 3 presents the results in two parts. The first part lists the policy problems, goals, and solutions addressed in the policy documents and explains how they are framed and articulated. The identification of the main ideas and values promoted by the particular framing of policy problems and goals allows the reader to understand the rationales that shape the water policy of Morocco 1995–2020. The second part of the results section presents the main water management challenges identified from the semi-structured interviews with government actors and residents of the MDV. In Section 4, we discuss our results, and Section 5 presents conclusions and recommendations.

2. Methods

This study is based on the evaluation of policy documents and qualitative data gathered during fieldwork conducted in the Middle Draa Valley between February to March 2020 and October to December 2021. The Middle Draa Valley is composed of six river oases. From upstream to downstream, the oases are Mezguita, Tinzouline, Ternata, Fezouata, Ktaoua, and M'hamid (see Figure 1). The analyzed interviews were conducted in all these oases with the exception of Mezguita.

The analyzed documents (listed in Appendix A) were identified as relevant after reviewing governmental documents, official websites of the government, specialized literature, and interviewing public servants of the Regional Office of Agricultural Development—Ouarzazate (ORMVAO), the Agricultural Subdivision—Zagora, the River Basin Agency—Draa, Oued Noun, the National Office of Electricity and Drinking Water—Ouarzazate, Zagora (ONEE-Ouarzazate, ONEE-Zagora), and the National Agency for the Development of the Oasis and the Argan Tree (ANDZOA-Zagora). As some documents, such as the National Program for Saving Water in Irrigation (2007), the National Water Plans, and the Drinking Water Supply and Irrigation 2020–2027 (2020), are not publicly accessible, we resorted to documents published on the official websites of the Ministry of Equipment, Transport, Logistics, and Water, and the Ministry of Agriculture and Maritime Fisheries (Appendix A), as well as documents of high-ranked government officials published in international journals and events, such as the presentations in [31,32] and the paper [33].

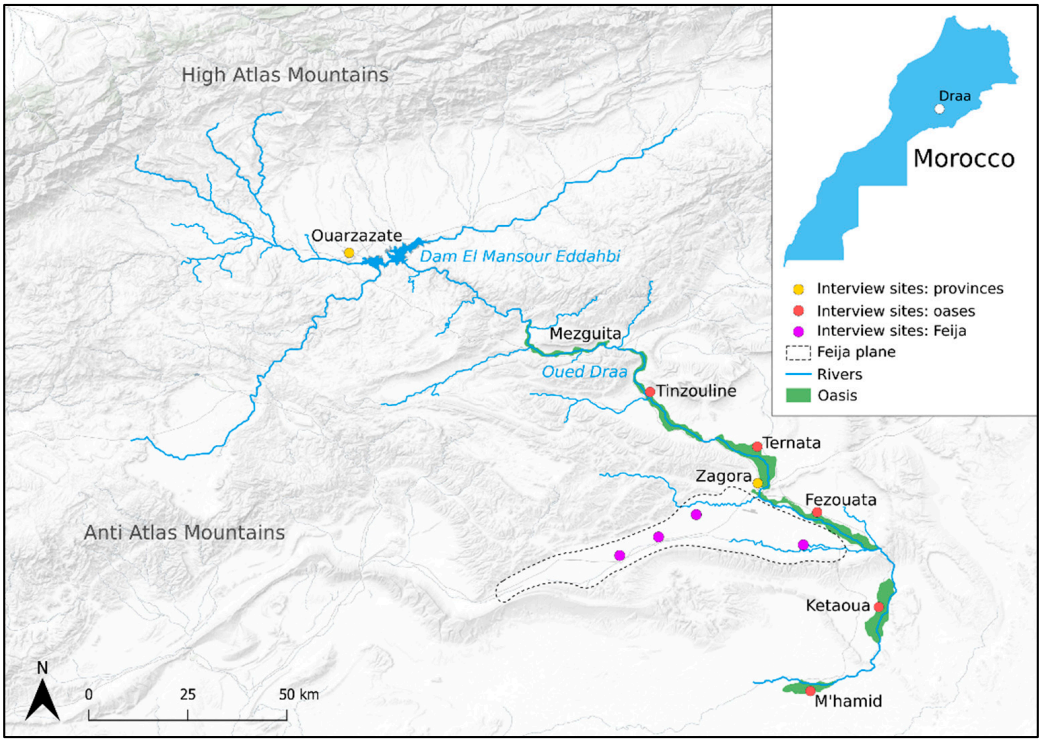

Figure 1. Location of Middle Draa Valley.

We used a purposeful sampling strategy to select interviewees in the government and inhabitants of the MDV. The purpose of the interviews was to understand what the water-related challenges identified by water managers and water users are and how they perceive these water-related challenges (see Appendix A). The government interviewees were selected based on the identification of the main governmental institutions linked to water resources' management in the study area. For inhabitants of the MDV, we used a "snowballing" sampling procedure in combination with a "maximal variation" approach [34]. The latter approach aims to obtain the perspective that actors with different backgrounds have about the studied phenomenon. We focused on interviewing inhabitants from different areas of the MDV, from different age groups, different sex, ethnicity, and with different occupations. To protect the identity of our interviewees we assigned a code to each of them and use these codes every time we insert a quotation. For government officers we use the code Gov. followed by a number (i.e. Gov.01). For inhabitants of the MDV we use Inh. and a number (i.e. Inh.05). For representatives of irrigation water user associations, we use WUA and a number (i.e. WUA04).

In total, 37 semi-structured interviews were conducted with 31 interviewees (Table 1). Among them, 26 were male and 5 were female interviewees, with different occupations, such as governmental officers, farmers, house maids, university students, and people working in the service sector. In addition, five female members of a cooperative producing and selling henna participated in a focus group in which problems related to access to water and land were discussed. Ten of the thirty-seven interviews were conducted with governmental actors. Twenty-one interviews were conducted with farmers of the MDV. Four of these farmers are also representative of irrigation water user associations. Interviews with farmers were conducted in Amazigh and Darija. Interviews with government officers were conducted in French and Darija. Interviews in Amazigh and Darija were translated by a native speaker. Most interviews were audio-recorded and transcribed in English.

Table 1. Number of interviewees by type and sex (Luis Miguel Silva-Novoa Sanchez).

Type of Interviewees	No. of Interviewees	Male	Female
Government	10	9	1
Irrigation water user association	4	4	0
Inhabitants	17	13	4
Total	31	26	5

With the support of MAXQDA software, we conducted a content analysis of 10 governmental documents (see Appendix A), the 37 semi-structured interviews, and the focus group discussion. We combined a deductive approach (codes selected in advance based on our key concepts) with an inductive approach (themes assigned as codes as they emerged from the documents). Codes established deductively are "policy problems", "policy goals", and "policy solutions". The analyzed documents are written in French, with the exception of "Water sector in Morocco: situation and perspectives" [33], which is written in English. The coding process was conducted in the original language. We have translated the quoted segments from French to English and double-checked the translation with a certified native speaker. To analyze the interviews and focus group, parent codes established deductively were: "Policy Solutions" (subdivided in "increasing water value", "water resource protection", "water saving", and "increasing water supply"), and "Policy Problems" (we used the policy problems identified in the document analysis as sub-codes). In addition, a third group of codes emerged inductively, "Local water-related dynamics". Among the main sub-codes in this group, we have: "unequal access to water between upstream and downstream oases", "unequal access to water inside the oases", "water-related conflicts", "salinization of soil and water", "development of new agricultural areas outside the traditional oases", and "aquifer depletion".

By National Water Policy, we refer to a set of broad goals and strategies set-up to organize the management of the national water resources for the long term in a structured and organic way to resolve public problems or to take advantage of given opportunities [35] (p. 8). In relation to "policy problems", we agree with Hanberger on the notion that " . . . policy problems are socially or politically created. From an ontological point of view, there are no objective policy problems" [36] (p. 53). In this sense, we are considering as policy problems those situations, facts, and processes that are framed in the analyzed policy documents as problems, or more generally, as undesirable conditions to the public interest and consequently require some kind of government intervention to either prevent the problem, change it in a way that leads to a more desirable situation, or mitigate the negative effects. By "policy goals", we mean explicit objectives framed in the policy documents in terms of the purposes of the policy. The concept of "policy solutions" alludes here to the concrete set of measures planned to be implemented by the government as means for achieving the policy goals.

