WATER GOVERNANCE CHALLENGES IN THE MIDDLE DRÂA VALLEY OF MOROCCO: ANALYSING POLICIES, PRACTICES AND CONFLICT

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Declaration

I declare that the dissertation entitled “Water Governance Challenges in the Middle Drâa Valley of Morocco: Analysing Policies, Practices, and Conflicts” is my own work. All sources have been cited, and the contributions of other authors have been specified and documented. I confirm that this dissertation has never been submitted for any degree at any university or other educational and research institution.

I hereby declare that the content of this PhD thesis has been proofread and edited for grammar, spelling, and readability using ChatGPT and Grammarly. ChatGPT is artificial intelligence-based language model developed by Open AI. I used this tool to improve the clarity, coherence, and overall readability of the text. ChatGPT provided suggestions for rephrasing sentences and paragraphs, and for enhancing the logical flow of ideas. Grammarly is a software tool I used to identify and correct grammatical errors, spelling mistakes, and punctuation issues.

The intellectual contributions, original research, and analyses contained in this thesis are entirely my own. The use of ChatGPT and Grammarly was strictly limited to linguistic and stylistic refinement, and did not influence the research findings or the intellectual content of this work.

Luis Miguel Silva-Novoa Sánchez

Luis Miguel Silva-Novoa

Landau, 22/07/2024

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List of Publications

This cumulative dissertation includes three articles (Chapters 2-4) which have been published in or submitted to peer-reviewed scientific journals. For inclusion in this manuscript, the formatting required by the journal has been removed, spelling mistakes have been corrected, and all sections, figures, and tables have been renumbered to fit a common layout. References for each chapter have been combined into a single list at the end of this dissertation. The research was funded by the "SALIDRAA 2" project under the Social-Ecological Research Programme of the German Federal Ministry of Education and Research (grant no. 01UU1906). The articles are detailed below:

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Summary

The inability to reverse the degradation of water resources has sparked growing criticism among scholars towards the advocacy of managerial-focused paradigms that neglect the context-specific nature of water governance processes and treat them as politically neutral (Cleaver, 2000; Castro, 2007; Ingram, 2011; Boelens & Vos, 2012; Zwarteveen et al., 2017; Birkenholtz, 2017; Zwarteveen et al., 2021). In recent years, the focus of water scholars has been placed on governance frameworks to try to elucidate whether and how societies can develop governance systems that help achieve resource sustainability while promoting economic development and social equity. This thesis aims to contribute to this debate through insights from empirical and context-specific data of an arid region to answer the following research question: what are the water governance challenges in the Middle Drâa Valley (MDV)?

The MDV is located in the province of Zagora in southeaster Morocco. The valley consists of six oases with palm groves (from upstream to downstream: Mezguita, Tinzouline, Ternata, Fezouata, Ktaoua, and M'hamid), which extend over a length of 200 km and an average area of 26,000 ha and have a population of around 240,000 inhabitants (Karmaoui et al., 2014; Lamqadem et al., 2019). The region is characterised by an arid to hyper-arid climate (Klose, 2012) with an average annual precipitation of 70 mm (Moumane et al., 2021). After exploratory fieldwork in different oases of the valley, I focus my research on three areas: the plain of Faija and the oases of Fezouata and M'hamid.

To answer the research question, I organised the research based on the following objectives. First, I aim to identify the challenges the water policy of Morocco during 1995–2020 faced in achieving sustainable development and to implement Integrated Water Resources Management (IWRM). To this end, I address first the question of how water policy documents frame water-related problems, goals, and solutions. Second, how does the national water policy respond to or provoke the water problems identified by local inhabitants and local governmental representatives in the MDV? The research findings, presented in Chapter 2, reveal a significant gap between policy objectives and actual water access, particularly for marginalised groups, hindering inclusive socio-economic development. Two main conclusions can be drawn from these findings. First, policy reforms may be needed to develop a holistic approach to better address the complex links between the social, political, economic, and environmental dimensions of water-related problems. Second, two main factors hamper the development of this holistic approach: the prevalence of a disciplinary approach informing the national water policy of Morocco, which is based on economic and engineering perspectives, and the compartmentalisation between governmental sectors. The dominance of engineering and economic perspectives in policy formulation underscores the need to address power dynamics and break down compartmentalisation between government sectors. Additionally, tensions between environmental sustainability and economic growth pose challenges to policy coherence.

A second objective is to use the Social-Ecological System Framework (SESF) of McGinnis & Ostrom (2014) to analyse three groundwater governance cases in the MDV (Faija, Fezouata, and M’hamid) and explain their challenges under the light of their social-ecological particularities. The research findings are presented in Chapter 3. The analysis shows that hierarchical governance in Fezouata struggles with rule compliance due to mismatches between state regulations and local realities, while self-governance in M’hamid and Faija shows promise for rule compliance but lacks effective enforcement mechanisms, compromising long term sustainability. Faija's aquifer contract faces challenges in stakeholder

engagement and generating natural incentives for participation, requiring active involvement and legal incentives for cooperation. This evidence leads me to the conclusion that self-governance organisations in the MDV represent an important opportunity to create conditions for more sustainable groundwater use in the region. However, the important limitations these organisations face in imposing sanctions and coordinating with other local self-governance organisations suggest that currently, self-governance organisations are insufficient to ensure groundwater sustainability. To overcome these limitations, self-governance organisations need to cooperate with governmental institutions, but in such a way that their self-governance capacity to create rules and monitor groundwater use is not compromised. Concerning the analytical framework used, the conclusion is that the Social-Ecological Systems Framework (SESF) is a valuable tool for structure analysis aiming to shed light on how water management institutions in place are linked to broader socio-ecological contexts.

The third objective is to better understand the implications of tribal conflicts over land for restructuring authority and power relations, which shape access not only to land but also to groundwater in the area. Additionally, the objective aims to explore the implications of these conflicts for achieving sustainable development in the region. To this purpose, I analyse a conflict between Kaaba and Mssoufa tribes in Faija Plain. I identify the drivers of conflict and explain the distributional outcomes the conflict has in terms of water, land, power, and authority. My analysis has been inspired by access theory (Ribot & Peluso, 2020) and an actor-based approach. The results, presented in Chapter 4, reveal that the conflict stems from unequal land access between tribes, rooted in historical power reconfigurations influenced by droughts, market dynamics, national agrarian development policies, and changes in customary land access rules. I argue that preventing further escalation of intertribal land conflicts in the MDV requires directing the actors' motivations and capabilities towards cooperation and resource sharing by implementing a third-party intervention model of conflict resolution in combination with a structural peacebuilding approach. Additionally, we discuss the implications of our findings for promoting sustainable development in the MDV, particularly focusing on Sustainable Development Goal (SDG) 16: Peace, Justice, and Strong Institutions, while also identifying implications for SDGs 1, 10, and 13.

Chapter 5 is divided into three subsections. First, I summarise the main findings of each chapter (5.1). Then, I present the general conclusions of the research, along with some recommendations (5.2). The last section of this chapter presents ideas for possible future research (5.3).

Zusammenfassung

Die Unfähigkeit, die Verschlechterung der Wasserressourcen rückgängig zu machen, hat in der Wissenschaft zu wachsender Kritik an managementorientierten Paradigmen geführt, die die kontextspezifische Natur von Wasser-Governance-Prozessen vernachlässigen und sie als politisch neutral behandeln (Cleaver, 2000; Castro, 2007; Ingram, 2011; Boelens & Vos, 2012; Zwarteveen et al., 2017; Birkenholtz, 2017; Zwarteveen et al., 2021). In den letzten Jahren hat sich der Fokus der Wasserwissenschaftler auf die Governance-Rahmenbedingungen gerichtet, um zu klären, ob und wie Gesellschaften Governance-Systeme entwickeln können, die zur Nachhaltigkeit der Ressourcen beitragen und gleichzeitig die wirtschaftliche Entwicklung und soziale Gerechtigkeit fördern. Die vorliegende Arbeit will zu dieser Debatte beitragen, indem sie Erkenntnisse aus empirischen und kontextspezifischen Daten einer Trockenregion nutzt, um die folgende Forschungsfrage zu beantworten: Welche Herausforderungen bestehen für die Wasserpolitik im Mittleren Drâa-Tal (MDV) in Südmarokko?

Das Mittlere Drâa-Tal (MDV) liegt in der Provinz Zagora im Süden Marokkos. Das Tal besteht aus sechs Oasen mit Palmenhainen (von flussaufwärts nach flussabwärts: Mezguita, Tinzouline, Ternata, Fezouata, Ktaoua und M'hamid), die sich über eine Länge von 200 km und eine durchschnittliche Fläche von 26.000 ha erstrecken und eine Bevölkerung von etwa 240.000 Einwohnern haben (Karmaoui et al., 2014; Lamqadem et al., 2019). Die Region ist durch ein arides bis hyperarides Klima gekennzeichnet (Klose, 2012) mit einem jährlichen Durchschnittsniederschlag von 70 mm (Moumane et al., 2021). Nach einer explorativen Feldarbeit in verschiedenen Oasen des Tals konzentriere ich meine Forschung auf drei Bereiche. Dies sind die Ebene von Faija und die Oasen von Fezouata und M'hamid.

Um die Forschungsfrage zu beantworten, habe ich die Forschung auf der Grundlage der folgenden Ziele organisiert. Erstens möchte ich die Herausforderungen identifizieren, denen sich die marokkanische Wasserpolitik im Zeitraum 1995-2020 gegenübersah, um eine nachhaltige Entwicklung zu erreichen und das IWRM umzusetzen. Zu diesem Zweck gehe ich zunächst der Frage nach, wie wasserpolitische Dokumente wasserbezogene Probleme, Ziele und Lösungen formulieren. Zweitens: Wie verhält sich die nationale Wasserpolitik zu den Wasserproblemen, die von den Einwohnern und den lokalen Regierungsvertretern in der MDV identifiziert wurden (und wie reagiert sie darauf?)? Die in Kapitel 2 vorgestellten Forschungsergebnisse zeigen eine erhebliche Kluft zwischen den politischen Zielen und dem tatsächlichen Zugang zu Wasser, insbesondere für marginalisierte Gruppen, was eine integrative sozioökonomische Entwicklung behindert. Aus diesen Ergebnissen lassen sich zwei wesentliche Schlussfolgerungen ziehen. Erstens sind möglicherweise politische Reformen erforderlich, um einen ganzheitlichen Ansatz zu entwickeln, der die komplexen Zusammenhänge zwischen den sozialen, politischen, wirtschaftlichen und ökologischen Dimensionen der wasserbezogenen Probleme besser berücksichtigt. Zweitens behindern zwei Hauptfaktoren die Entwicklung dieses ganzheitlichen Ansatzes: der vorherrschende disziplinäre Ansatz, der die nationale Wasserpolitik Marokkos bestimmt und auf wirtschaftlichen und technischen Perspektiven beruht, und die Abschottung zwischen den Regierungssektoren. Die Dominanz der ingenieurwissenschaftlichen und wirtschaftlichen Sichtweise bei der Politikformulierung unterstreicht die Notwendigkeit, die Machtdynamik anzugehen und die Abschottung zwischen den Regierungssektoren aufzubrechen. Darüber hinaus stellt das Spannungsverhältnis zwischen ökologischer Nachhaltigkeit und Wirtschaftswachstum eine Herausforderung für die Kohärenz der Politik dar.

Ein zweites Ziel besteht darin, das Social-Ecological System Framework (SESF) von McGinnis & Ostrom (2014) zu nutzen, um drei Fälle von Grundwasser-Governance in der MDV (Faija, Fezouata und M'hamid) zu analysieren und ihre Herausforderungen im Lichte ihrer sozial-ökologischen Besonderheiten zu erklären. Die Forschungsergebnisse werden in Kapitel 3 vorgestellt. Die Analyse zeigt, dass die hierarchische Verwaltung in Fezouata aufgrund der Diskrepanz zwischen den staatlichen Vorschriften und den lokalen Gegebenheiten Probleme mit der Einhaltung der Vorschriften hat, während die Selbstverwaltung in M'hamid und Faija zwar vielversprechend ist, aber keine wirksamen Durchsetzungsmechanismen aufweist, was die langfristige Nachhaltigkeit gefährdet. Der Aquifer-Vertrag in Faija steht vor der Herausforderung, die Interessengruppen einzubinden und natürliche Anreize für die Beteiligung zu schaffen, was eine aktive Beteiligung und rechtliche Anreize für die Zusammenarbeit erfordert. Diese Erkenntnisse führen mich zu dem Schluss, dass die Selbstverwaltungsorganisationen in der MDV eine wichtige Möglichkeit darstellen, die Bedingungen für eine nachhaltigere Grundwassernutzung in der Region zu schaffen. Die erheblichen Einschränkungen, denen diese Organisationen bei der Verhängung von Sanktionen und der Koordinierung mit anderen lokalen Selbstverwaltungsorganisationen unterliegen, deuten jedoch darauf hin, dass die Selbstverwaltungsorganisationen derzeit nicht ausreichen, um eine nachhaltige Grundwassernutzung zu gewährleisten. Um diese Einschränkungen zu überwinden, müssen die Selbstverwaltungsorganisationen mit den staatlichen Institutionen zusammenarbeiten, jedoch so, dass ihre Selbstverwaltungskapazität zur Schaffung von Regeln und zur Überwachung der Grundwassernutzung nicht beeinträchtigt wird. Was den verwendeten Analyserahmen betrifft, so lautet die Schlussfolgerung, dass der Rahmen für sozial-ökologische Systeme (SESF) ein wertvolles Instrument für die Strukturanalyse ist, das Aufschluss darüber geben soll, wie die bestehenden wasserwirtschaftlichen Institutionen mit dem breiteren sozio-ökologischen Kontext verbunden sind.

Das dritte Ziel besteht darin, die Auswirkungen von Konflikten zwischen Stämmen um kollektives Land auf die lokale Dynamik zu verstehen, die den Zugang zu Grundwasser bestimmt, der durch den Zugang zu kollektivem Land vermittelt wird. Zu diesem Zweck analysiere ich einen Konflikt zwischen patrilinearen Gruppen in Faija. Ich ermittle die Triebkräfte des Konflikts und erkläre die Verteilungsergebnisse, die der Konflikt in Bezug auf Wasser, Land, Macht und Autorität hat. Meine Analyse wurde von der Zugangstheorie (Ribot & Peluso, 2020) und einem akteursbasierten Ansatz inspiriert. Die Ergebnisse, die in Kapitel 4 vorgestellt werden, zeigen, dass der Konflikt in einer komplexen Dynamik historischer Veränderungen der Machtverhältnisse wurzelt. Diese historischen Veränderungen werden durch umfassendere sozio-ökologische Transformationen erklärt, darunter Klimawandel, globale Marktexpansion, regulatorische Veränderungen und Infrastrukturentwicklung, die die Machtdynamik und den Ressourcenzugang in der MDV neugestalten. Der Wassermelonenanbau ist nicht nur ein wirtschaftliches Ziel, sondern auch ein Mittel zur Erlangung von sozialem Status und politischem Einfluss. Dies verdeutlicht den politischen Charakter von Ressourcenkonflikten und die Bedeutung von Stammesinstitutionen und ethnischen Identitäten als Faktoren, die den Zugang zu Land und Grundwasser bestimmen, sowie die enge Verbindung zwischen diesen beiden Ressourcen. Abschließend unterstreicht die Studie, dass Konflikte um Land und Wasser in der MDV nicht nur durch die Verfügbarkeit von Ressourcen, sondern auch durch soziale Veränderungen und Machtkämpfe bestimmt werden. Die Analyse zeigt, dass die verschiedenen Akteure, die als Nutznießer der Grundwassernutzung in Faija identifiziert wurden, aus dem Grundwasser Kapital schlagen, indem sie die bestehenden

Wasserbewirtschaftungsvorschriften umgehen und verbiegen und dabei verschiedene Praktiken anwenden, einschließlich der Zahlung von Bestechungsgeldern. Dies verdeutlicht, dass zahlreiche lokale Akteure ein Eigeninteresse an der Aufrechterhaltung des Status quo haben, was die Durchsetzung von Beschränkungen der Grundwasserentnahme in Frage stellt. Darüber hinaus fungieren die kollektiven Landkonflikte in der MDV als politische Arenen, in denen Autorität auf lokaler Ebene produziert und bestritten wird, was zu Verteilungsergebnissen führt, die die Macht zur Regulierung des Zugangs zu Land und Grundwasser bestimmen.