3. Results

The results are presented in two sections, one corresponding to the outcome of the content analysis conducted on the policy documents, and the other to the semi-structured interviews conducted in the Middle Draa Valley.

3.1. Policy Document Analysis

In this section, we identify the main water-related problems targeted by the policy documents, as well as the policy goals and solutions these documents proposed to address these problems (see Table 2 at the end of this section). The analysis of the way policy goals and solutions has been framed will help us to discuss the way the paradigms of sustainable development and IWRM have been incorporated in the water policy.

Table 2. Articulation of policy problems, policy goals, and policy solutions.

Ultimate goals		
Meet national water needs to enable the socio-economic development of the country.		
Ensure sustainability of the irrigation sector.		
Improve rural living conditions.		
Policy problems	**Policy goals**	**Policy solutions**
Water scarcity Uneven water distribution in time and space Changing conditions in water availability and demand	Increase water supply Increase water value	**WATER SAVING** Financial solutions 1. Financial incentives for adopting water-saving techniques (subsidies, guarantee funds, mutuality, credits, etc.). 2. Irrigation water tariff readjustment plan. 3. Macroeconomic levers (exchange rates, interest rates, tariffs and taxation). Infrastructural solutions 1. Program to rehabilitate and modernise irrigation and potable water infrastructure. 2. Development of large-scale localised irrigation (555,000 ha by 2020). Technical/knowledge solutions 1. Strengthen irrigation system management through computerised tools. 2. Proximity council for improving design of water-saving irrigation systems. Institutional solutions 1. Private company-type accounting and financial system to improve efficiency of ORMVAs. 2. Long-term regionalized action plan for the implementation of participatory irrigation management. 3. Institutional communication plan and campaign for water-use behavioural change. 4. Water saving contracts to stop overexploited aquifers.

Table 2. *Cont.*

Ultimate goals		
Meet national water needs to enable the socio-economic development of the country.		
Ensure sustainability of the irrigation sector.		
Improve rural living conditions.		
Policy problems	**Policy goals**	**Policy solutions**
Water waste Water allocation among competing activities	Water saving/demand management	**INCREASE WATER VALUE** Technical/knowledge solutions 1. Research into more productive and water-efficient cropping systems (conversion to value-adding techniques and crops). 2. Advice on the design of irrigation systems and support to improve productivity and valuation. Institutional solutions 1. Developing downstream agriculture through partnership and "contractualisation" with the agroindustry. 2. Institutional reform and public-private partnerships to manage collective irrigation schemes. Infrastructural solutions 1. Equipment and construction of conveyance infrastructure to utilise the water resources mobilised by dams. 2. Promote drip-irrigation to increase productivity per m^3 and, consequently, the water value.
Climate change Food security	Adaptation to climate change effects	**DEVELOPMENT OF WATER SUPPLY** Infrastructural solutions 1. Large dam building: (27.3 billion m^3) and small dams for local development. 2. Three new seawater desalination plants. 3. Equipment and adductions for securing drinking water supply. 4. Prospecting for and releasing groundwater resources to strengthen drinking water supply, livestock watering and irrigation.

Table 2. *Cont.*

Ultimate goals		
Meet national water needs to enable the socio-economic development of the country.		
Ensure sustainability of the irrigation sector.		
Improve rural living conditions.		
Policy problems	**Policy goals**	**Policy solutions**
Overexploitation and pollution of water resources	Water resources protection/conservation	**RESOURCE PROTECTION** Infrastructural solutions 1. Control of fertiliser leaching (localised irrigation?). 2. Purification and recycling of effluents. Institutional solutions 3. Water saving contracts for overexploited aquifers. 4. Enforcing legal regulation to control pollutant activities and groundwater abstractions.
Silting of dam reservoirs and loss of storage capacity		

3.1.1. Definition and Framing of Policy Problems

A total of 14 policy problems were identified as part of the policy document analysis. Among these policy problems, three occupy a central place in relation to the rest: "changing conditions in water availability", "changing conditions in water demand", and "water scarcity" (see Figure 2). "Changing water conditions" is linked to the socio-economic development of the country. According to the policy documents, the increase in the demand of the resource is both a consequence of and a condition for economic growth, the reason why the limitations to supply water must be overcome [12] (p. 7). During the 20th century, two conflicting processes have affected water availability in Morocco. First, water infrastructure development has enabled a massive increase in the availability of water resources. However, at the same time, water availability has also decreased as a consequence of climate change, increasing water pollution, and a loss of dam storage capacity [12,14].

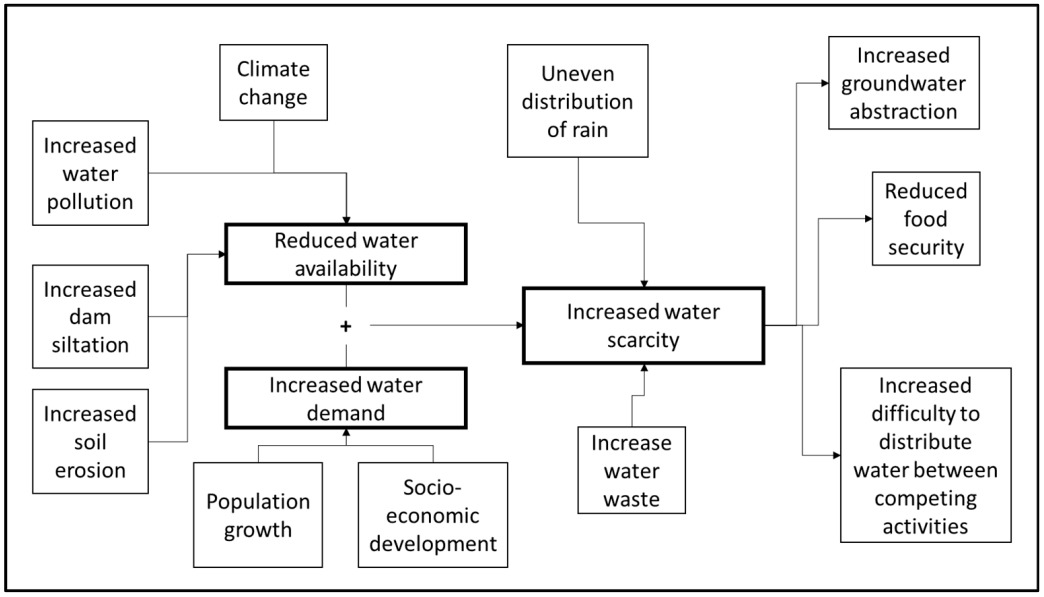

Figure 2. Policy problems and their interconnection. Source: the authors, based on policy documents specified in Appendix A.

In the policy documents, changing conditions in water availability and water demand are directly connected to water scarcity. Water scarcity is expressed as a mismatch between water demand and supply. This problem is aggravated by the effect of human activities, which increase water demand and degrade the resource as a consequence of population growth, urban development, tourism and industry development, water pollution, and resource overexploitation [33] (p. 110), [13] (p.13). Alternatively, water scarcity is depicted as an " ... intrinsic feature of Morocco's climate ... ", aggravated by the effect of the increased frequency and longer periods of drought [12] (p. 15), [32] (p. 48), [33] (p. 109). The combination of these human and climatic factors results in the reduction of the water resources' mobilizable potential [32] (p. 48), [33] (p. 110), [12] (p. 15). Finally, water scarcity is also described in terms of insufficient water availability per inhabitant [33] (p. 109).

At the same time, water scarcity is depicted as contributing to three other policy problems: a lack of surface water leads to increased groundwater overexploitation, to an increased difficulty of allocating water between competing activities, and to difficulty of achieving food security. In relation to allocating water between competing activities, agriculture is described as a sector threatened by the growing water demands of tourism and industry [13] (p. 12). The call to keep balance among economic activities (not to grow one sector to the detriment of others) implicitly values water as an economic good: water is an essential input for economic activities and, therefore, for the country's development. In relation to groundwater overexploitation, the policy documents recognize that water

level monitoring shows, in almost all the country's aquifers, a continuous decline. Policy documents recognize that, despite that groundwater plays a strategic role for improving drinking water supply in rural areas and developing the private irrigation sector of crops with high added value for export, it is managed in an unsustainable way [12] (pp. 31–32).

3.1.2. Definition and Framing of Policy Goals and Solutions

In this section, we show how the policy goals and solutions are defined and articulated, and how they aim to respond to the policy problems that have been targeted. We identified nine main policy goals and four types of policy solutions.

Among the policy goals identified, we distinguished between "ultimate goals", related to the intent of the policy, and "operational goals". The former includes "meeting national water needs to enable the socio-economic development of the country", "improving rural livelihoods", and "ensuring the sustainability of the irrigation sector". The operational objectives, on the other hand, seek to respond directly to the policy issues, and in this sense are means to achieve the ultimate goals. Operational goals are to "increase water supply", "increase water value", "achieve water saving/water demand management", "protect/conserve water resources", and "adapt to climate change".

The "ultimate goals" show a strong emphasis on ensuring the socio-economic development, or alternatively, meeting the needs of the growth of the country in the long-term. The sustainability of water resources is presented as a necessary condition for the realization of this objective. The reference to the paradigm of "sustainable development" is explicit.

> "Their implementation [solutions to adapt to new water availability conditions] as part of an innovative and integrated strategy for the entire water sector should enable the Kingdom to address the most pressing problems and make water a decisive factor in our sustainable development" [12] (p. 7)

Irrigated agriculture is presented as playing a key role in the promotion of the socio-economic development of the country [13] (p. 14). There is no explicit definition of what is meant by "socio-economic development", but the promotion of the agriculture sector is linked to its contribution to employment and farm income in rural areas, as well as to the national GDP [13]. Consequently, this goal is strategic and puts pressure on the government to cope with the threat that water constraints pose to irrigated agriculture. Operational goals (increasing water supply, increasing water value, achieving water saving, adapting to climate change, and protecting resources) are ways the Moroccan government has proposed to cope with water constraints. These goals do not relate to one particular policy problem but aim instead to be multipurpose and complementary in order to simultaneously address most policy problems.

Ultimate goals

To meet national water needs to enable the socio-economic development of the country

Satisfying the always-growing water needs of the country is considered a prerequisite for achieving socio-economic development. Contributing to socio-economic development is the overarching goal of the national water policy: "The development of water resources must ensure sufficient availability of water in quantity and quality for the benefit of all users in accordance with the aspirations of harmonious economic and social development . . . " [14] (p. 3). "This new water strategy should make it possible to support Morocco's development in the long term, by satisfying the needs of growth and protecting the Kingdom from the unpredictable effects of global warming" [12] (p. 7).

To improve rural living conditions by increasing rural income and employment

The main idea here is that rural conditions can be improved by increasing the productivity and value of each cubic meter of water. This can be achieved by improving the efficiency of infrastructure and implementing economic and institutional mechanisms such as water tariffs, economic support to encourage water saving, partnership with industry, and use of contracts to increase water value and production [31] (pp. 17, 24).

To ensure the sustainability of the irrigation sector

This goal is based on the idea that agriculture plays a strategic role in Morocco's socio-economic development and food security. Socio-economic development and food security can be achieved by increasing water's efficiency and its economic value: "After the realization of the million irrigated hectares whose contribution to food security, national, regional, and rural development is no longer to be demonstrated, the challenge that irrigated agriculture is called to take up is to produce more and better per m^3 of water and in a sustainable way" [31] (p. 27). For this reason, it is necessary to secure the irrigation sector's sustainability in the long-term: "The ultimate goal is the protection and sustainability of water resources, the sustainability of irrigated agriculture, and the strengthening of its strategic role in the country's food security" [32] (p. 51), [31] (p. 4).

Operational goals and solutions
To increase water supply

Meeting the water needs of the country's development is framed in terms of supply–demand and deficit. "Water demand in 2030 would be 16.2 billion m^3 and, if no measures are taken, the deficit would be 5 billion m^3" [33] (p. 110). "To cope with the increased demand for water, two ... solutions exist: water resources managers must first act on the water demand for water savings and then increase the supply by mobilization of additional water resources to fill the gap" [33] (p. 112). Water supply is thus framed in terms of controlling and mobilizing the water resources' potential: " ... Morocco has been committed to controlling the mobilization of water resources in order to ensure water needs without major difficulties" [33] (p. 109).

Increasing the water supply is pursued through infrastructural solutions. These are: the construction of additional large-scale dams to increase the water supply capacity to 27.3 billion m^3, as well as small dams to promote local development, building three new seawater desalination plants, providing equipment and adduction systems for securing drinking water supply, particularly in rural areas, and prospecting for and releasing groundwater resources to strengthen drinking water supply, livestock watering, and irrigation [12].

To increase water's value

To increase water's value involves two main ideas. First, producing more and receiving more revenue in return per cubic meter of water and making better use of the resource. The second is that promoting the best use of water also means to allocate water to the most economically valuable uses (economic efficiency). This can be alternatively described as preventing or reducing non-productive water use. Increasing water's value is a measure strongly linked to the irrigation sector and is framed as a measure to deal with water scarcity.

The documents linked to the National Program for Saving Water in Irrigation (PNEEI) propose increasing the production efficiency (increase crop yields per m^3) and the added value per cubic meter along the agricultural value change [31] (p. 14). To achieve this, the policies promote the adoption of localized irrigation (drip-irrigation), the rehabilitation and modernization of irrigation infrastructure, and building conveyance systems to utilize water stored in dams in irrigable areas. Financial solutions include readjustment of irrigation water tariffs and granting subsidies to promote the adoption of modern irrigation techniques. Solutions aiming to improve technical knowledge propose research to develop more productive and water-efficient cropping systems and providing incentives to farmers to shift to value-adding techniques and crops. The use of government-promoted "proximity councils" (boards of experts) should also help to improve the productivity and water value by providing farmers with better irrigation system designs and technical advice. Institutional solutions include promoting agroindustry and public–private partnerships for the management of collective irrigation schemes [31,32]. Achieving increased water value is described as a strategic challenge, as it will make the irrigation sector more sustainable and preserve Morocco's achievements in agricultural, rural, and economic development.

Water saving/water demand management

To achieve water savings, policy documents propose increasing the efficiency of water infrastructure and implementing pricing mechanisms to discourage water waste. This policy goal is operationalized through the modernization of infrastructure to reduce water loss in conveyance and " ... through the conversion of existing irrigation techniques with limited efficiency, notably gravity-fed irrigation, to localized irrigation ... " [32] (p. 51). " ... With the objective of reaching 555,000 ha by 2020 ... the area to be reconverted until 2030 is 920,000 ha ... knowing that this reconversion will allow a water saving of nearly 1.4 billion m^3" [13] (p. 15). The documents also include a package of institutional solutions, such as: implementing aquifer contracts to prevent groundwater overexploitation, implementing private company-type accounting and financial systems to improve the efficiency of the Regional Offices of Agricultural Development, promoting participatory irrigation management through the development of water user associations and long-term regional action management plans, and institutional communication plans and campaigns for behavioral change in water use [32]. Achieving water savings is also described as a way to reduce water deficits in agriculture.