Kapitel 5 ist in drei Unterabschnitte unterteilt. Zunächst fasse ich die wichtigsten Ergebnisse der einzelnen Kapitel zusammen (5.1). Dann stelle ich die allgemeinen Schlussfolgerungen der Forschung zusammen mit einigen Empfehlungen vor (5.2). Im letzten Abschnitt dieses Kapitels werden Ideen für mögliche zukünftige Forschungsaktivitäten vorgestellt (5.3).

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Chapter 1

INTRODUCTION

1.1. Background and problem statement

The expansion of intensive agriculture has been an important global trend during the 20th century (Tilman, 1999), and it is highly likely to continue during the next decades (Zabel et al., 2019). It is estimated that between 1900 and 2005, irrigated areas in the world increased from approximately 0.63 million km^2 to 3.1 million km^2 (Al-Yaari et al., 2022). Recent estimations on irrigated areas expansion range between 3 141 000 km^2 and 3 985 270 km^2 (Meier et al., 2018; Thenkabail et al., 2009). Puy et al. (2020) argue that existing models on the future size of irrigated areas overlook basic parametric and structural uncertainties, making the potential extension of irrigation in 2050 to be much larger than previously suggested, up to 1.8 billion hectares. This type of agriculture not only contributes to the degradation of ecosystems and biodiversity but of water resources (Hu et al., 2019; Hunke et al., 2015; Ilampooranan et al., 2022; Mendivil-Garcia et al., 2020, 2020; Mohammed et al., 2022, 2022; Tian et al., 2015) and to the accentuation of social inequalities in access to water (Houdret, 2012; Mehta et al., 2012; Woodhouse, 2012). Arid and semi-arid regions, where populations suffer the multiple implications of water scarcity, have not been exempted from this global trend, which is contributing to increased pressure on water resources and creating tensions and contradictions within societies (Mehta et al., 2012; Venot et al., 2014; Molle, 2017; Molle, Sanchis-Ibor, et al., 2019).

The expansion of intensive agriculture in arid regions is commonly fuelled by national policies of agricultural development that are promoted with the argument that the agriculture sector plays a key role in the development of national economies, poverty alleviation and achieving national and global food security (Venot et al., 2014; World Bank, n. d.). However, the global trend of water resource degradation is coinciding with an increasing demand for water driven by population growth and economic development (Boretti & Rosa, 2019). The combination of resource degradation and increasing water demand, intensifies the competition over water between sectors like agriculture, drinking water production, industry, tourism, and the environment. This, in turn, poses major management challenges in terms of resource allocation, particularly during periods of drought. Morocco is currently facing a period of drought that has led to a significant reduction of the water stored in the country's main reservoirs (Médias24, 2023; Zerrour, 2023). The consequent priority given to drinking-water supply has reduced the percentage of the water stored in these reservoirs devoted to irrigation, presumably impacting the livelihood of rural inhabitants.

The effects of climate change in arid regions add a new layer of difficulty to water management. Studies on climate change not only predict that dry areas in the world will become drier (El-Beltagy & Madkour, 2012), but that there is a global trend of dryland expansion, particularly in the continents of the Eastern Hemisphere (Huang et al., 2016; Singh & Chudasama, 2021). The Middle East and North African (MENA) region emerges as one of the hot spots for worsening extreme heat, drought, and aridity conditions, in which rural livelihoods are expected to deteriorate as a consequence of declining agricultural productivity (Waha et al., 2017). In this region, groundwater is an essential source for irrigation (Wada et al., 2010; Jakeman et al., 2016; Molle, Sanchis-Ibor, et al., 2019;). The evidence suggests that the

intensification of agriculture production in these regions comes at the cost of compromising the sustainability of aquifers (Jakeman et al., 2016; Hssaisoune et al., 2020; Molle, Sanchis-Ibor, et al., 2019).

In this context, governments face a double challenge: on the one hand, they have to cope with the degradation of water resources and, on the other hand, they have to deal with the increasing demand for water driven by the current paradigm of keeping a constantly growing economy (Hediger, 2006; Richardson et al., 2023). Integrated Water Resources Management (IWRM) has been promoted worldwide since the 1990s to reconcile socio-economic development with environmental sustainability and social equity (Woodhouse & Muller, 2017). Today, IWRM is the dominant water policy paradigm around the world. Authors such as Allan (2003), Allouche (2016a, 2016b) and Mehta et al., (2016) have explained that its hegemonic positioning is the result of discourse coalitions and the popularity of the concept rather than any proof that it can achieve more sustainable outcomes. Critics of this paradigm point to internal inconsistencies that make it unimplementable (Biswas, 2004; Molle, 2008), as well as to a lack of clarity on how to achieve integration of water management into other fields (Bolding et al., 2000).

For this reason, it is not surprising that although IWRM suggests shifting from a water offer management approach to a demand management approach, governments such as Morocco, facing water shortage, are still deploying a narrative centred on the need to invest in large-scale water infrastructure to fully exploit the mobilisable resource potential of the country (Allan, 2003; Molle & Tanouti, 2017). The idea is to mobilise water resources to make them available where and when they are needed, and in this way, satisfy the socio-economic development needs of the country. Dams, inter-basin water transfer, demineralisation plants, waste-water treatment for water re-use are the common repertoire to increase the national water offer. In arid regions, this narrative is associated with a conceptualisation of physical water scarcity in terms of deficit (more demand than offer) and coupled with a second narrative predicating the need for promoting a more rational and efficient use of water (Benouniche et al., 2014; Molle, 2017; Venot et al., 2014; Woodhouse & Muller, 2017). Despite the various shortcomings pointed out by researchers, governments have continued to implement policies informed by these narratives without significant changes (del Vecchio & Barone, 2018; Molle & Closas, 2017; Zwarteveen et al., 2021).

The inability to reverse the degradation of water resources has sparked among scholars growing criticism towards the advocacy of managerial-focused paradigms that neglect the context-specific nature of water processes and treat water governance as politically neutral (Cleaver, 2000; Castro, 2007; Ingram, 2011; Boelens & Vos, 2012; Zwarteveen et al., 2017; Birkenholtz, 2017; Zwarteveen et al., 2021). As a result, the focus has been placed on governance frameworks to try to elucidate whether and how societies can develop governance systems that help achieving resource sustainability while promoting economic development and social equity (Pahl-Wostl, 2015, 2019). This thesis aims to contribute to this endeavour. Based on empirical data, I aim to better understand the water governance challenges in the arid Middle Drâa Valley (MDV) of Morocco. To achieve this purpose, the first part of this research focuses on identifying the challenges faced by the water policy implemented in Morocco during 1995–2020 in achieving sustainable development and the limitations encountered in implementing IWRM (Chapter 2). As part of this effort, I aim to answer how water policy documents frame water-related problems, goals, and solutions, as well as how the national water policy responds to or provokes the water problems identified by local inhabitants and local governmental representatives in the MDV.

After this, I investigate three cases of groundwater governance (Faija, Fezouata, and M'hamid) to provide empirical insights into governance challenges in this arid region (Chapter 3). The objective is to examine the development and operation of institutional arrangements for groundwater governance and offer empirical insights into the specific groundwater governance challenges in this arid region. To achieve this, we address the following research questions: 1) What are the characteristics of groundwater governance in the MDV? 2) How is groundwater governance influenced by the contextual specificities of the social-ecological system? And 3) what factors impact rule compliance within the identified groundwater governance systems? The analysis is guided by governance modes (Kooiman, 2003; Kooiman et al., 2008), the Social-Ecological System Framework (SESF) (McGinnis & Ostrom, 2014), and an incentive structure analysis approach (Wight et al., 2021).

For understanding access to groundwater and land, which are intimately connected, in Chapter 4, I focus on unravelling conflicts over customary land between tribal groups. More specifically, I use access theory (Peluso & Ribot, 2020) to analyse how power dynamics influence access to customary land, and an actor-based approach to identify the links between the main drivers of conflict and broader social, political, and economic factors at local and national levels (Schilling, 2016; Schilling et al., 2018). I use the Sustainable Development Goals (SDGs) to discuss the implications of my findings for sustainable development in the study area.

Resource conflicts constitute an interesting entry point to study governance because they present the opportunity to see the everyday practices through which resources are accessed and used, the different actors involved in this use, their interests and power dynamics shaping who can access resources, under which conditions and for what purposes. Studying conflicts also shed light on how national policies affects groundwater use practices, for instance, by indirectly incentivising groundwater use through subsidies aimed at promoting agriculture development and consequently increasing competition over the resource. It revels what are the institutions and social relations framing groundwater exploitation, and the links between the case study and broader historical processes taking place at different levels. In this way, focussing conflict enriches the SESF, providing empirical data on the actors' interactions within a given SES. With this in mind, I approach the study of conflicts using a political ecology perspective that sees resource-based conflicts as part of historically-driven and multi-level socio-environmental processes that create an unequal distribution of benefits and burdens from resource-based production and environmental change (Le Billon, 2012; Robbins, 2020). In this light, conflicts arise when less privileged actors resist this inequality and struggle to enforce their interests over those they see as rivals (Schilling et al., 2018).

The three chapters combined offer complementary entry points that contribute advancing the empirical knowledge on how water governance works in arid regions such as the MDV, what are the governance challenges that the institutional arrangements in place face, and how these challenges are linked to the particular social-ecological characteristics of each case. The results highlight the political nature of water governance, shedding light on the factors that determine how decisions and practices affect water flows, how it is used, who benefits from it, and who is excluded. In this sense, this thesis demonstrates the fruitfulness of not limiting the study of governance to the analysis of policies, documents (like the National Water Strategy or the water laws), and legal aspects (such as formal property rights), but combining this with the analysis of empirical data collected in the field through observations and interviews focussing on the practices and processes through which water governance actually occurs. This

approach sheds light on how the framing of policy problems and solutions in policy documents is shaped by particular ontologies, values and interests that prevail over others, which reveal in turn the power dynamics that are part of policy-making. By adding the empirical data, the thesis shows how the solutions implemented as part of this policy provoke water problems in the local space. This thesis also contributes to advance the knowledge on how the contextual particularities of social-ecological systems resist the implementation of water management models prescribed internationally as universal solutions, shedding light especially on the challenges that the particularities of arid regions like the MDV pose on water governance institutions. Finally, the study of the conflict over collective land has shown first the important link between land and groundwater governance in the MDV, and how this link is neglected in the sectorial (and compartmentalised) national policies. It also highlights the distributive outcomes of this type of conflict in terms of authority to control access and use of collective land and groundwater, and how the competition between statutory and customary institutions to legitimise their authority is a key component of this process. The light shed on conflicts as processes that produce authority over resources suggests that it could be fruitful to study the collective lands in Morocco as spaces in which the power and the authority of the state is produce and consolidated (Rasmussen & Lund, 2018).

I conducted this research in the framework of the project SaliDraa Juj -Salt in the system - Biodiversity and ecosystem services in the water management of the arid Draa river basin, Morocco, between October 2019 and February 2024. The SaliDraa Juj team was composed of biologists, environmental economists, sociologists, and anthropologists. Chapter 3 of this thesis is the product of a collaborative and interdisciplinary work with my colleague Imane Mahjoubi, which provided the conceptual framework to study rule compliance incentives in the identified governance systems.

It is worth noticing the impact that the COVID-19 pandemic had on my research. The pandemic was declared in 2020 while I was in Morocco, shortly after I started the first fieldwork activities to collect data. I had to interrupt my fieldwork and was unable to restart it before October of 2021. Unpredictable quarantines and closures of international borders made it particularly difficult to plan for more prolonged and intense fieldwork. This reduced the capacity to collect data on everyday water use practices, forcing me to shift my original analytical approach from critical institutionalism to the Social-Ecological System Framework.

1.2. Research questions

By analysing empirical data, I aim to better understand **what are the water governance challenges in the MDV?** This is the overarching research question of this dissertation. To answer it, I organised the research based on the following objectives.

- Identify the challenges the water policy of Morocco during 1995–2020 faces for achieving sustainable development and the limitations in implementing IWRM. To this end, I aim to answer first how water policy documents frame water-related problems, goals, and solutions. Second, how the national water policy responds or provokes the water problems identified by local inhabitants and local governmental representatives in the MDV.
- Use the SESF to analyse three groundwater governance cases in the MDV and explain their strengths and limitations in light of their social-ecological particularities.

- Use an actor-based approach and access theory to analyse the drivers of conflict over groundwater and customary land between tribes in the MDV and explain the distributional outcomes of the conflict in terms of water, land, power and authority.
- Identify the implications that customary land conflicts have for sustainable development in the study area.

1.3. Research area

1.3.1. Environment, climate, and agricultural activities

The MDV is located in the province of Zagora in southern Morocco. The valley is made up of six oases with palm groves (from upstream to downstream: Mezguita, Tinzouline, Ternata, Fezouata, Ktaoua, and M'hamid), which cover 200 km in length and an average area of 26,000 ha, and a population of some 240,000 inhabitants (Karmaoui et al., 2014; Lamqadem et al., 2019). The region is characterised by an arid to hyper-arid climate (Klose, 2012) with an annual average precipitation of 70 mm (Moumane et al., 2021).

I conducted my research on the plain of Faija and the oases of Tinzouline, Ternata, Fezouata, K'taoua and M'hamid (Figure 2.1). The hydrogeological basin of the Faija Aquifer has an area of 2450 Km^2 (ABH - DON, 2020). The plain is surrounded by mountains that help collect and drain the rain that recharges the aquifer beneath it. These mountains are Jbel Boujniba to the north, Jbel Boukhachba to the northwest, and Jbel Bani to the south. To the east, the plain is bordered by Fezouata Oasis and the Drâa River. The Feija plain is crossed by a national road, which facilitates articulating the area to national markets and the city of Zagora.