Water resource protection/conservation

Policy documents recognize that productive activities have a negative impact on natural resources. However, they do not elaborate on the protection of water resources in detail. The goal is addressed in terms of the "control" of polluting activities (i.e., fertilizer leaching), " ... preservation of resources through the purification and recycling of effluents ... ", through water treatment plants and developing sanitary infrastructure, as well as the " ... reduction of groundwater overexploitation ... " by means of a more " ... efficient and sustainable management ... " of these resources [31] (p. 24). The institutional solutions are the implementation of water saving contracts for overexploited aquifers and the enforcement of legal regulation to control pollutant activities and illegal groundwater abstractions [32]. An important framing element is that the sustainability of water resources and irrigated agriculture are presented as of equal importance: "The ultimate goal is the conservation and sustainable management of limited water resources, the sustainability of irrigated agriculture, and the strengthening of its strategic role in the country's food security" [37].

Adaptation to climate change effects

Measures for adapting to climate change include increasing the water supply, water use efficiency, and water productivity [13] (pp. 10, 13). Since floods and droughts will become more frequent and intense, the government foresees measures to protect infrastructure and people.

In summary, this section shows that the way policy documents define and frame water-related problems has a strong emphasis on the relation between water availability and the capacity of the government to provide enough water to satisfy both the basic needs of the population and the long-term needs of socio-economic growth. The conceptualization of water scarcity in terms of the gap between the offer and the demand justifies the idea of the necessity of increasing water supply in the country through the construction of large-scale infrastructure. It is also the foundation to justify policy goals and solutions aiming to promote a more "rational" and "efficient" use of water through economic mechanisms and the development of infrastructure that helps in reducing physical water loses and increasing water yields and productivity.

The central role that "efficiency" plays in policy documents reveals that the 1995–2020 water policy of Morocco is shaped by economic and engineering perspectives. The importance given to economic mechanisms to achieve a more efficient water use is also part of the influence of the IWRM paradigm. This influence manifests itself in a number of ways. We identify, for example, an emphasis on the competing economic values of water (reference to the problem of increasing difficulty in allocating water between sectors such as agriculture, tourism, and industry) and the proposal to increase the value and productivity of water

as a way of increasing efficiency in its use and, consequently, as a way of improving the sustainability of the resource. The formation of Water User Associations is one way of implementing the participatory principles approach. By creating the "Agence de Basin Hydraulic" (the authority of the water basin), the Moroccan government has implemented the IWRM principle, according to which water should be managed within the boundaries of river basins. Furthermore, the framing of drip-irrigation as a water demand management solution is another way in which this policy aligns with IWRM principles, at least discursively. However, there are three ways in which water policy documents depart from the IWRM approach. One is the continuity given to the strategy of increasing water supply, which represents a major contradiction with the idea that IWRM advocators propose on the necessity to shift from water supply-oriented policies to water demand management. Second, there is no reference to the link between water and land use and the necessity to integrate the management of these two resources. Finally, there is no recognition of or reference to the role played by women in provision, management, and safeguarding of water.

3.2. Empirical Data on Water Management Challenges in the Middle Draa Valley

Based on interviews conducted with government officers and inhabitants of the MDV, we identified seven water-related problems: water scarcity, unequal access to water between upstream and downstream oases, unequal access to water inside the oases, unequal access to water between farmers inside oases and farmers in irrigated areas outside the oases, water-related conflicts, salinization of soil and water, and finally, the compartmentalization of government sectors.

Our interviews provide important insights on how well the water policy of Morocco responds or contributes to worsening the water-related problems of an arid region such as the MDV. The interviews also provide information on the constraints and challenges the water policy faces to achieve integration of water resources' management and sustainability as well as address the different ways in which water scarcity is experienced by different groups of society.

3.2.1. Water Scarcity

Both government officers and farmers report water scarcity as the main problem of the region, and climate change, reduced amount of precipitation per year, and drought as main causes of this problem. Water scarcity affects both potable water provisioning and irrigation. Interviewees from the oases, particularly women, reported potable water shortages, which manifest in the intermittency in the water supply service and in the fact that " . . . there are people who are still without proper drinking water in their house until now, and they have to get it from outside and store it somehow" (Inh.02–Zagora, 29 December 2020). To deal with the lack of access to potable water, some households in Zagora city rely on private wells and reservoirs, and in rural areas, on collective wells and groundwater reservoirs built in some cases by the Commune (public administration) and in others by NGOs. The latter are administered by drinking water users' associations.

In relation to irrigation, the perception of water scarcity is affected by the historical reduction in the number of water releases from El Mansour Eddahbi Dam, and by the timing of these releases, which is strongly related to the success or failure of the harvest:

> "We can use water four to five times per year, it would be good. But, as you already know, in the last years, we only receive it two to three times per year if we are lucky. The problem is that we usually do not receive it in the time we need it. If we just receive it on time, in those two or three times, would be better" (Inh.07, Tagounite, 17 January 2021)

3.2.2. Unequal Access to Water Inside Oases

The collected testimonies indicate that the constraints experienced by farmers to access surface water inside the oases are mediated by four factors interacting with each other:

uneven water rights, the order of irrigation turns, the time water is available in the irrigation canals, and the distance between the farm and the canals.

In relation to the first factor, the water demand for irrigation in each oasis is calculated by ORMVAO based on projections for the cultivated area, crop water requirements, and hydrological and climatic data for each agricultural campaign (Gov.01, 25 February 2020; Gov.05, 04 March 2020). However, the water in the traditional canals is distributed inside the oases according to water rights, which may vary significantly from one farmer to another.

> "Here the water shares are diversified. There are those who have water share called "Kharouba", which equals 45 min of irrigation. There are those who have the 1/8, which equals one hour and a half. And there is the 1/4 which equals three hours. Also, half Nouba or turn equals six hours, and a whole Nouba equals 12 h" (. . .) "We only had water for four days, where eight water turns were distributed" (Pt. WUA Beni Ali-Fezouata, 17 July 2020)

We have not collected data on the relation between water rights and the size of farms, however one government interviewee explained that water released from the dam does not reach all farmers because there are some farmers with a surplus of water that is not being redistributed to other farmers in need of irrigating their lands.

> "When there is a release of water [from the dam] only 70% irrigate while 30% cannot irrigate because there are people who keep irrigating and wasting water. In some cases, 2 h is fairly enough to irrigate a land of 0.5 hectares but the owner has 6 h of water so he irrigates and irrigates until the 6 h are over" (Gov.02, 02 March 2020)

The second factor (the time the water stays in the canals) interacts with the third factor (the order of irrigation turns) and the fourth factor (the distance between the farm and the canal): if the water is cutoff before farmers reaches their irrigation turn, they will not be able to irrigate and will have to wait until the next water release. During the next water release, the water distribution will start with the turn where the distribution stopped. In addition, the further the farm is from the canal, the longer it takes for the water to reach the farm. During periods of drought, longer distances increase the chances that the water will be cutoff before farmers arrive for their turn to irrigate.

> "The water stays on each Seguia for three days or even less, for 24 h. If you get your turn on the Seguia you irrigate your land, if not, you cannot" (Pte. WUA of Ternata 10 March 2020)

The role played by factors such as "the time water is available in the canals" and "the distance between the farm and the main canals" reassures the notion of "physical" water scarcity and the engineering perspective over the necessity of increasing the water supply. As we mentioned before, the increasing water supply strategy is in direct contradiction with the IWRM, that recommends a shift in this approach to a water demand management one. However, factors such as "the order of irrigation turns" and "uneven water rights" make apparent the institutional and political dimensions mediating access to water. These dimensions of "water scarcity" are neglected by the engineering approach that prioritizes policy solutions aimed at increasing the water supply.

3.2.3. Unequal Access to Water between Upstream and Downstream Oases

Collected testimonies also show a dynamic of unequal access to water between upstream and downstream oases. Government interviewees explain that, besides the fact that rainfall reduces as one moves downstream, another important factor is the distance between the last oases and El Mansour Eddahbi Dam. The longer the distance and travel time, the greater the evaporation of water in the canals, reducing the amount of water that is actually available for downstream oases: "It takes like eight days [for water] to reach M'Hamid [last oasis], and sometimes water isn't even enough to reach it" (Gov.06, 09 March 2020).

Downstream farmers explain that upstream oases can wait longer for the dam water release because they have access to groundwater of better quality. In downstream oases, the salt concentration in groundwater is higher, which means farmers rely more on surface water. Access to groundwater is mediated by the financial capacity of farmers to dig and operate wells. Water availability in the wells, however, depends on aquifer recharge, which is linked to the availability of surface water:

> "We have our own well, almost 19 m deep. We are located far from the river, so we usually don't benefit [with direct abstractions] from the water released from the dam" (. . .) "We only have to wait for this water to recharge the aquifers, another option is to wait until it rains in the mountains to also recharge the aquifers" (Inh.06, Ternata, 10 March 2020)

3.2.4. Unequal Access to Water between Farmers Inside Oases and Farmers in Irrigated Areas Outside the Oases

Our empirical data suggest that unequal access to drip-irrigation subsidies is indirectly contributing to reproduce inequalities around access to water. In the MDV, the development of watermelon farming in collective land outside the oases has accelerated after the Moroccan government started granting subsidies aimed at promoting the adoption of drip-irrigation [38]. In contrast, according to farmers and government officers, the adoption of drip-irrigation inside the oases is limited due to fragmentation of land and limited land size. Farmers usually possess several plots of less than 5 ha in size scattered in the oasis territory. Consequently, the private companies supplying drip-irrigation infrastructure are not willing to work with these farmers, and this ends up preventing farmers within oases from accessing drip-irrigation subsidies. The way in which subsidies for drip-irrigation are granted contributes to increasing inequality in access to groundwater between farmers inside and outside oases as the water savings generated by this technology allow surplus profits to be reinvested in the construction of new wells, which in turn allow farmers to expand the area under cultivation.

> "For us the state, there is no problem, the problem is . . . for small land, companies don't want to install an irrigation system because they say it is more difficult with small surfaces." Interviewer: "Does this happen even if the subsidies application is accepted?" Respondent: "No, before applying the farmer has to find a company that is willing to equip his land with an irrigation system, it is here where the problem resides" (Gov.06, 09 March 2020)

3.2.5. Water-Related Tensions and Conflicts

Farmers upstream need to irrigate in different months of the year than farmers downstream, which creates a disagreement on when to schedule dam water releases. Both the upstream and downstream farmers interviewed claim they do not receive water when needed. However, downstream farmers perceive that during the annual meetings held to schedule the number and dates of water releases from the El Mansour Eddahbi Dam, upstream farmers (located in the Mezguita, Tinzouline, and Ternata oases) have a greater influence in the decision process, and as a consequence, the dates selected for water releases always favor them.

> " . . . for us [Tagounite, K'taoua] we want the water to be available in the months nine or at the beginning of the month ten, for example. They in Agdaz or other places, because they have a small oasis not like here that the oasis is wider and bigger and they have wells, so they do not have a problem if the water is late . . . " (WUA.01—Tagounite, K'taoua 06 March 2020)

> "Upstream people killed us. Now we are going to harvest but their crops are still green. They are stronger than us, they have 4 or 5 representatives, and we only have 2. And even if they have a vote they win" (Inh.08—Blida, K'taoua, 13 March 2020)

Besides this upstream–downstream tension, government interviewees reported three other types of tensions and conflicts. One of these tensions is between farmers of oases and farmers working on relatively new agricultural land outside oases, referred to as "extensions". In the extensions, farmers cultivate mainly watermelons, which fully rely on groundwater resources. Farmers in oases complain about how watermelon fields are depleting the aquifers they also use inside the oases.

> "It's true that the water requirements [by watermelon] are less compared to those of the palm tree, but this crop has not been scheduled to be cultivated. This additional water demand leads to the conflict of the overexploitation of the aquifer" (. . .) Interviewer: "So, the tension is now between who?" Respondent: "It's between the farmers of Draa Valley and the farmers of the extensions. The latter defend this new crop. However, the farmers of the valley and especially of the last two oases are against it" (Gov.01, 25 February 2020)

The greater area dedicated to growing watermelon in the Middle Draa (3055 ha) is a plain known as Feija [39] (p. 74). This is the locus of the other two conflicts. One is between tribes fighting over the control of collective lands with good access to groundwater. The other is a conflict between watermelon farmers and the National Office of Electricity and Drinking Water (ONEE), in charge of abstracting groundwater from this aquifer for potable water production to supply Zagora city and rural communes. The latter conflict had a heated moment in 2017 when farmers organized a protest to block the progress of ONEE's construction of new wells (Gov.09, 18 October 2021), while Zagora residents were harshly repressed by the police during protests organized in the streets of the city against recurrent cuts in the potable water provision. Agricultural development in Feija has accelerated since 2008, which coincides with the beginning of an agricultural subsidies program implemented as part of the Green Morocco Plan to promote the adoption of drip-irrigation infrastructure [39]. Consequently, the competition over this resource between irrigation and drinking water production is increasing.

> "They [watermelon farmers in Feija] mostly say that they [ONEE] took their water. They insist on saying it is their water, which is not true. So, in those discussions, we [the government] try to explain to them that groundwater belongs to the state. And secondly, that this water is only for drinking purposes. Moreover, the rate of water consumed as drinking water is largely inferior to that for irrigation. This means that this water issue [aquifer depletion] is mostly due to agriculture" (Gov.07, 09 March 2020)

3.2.6. Salinization of Soil and Water

Governmental actors report that: "This phenomenon of salinity becomes higher downstream. In the downstream direction, the valley narrows down. As a consequence, the groundwater table is more superficial, and this facilitates the evaporation of water. This process brings up the salinity to the surface and the concentration increase" (Gov.03, 24 February 2020).

The salinization problem severely constrains the agriculture activities of the last two oases of the valley, K'taoua and M'hamid. According to interviewees, this is forcing people to replace agriculture with other activities, such as tourism, and to emigrate to find other sources of income.

> "Wells inside the Oasis are useless since they only have salty water. When we use it to irrigate our lands, we always regret it. The lands go dry so fast, and the white layer of salt stays concentrated in the land, keeping us from using it for days, and maybe weeks" (Inh.11, 27 February 2020, M'hamid)

3.2.7. Compartmentalization of Governmental Sectors

Governmental officers confirmed that the promotion of drip-irrigation through subsidies has accelerated the development of new irrigated areas in collective lands outside the oases. The increased demand for water that this agricultural development has brought is contributing to worsening an aquifer depletion problem in the area [39]. The link between groundwater depletion and agricultural development well-illustrates the difficulties of the government to articulate the policies of different sectors. Government interviewees explain that the lack of control over groundwater abstraction is partially due to limited staff and resources to enforce regulation in remote areas, but also due to the complexity and difficulty of harmonizing the mandates and interests of the agricultural, the water, and the interior affairs sectors.

> "According to the mission of the Ministry of Agriculture, we have to promote the investor. If all his papers and certificates are legal, we cannot not give him the subsidy: equipping the land with localized irrigation and digging boreholes. It's not the job of the Ministry of Agriculture to solve water problems. It's the responsibility of the Ministry of Water to find the solution" (. . .) "More than 90% are collective lands that are managed by the Ministry of Interior. The ministry gives certificates of land exploitation according to the rights of each tribe" (Gov.01, 25 February 2020)

From interviews with both farmers and governmental officers, it follows that there is no real control over the digging of new wells.

> "Even sometimes we dig at night illegally. One time I dug in the night after the wells I had collapsed. I dug 2 other wells of 52 m." Interviewer: "What was the administrative procedure to dig a well?" Respondent: "They didn't give me the permit at the time. I started digging without it because you need to give money to people as part of the procedure. In the end, I dug without the permits" (. . .) "Sometimes we pay bribes and sometimes we call people we know [in public administration] and move some influence or even we beg to let us work" (Inh.14, Feija, 02 December 2021)

Governmental interviewees also stressed that the difficulty of enforcing regulations to control groundwater abstractions lies in the social and political cost this would bring to the region. One argument, for instance, is that it would not be fair to process people for digging unauthorized wells for drinking water when the government does not have the means to provide potable water to some remote villages. Another reason is the economic importance that the agriculture sector has for the region.