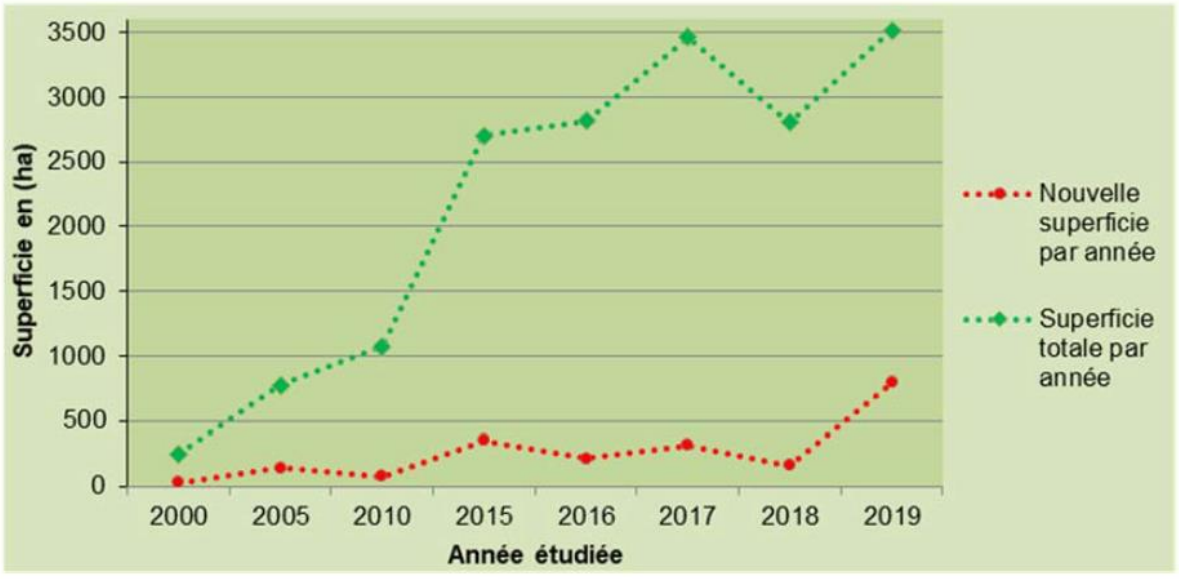

Figure 1.1. Evolution of irrigated areas in Faija between 2000 and 2019. Source : Royaume du Maroc-Agence du Basin Hydraulique Draa-Oued-Noun, 2020 : 70.

In Faija, land is collectively owned by patrilineal ethnic groups (also known as tribes). In a recent technical study of ABH (ABH - DON, 2020), the total agricultural area surveyed was estimated at 5,910 hectares, including 3,055 hectares of irrigated land. As shown in Figure 1.1, major expansions of the irrigated area occurred between 2010 and 2015 and 2018 and 2019. The 2019 survey identified almost

850 water points on 605 farms, the majority of which were small (<5Ha) and medium (between 5 Ha and 10 Ha) (ABH - DON, 2020). This study report also indicates that the predominant crop in Faija is watermelon (almost 81% of the irrigated area). This crop was followed by alfalfa (6%), palm (5%), and henna (4%). The agricultural pumping was estimated at nearly 21 Mm^3/year. This volume has doubled since 2014. It is important to notice that the report warns that the 2019 survey is not exhaustive (ABH - DON, 2020: 73-74).

In the oases, farmers practice subsistence agriculture, characterised by a stratified production system, where date palms, fruit trees and annual crops are combined. The canopy provides protection against the arid climate for the lower crops such as Henna, grenadiers, vegetables, gardening, and livestock fodder (Karmaoui et al., 2015).

According to the technical study commissioned by the River Basin Agency Souss Massa – Agadir in 2010, the agricultural area of the Fezouata oasis was estimated at 3,440 ha. The oasis is irrigated by diverting the water released from the El Mansour Eddahbi dam via the Zagora intake dam connected to the main concrete-lined canals. In addition to the water from the dam, this area is irrigated by pumping from the alluvial groundwater and by groundwater resurgences that appear in the bed of the Oued Drâa (Royaume du Maroc-ABHSMD, 2010).

Groundwater in Fezouata is also used to supply drinking water to the population. At the moment of the study, the centre of rural commune Tamegroute, main settlement in the oasis, was supplied with drinking water by ONEP (National Office of Potable Water) from a well with a flow rate of 10l/s. The neighbouring villages scattered throughout the palm grove are supplied with drinking water from individual wells or springs. The flow rate use is estimated at 11.8 l/s for 34,162 inhabitants (Royaume du Maroc-ABHSMD, 2010).

In 2010, the agricultural area of the M'hamid oasis was estimated at 1780 ha. As is the case for the rest of the oases, M'hamid is irrigated by diverting the water released from the El Mansour Eddahbi dam. In addition to water from the dam, this area is irrigated with water from the alluvial aquifer. Drinking water supply to the centre of M'hamid and neighbouring villages was provided by ONEP from 2 wells (N°IRE 599/82, 550/82) with an equipped flow rate of 10l/s. In 2009, production was estimated at 0.17 Mm^3 and consumption at 0.14 Mm^3 for a population of 8,000 (Royaume du Maroc-ABHSMD, 2010).

1.3.2. Key categories of social organisation

Oases have been historically socially stratified societies. Based on research on this area, Potin (1995) identifies six types of criteria for the formation of traditional identity and solidarity groups structuring social relations and dynamics: ethnicity; social notability based on religion ("Chorfa" families are considered descended from the prophet and are the preeminent category, and "M'rabtine" families, considered descended from saints) or secular notabilities (descendants of former caïds , lineages of honour, etc.); cohabitation in the same village; belonging to the same hydraulic socio-territorial community (which could comprise all or part of a village or several villages based on sharing primary or secondary irrigation canals); social status of "protector" (armed semi-nomad Arab and Amazigh groups) or

“protected” (sedentary native population); and tribal segmentary organisation. “Today, it seems that only the status of protector or protégé has disappeared once and for all” (Potin, 1995).

The main ethnic groups present in the region are the native Draoua population; descended from former slaves brought from Sudan; Arabs; Berberised Arabs; and Berbers (or Amazigh). In terms of religion, in addition to Muslims, there used to be also Jews but they massively emigrated to Palestine in the 1950s-1960s (Ouhajou, 1996). Ethnic, tribal, and territorial identities linked to villages (Kqsour) are strongly related and usually mobilised to claim access to collective land and water (Ouhajou, 1996). For this reason, I paid particular attention to the segmentary-tribal identity. Hence, a brief explanation of this type of social organisation is necessary.

For this dissertation, I define tribes as segmentary groups in which members consider they share a common male ancestor and use customary laws to decide, among other things, on division of the group territory into large blocks (cultivated land, rangelands, habitat), irrigation, land repartition between members, etc. (Bouderbala, 2000). My observations of the social organisation of tribes in the MDV coincide with the description of Adra (2021), which the author holds it is valid for the entire MENA region. The author explain that tribes are organised into units (segments) of increasing size and scope built on the household as their central foundation. Some segments are named for putative kin (common in the MDV). Others are distinguished as numerical fractions of a whole, such as third, fifth, and eighth, as parts of the body such as thigh (also the case in the MDV), by practical usage, for example, domicile, and still others by place names. Bounded communities, such as villages, are often considered tribal segments (also common in the MDV).

On the topic, Potin (1995) reports that patrilineages may still be the reference for private water rights for the irrigation of traditional perimeters, and that villages had communal grazing and agricultural territories. These are areas "of power relations and confrontation" (Potin, 1995: 28) between the village and the tribal segments of historical semi-nomadic protectors, among which the powerful confederation of the Aït Atta stands out.

1.3.3. Changes in a hydraulic society: social hierarchies, water access, and land-use

The MDV relies on agriculture as the main occupation and source of income for locals. Historically, the nobility groups (“Chorfa”, “M'rabtine” and secular notabilities) were at the top of the social hierarchy and had preeminent access to water rights and land (Hammoudi, 1982; Ouhajou, 1996). Ouhajou (1996) explains that “The moral prestige of these families often earned them economic power, as evidenced even today by the large land holdings of certain zaouias” (pp. 61-62). Nobility groups were under the protection of nomads as well as sedentary people. According to Ouhajou (1996), the protectors were second in the social hierarchy and included Arabs and Amazigh groups, most often nomads. This institution of protection emerged during periods of extreme violence in the valley in which the villages were exposed to the greed and attacks of the remaining nomadic groups. The last of these periods of violence took place from the 17th century to the beginning of the 20th century. Each tribe or fraction of a nomadic tribe undertook the protection of one or more villages. In return, the sedentary people had to cede a quarter of their territory. The protectors eventually settled down, generally in the regions they protected (Ouhajou, 1996). At the bottom of the hierarchy were the native Draoui population and the descendants of former slaves from Sudan. According to Ouhajou (1996), after long-serving other groups as agriculture and domestic labourers

in exchange for part of the harvest, this group still forms the majority of the deprived population today, forced to work the land or emigrate.

According to customary rules, the claim to the water of an irrigation canal is linked to the labour, the work done by the water user or one of his ancestors in building the canal (Hammoudi, 1982). In practice, however, water rights, political representation and claims of belonging to the territory were strongly linked to social hierarchy, being the lower class of the Draoua commonly excluded from equal participation in the political decisions of the oasis society and from ownership of water rights over the local irrigation system (Hammoudi, 1982; Ouhajou, 1996; Liebelt, 2003).

The power relations between these groups progressively changed during the 20th century. According to Rignall, (2015), the “migration economy" created based on the remittances sent back to the pre-Saharan region by labour migrants, contributed to dismantling sharecropping as an institution of racialised domination. The remittance money made in northern cities of Morocco and later on in Europe (Aït Hamza et al., 2010; de Haas, 2006; Rademacher-Schulz, 2014) contributed to enhancing the economic position of these marginalised groups, who invested in agricultural land, water rights, and infrastructure like wells and motor pumps (Liebelt, 2003). This, in turn, allowed them to occupy local political positions that had previously been denied to them, increasing their political power (Liebelt, 2003). The reconfiguration of power relations between the traditional hierarchical groups has also be influenced by the historical articulation of the Anti-Atlas region to the modern state and the capitalist economy through infrastructure development and means of transportation during the 20th century (De Haas, 2005). This is because these processes made access to water more dependent on the financial possibilities of a household and its access to the cash economy than, as in the past, a high social or political position that secures agricultural activity (Liebelt, 2003).

Since the mid-1970s, frequent and prolonged droughts have increased dependence on groundwater, facilitated by more affordable pumps, well infrastructure, and solar panels, leading to declining water tables (Bossenbroek et al., 2023; Houdret & Heinz, 2022; ABH-DON, 2020; Hssaisoune et al., 2020; Kuper et al., 2016). According to Chelleri et al. (2014), the increased number of wells in the MDV is also a response to the shortage of water farmers started to experience after the construction of El Mansour Eddahbi Dam in 1972, and the system of canals that distribute the dam water in the valley, as well as the implementation of a new schedule of water distribution imposed by the government. The number of water pumps increased from 2.000 in 1977, to 4.000 in 1985, nearly 7.000 in 2005 and more than 10.000 in 2011, which resulted in soil and groundwater salinisation (Chelleri et al., 2014). Ouhajou (1996) propose that the increase in wells was also a response of the population that wanted to become as independent as possible from the now state-controlled river water.

Another significant change in the MDV has occurred regarding land-use patterns in areas outside the traditional oases. These areas are collective land of tribes previously used as grazing lands and today as agricultural land. This land is subject of a process of privatisation promoted by the national government (Mahdi, 2014; Balgley, 2017; Berriane, 2017; Kadiri & Er-rayhany 2019; Balgley & Rignall, 2021). During my fieldwork, I visited several of these areas. Interviewees explained that they developed agriculture in these areas during the 1980s on the basis of groundwater irrigation. This expansion of the agricultural frontier in the valley was a response to drought and the lack of agricultural land inside the oases to satisfy the demands of the young generations. With time, the groundwater in some of these areas was depleted and

the areas abandoned. Others are still exploited, though interviewees mentioned groundwater availability has decreased significantly.

Collective land has historically been contested areas of power relations between segmentary groups in the MDV (Potin, 1995, Ouhajou, 1996). During my fieldwork, informants pointed at them as the reason for the main conflicts in the MDV today. In the context of acute water scarcity and decreased agricultural yields, the increased value of collective lands increases the competition for this resource between tribes.

1.4. Conceptual approach

In this section, I define the main concepts informing my thesis, the debate or criticism around each of these concepts, and how I use them in my research. These concepts are water governance, social-ecological systems, resource conflicts, and resource access.

1.4.1. Water governance

Broadly speaking, two ways exist to define or use the term governance in the water sector. One, labelled by its critics as managerial-focused or techno-managerial, emerged from techno-engineering approaches in natural resource use and management (Venot et al., 2014; Closas & Villholth, 2020). In this conceptualisation, governance is presented as a way to steer water resources toward a desired state, normatively prescribing particular institutional, organisational, and financial arrangements for making water decisions and regulating water (Woodhouse & Muller, 2017; Zwarteveen et al., 2017; Closas & Villholth, 2020). According to this conceptualisation, "good governance" is characterised by transparency, accountability, participation, integrated resource management, resource efficiency and sustainability. To achieve these principles, advocators of this conceptualisation commonly recommend decentralisation, increased reliance on nongovernmental and community-based organisations (like water user associations), implement marked-oriented mechanisms, water rights, and strict monitoring and rule enforcement (UNDP, 2013; FAO, 2016; Zwarteveen et al., 2017; Closas & Villholth, 2020). A definition example in this line can be found in a World Bank study in which water governance is defined as "the operation of rules, instruments and organisations that can align stakeholder behaviour and actual outcomes with policy objectives" (Wijnen et al., 2012, p. 17).

There are several criticisms of this conceptualisation of water governance. For instance, recommendations to achieve good governance have to do more with the goals of management than with the governance process (García et al., 2017). This confusion between management and governance leads to normative propositions that over-simplify water governance issues (Cleaver, 2000). This, in turn, leads to solutions that do not encompass the full array of socio-environmental problems. In addition, the normative-prescriptive character in this governance conceptualisation limits the realm of possible designs of policy tools and interventions, precluding alternative ways and other solutions (Ingram, 2011; Zwarteveen et al., 2021).

Second, the managerial-focused governance approaches neglect power dynamics and inequalities in the distribution of benefits from water. Consequently, it is incapable of fully encompassing the reality of governance as a socio-political phenomenon and proposing solutions capable of addressing the root of the problems (Birkenholtz, 2017; Boelens & Vos, 2012; Castro, 2007; Closas & Villholth, 2020; Zwarteveen et al., 2017). By neglecting the fact that there are actors in each society with vested interests in maintaining

the water status quo, this approach to governance could hardly promote a fundamental transformation toward more sustainable and equitable governance systems (Closas & Villholth, 2020; Zwarteveen et al., 2021). Thirdly, in their eagerness to present governance as politically neutral, advocators of managerial governance approaches remove the intrinsically political aspects of how water resources are actually managed, used, and allocated, leaving them decontextualised and thus disconnected from reality (Closas & Villholth, 2020).

The recognition among scholars that governance processes are context-specific is steering interests away from managerial-focus approaches that suggest universal normative governance paradigms, such as IWRM (Molle, 2008; Mehta et al., 2016; Woodhouse and Muller, 2017). Instead, scholars are increasingly open to the idea that there can be different answers to key governance questions (Zwarteveen et al., 2021), such as who should be engaged in decision-making? Who should oversee rule enforcement? At what geographic and political levels should water governance operate? Or how beneficial polycentric governance systems are? (Daniell & Barreteau, 2014; Pahl-Wostl, 2015, 2019; Woodhouse & Muller, 2017; Baldwin et al., 2018).

From these critics, a second conceptualisation of water governance emerges. It states that governance does not represent an idealistic and aspirational state of sustainable resource management, but a process already occurring within society, within an existing system of resource appropriation and use that is shaped by the capital and power of stakeholders pulling agendas in different directions, constituting a specific governance reality (Closas & Villholth, 2020). Rather than a controlled process, governance originates from user interaction with the resource and between users, communities, and the state (Birkenholtz, 2017). Similarly, Zwarteveen et al. (2017) emphasise the political and distributive nature of governance: “Water governance at heart is about political choices as to where water should flow; about the norms, rules and laws on which such choices should be based; about who is best able or qualified to decide about this; and about the kind of societal future such choices support” (Zwarteveen et al., 2017: 8). Furthermore, Zwarteveen et al. (2017) propose to normatively assess the merits of particular governance processes and arrangements in terms of their distributional outcomes (distribution of water, voice, authority, and expertise) rather than a priori labelling a particular ideological model of water governance as better. This approach aims to build in-depth empirical understanding of how water governance “actually occurs”, documenting the actual functioning of particular institutional, financial, and organisational governance arrangements and processes.

After a first review of the literature on the topic, I adopted some important guidelines that informed my study of groundwater governance in the MDV. First, avoiding a priori labelling a particular ideological water governance model as better. Instead, I recognise that governance processes are context-specific, and should not be judged based on their alignment with pre-defined management paradigms but should be understood based on their distributive outcomes and social-ecological particularities. Second, I aimed to shed some light on how water governance “actually occurs” in the MDV. At the same time, I recognise the importance of building knowledge on the possible factors hindering the development of more sustainable governance systems.

In my search for entry points to anchor my analysis, I came across the concept of "modes of governance" (Kooiman, 2000, 2003, 2008; Pahl-Wostl, 2019). This concept develops ideal typologies of how decisions and interactions affecting water flows are organised and some structural factors that affect

who makes decisions and how these decisions are made. I choose to work with a commonly used typology built on the role played by governmental and non-governmental actors that distinguishes "hierarchical governance" (government steering and top-down control), "self-governance" (resource users take care of themselves), and "co-governance" (public and private actors coordinate without central governing actor) (Kooiman, 2000, 2003, 2008; Pahl-Wostl, 2019).

On this topic, Pahl-Wostl (2019) argues that hybrid governance styles, characterised by a synergistic interplay between governance modes, have a higher performance in dealing with complex water management challenges (2019: 7). I assume instead that in practice, all governance systems are somehow hybrids. Ideal types of governance do not exist in a pure state but as a mix of the components of the different types (Ingram et al., 2015). Consequently, I focus on using the concept of governance modes as a starting point to describe the configuration of organisational and institutional groundwater management arrangements. The aim is to understand how these arrangement configurations came to be, how they work, and their limitations or strengths in promoting resource sustainability.

1.4.2. The concept of social-ecological systems as an entry point to address the context-specificity of water governance

To address the context-specific nature of governance processes, I found a second analytical anchor in the concept of social-ecological system (SES) as conceptualised by the social-ecological system framework (SESF) developed by McGinnis & Ostrom (2014). The SESF is a conceptual framework providing a list of variables, interactions and types of institutional arrangements that are most likely to enable actors to work together and solve social dilemmas in systems with common-pool resources and public goods, influencing the likelihood of achieving sustainable resource use (McGinnis & Ostrom, 2014; Ostrom, 2007, 2009; Partelow et al., 2018). In his literature review of the applications and evolution of the SESF, Partelow (2018) explains that this list of variables was identified and empirically supported by the work of Ostrom and other commons scholars (Olson 1965; Ostrom 1990, 2005; Agrawal 2003; Anderies et al. 2004, Poteete et al. 2010), becoming a comprehensive list of social and ecological variables influencing cooperation and self-organised governance under a theory of collective action. However, Partelow (2018) highlights that it soon became clear that the success of this cooperation is likely to vary under different social and ecological conditions. It is not possible to develop a strong set of theoretical claims that any group of variables will influence sustainability outcomes in predictable and generalisable ways across diverse cases (Partelow, 2018: 3). For this reason, the list of variables of the SESF were presented as "non-theoretical" and as a diagnostic approach (Hinkel et al., 2015). The SESF has evolved into a mainstream field of research, associated with many different concepts, theories, and methods under two broad conceptual pillars: (1) understanding SES functioning and (2) understanding all aspects related to the development, implementation, and transformation toward normative sustainability goals (Partelow, 2018: 3).

I use the SESF in three ways. First, to describe the context of three groundwater governance cases in the MDV and how the particularities of the biophysical environment in each case are linked to the particularities of the institutions under analysis. Second, as a starting point to identify and discuss potential factors hindering sustainable groundwater use in the MDV. Finally, I use the SESF as a common language for communication, first with colleagues in the research project in the framework of which I carried out this doctoral thesis, and with the scientific community at large.

1.4.3. The critics of Critical Institutionalism and the possible blind spots of my approach

As I mentioned, the SESF stems from collective action and common property (or pool) resources (CPR) theory (Ostrom 2007, 2009; Partelow, 2018). Main critics to CPR theory have been formulated by critical institutionalists and have been well summarised in the work of Cleaver (2000) and Cleaver & de Koning (2015). Particularly in relation to the institutional design principles linked to sustainable resource use (Ostrom, 1990).

Critical institutionalists start by questioning the economistic rational choice assumptions from which CPR models depart. Critical institutionalist state that people's motivations to cooperate in collective arrangements are not only economic, but a mix of emotional, moral and social rationalities informed by differing logics and world-views (Cleaver, 2000; Cleaver & de Koning, 2015). Second, they question whether better institutions can be "crafted" as part of a continuous evolutionary process of developing the optimal institution for the job at hand. From a critical institutionalism perspective, individuals' actions are influenced by the structural characteristics of the society, but at the same time, individuals have agency to recreate and alter those structures through their actions. In these processes, institutions are not necessarily designed for a particular purpose but borrowed or adapted from other working arrangements (Cleaver & de Koning, 2015).

Finally, critical institutionalist holds that the CPR conceptualisation of institutions for water management is too abstract. To study how water institutions work, we need to study how institutions are located in daily life in the frame of actual relationships. "CPR theory often struggles to effectively conceptualise socially embedded resource users and so to fully understand norms, values and interests; in focusing on efficiency and functionality CPR theory may overlook the ways in which local dynamics are shaped by interactions at multiple scales"… "dealing inadequately with heterogeneity within communities"… "skating over the politics of policies, discourses and local power dynamics"… they present "lack of meaningful conceptualisation of the social relations and meanings associated with natural resource management" (Cleaver & de Koning, 2015: 7).

These critics do not render CPR approaches completely invalid. After all, it is a theory that has been built on empirical data and longitudinal case study comparisons and re-evaluated by studies such as Cox et al. (2010). The latter study concluded that the Design Principles for Community-based Natural Resource Management (Ostrom, 1990) are empirically supported. However, it is important to recognise the different blind spots listed in the previous paragraph for studies adopting CPR as interpretative framework.

Ideally, I would try to implement both approaches in a complementary way, using the SESF as starting point to contextualise concrete governance processes in particular socio-ecological settings. Then, I would use the critical institutionalism approach to explain how the institutions are socially embedded, what are the other possible purposes and functions that water institutions are fulfilling, and how motivations to cooperate in collective arrangements can be responding not only to economic interests but to emotional, moral and social rationalities. In practice, the possibility of mixing both approaches depend on the practical conditions enabling but also constraining each research process. In my case, language barriers[1] and the difficulty of finding a translator willing or available for longer and more intense periods of fieldwork limit my ability to engage in a more detailed study of everyday water practices. As I mentioned

[1] Most interviews were conducted in Darija (Moroccan Arabic) and Amazigh.

in the introduction, the pandemic of Covid-19 also created a factor of uncertainty that hindered the planning of longer periods of fieldwork. For these reasons, the analysis of three ground governance cases presented in chapter 3 of this dissertation focuses mainly on the formal characteristics of groundwater institutional arrangements, their relation with the broader characteristics of the SES in which they emerged, on the history of how they emerged, and a reconstruction of how these institutional arrangements work based on the testimony of water user and government representative interviewed.

1.4.4. Resource conflicts and water governance

Nonetheless, I partially counteract the limitations of the SES and CPR approach through the case study of an inter-tribal conflict over collective land and groundwater presented in Chapter 4. Although the main focus of this chapter is on explaining the drivers of the conflict, the analysis also addresses the different practices to access and use groundwater, how these practices are embedded in historical reconfigurations of power relations and authority, and how these practices are imbued of different meanings that goes beyond the realm of water.

To analyse this conflict, I use an actor-based approach (Schilling et al., 2018; Schilling 2016), that considers the links between the main drivers of conflict and broader social, political, and economic factors at local and national levels. I move away from a deterministic view of the link between resource scarcity and conflict (Detges, 2014; Homer-Dixon, 1994). Instead, I adopted a political-ecology approach that sees resource-based conflicts as part of historically-driven and multi-level socio-environmental processes that create unequal distribution of benefits and burdens from resource-based production and environmental change (Le Billon & Duffy, 2018; Robbins, 2020). In these situations, conflicts arise when less privileged actors resist this inequality and struggle to enforce their interests over those they see as rivals. The historical approach to conflict reveals the dynamic nature of conflicts, demonstrating how unequal power relations shaping access to resources are subject of reconfiguration over time.

I combine this approach with access theory (Peluso & Ribot, 2020) to analyse how power dynamics influence access to land (and consequently to groundwater). The concept of access as the ability to benefit from resources (Peluso & Ribot, 2020) present the advantage of taking the analysis away from the emphasis on property rights to focus instead on whether, why, and how particular benefits are derived from resources. The concept allows to study cases such as the Kaaba-Mssoufa conflict, where one actor benefits from land for which it does not hold formal property rights.

1.5. Methodology

1.5.1. Research approach

I use the Case Study as a general qualitative methodological approach. This involves the study of an issue through one or more cases. In this approach, the investigator explores a case or multiple cases over time, through detailed, in-depth data collection involving multiple sources of information (observations, interviews, documents and reports, audio-visual material), reporting a case description and case-based themes (Creswell, 2007, pp. 73-74). Three variations exist in terms of the intent of the case analysis: the single instrumental case study (the researcher focuses on an issue or concern and then selects one bounded case to illustrate this issue), the collective or multiple case study (the issue at concern is illustrated through multiple cases), and the intrinsic case study (the focus is on the case itself because the

case presents an unusual or unique situation - Creswell, 2007: 74). The cases I present in this thesis are, first, the national water policy of Morocco and its relation with local water realities of the MDV (instrumental case approach presented in Chapter 2); second, the three groundwater governance cases of Faija, Fezouata and M'hamid (multiple case study approach presented in Chapter 3); and third, the Mssoufa-Kaaba conflict (instrumental case study approach, presented in Chapter 4).

1.5.2. Data collection and analysis

To develop a detailed description of my case studies, I collect qualitative data through different techniques. 1) Official governmental documents and reports were collected and analysed for all the case studies. These documents were identified as relevant after reviewing governmental documents, official government websites, specialised literature, and interviewing public servants. 2) Three focus group discussions were held as part of the case studies presented in chapters 2 and 4. 3) A total of 147 semi-structured interviews were conducted for all the case studies (Appendix Table S 1). Focus group discussions and interviews were conducted as part of several fieldwork visits in the MDV that took place during February and March 2020, during October and December 2021, during May and June 2022, during September and October 2022, and during May and June 2023. Interviews were conducted in Darija (Moroccan Arabic), Amazigh, and French with the intermediation of a native-speaker translator. Most interviews were audio-recorded, and the transcriptions were transcribed into English by native speakers. The OpenAI. (2024). ChatGPT (GPT-4) was used to proof-read the document and correct grammar and spelling mistakes.

I used purposeful sampling as a general sampling strategy (Creswell, 2007). Government interviewees were selected based on the identification of the main governmental institutions related to water management, the knowledge of the potential interviewees on the topic sunder study, and the availability / willingness of the person to be interviewed. For inhabitants of the MDV, I used a "snow balling" sampling technique (Creswell, 2007). I focused on interviewing inhabitants from different areas of the MDV, from various age groups, different sexes, and ethnicity, and with different occupations, such as farmers, housemaids, university students, owners of tourist facilities, and people working in the service sector.

I analysed the content of the governmental documents as well as the transcriptions of focus groups and interviews using a thematic analysis approach. With the support of MAXQDA software (VERBI Software, 2021), I 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).

1.5.3. Limitations and potential biases

The greatest difficulty I faced while conducting this research was the language barrier. Most interviews were conducted in Amazigh language and Darija, and some in French. With this in mind, I incorporate a budget for fieldwork, which includes hiring fieldwork assistants. Their role involved assisting with translation during interviews, reaching out to potential interviewees, and, ideally, when possible, transcribing interview audio recordings.

As anticipated, the translators did not convey every single detail from the interviewees' responses during the interviews. It was only through reading the transcriptions of the audio recordings that I gained a comprehensive understanding of the content and nuances of each interview. In this regard, the transcription played a crucial role in the data analysis process. However, a limitation arose as I was not able to pose some important follow-up questions that I would have asked during the interviews if I had

understood the language myself. It is possible that these limitations imposed by language barriers made the process of acquiring an understanding of the phenomena under study longer than it would have taken without language barriers.

In addition, I originally planned to conduct longer fieldworks and stay in the areas of the interviews. This was not possible as I found difficult to find candidates to the position of translator/fieldwork assistant with the right profile, willingness and availability to stay for long periods in the field. I aimed to contact students or people linked to academia, ideally with a background in social science. The first person I worked with did not fulfil these criteria and as a consequence, I had to invest more time in explaining the aims of the research and the interview guides. The second one, was a PhD student with background in economics, and his contribution to the work was significant. Unfortunately, this person was not available to work with me for the entire duration of the PhD. Consequently, I worked with another PhD student with a background in biology.

1.6. Structure of the dissertation

This dissertation is structured around three scientific journal articles, one of which has been published, and two that have been submitted to peer-reviewed journals. I led the three articles as main author. The third article was developed in co-authorship with Imane Mahjoubi, a colleague of the research project SaliDrâa Juj.

In **Chapter 2**, I focus my analysis on answering how the national water policy of Morocco (1995-2020) responds to, or provokes the water problems identified by local inhabitants of the MDV. I pay particular attention to the challenges this policy faces in achieving sustainable development and implementing the Integrated Water Resource Management (IWRM) paradigm in the MDV. To this purpose, the thematic analysis of governmental documents aims at describing how “policy problems”, “policy goals”, and “policy solutions” are framed, and describe the water-related problems identified by the locals. To establish the links between the water policy and the local problems, I resort to the testimonies of interviewees about how the national water policy was implemented in the MDV and the problems it faces and generates.

Chapter 3 explores the challenges of the groundwater governance cases of Faija plain, Fezouata, and M’hamid oases, particularly in dealing with groundwater sustainability problems and water allocation. The thematic analysis of governmental documents and interview transcriptions allow to generate detailed descriptions of the variables proposed by the Social-Ecological Framework (SESF). I use this framework to illustrate the particularities of the socio-ecological systems of each case. In addition, the analysis of the interviews produces insights into how these groundwater institutions and organisations emerged, how they function, and identified their main strengths and limitations in dealing with water scarcity, resource sustainability, and resource allocation.

Chapter 4 analyses the drivers of the conflict over collective land between the tribes of Mssoufa and Kaaba, in Faija plain. After presenting the historical background of the conflict, the chapter identifies the actors involved in the conflict, their role, motivations to engage in the conflict and, capabilities to pursue their interests, and the power relations between actors. This information results from an actor-based conflict-analysis combined with access theory, which is based on thematic analysis of interviews and focus group transcription. The actor-based conflict-analysis allows to describe the dynamics of the conflict and its roots in a broad historical process that took place at different levels. The use of access theory helps to identify patterns in terms of access to land, groundwater and other resources involved in groundwater use

in Faija, as well as the distributive outcomes of the conflict regarding power and authority between local actors.

The different cases presented in chapters 2, 3, and 4 provide a bigger picture of groundwater governance in the MDV. By presenting national policies, institutions, and organisations for groundwater management, as well as their interactions, chapters 2 and 3 give an account of the formal conditions in which water governance processes take place. By illustrating how access to groundwater occurs in Faija and the dynamic power relations that frame this access, Chapter 4 presents a better understanding of how governance processes arise in everyday life.