> "When they dig for water, if we stop them [water users] because they are out of law we are not providing a solution for them and it is contradictory with the aim of the administration, so we have to see and take into consideration the social side" (. . .) "The first sector is agriculture, which is the most valued in Morocco and generates a lot of money, and it always receive a lot of attention, more if the regulations are always evolving, and we always put the social aspect in the picture so as not to create conflicts within the country" (Gov.08, 26 July 2021)

> "If we do not talk about agriculture in this area, we will have a strong migration" (Gov.01, 26 July 2021)

According to our interviews with both farmers and the National Office of Agriculture Development, a digging permit is not required in the process of applying for subsidies for drip-irrigation infrastructure. Governmental officers only check whether the farmer applying for the subsidies already owns a well with available water. This omission in the requirements for subsidies in combination with the reduced capacity of the government to exert control over the construction of new wells facilitates for farmers to circumvent the authority of the Water Basin Agency (ABH) when they deny authorization to dig new wells.

> "There is nothing about the digging permits. If he [the farmer] has a well, he has the right to be subsidized." Interviewer: "Even if he doesn't have a digging permit?" "Exactly, this is the problem" (Gov.01, 25 February 2020)

In addition, we found that some particular tribes request from their members to start farming the land as a requirement for them to receive a land-use right certificate from the tribal organization. This rule, that some tribes include as part of their customary laws, creates a contradiction in the procedures established by the government that requires land-use certificates before granting permission for subsidies and well digging. This contradiction ends up creating an incentive for the proliferation of illegal wells:

> "This is the contradiction between the government officers who asked for the land-use authorization when it comes to [agricultural] subsidies. This [land-use] authorization must be given by the tribal organization, who ask first the farmer to start working in the land. For this we need water. So, we need the well. The well must be with a permit to dig. And this permit comes after having the land-use authorization" (Inh.14, on 30 October 2021)

The analysis of the perception that governmental officers and local inhabitants of the MDV have about local water problems revel similarities with the way water problems are addressed in the policy documents, but also several factors that have not been considered in the policy documents. For instance, both policy documents and local perceptions emphasize the physical dimension of water scarcity, which is used in policy documents to justify the strategy of increasing water supply. However, interviews also show how the way water scarcity is experienced by local inhabitants is mediated by access to water. Interviewees perceive access to water as unequal and as a major problem in the valley. While two of the explanatory factors given by the interviewees for unequal access to water inside oases (reduced time water is available in the canals, and distance between farms and canals) re-emphasize a notion of "physical" water scarcity, other factors such as the order of irrigation turns and unequal water rights reveal the institutional dimension that mediates access to water. During the analysis of the perceived inequality to access water between upstream and downstream oases, was notorious the government's effort to apply the participatory principle promoted by the IWRM approach: irrigation water user association participates in multi-sectoral governmental meetings to schedule dam water releases. There is however an issue of trust between these user associations that revel a problem in the mechanisms of articulation and information exchange during the decision-making process. Water policy documents do not address these issues; nevertheless, given that these are issues involving power relations and structures of decision-making, it could be more appropriate to address them in terms of water governance.

These findings on unequal access to water shows how the experience of water scarcity does not relate solely to the physical availability of water, but how the experience of water scarcity is also a socially and politically mediated outcome. The social and political dimensions of water scarcity are not encompassed by the economic and engineering approaches that focus on increasing water use efficiency. This in turn reveals the important role that ontological and epistemological systems play in the early stage of policy formulation, since they shape the way public problems are conceptualized and consequently, the formulation of policy goals and solutions. Progress in integrated water resources' management also requires integration of different perspectives or areas of knowledge. Here, rather than attempting an exhaustive list of disciplines that seek to encompass complex nature–society relations (examples include Political and Social Ecology, Political Economy, Sustainability Science, Environmental Economics, Human Geography), we advocate the use of interdisciplinary, or better yet, transdisciplinary, approaches in policy-making processes as a way to strengthen the implementation of the IWRM approach.

Finally, we found that the agricultural policy of subsidies on drip-irrigation infrastructure may be aggravating aquifer depletion in the MDV. This in turn shows the limitations of the government to implement the IWRM paradigm, at least in two ways: One is the difficulty

to achieve a balance between socio-economic welfare through the promotion of agriculture development and sustainable use of water resources. The other is the limited integration of the water management into sectoral policies and other resource management. In the MDV, the overexploitation of aquifers occurs mainly on collective lands. These lands are co-managed by tribes, as rightful owners, and the Ministry of Interior Affairs, who has the tutelage of these resources. Access to groundwater necessarily involve access to land. However, this link between land and water management is not addressed in policy documents.

4. Discussion

4.1. Water Scarcity: A Discourse That Gives Continuity to the Construction of Large-Scale Water Infrastructures but Overlooks the Reproduction of Social Disparities

We discuss our results under the light of the current debate on IWRM and water governance. The analysis of both water policy documents and interviews identified "scarcity" as the central water-related problem. In their broad review of water governance approaches, the authors of [1] found that the use of a narrative of water scarcity has been central in the promotion of the IWRM paradigm worldwide. The analysis of the policy documents revealed that this has also been the case for the 1995–2020 Moroccan water policy, but with one major divergence. The narrative of water scarcity has also been used in the Moroccan policy to give continuity to the strategy of increasing water supply through the construction of large-scale infrastructure. The IWRM explicitly advocates for a shift from supply-oriented policies to an emphasis on water demand management strategies.

In addition to the discursive use of water scarcity, insights from the interviews suggest that the way water scarcity is experienced by water users is determined by how water is actually accessed. In relation to access to drinking water, interviewees referred to problems of intermittency in the water supply service and to the fact that there are households with no connection to the drinking water infrastructure network. Although we have not elaborated on these problems, the literature (see, for example, [40–44]) indicates that water availability, the intermittency of the water supply, and the type of drinking water source used are strongly linked to seasonality. In turn, water availability, intermittency, and the type of water source used are linked to variations in water quality, which means that people with poor access to water are more exposed to water-borne diseases. In relation to water for irrigation, interviewees identified the following as factors linked to unequal access to the resource: the distance between users and infrastructure (i.e., from Eddahbi Dam and from canals), the salt concentration in groundwater (that increases downstream), and social variables such as social stratification and status (i.e., water rights), power dynamics (i.e., between upstream and downstream oases around the dam water release schedule), and institutional frameworks, particularly customary systems of water allocation inside the oasis.

These findings show that water scarcity is a complex problem that cannot be addressed by a conceptualization based only on the physical availability of the resource and the relation of supply–demand. In this sense, we found that the social and political dimensions influencing actual access to water are neglected by the economic and engineering perspectives informing the analyzed policy solutions, particularly those aiming to increase the water supply. Similar conclusions were drawn from a water scarcity study conducted by Mehta [45] in western India. This study demonstrated the necessity of distinguishing between the biophysical aspects of scarcity, that are lived and experienced differently by different people, and its 'constructed' aspects. Furthermore, the author highlights the fact that water scarcity is usually socially mediated and the result of socio-political and institutional processes. We found a similar approach to water scarcity in [46] and [47], who propose distinguishing "limits" as objective, empirically verifiable characteristics (measurable in terms of flow volumes or recharge rates) and "scarcity" as individual or social subjective perceptions of what those limits signify, which is subject to cultural and political values and priorities.

In the analyzed policy documents, it is clear that the increasing supply strategy aims at reducing the water deficit, not addressing social inequities. However, it is important to keep

in mind that the intent of the policy is to contribute to the socio-economic development of the country. We assume that there cannot be development if there are sectors of society that are being excluded from economic growth. Consequently, we suggest including access to water as a major point of concern in the policy, rather than simply increasing the water supply. In this sense, the social effects of drip-irrigation should also be carefully assessed. The empirical data suggest that the promotion of drip-irrigation through subsidies is benefiting only some farmers; in the MDV, mainly those with better access to capital growing watermelons in collective lands outside the traditional oases. This infrastructure aims to allow farmers to increase their revenues per cubic meter of water, which means the drip-irrigation conversion strategy may be contributing to reproducing and widening social inequalities around water use in our study area.