Chapter 5 is divided into three subsections. First, I summarise the main findings of each chapter (5.1). Then, I present the general conclusions of the research, along with some recommendations (5.2). The last section of this chapter presents ideas for possible future research activities (5.3).

Chapter 2

GOVERNANCE AND SUSTAINABILITY CHALLENGES IN THE WATER POLICY OF MOROCCO 1995–2020: INSIGHTS FROM THE MIDDLE DRÂA VALLEY

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2.1. Abstract

Since the UN Water Conference in 1977, international debates have centred 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 Drâa Valley (south Morocco). We find that sustainability and social inequality problems unintendedly triggered by the policy are 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 compartmentalisation 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.

2.2. 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 (Woodhouse & Muller, 2017). With many developing countries facing the challenge of water scarcity, the associated narrative became the foundation for promoting Integrated Water Resources Management (IWRM) (Woodhouse & Muller, 2017). 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, and 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 recognised. 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 maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (Mehta et al., 2016; Woodhouse & Muller, 2017).

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 (Allan, 2003; Allouche, 2016; Mehta et al., 2016). Critics of this paradigm point to internal inconsistencies that make it unimplementable (Biswas, 2004; Molle, 2008), as well as to a lack of clarity on how to achieve integration of water management into other fields (Bolding et al., 2000). Consequently, IWRM is interpreted and deployed by different actors in different ways in accordance with prevailing political interests and ontological and epistemological frameworks (Mehta et al., 2016). 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 by Pahl-Wostl (2015, 2019) and Abson et al. (2017). The efforts made in the water sector to find better ways of assessing progress on the Sustainable Development Goals' targets (Bhaduri et al., 2016) 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 (Pahl-Wostl, 2019).

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 to 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 (Royaume du Maroc, 2009, 2020).

To enable the country to adapt to changing water conditions and meet 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 (Royaume du Maroc, 1995). 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 (Kadiri and Mahdi, 2013). 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 (Swearingen, 1987; Molle, Tanouti, et al., 2019), 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 (Molle, Tanouti, et al., 2019; El Gueddari and Arrifi, 2009; Hssaisoune, et al., 2020), and some authors argue that the water policy has placed even heavier pressure on water resources, particularly on aquifers (Benouniche et al., 2014; Kuper et al., 2016; Molle, 2017; Molle & Tanouti, 2017). For instance, Molle (2017) points to a contradiction between Morocco's agricultural policy (Green Morocco Plan 2008–2020) and its water conservation policies. The author concluded that incentivised expansion of groundwater-based agriculture through a highly subsidised production process results in the further depletion of water (Molle, 2017, p. 17). Other authors show how aquifer depletion in Morocco is linked to the flourishing of a groundwater economy from the 1980s (Kuper et al., 2012, 2017; Kuper et al., 2016). 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' initiative (Kuper et al., 2016, 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 in implementing IWRM. To this end, the article first analyses how water policy documents frame water-related problems, goals, and solutions. Second, the article analyses the key water governance challenges identified by water managers and water users in the Middle Drâa 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 (Royaume du Maroc, 2009, 2020). Therefore, it brings important insights into 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 for 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 of 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 (Royaume du Maroc, 2014). The climate of the region ranges from arid to hyper-arid (Klose, 2012), presenting an annual rainfall average of around 70 mm at the meteorological station in Zagora (Moumane et al., 2021). The average potential evaporation goes up to 3000 mm (Karmaoui et al., 2015). In 1972, the government built the El Mansour Eddahbi Dam to regulate the water flow of the Drâa 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 (Heidecke &

Heckelei, 2010) 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 2.3 introduces the methodology, and section 2.4 presents the results in two parts. The first part (2.4.1) 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 shaped the water policy of Morocco 1995–2020. The second part of the results section (2.4.2) presents the main water management challenges identified from the semi-structured interviews with government actors and residents of the MDV. In section 2.5, we discuss our results, and Section 2.6 presents the conclusions of this chapter.

2.3. Methods

This study is based on the evaluation of policy documents and qualitative data gathered during fieldwork conducted in the MDV between February to March 2020 and October to December 2021. The MDV is composed of six river oases. From upstream to downstream, the oases are Mezguita, Tinzouline, Ternata, Fezouata, Ktaoua, and M'hamid (see Figure 2.1). The analysed interviews were conducted in all these oases with the exception of Mezguita.

The analysed documents (listed in Appendix, Table S 2) were identified as relevant after reviewing governmental documents, official websites of the government, specialised literature, and interviewing public servants of the Regional Office of Agricultural Development— Ouarzazate (ORMVAO), the Agricultural Subdivision—Zagora, the River Basin Agency— Drâa, 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, , Table S 2), as well as documents of high-ranked government officials published in international journals and events, such as the presentations in (Arrifi, 2009; Belghiti, 2008); and the paper Alaoui (2013).

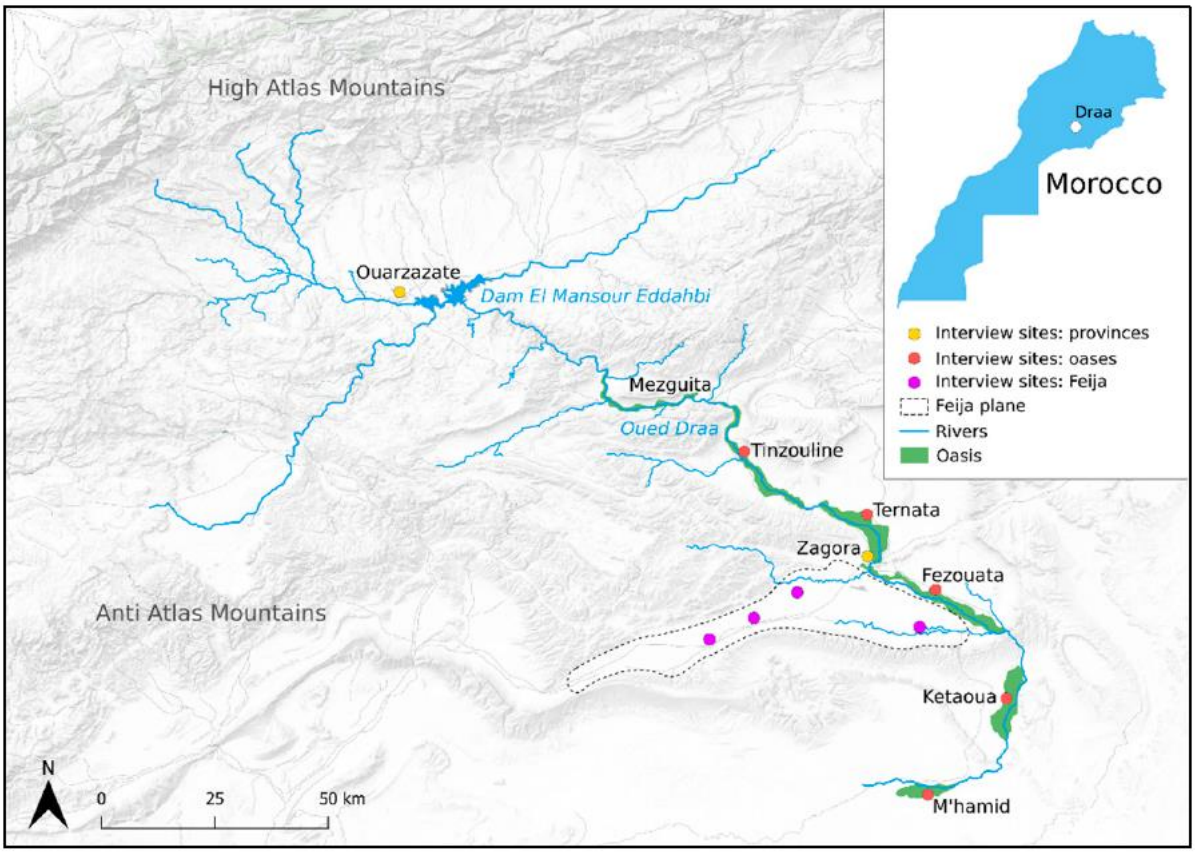

Figure 2.1. Location of Middle Drâa Valley

We used a purposeful sampling strategy to select interviewees in the government and among the 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. 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 (Creswell, 2007). 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 2.1). Among them, 26 were male and 5 were female interviewees, with different occupations, such as government officers, farmers, housemaids, 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 2.1. 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 (Appendix, Table S 2), 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 analysed documents are written in French, with the exception of “Water sector in Morocco: situation and perspectives” (Alaoui, 2013), 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 analyse the interviews and focus group, parent codes established deductively were: “Policy Solutions” (subdivided into “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”, “salinisation 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 organise 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 (Amosa, 2018, 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” (Handberger, 2001, p. 53). In this sense, we are considering as policy problems those situations, facts, and processes that are framed in the analysed 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.

2.4. 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 MDV.

2.4.1. 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 (Table 2.2). The analysis of the way policy goals and solutions have been framed will help us to discuss the way the paradigms of sustainable development and IWRM have been incorporated into the water policy.

Table 2.2. Articulation of policy problems, policy goals, and policy solutions

Ultimate goals		
(a) To meet national water needs to enable the socio-economic development of the country		
(b) To improve rural living conditions by increasing rural income and employment		
(c) To ensure the sustainability of the irrigation sector		
Operational goals and solutions		
Policy problems	**Policy goals**	**Policy solutions**
Water Scarcity Uneven water distribution in time and space Changing conditions in water availability and water demand Water waste	To increase water supply Water valorisation Water saving / water demand management Adaptation to climate change effects	**WATER SAVING** Financial solutions 1. Financial incentives for adoption of 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. Programme to rehabilitate and modernise irrigation infrastructure 2. The development of large-scale localised irrigation (555,000 ha by 2020) Technical/knowledge solutions 1. Strengthening managing irrigation systems through computerised tools 2. Proximity council for improve 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 for overexploited aquifers.

Table 2.2. Articulation of policy problems, policy goals, and policy solution (continued)

Operational goals and solutions		
Policy problems	**Policy goals**	**Policy solutions**
Water Allocation among competing activities	To increase water supply	WATER VALORISATION 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 valorisation.
Climate change	Water valorisation Water saving / water demand management	Institutional solutions 1. Development downstream agriculture through partnership and "contractualisation" with the agroindustry. 2. Institutional reform and public-private partnerships for the management of collective irrigation schemes. Infrastructural solutions 1. Equipment and construction of conveyance infrastructure to put in use the water resources mobilised by dams. 3. Promotion of drip-irrigation to increase the productivity per m3 and therefore the water value.
Food security	Adaptation to climate change effects	DEVELOPMENT OF WATER SUPPLY Infrastructural solutions 1. Large dam building: (27.3 billion m3) and small dams for local development 2. three new seawater desalination plants; 3. Equipment and adductions for securing drinking water supply
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. enforcement of legal regulation to control pollutant activities and groundwater abstractions
Silting of dam reservoirs and loss of storage capacity		

2.4.1.1 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 2.2). "Changing water conditions" is linked to the socio-economic development of the country. According to the policy documents, the increase in the demand for the resource is both a consequence of and a condition for economic growth, the reason why the limitations to supply water must be overcome (Royaume du Maroc, 2009, p. 7). During the 20th century, two conflicting processes 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 (Royaume du Maroc, 2009; Royaume du Maroc, 1995).

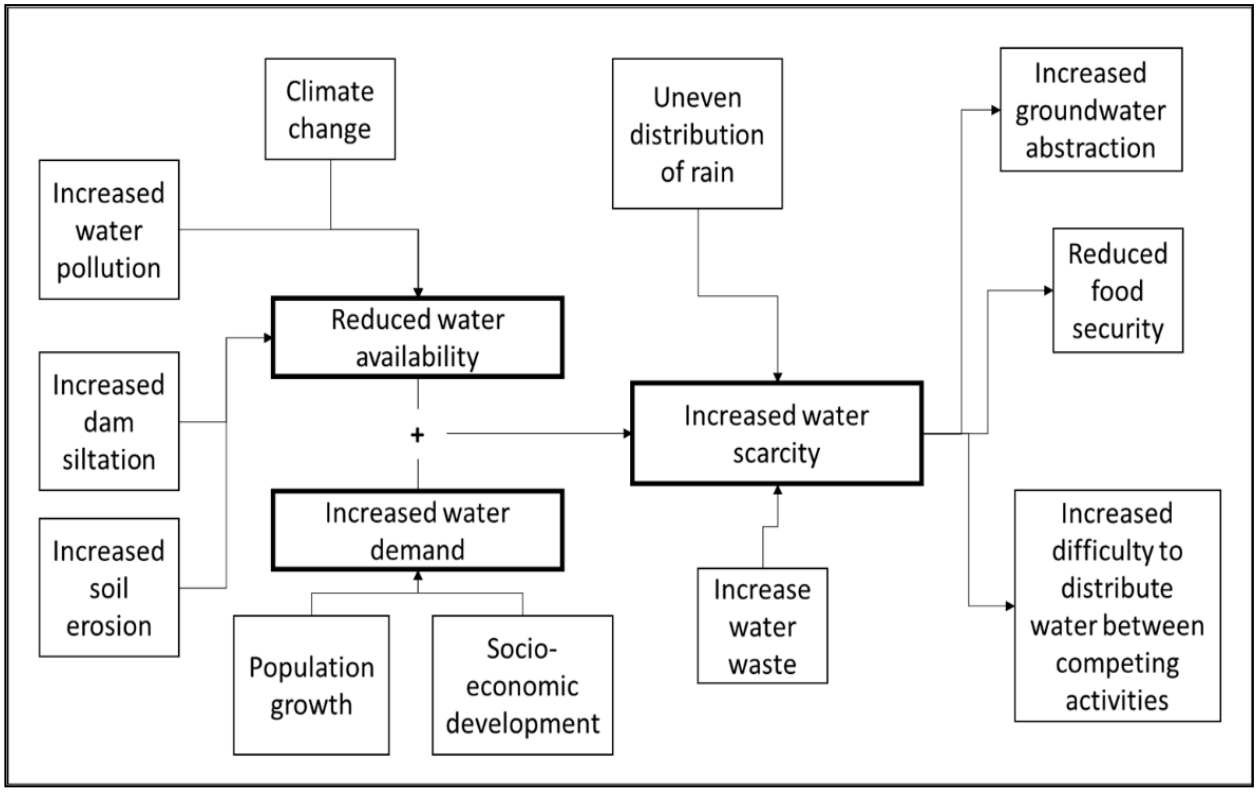

Figure 2.2. Policy problems and their interconnection. Source: the authors, based on policy documents specified in Appendix A.

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 (Alaoui, 2013, p. 110; Royaume du Maroc, 2020, 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 (Royaume du Maroc, 2009, p. 15; Arrifi, 2009, p. 48; Alaoui, 2013, p. 109). The combination of these human and climatic factors results in the reduction of the water resources' mobilisable potential (Arrifi, 2009, p. 48; Alaoui, 2013, p. 110; Royaume du Maroc, 2009, p. 15). Finally, water scarcity is also described in terms of insufficient water availability per inhabitant (Alaoui, 2013, 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, an increased difficulty in allocating water between competing activities, and difficulty in 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 (Royaume du Maroc, 2020, 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 recognise that water level monitoring shows, in almost all the country's aquifers, a continuous decline. Policy documents recognise that, despite that groundwater plays a strategic role in 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 (Royaume du Maroc, 2009, pp. 31–32).