4.2. Unsustainability of Water Resources: A Problem Aggravated by Infrastructural Solutions

We also observed a contradiction between the goal of achieving sustainability and the implementation of measures that contribute to aquifer depletion, namely, construction of large-scale water infrastructure and the promotion of drip-irrigation. Following what Allan [3] called the "hydraulic mission", the Moroccan government is committed to constructing large-scale hydraulic infrastructure to fully exploit the "mobilizable resource potential of the country". This narrative has been in place in Morocco since the 1930s, when the much publicized "dam policy" began to be implemented [16,17]. However, along with the high environmental cost produced by dam construction [48–51], the efficacy of this policy solution to ensure water supply in the long-term has been questioned by the scientific community [52–54]. For instance, the storage capacity of dams seems to be inevitably reduced over time due to siltation (see [29,54] for El Mansour Eddahbi Dam). Siltation can, in turn, be linked to other complex processes such as soil erosion, deforestation, and extreme rainfall due to climate change. Climate change is also linked to reductions in dam inflow due to decreasing annual average precipitation [30]. This means that dams contribute to create a demand for water that may not be sustainable in the future. When dams can no longer release the originally planned volumes of water, users increase water abstraction from aquifers to satisfy their needs [30]. Dams also negatively impact the natural recharge capacity of downstream aquifers [27,55,56]. The combination of increments in groundwater abstraction with reductions in recharge rates leads to groundwater depletion. Therefore, the model of socio-economic growth based on groundwater-based agriculture may become unsustainable under these scenarios, particularly in regions with small recharge rate aquifers [17,24,25].

In relation to the promotion of drip-irrigation as a technology that allows saving water, the empirical data suggest, on one hand, that this policy solution has limited reach within the oases of the MDV. This is because fragmentation and scattering of land make it not profitable for private companies supplying drip-irrigation infrastructure to work with smallholder farmers. On the other hand, the drip-irrigation conversion program is one of the factors enabling the rapid development of new irrigated areas outside the oases, where people are using aquifers to grow early-season watermelons. In this way, instead of limiting water consumption, this policy solution contributes to increase water demand and groundwater abstractions in the region.

The contradictory effect of technologies that increase the efficiency in the use of a resource but incentivize an increment in its consumption is well-known in environmental economics as the "Jevons paradox" or "rebound effect" [22,57–60]. Theoretically, drip-irrigation allows saving water and to produce more per cubic meter of water. Nevertheless, policy documents do not explicitly state that water is saved in comparison to the other irrigation techniques (i.e., irrigation by gravity) and not in absolute terms of total water volumes used before and after the introduction of drip-irrigation. As different studies have shown for other regions in Morocco [20,22,23,61,62], as for other parts of the world [63–66], it is common that the introduction of drip-irrigation technology does not translate in the reduction of the amount of water consumed, but very often the opposite is the case. As

highlighted in 2017 FAO's report for the Near East and North Africa regions, "introducing hi-tech irrigation in the absence of controls on water allocations will usually make the situation worse" [66] (p. xi). Our empirical data indicate that in the MDV, there is no effective control over groundwater abstractions. Therefore, the "water saving" and "water demand management" framing used in policy documents to promote this technology can be misleading as it implies that water consumption is being limited and that there is an effective impact in terms of water resource conservation. This framing thus hinders the development of sound solutions to the problem of aquifer depletion.

4.3. The Limitations That the Use of Disciplinary Approaches Impose on the Achievement of IWRM

These limitations and contradictions in terms of resource sustainability go beyond the solutions proposed in the water policy. They manifest the limitations of the disciplinary approach that has shaped the formulation of these solutions in the first place and the limitations of the IWRM paradigm itself. In relation to the disciplinary approach, the central place occupied by policy solutions aiming at increasing physical and economic efficiency in the use of water reveal prevailing engineering and economic perspectives that cannot encompass the complexity of the feedback between the components of the social-ecological systems [10,20,23,61,62]. Our findings have highlighted particularly the limitations of these perspectives to address the complexities of water scarcity and the rebound effect that has emerged in the MDV as a consequence of promoting drip-irrigation without considering measures to prevent over-abstraction of groundwater.

In relation to the limitations of the IWRM paradigm, Bolding et al. [7] has argued that there is a general lack of clarity around the notion of "integration" in the IWRM paradigm. The authors state that there are at least four possible meanings for this term. Our findings suggest that the Moroccan water policy faces challenges to achieve integration in at least three of these possible meanings: (1) the integration of different uses of water (i.e., drinking and irrigation), (2) the integration of analytical perspectives (i.e., prevailing engineering and economic disciplinary approaches in the formulation of the policy), and (3) the integration of the different institutions and compartmentalized sectors between different ministries (i.e., between the agriculture, water, and interior sectors). The empirical data also show that the way water resources are allocated and used is the result of power relations and decision-making processes that involve not only the government but also different actors in society. Therefore, the limitations to achieve IWRM and sustainable development are not just a management problem but mainly a governance one that needs to take the social complexities into account.

4.4. There Are Limitations to Achieve Sustainable Development That Derive Directly from the Conceptual Inconsistencies of the Sustainable Development Paradigm Itself

Finally, water policy documents explicitly refer to "sustainable development", but without explicitly defining what is meant by development and sustainability. This lack of clarity around both concepts goes far beyond the Moroccan water policy documents—it has been pointed out as one inherent problem of the "sustainable development" paradigm itself [67]. When the analyzed policy documents refer to ensuring the sustainability of resources, the latter appears as a necessary condition to ensure the sustainability of economic sectors and their growth. This approach to sustainability fits well with what has been labeled as "weak sustainability": sustainability here is not about preserving the total stock of natural capital constant over time but about minimizing adverse environmental impacts to sustain the ecosystem's overall integrity, its resilience capacity, and preventing potentially irreversible effects [67]. Under this rationale, the resource-use efficiency strategy aims to guarantee that the ecological basis for development is not at risk. Nevertheless, the worsening of the aquifer depletion situation suggests that this efficiency strategy is not working as expected in Morocco.

Since modes of production and consumption are shaped by societal values and specific (aspirational?) lifestyles, there is a behavioral component that must be addressed. The

Moroccan water policy refers to this behavioral component but not in terms of the amounts of resources used as a society, but rather to promote a change centered on the individual: individuals should use resources more rationally, and more efficiently. As Boelens and Vos [68] and Birkenholtz [63] have already argued, under this narrative of water efficiency and rationality, groundwater over-abstraction appears to be the direct responsibility of farmers' bad or irrational practices because it is not possible to see the political economy and political ecologies that incentivize irrigation intensification via more groundwater extraction in the first place. Not recognizing this may lead to ineffective policy solutions in the future.

5. Conclusions

In this article, we focused on identifying the challenges the water policy of Morocco 1995–2020 provokes for achieving sustainable development and the limitations it faces to implement IWRM. To this end, we analyzed how water-related problems, objectives, and solutions are framed in the water policy documents and the key water governance challenges identified by water managers and water users in the MDV.

We found that the ultimate objective of the water policy is to ensure sufficient water to support the sustainable socio-economic development of the country. References to the "sustainable development" paradigm are explicit and emphasis is placed on the national needs of growth as part of the concept of development. The way in which problems, goals, and solutions are defined and framed in the water policy reveals the dominance of an economic and engineering approach. Three important policy goals developed from this approach focus on using infrastructure and economic mechanisms to increase the national water supply, water savings, and water value. Factors affecting actual access to water, however, are not addressed. Water infrastructure is an important factor for mobilizing water and bringing it closer to people, but it does not ensure water access for all groups. In this sense, considering that the ultimate goal of the policy is to make water a factor for the country's development, including actual access to water should be a major point of concern in water policies.