2.4.1.2 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 socio-economic development, or 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 realisation 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" (Royaume du Maroc, 2009, p. 7).

Irrigated agriculture is presented as playing a key role in the promotion of the socio-economic development of the country (Royaume du Maroc, 2020, 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 (Royaume du

Maroc, 2020). 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 to simultaneously address most policy problems.

2.4.1.3 Ultimate goals

(a) 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…" (Royaume du Maroc, 1995, 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" (Royaume du Maroc, 2009, p. 7).

(b) 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 (Belghiti, 2008, pp. 17, 24).

(c) 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 realisation 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 m3 of water and in a sustainable way" (Belghiti, 2008, 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" (Arrifi, 2009, p. 51; Belghiti, 2008, p. 4).

2.4.1.4 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 m3 and, if no measures are taken, the deficit would be 5 billion m3" (Alaoui, 2013, 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 mobilisation of additional water resources to fill the gap" (Alaoui, 2013, p. 112). Water supply is thus framed in terms of controlling and mobilising the water resources' potential: ". . . Morocco has been committed to controlling the mobilisation of water resources in order to ensure water needs without major difficulties" (Alaoui, 2013, 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 m3, 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 (Royaume du Maroc, 2009).

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 m3) and the added value per cubic meter along with the agricultural value change (Belghiti, 2008, p. 14). To achieve this, the policies promote the adoption of localised irrigation (drip-irrigation), the rehabilitation and modernisation of irrigation infrastructure, and the building of conveyance systems to use water stored in dams in irrigable areas. Financial solutions include the 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 provide 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 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 (Belghiti, 2008; Arrifi, 2009). 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 operationalised through the modernisation of infrastructure to reduce water loss in conveyance and "… through the conversion of existing irrigation techniques with limited efficiency, notably gravity-fed irrigation, to localised irrigation…" (Arrific, 2009, 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 m3" (Royaume du Maroc, 2020, 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 behavioural change in water use (Arrifi, 2009). Achieving water savings is also described as a way to reduce water deficits in agriculture.

Water resource protection/conservation

Policy documents recognise 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., fertiliser leaching), "…preservation of resources through the purification and recycling of effluents…", through water treatment plants and development of sanitary infrastructure, as well as the "…reduction of groundwater overexploitation…" by means of a more "… efficient and sustainable management…" of these resources (Belghiti, 2008, 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 (Arrific, 2009). 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" (Royaume du Maroc, n.d., accessed online on 11 February 2021).

Adaptation to climate change effects

Measures for adapting to climate change include increasing the water supply, water use efficiency, and water productivity (Royaume du Maroc, 2020, 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 have 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 conceptualisation 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 loss 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 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 (a 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 the provision, management, and safeguarding of water.

2.4.2. Empirical data on water management challenges in the MDV

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, salinisation of soil and water, and finally, the compartmentalisation of government sectors.

Our interviews provide important insights into 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.

2.4.2.1 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 the 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:

> "If 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).

2.4.2.2 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 hours is fairly enough to irrigate a land of 0.5 hectares but the owner has 6 hours of water so he irrigates and irrigates until the 6 hours 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 cut-off before farmers reach 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 cut-off before farmers arrive for their turn to irrigate.

> "The water stays on each Seguia for three days or even less, for 24 hours. 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, which 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 prioritises policy solutions aimed at increasing the water supply.

2.4.2.3 Unequal access to water between upstream and downstream oases

Collected testimonies also show a dynamic of unequal access to water between up-stream 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).

Governmental actors report that: "This phenomenon of salinity becomes higher down- stream. 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 increases" (Gov.03, 24 February 2020).

The salinisation 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).

In addition, farmers upstream need to irrigate in different months of the year than farmers down-stream, 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 favour 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).

2.4.2.4 Unequal access to water between farmers inside oases and farmers in irrigated areas outside the oases

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 Drâa 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 Drâa (3055 ha) is a plain known as Feija (ABH-DON, 2020, 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 organised 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 organised 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 (ABH-DON, 2020). 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).

Our empirical data suggest that unequal access to drip-irrigation subsidies is indirectly contributing to reproducing inequalities around access to groundwater. 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 (Lamqadem et al., 2019). 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 in the extensions 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).

2.4.2.5 Compartmentalisation 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 the aquifer depletion problem in the area (ABH-DON, 2020). The link between groundwater depletion and agricultural development well illustrates the difficulties of the government in articulating 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 harmonising the mandates and interests of the agricultural, 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 localised 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 unauthorised 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 farmers to circumvent the authority of the Water Basin Agency (ABH) when they deny authorisation to dig new wells.

> "There is nothing about the digging permits. If he [the farmer] has a well, he has the right to be subsidised." 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 their members to start farming the land as a requirement for them to receive a land-use right certificate from the tribal organisation. This rule, which some tribes include as part of their customary laws, creates a contradiction in the procedures established by the government, that require 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 authorisation when it comes to [agricultural] subsidies. This [land-use] authorisation must be given by the tribal organisation, 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 authorisation" (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 reveals 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 emphasise 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) reemphasise 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 in 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 reveals 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 show 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 conceptualised and consequently, the formulation of policy goals and solutions. Progress in integrated water resources management also requires the 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, and 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 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, which has the tutelage of these resources. Access to groundwater necessarily involves access to land. However, this link between land and water management is not addressed in policy documents.

2.5. Discussion

2.5.1. 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 in 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 Woodhouse & Muller (2017) 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 Akinyemi, et al., 2022; Chiahemba and Jewitt, 2022; Zhang, et al., 2021; Silva-Novoa Sánchez et al., 2020; Kelly et al., 2018) 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 conceptualisation based only on the physical availability of the resource and the relation between supply and 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 analysed policy solutions, particularly those aiming to increase the water supply. Similar conclusions were drawn from a water scarcity study conducted by Mehta (2007) 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 (Lukas, 2010) and (WEF, 2014), who propose distinguishing "limits" as objective, empirically verifiable characteristics (measurable in terms of flow volumes or recharge rates) and "scarcity" as individual or socially subjective perceptions of what those limits signify, which is subject to cultural and political values and priorities.

In the analysed 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.

2.5.2. 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, the construction of large-scale water infrastructure and the promotion of drip-irrigation. Following what Allan (2003) called the "hydraulic mission", the Moroccan government is committed to constructing large-scale hydraulic infrastructure to fully exploit the "mobilisable resource potential of the country". This narrative has been in place in Morocco since the 1930s when the much-publicised "dam policy" began to be implemented (Molle, et al., 2019; Swearingen, 1987). However, along with the high environmental cost produced by dam construction (Di Baldassarre, 2019; Zarfl et al., 2015; Maeck, 2013; Liermann et al., 2012), the efficacy of this policy solution to ensure water supply in the long term has been questioned by the scientific community (Ward, 2020; Garcia, 2020; Johannsen, 2016). For instance, the storage capacity of dams seems to be inevitably reduced over time due to siltation (see Karmaoui et al., 2015, Johannsen, 2016 for the case of 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 (Heidecke, and Heckelei, 2010). This means that dams contribute to creating 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 (Heidecke, and Heckelei, 2010). Dams also negatively impact the natural recharge capacity of downstream aquifers (Klose, 2012; Karmaoui et al., 2014; Minucci, and Karmaoui, 2017). 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 (Molle, et al., 2019; Kuper et al., 2012).

Concerning the promotion of drip-irrigation as a technology that allows for 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 increasing water demand and groundwater abstractions in the region.

The contradictory effect of technologies that increase the efficiency in the use of a resource but incentivise an increment in its consumption is well-known in environmental economics as the “Jevons paradox” or “rebound effect” (Lange et al., 2021; Molle, 2017; Font Vivanco et al., 2016; Blake, 2005; Jevons, 1866). Theoretically, drip-irrigation allows for saving water and producing 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 (Molle, 2017; Molle and Tanouti, 2017; Van der Kooij et al., 2017; Benouniche, et al., 2014; Venot et al., 2014), as for other parts of the world (Birkenholtz, 2017; Perry; Batchelor, 2014; Berbel et al., 2013), 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” (Perry, 2017, 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 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.

2.5.3. 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.

Concerning the disciplinary approach, the central place occupied by policy solutions aiming at increasing physical and economic efficiency in the use of water reveals prevailing engineering and economic perspectives that cannot encompass the complexity of the feedback between the components of the social-ecological systems (Abson et al., 2017; Benouniche, 2014; Molle and Tanouti, 2017; Van der Kooij et al., 2017; Venot et al., 2014). 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. (2000) have 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 compartmentalised 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 achieving IWRM and sustainable development are not just a management problem but mainly a governance one that needs to take the social complexities into account.

2.5.4. Sustainable development limitations and the conceptual inconsistencies of the sustainable development paradigm

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 (Hediger, 2006). When the analysed 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 labelled as "weak sustainability": sustainability here is not about preserving the total stock of natural capital constant over time but about minimising adverse environmental impacts to sustain the ecosystem's overall integrity, its resilience capacity, and preventing potentially irreversible effects (Hediger, 2006). 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 behavioural component that must be addressed. The Moroccan water policy refers to this behavioural component but not in terms of the amounts of resources used as a society, but rather to promote a change centred on the individual: individuals should use resources more rationally, and more efficiently. As Boelens and Vos (2012) and Birkenholtz (2017) 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 incentivise irrigation intensification via more groundwater extraction in the first place. Not recognising this may lead to ineffective policy solutions in the future.

2.6. Conclusions of the chapter

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 in implementing IWRM. To this end, we analysed 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 mobilising 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 in the country's development, including actual access to water should be a major point of concern in water policies.

Making 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 compartmentalisation 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 Pahl-Wostl (2019, 2015), this means that our attention should be not only on improving the management side (this is the activities of analysing 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 to include explicit definitions of the particular notion of

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

Chapter 3

WHAT WATER GOVERNANCE CHALLENGES AND OPPORTUNITIES ARISE IN ARID REGIONS? LESSONS FROM THE MIDDLE DRÂA VALLEY, MOROCCO

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3.1. Abstract

The strain on global aquifers, particularly in arid regions, is increasing, emphasising the strategic importance of these resources amid escalating resource degradation. Scholars increasingly recognise the contextual specificity of water governance issues, challenging the prescription of universal solutions. In this context, whether and how groundwater degradation could be reversed remains an urgent question to address, directing attention to governance frameworks. This paper investigates three cases of groundwater governance in Morocco's Middle Drâa Valley (Faija, Fezouata, and M'hamid), to provide empirical insights into governance challenges and opportunities in this arid region. Guided by governance modes, the Social-Ecological System Framework, and incentive structure analysis, we analysed 76 semi-structured interviews, 30 structured interviews, and 2 focus group discussions. We found that water users face diverse governance challenges that are influenced by each social-ecological system's unique features. Hierarchical governance, self-governance, and hybrid models emerge as different governance modes. Institutional diversity reflects variations in each area's social-ecological system, presenting challenges in aligning governance efforts between self-governance institutions and governmental organisations. Government-proposed aquifer contracts may provide a framework to address this issue by promoting a unified governance system for self-governance and governmental organisations in each aquifer. However, our analysis shows that significant adjustments are needed to enhance resource user involvement in decision-making and ensure rule adherence.

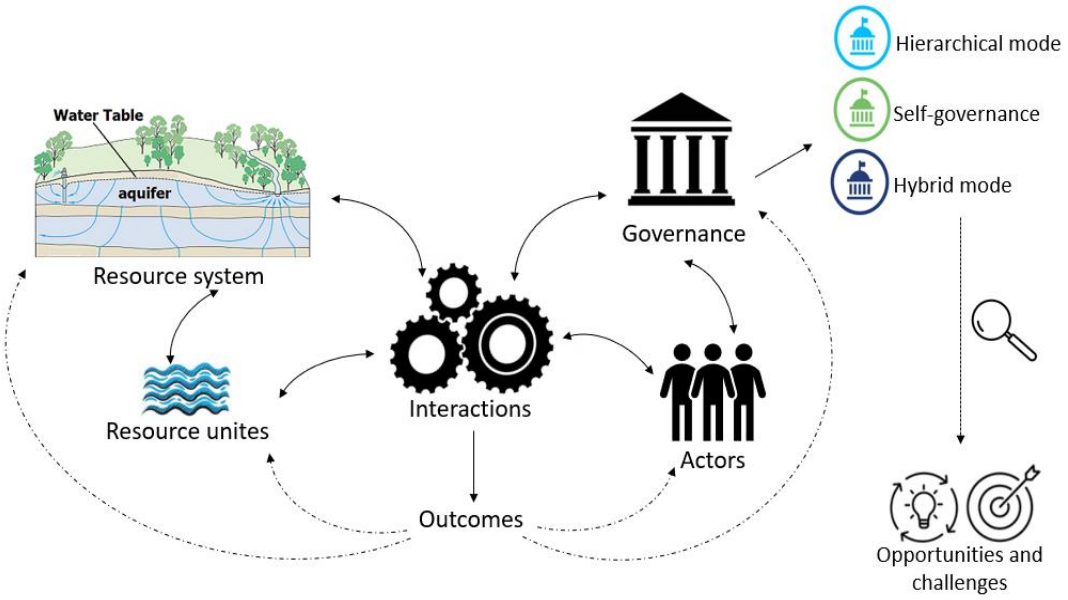

Figure 3.1. Graphical Abstract for Chapter 3.

3.2. Introduction

The strain on global aquifers, particularly in arid and semi-arid regions, is intensifying (Fienen & Arshad, 2016; Kuper et al, 2016; Kuper et al., 2017; Lezzaik et. al, 2018; Hssaisoune et al., 2020). This occurs along with a growing strategic importance of groundwater for drinking water production, agriculture, and industry, all of which contribute to socio-economic development. Consequently, in the last decade, there has been increased attention to how to design governance systems that allow resource sustainability, equitable allocation, and socioeconomic development (Pahl-Wolst, 2015; Pahl-Wolst, 2019).

The management of groundwater resources poses a significant challenge due to their open-access nature, making them susceptible to overexploitation (Holt et al., 2021). As common Pool Resources (CPR), aquifers exhibit conditions that foster individual appropriation for users' immediate benefit, often at the detriment of communal interests, thereby promoting unsustainable resource utilisation and inciting conflicts (Baldwin et al., 2018). CPR theory suggests the necessity of collective action among users to create rules and norms to address this behaviour and promote sustainable governance systems (Ostrom, 2009; Poteete et al., 2010; Baldwin et al., 2018). However, coordinating this action among diverse users poses multilevel and multiscale coordination challenges that exceed the capacities of locally focused water user organisations. The question of how to effectively structure water governance processes, integrating the efforts of local user organisations with governmental entities across various levels and scales, remains unresolved (Baldwin et al., 2018; Molle & Closas, 2020; Slough et al., 2021; Munoz-Arriola et al., 2021). As Molle & Closas (2020) pointed out, the question of whether and how the trend of groundwater degradation could be reversed interrogates governance frameworks and remains a question that is urgent to address.

The OECD's assertion that "water crises are often primarily governance crises" (OECD, 2011) underscores the growing importance of water governance. However, contemporary policymakers and water practitioners tend to adopt a narrow view of governance, conflating it with normative water management approaches (Closas & Villholth, 2019). This conflation has drawn criticism for oversimplifying

water governance issues and proposing solutions that fail to address the complex socio-environmental challenges comprehensively. Managerial solutions often stem from inadequate groundwater knowledge, resulting in interventions that overlook fundamental resource limitations and context-specific groundwater challenges (Ingram, 2011; Closas & Villholth, 2019; Zwarteveen et al., 2021). Furthermore, this managerial approach fails to address power dynamics and inequities in water benefit distribution, thereby overlooking the socio-political dimensions of governance and offering incomplete solutions (Castro, 2007; Boelens & Vos, 2012; Zwarteveen et al., 2017; Closas & Villholth, 2019). Critics argue that groundwater governance cannot adhere to a prescribed, linear process of policy decision-making and management rule implementation (Molle, 2008; Mehta et al., 2018; Woodhouse and Muller, 2017; Closas & Villholth, 2019).

An alternative perspective on water governance challenges the notion that governance represents an idealised form of sustainable resource management. Instead, it views governance as an ongoing process embedded within society, shaped by various stakeholders with divergent agendas, thus constituting a specific governance reality (Closas & Villholth, 2019). Governance, according to Birkenholtz (2014), arises from interactions among users, communities, and the state, rather than being a controlled process. As articulated by Zwarteveen et al. (2017), "Water governance at heart is about political choices regarding water flow, the norms, rules, and laws guiding these choices, who has the authority to decide, and the societal future these choices endorse" (Zwarteveen et al., 2017: 8).

In this study, we adopt the latter conceptualisation of water governance. Our objective is to examine the development and operation of institutional arrangements for groundwater governance in the Middle Drâa Valley (MDV) of Morocco, aiming to offer empirical insights into the specific groundwater governance challenges in this arid region. To achieve this, we analyse three aquifers: Faija, Fezouata, and M'hamid, addressing the following research questions: 1) What are the characteristics of groundwater governance in the MDV? 2) How is groundwater governance influenced by the contextual specificities of the social-ecological system? and 3) What factors impact rule compliance within the identified groundwater governance systems? Our analysis is guided by governance modes (Kooiman, 2000, 2003), the Social-Ecological System Framework (SESF) (McGinnis & Ostrom, 2014), and an incentive structure analysis approach (Kerr et al., 2012; Wight et al., 2021).

The concept of governance modes encompasses ideal typologies aimed at describing various patterns in which governance processes are structured. Different typologies focus on distinct aspects or dimensions of governance. In this paper, we use a typology that highlights the roles of governmental and non-governmental actors in creating, monitoring, and sanctioning governance institutions. This typology delineates between "hierarchical governance," "self-governance," and "co-governance" (Kooiman, 2000, 2003). Hierarchical governance, also known as "command and control" (Varady et al., 2016) or "bureaucratic governance" (Pahl-Wostl, 2019), entails top-down governmental control with regulatory processes primarily based on formal rules and sanction mechanisms. Hierarchical governance often involves permits, quotas, and extraction restrictions. In contrast, self-governance represents a departure from top-down governmental control, where actors autonomously govern themselves, independent of government oversight (Symes, 2006). An example is community-based management of water resources, where local users establish rules for resource allocation, infrastructure use, and maintenance, as well as monitoring and rule enforcement. Co-governance, also known as interactive or collaborative governance (Kooiman, 2016; Pahl-Wostl, 2019; Molle & Closas, 2020), occurs when public and private actors coordinate and communicate to address issues without a central governing authority. In such cases,

resource users, whether community-based or not, have decision-making power and share responsibilities with the government (Pahl-Wostl, 2019; Molle & Closas, 2020).

While recognising the inherent limitations of typologies, we acknowledge that our aim is not to capture every aspect of governance comprehensively. We also understand that empirical data collected in the field may not neatly fit predefined categories. Our analysis aims to shed light on how governance processes align with or diverge from these typologies, and the underlying reasons for such patterns. Therefore, our goal is to maintain simplicity while using this typology as a starting point for a more nuanced examination of the roles of governmental and non-governmental actors in governance processes, particularly in formulating, monitoring, and enforcing resource use rules. We chose to focus on the aquifers of Faija, Fezouata, and M'hamid due to their distinct social-ecological characteristics and the diverse groundwater governance responses they exhibit to these conditions.

We employ the SESF to characterise the SESs of the three groundwater governance cases (See section 3.1). Our aim is not to encompass the full array of interactions within each SES. Instead, we use the SESF to pinpoint relevant variables that elucidate the groundwater institutional arrangements and as a common language for communication with the scientific community. To understand the factors influencing compliance with groundwater regulations, we integrate the SESF with an incentive structure analysis approach. This approach operates under the premise that individuals and organisations respond to incentives, with their behaviour shaped by associated costs and benefits (RB Howarth et al., 2000; Bolton and Ockenfels, 2000; Gneezy et al., 2011). Combining these approaches is relatively uncommon, and thus, another objective of this paper is to evaluate the utility of the SESF in understanding the specific challenges within each SES identified in the MDV, along with the added value of integrating an incentive analysis. We contend that employing incentive analysis reveals the complexities of rule compliance within each case. We address this question in the discussion section, highlighting the advantages and limitations of each analytical framework and how they complement each other.

The paper is organised as follows: section 3.3 gives an overview of the study area and Section 3.4 explains the methods used to collect and analyse data. Section 3.5 contains the results, which are presented in three sub-sections, each one devoted to each case. In section 3.6 we critically discuss our findings. Finally, we present the conclusions of the chapter in section 3.7.

3.3. Study area

The MDV is located in the province of Zagora in the southeaster part of Morocco, in the north of the Sahara Desert (Figure 3.2). This region is characterised by an arid to hyper-arid climate (Klose, 2016) with annual average precipitation of 70 mm (Moumane et al., 2021), and average potential evaporation of up to 3000 mm (Karmaoui et al., 2015; Schulz, 2006). The valley contains six oases, each oasis as an aggregation of small plots in which local inhabitants cultivate diverse crops on different levels. Date palm and fruit trees form the garden canopy and serve as cash crops and create a microclimate for lower-level crops such as alfalfa for livestock feed and self-consumption crops like wheat, corn, and vegetables.

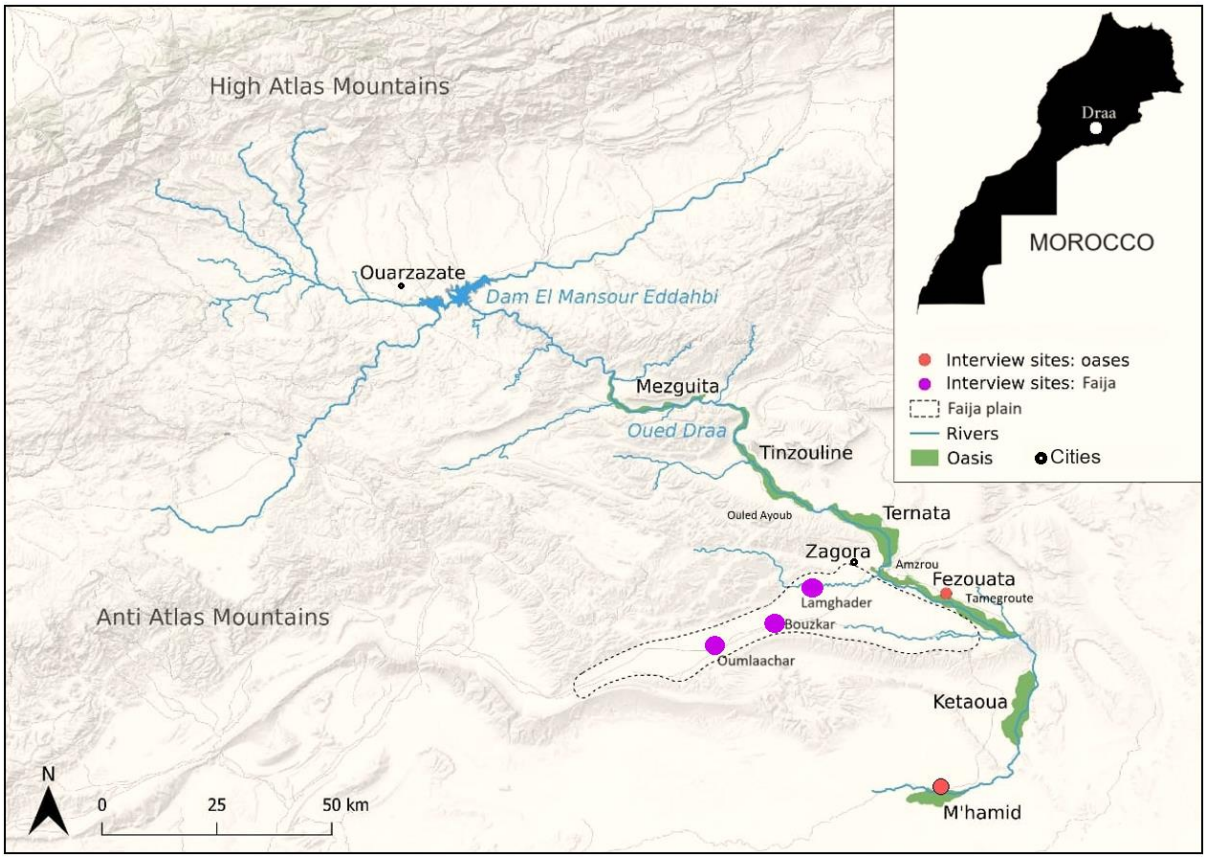

Figure 3.2. Map showing the case studies' locations and interview sites.

The MDV historically relied on agriculture as the main occupation and source of income for locals. Water scarcity and salinity have driven migration from the area (Ait Hamza, 2010; Rademacher-Schulz, 2014). Since the mid-1970s, frequent and prolonged droughts have Increased dependence on groundwater, facilitated by affordable pumps, well infrastructure, and solar panels, leading to declining water tables (Kuper et al., 2016; Houdret & Heinz, 2022; Hssaisoune et al., 2020; ABH, 2022). The El Mansour Eddahbi Dam, built in 1972, aimed to secure water for Ouarzazate, and has contributed to reducing aquifer recharge rates in the valley (Ait Hamza, 2010). The Green Morocco Plan (2008–2020) promoted agriculture development with subsidies for drip irrigation systems. In the MDV, this plan has contributed to expanding groundwater-based farming in the lands surrounding the traditional oases, increasing pressure on the MDV aquifers.

As stated in the introduction, our study centres on the Faija Plain, Fezouata, and M'hamid aquifers, which are situated within the same river basin. Despite their shared geographical context, we chose to treat them as distinct case studies due to their representation of varying governance modes—both self and hierarchical—discussed earlier. Additionally, they exhibit diverse social-ecological characteristics and possess different institutional frameworks for groundwater management, each catering to user communities with unique attributes. This diversity allows us to explore how the intricacies of each SES are intertwined with the constraints and hurdles faced by these groundwater institutional arrangements.

3.4. Methods

3.4.1. The Social-Ecological System Framework

The SESF addresses social-ecological systems as an aggregation of subsystems that "are relatively separable but interact to produce outcomes at the SES level, which in turn feedback to affect these subsystems and their components, as well as other larger or smaller SESs" (Ostrom, 2009: 419). We treat each of our aquifer cases (Faija, Fezouata, M'hamid) as SESs. The SESF focuses on the analysis of four main components of the SES: Resource System (RS), Governance System (GS), Resource Units (RU), and Actors (A). According to McGinnis and Ostrom (2014), the framework was designed to be applied to relatively well-defined domains of common-pool resource management situations in which resource users extract Resource Units (in our case studies groundwater) from Resource Systems. The behaviour of the actors in the SES is determined by the biophysical characteristics and dynamics of the Resource System, by the rules and procedures determined by the Governance System in place, and by broader social-political-economic settings as well as the related ecosystems.

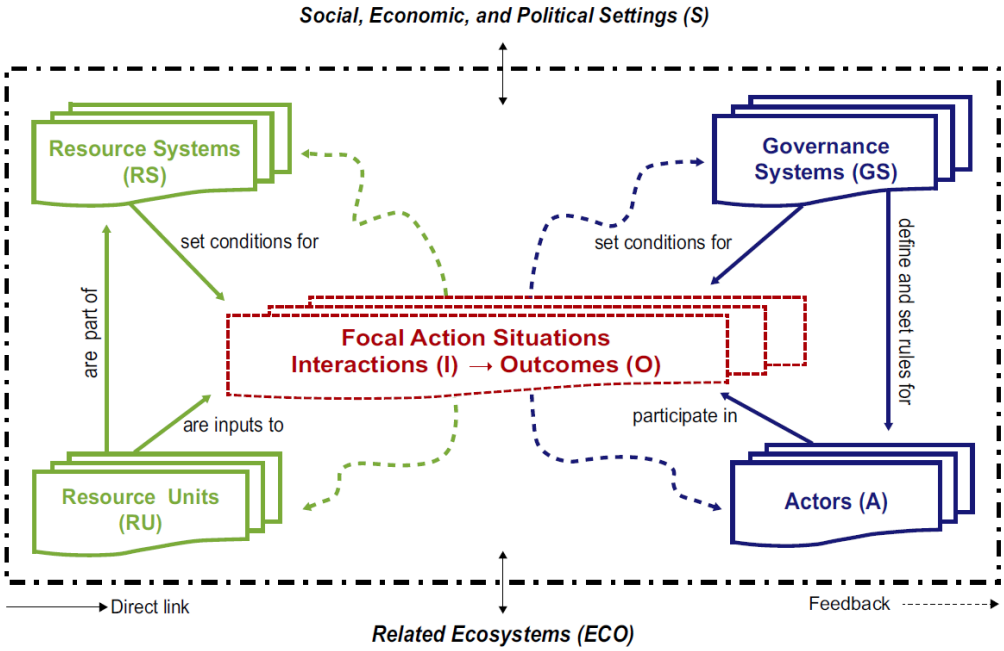

Figure 3.3. The Social-Ecological System Framework (*McGinnis and Ostrom, 2014).*

Resource units, resource systems, actors, and governance systems are the highest-tier variables that contain multiple variables at the second tier (Figure 3.3). Focal Action Situations refer to processes by which the inputs of the different components of the SES are transformed by the actions of multiple actors into outcomes. In our case studies (Faija, Fezouata, M'hamid), the focal action situation refers to groundwater use and the governance challenges linked to groundwater distribution between users and resource degradation prevention. The dotted-and-dashed line that surrounds the interior elements of figure 3.3 indicates that the SES analysed can be considered as a logical whole, but that exogenous influences from related ecological systems or social-economic-political settings can affect any component of the SES. These exogenous influences might emerge from the dynamic operation of processes at larger or smaller scales than that of the focal SES (McGinnis and Ostrom, 2014: 4).

The SESF assumes that actors make choices among available options in light of information about the likely actions of other actors and the benefits and costs of potential outcomes. In this way, the social and ecological outcomes in each SES are conceptualised as consequences of actors' actions in interaction with the Resource System, the Governance System, and the broader social-political-economic settings. The outcomes referred to in the Common Pool Resources (CPR) and Social-Ecological System (SES) literature are typically environmental outcomes (in our case impacts in groundwater resources conditions), social outcomes in connection to resource access, and outcomes in terms of governance institutions performance (Figure 3.4).