How to make access to water more equitable is a complex problem. It involves factors affecting the physical environment of water, such as climatic conditions and infrastructure, but also social, political, economic, and discursive dimensions interacting and creating feedback among themselves. This complexity demands a more holistic approach that takes social complexities into account rather than a disciplinary one. The recognition of the limitations of disciplinary approaches should lead us to reflect on how we, as societies, produce knowledge, and how this knowledge is used to inform policies and societal change. An important point of this reflection, therefore, must be orientated to better understand the power relations that end up privileging some particular epistemological systems over others in the process of policy-making. This, in turn, has the potential to contribute to overcoming the compartmentalization between government sectors that, as we showed, hinders the development of sound solutions to water-related problems, such as groundwater depletion. Breaking these compartments necessarily requires building a common understanding of the problems policies seek to address and the better ways of solving them.

Knowledge creation and the flow of this knowledge between government sectors (and in society at large) is an eminently political process where different interests and power relations are at stake. Following [8,9], this means that our attention should be not only on improving the management side (this is the activities of analyzing and monitoring, developing, and implementing measures to keep the state of a resource within desirable bounds) but also on understanding the power dynamics between different actors and networks that help formulate and implement environmental policy and policy instruments.

Finally, Morocco's water policy analysis also reveals contradictions stemming directly from the 'sustainable development' paradigm. In particular, there is an inherent contradiction in proclaiming the pursuit of environmental sustainability and, at the same time, pursuing indefinite economic growth. In this sense, there is a need for including explicit

definitions of the particular notion of development used in public policies as well as explicit exposition of the expected trade-offs that this particular vision of development will bring between economic growth and environmental conservation.

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Appendix A. Analyzed Policy Documents

Year of Release	Policy Instruments	Documents
1995	Loi No. 10–95 relative à l'eau	Kingdom of Morocco (20 September 1995). Loi No. 10–95 relative à l'eau. Bulletin officiel No. 4325. Rabat: Kingdom of Morocco.
2007	National Program for Saving Water in Irrigation (PNEEI)	Arrifi E-M. (2009). L'économie et la valorisation de l'eau en irrigation au Maroc: un défi pour la durabilité de l'agriculture irriguée. In: Symposium international "Agriculture durable en région Méditerranéenne (AGDUMED)", Rabat, Maroc, 14–16 mai 2009.
		Ref: Belghiti Mhamed (2008). Administration du Génie Rural. "Le Programme National d'Economie et de Valorisation de l'Eau en Irrigation » Presentation during Journée mondiale de l'alimentation. Rabat, 14 November 2008. Accessed on 28 October 2020 from http://www.fao.org/fileadmin/user_upload/FAO-countries/Maroc/programme_national_economie_eau.pdf
		Ministère de l'Agriculture, de la Pèche maritime, du Développement Rural et des Eaux et Forêts–MAPDREF. (n.d.) "L'économie de l'eau". Accessed on 11 February 2021 from http://www.agriculture.gov.ma/
2009	National Water Strategy	Royaume du Maroc (2009). Stratégie National de l'Eau. Accessed on 18 February 2021 from http://www.environnement.gov.ma/fr/eau/112-theme/eau.
		Alaoui, M. (2013). Water sector in Morocco. Situation and perspectives. *Journal of Water Resources and Ocean Science*; 2(5): 108–114.
2014	National Water Plan	Direction General de l'Eau-Ministère de l'Équipement, du Transport, de la Logistique, et de l'Eau (n.d.). Politique de l'Eau. Accessed on 18 February 2021 from http://81.192.10.228/ressources-en-eau/politique-de-leau/
2016	Loi No. 36–15 relative à l'eau	Kingdom of Morocco (10 August 2016). Loi No. 36–15 relative à l'eau. Tétouan, Morocco: Kingdom of Morocco.
2020	National Drinking Water Supply and Irrigation 2020–2027	Direction General de l'Eau-Ministère de l'Équipement, du Transport, de la Logistique, et de l'Eau (2020). Approvisionnement en eau potable et l'irrigation 2020–2027. Retrieved on 18 February 2021 from http://81.192.10.228/ressources-en-eau/lapprovisionnement-en-eau-potable-et-lirrigation/
2020	Climate change adaptation policies for the water and agriculture sectors	Royaume du Maroc-Ministère de l'Economie, des Finances et de la Réforme de l'Administration; Ministère de l'Equipement, du Transport, de la Logistique et de L'eau Direction de la Recherche et de la Planification de l'Eau (2020). "Le Maroc à l'épreuve du changement climatique: situation, impacts et politiques de réponse dans les secteurs de l'eau et de l'agriculture". DEPF Policy Brief, DECEMBRE 2020 I N° 18 Direction des Etudes et des Prévisions Financières

Appendix B. Codebook—Deductive Coding

Coding rules:

- Unit of coding: sentence or paragraph depending on the content.
- Each sentence/paragraph must be coded with only one sub-code.
- In case of doubt as to which sub-codes to use, follow the framing of the text: is the segment presented as a goal, achievement, or problem?

Code	Sub-Code	When to Use the Code
Policy Issue	Policy problem	If the segment refers to a public problem, undesirable situations, or reference to negative impacts the policy aims to solve, mitigate, or address.
	Policy goals	If the segment refers to government objectives, pursued achievements, or a situation that is sought as a result of government intervention.
Policy Solution		If the segment mentions concrete measures to solve, address, or change policy problems.
	Institutional	If the segment refers to institutional processes, mobilization or changing of rules, and organizational development as a means to achieving policy goals or implementing policy solutions.
	Technological/infrastructural	If the segment refers to interventions based on technology or infrastructure as a means to achieving policy goals or implementing policy solutions.
	Technical/knowledge	If the segment refers to the use, support, or improvement of knowledge as a means to achieving policy goals or implementing policy solutions.
	Financial/economic	If the segment refers to the use of economic or financial mechanisms (subsidies, taxes, pricing, etc.) as a means to achieving policy goals or implementing policy solutions.

Appendix C. Exploratory Interviews with Governmental Institutions

Topics	Questions
Role of the institutional area of the interviewee, and role of the interviewee in this institution: The idea is to understand who we are talking to in terms of position and role in the organization, and what kind of information he/she can provide us. This can also be important for later understanding the position and interests of the organization in relation to the topics addressed in our research.	• Complete name • Position in the institution • What are the functions and competencies of the institution? • What is your role/responsibilities in this institution? • What are the main problems at the Draa catchment that this office has to deal with?
What are the key regulatory and policy frameworks about water and land access, use, and distribution?	What are the documents we should read to have a good understanding of the regulatory framework in terms of water and land access, use, and distribution?
	Can you facilitate us access to these documents?
Overview of the current situation of access, use, and distribution of land and water in the upper and middle part of the catchment.	What are the main problems related to land and water in the Draa Catchment? (Distinguish between the problems in the area of the Oases and the urban area in the upper and middle part of the catchment, particularly downstream Zagora).
Conflicts and tensions in the catchment	What are the areas with major incidence of conflicts in the catchment?
	What are these conflicts about? (actors involved; what these actors are fighting for?)
	What do you think are the causes of these conflicts?
	Is this institution involved in any of these conflicts? How? Is intervening in these conflicts part of the competence of this governmental institution?
Actor mapping	Can you give us the contact information of other people that can help us to better understand these topics?

Appendix D. Interview Guide for Water Users

Personal information

1. Name
2. Age
3. Household composition
4. Tell us please, where are you from? Are you from this area?

Current livelihoods

5. What do you do for a living?
6. What are you mostly concerned about?

General changes

7. What changes have you noticed in relation to water in this area during the past 25 years?
8. How have these changes affected your life and the lives of the local inhabitants?
9. What are the causes of these changes?
10. Explore the connection between the changes in resource availability and access with historical, political, economic, and social processes happening in the country.

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