3.4.2. The Incentives Adequacy Approach

In the natural resources management sector, "incentives" refer to mechanisms designed to steer the behaviour of individuals and communities toward more responsible use of resources and compliance with regulations, to achieve in this way public policy goals (Kerr et al., 2012). We compiled and updated a standardised incentives scheme (see Appendix 2) from Kerr et al. (2012), Rapoport and Wing, (2001), Travers et al. (2011), and Vatn (2009). This scheme encompasses two broad categories: "financial incentives'' (such as tax incentives, tradable environmental permits, penalties, subsidies, rebates, and other monetary advantages) and "non-financial incentives'' (including information dissemination, collaborative monitoring, performance-driven agreements, technical support, and social motivation) (Minehart and Neeman, 2004; Delmas and Keller, 2005; Delmas and Montes, 2007; Nordhaus, 2015). The adequacy of incentives refers to how effective the incentives are in shaping the users' behaviour in the intended way. To this purpose, we check how well the incentive design considers the particular interests, objectives, and conditions of the actors whose behaviour is to be modified. The aim is to conclude incentives' ability to align individual and collective behaviours with water conservation goals (Wight et al., 2021). In the case of Fezouata and M'hamid, the incentives are already implemented and therefore, it is possible to see if they produced the intended effect on users' behaviour. In the case of Faija, currently, the government is promoting an aquifer contract. The results of the new rules promoted as part of this contract have not yet materialised. In this sense, our analysis seeks to identify the elements in the contract that may hinder the success of the proposed incentives.

3.4.3. Data collection

To understand the aquifer resource systems, groundwater usage regulations, and their operational mechanisms within the areas of Faija, Fezouata, and M'hamid, it was essential to gather data on the physical characteristics of these aquifers, obtain information on the relevant actors and their socio-economic profiles as well as on the interests of the groundwater users, and the groundwater regulation used in these areas.

For all three cases, we review the statutory water law n° 19-95 (Royaume du Maroc, 1995) and n° 36-15 (Royaume du Maroc, 2016). These regulations delineate the procedures for authorisations and concessions pertaining to the public hydraulic domain. For Fezouata, where only the statutory regulations are in use, we conducted 30 questionnaires in 2022 and 25 semi-structured interviews in 2023 with farmers. For the M'hamid case, customary community rules are in use in addition to statutory regulations. To assess customary rules, we conducted 12 interviews with farmers and owners of tourism facilities in 2022. For both cases, Fezouata and M'hamid, we also relied on the 2010 Assessment Study Report of

Groundwater Resources in the Drâa and Guelmim basins, commissioned by the Souss Massa Water Basin Agency.

For the Faija case, data collection was initiated by examining the aquifer contract document, an extensive 45-step action plan formulated by River Basin Agency Draa-Oued-Noun (ABH-DON) in Ouarzazate. This contract is formulated based on the water law n° 36-15. In addition, we examined study reports from ABH-DON (2020). These studies were conducted to formulate the Faija groundwater contract and contain data on the socio-economic characteristics of groundwater users and the geological and hydrological characteristics of the aquifer. These study reports include a survey database with 682 farmers. To delve into the characteristics of farmers, their resource access, the power dynamics, and the customary rules mediating access to groundwater in Faija, we conducted 25 interviews with water users in Faija in 2022. During 2023, a further 14 interviews were conducted with governmental actors and two focus group discussions with water users in Faija. These interviews and focus groups aimed to gain more understanding of the motivations and expectations to participate in the aquifer contract.

3.4.4. Data analysis

Based on the available data, we identified among the variables provided by the SESF (see Appendix 1) those variables that help us describe the particular characteristics of the SESs of Faija, Fezouata, and M'hamid. To this purpose, the software MAXQDA 2020 (VERBI Software, 2021) was used for the content analysis of both official government documents and the transcriptions of our semi-structured interviews. Following a deductive approach, we use the variables and sub-variables corresponding to Resource Systems (RS), Resource Units (RU), Governance System (GS), and Actor (A) provided by the SESF (McGinnis and Ostrom, 2014).

To better understand the groundwater regulations in place and the factors hindering compliance with these rules in the three case studies, we analyse the variable Rules-in-use (GS6) (Appendix 3.1) using an incentive adequacy analysis. In the first step, we identified rule-compliance incentives and how they are structured within the regulations, using the standardised scheme in appendix 3.2. In the second step, we assess the adequacy of the incentive structures identified. We do that by assessing the extent existing incentives align with the interests of the stakeholders and analysing whether these incentives are sufficient to persuade users that it is more beneficial for them to comply with the rules, especially in scenarios where alignment rules and interests may be lacking. Rules and incentives were assessed within the official government documents (e.g. water laws, Faija aquifer contract) and interview transcriptions using the software MAXQDA 2020 (VERBI Software, 2021).

3.5. Results

In examining the three Social-Ecological Systems (SESs) of Faija, Fezouata, and M'hamid, we use the higher-tier variables and several of the second-tier variables suggested by McGinnis and Ostrom (2014) (Appendix 3.1). Figure 3.4 below shows the list of variables we identified and analysed.

Here we explain some elements of the socioeconomic and political settings in which our case studies are embedded. Three policy areas influence the SESs of our case studies. 1) The water policy area, represented locally by the government institutions of ABH-DON (interested in resource conservation) and National Office of Water and Electricity (ONEE), (interest in securing drinking water production); 2) the agriculture policy area represented by the provincial and local institutions belonging to the Ministry of Agriculture, whose interest is to promote agriculture development - which contributes to increasing water

demand. 3) The interior security policy area, represented by the local institutions of the Ministry of Interior Affairs, (Caïdat[2], Gendarmery, Police) responsible for enforcing statutory rules. The interest of these institutions is to keep order and peace and avoid social and political instability.

This section is divided into three subsections presenting the characterisation of the SESs of our three study cases using the SES Framework proposed by McGinnis and Ostrom (2014) by using variables from figure 3.3 explained previously.

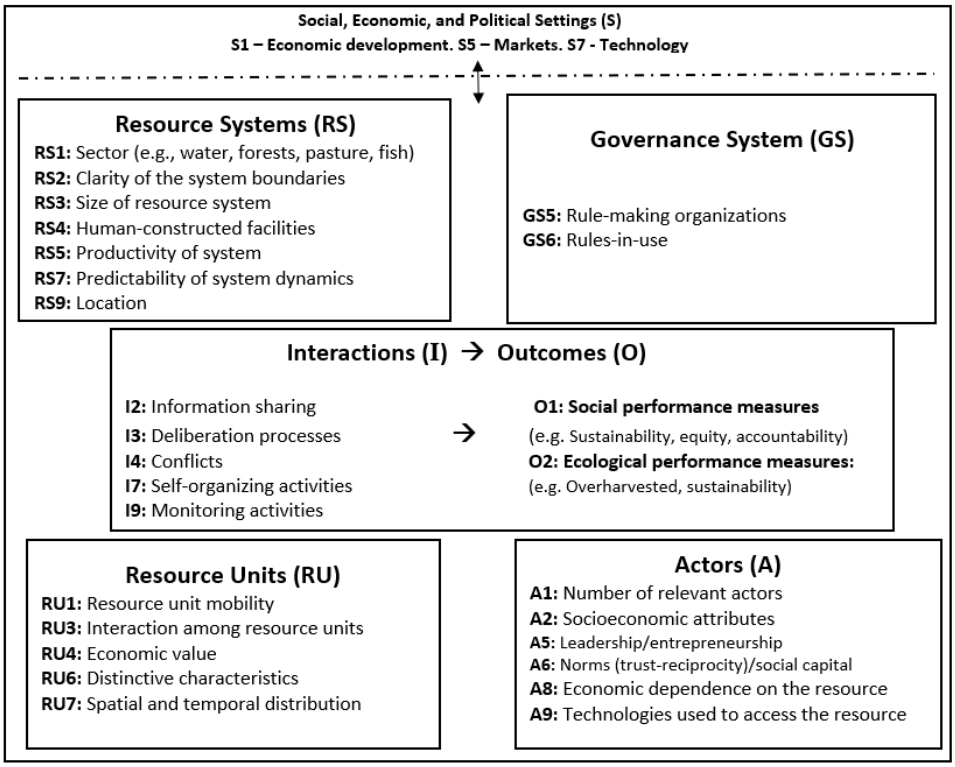

Figure 3.4. Second-tier variables used in the social-ecological system characterisation (Source: Adapted from Ostrom, 2009:421).

3.5.1. Characterisation of the Faija case

3.5.1.1 Resource System and Resource Units

Water users and government representatives define the Faija aquifer system as composed of the Faija Plain with 1,000 km2 (RS3), the mountains that border the plain, and the alluvial aquifer beneath the plain. The mountains to the north of the plain are Boukhachba and Boujniba and to the south mountain Bani. To the East, the plain is bordered by the Fezouata Oasis and the Drâa River (SES variable RS3, Figure 3.4). The alluvial aquifer is recharged by rainwater collected by surrounding mountains. In this sense, we can consider that actors in Faija SES have clarity on the resource system boundaries (RS2). Groundwater (RU1) is the primary resource. Access to it is mediated by access to collective land, which in turn is managed by tribal institutions. Tribal collective lands are thus another important resource unit to consider to

[2] The Caïdat (or Kaïdat) is a decentralised territorial administration unit to which one or more Communes are attached. The head of the Caïdat is the Caïd, who depends on the Ministry of Interior.

understand the dynamics of groundwater use in Faija. Groundwater is used for agriculture (watermelon is the main crop) through private wells and for drinking water production for Zagora city and territorial communes through public infrastructure operated by the National Office of Water and Electricity (ONEE) (RS4).

According to interviews, there is high uncertainty about future groundwater availability in Faija (RS7) which leads farmers to prefer annual crops (like watermelon) over perennial crops (like palm trees). The groundwater's spatial and temporal heterogeneity (RU7) is influenced by rain events and periods of increased abstraction during watermelon farming (Dec-Apr). Groundwater quality in Faija presents salinity concentrations generally below 1g/l, with an average of 0.6g/l (ABHSMD, 2010:72), which makes this aquifer a very important freshwater resource in the area. Interviewees state that variations in groundwater levels and soil conditions lead to unequal access to this resource among tribe members.

3.5.1.2 Actors

Actors benefiting from groundwater use in Faija are relatively well-defined (A1). We have identified nine distinct actor profiles (Appendix 3.3) that include right-holders of collective lands (tribe members), private land-right-holders; non-land-holders working as investors in watermelon; providers of agricultural inputs; drinking water users of the territorial communes of Zagora, Fezouata, Ternata, Blida and Tamegroute; and governmental actors: ONEE, which operate wells for drinking-water production, and representatives of the Ministry of Interior (Chikh and Moqadem).

These actors vary in economic dependence on the groundwater (A8), interests, socioeconomic attributes (A2), values and norms (A6), and different capacities to access the resource through infrastructure/technology like pumps and solar panels (A9), complicating agreement on resource-use rules. Members of the same tribe (categories I, II, & III, Appendix 3.3) are more homogeneous than non-tribal-actors due to shared social organisation based on kinship, customary rules, cultural values, institutions, and reciprocity relations (A2), facilitating easier communication, information sharing (I2), deliberative processes (I3), self-organisation (I7), and monitoring (I9). This cohesion also aids leadership emergence (A5). Different tribes do not have a common organisation that allows them to communicate and coordinate.

3.5.1.3 Governance system

a. Rules-in-use and rule-making organisations

There are two types of rules regulating access and use of groundwater in Faija: customary rules and statutory rules. The way customary rules were created and implemented fits into the typology of self-governance. These rules focus on collective land, but indirectly they affect access and use of groundwater. These rules are: only members of the tribe can claim use-right over collective land; tribe members need to start farming the land to receive a signed land-use certificate from the tribe and the Caid; it is not allowed to rent land or work with non-tribe members. In 2021, customary rules limited the watermelon irrigated area to 2 ha. per person for every season. This was initiated by the Mssoufa tribe, which appointed a committee for the monitoring of this rule. The Ouled-Aissa tribe replicated this initiative.

Statutory water regulations in Faija operate through a hierarchical, top-down control mechanism, constituting a form of hierarchical governance. These regulations outline the procedures for obtaining licenses to dig wells, designate restricted areas for groundwater extraction, and specify allowable water

extraction volumes. They are outlined in the National Water Law 36-15 (Royaume du Maroc, 2016), with ABH-DON establishing specific parameters based on local groundwater conditions. In response to the severe drought conditions affecting the province, the governor of Zagora implemented a regulation in October 2022. This regulation prohibits the cultivation of watermelons and melons in areas exceeding 1 hectare. Moreover, it extends the prohibition to cultivation in areas designated for drinking water supply (Royaume du Maroc, 2022).

In February 2022, different government institutions signed an aquifer contract with representatives of water user associations of farmers in Faija and representatives of the territorial communes benefiting from drinking water production. The contract covers the period from 2022 to 2027 and aims to implement a 45-action plan agreed to achieve sustainable development in the area. These actions are organised into five strategic axes resuming the objectives of the contract. These axes aim at 1) preserving the water reserves of the aquifer, restoring its quantitative balance and exploiting it sustainably; 2) Protecting and securing the agricultural activity in Faija plain; 3) maintaining the quality of the groundwater to meet the needs of users; 4) implementing participatory and consensual management of water resources in the Faija plain and establishing water governance; and 5) developing a policy for communication and awareness (ABH, 2022). To achieve resource sustainability, this contract aims to limit total water abstractions in Faija to 15 million m^3 per year. To this purpose, it foresees the implementation of a mandatory quota system for farmers allocated based on farm size and crop type. According to the contract documents, each well must be declared and equipped with a water meter, and the water police will be responsible for sanctioning users who exceed their authorised water shares. The contract includes strict guidelines to prevent the pollution of resources. Farmers are prohibited from drilling wells within drinking water abstraction perimeters, and collaboration with authorities is mandated to close abandoned wells and boreholes.

The content of the contract was developed by governmental institutions and only later communicated to groundwater users. However, it foresees the active participation of users in monitoring tasks and, presumably, in the allocation of water quotas through water user associations. Given the limited share of power decisions with users, we consider that the Faija aquifer contract cannot be described as conforming to co-governance.

b. Identification of incentives

Here we analyse the regulations that are currently in the process of implementation, notably the ones within the aquifer contract, and the provincial decision, by Zagora's governor, limiting watermelons and melons. Interviews with water users in Faija reveal that customary rules limiting watermelon areas are no longer in place. The rationale behind the abandonment of these customary regulations is elucidated previously.

Table 3.1. Incentives to comply with the aquifer contract of Faija.

Incentive	Rationale of incentive
Penalties in case of a 20% over-abstraction (Identified from the interviews). Penalties not yet specified.	A) Disincentivise non-compliance with the rule by creating a cost/burden that exceeds the expected benefits of breaking the rule.
Study on the socio-economic sustainability of the crops grown and the sustainability of irrigation infrastructure	B) Convince farmers to join the aquifer contract by providing technical and financial support to increase and protect economic benefits from agriculture while promoting more sustainable crops (long-term sustainability).
Awareness-raising to promote the protection of agricultural land.	
Promotion of scientific research: agronomy, optimal crop consumption, innovative irrigation methods, etc.	
Search for new alternative crops with high added value and minimal cost in terms of consumption of irrigation.	
Adoption of new support measures encouraging investment in crops requiring long periods to start the production cycle	
Creation and marketing of a registered trademark for the agricultural product of the Feija Plain for better access to international markets.	
Reduction of intermediaries in the marketing process of local agricultural products and training and support for farmers to access markets and increase their profit margins	
Adoption of specific measures to encourage small farmers	
Establishment of a water quality monitoring network.	C) Promoting trust among water users and between water users and the government by sharing information and engaging the water users in reporting and monitoring actions in Faija.
Creation of an information system on the Feija aquifer	

Within the contract, we identified actions that work as incentives to promote compliance among water users. These incentives can be grouped into three categories according to their aims (Table 3.1). First, we identified A) penalties that aim at creating a cost/burden that exceeds the expected benefits of not following the specified actions, particularly respecting the water quotas. Interviewees reported that penalties will be applied when exceeding the defined groundwater volume by 20%. In addition, insights from interviews with WUAs representatives suggest that penalties would primarily be monetary. The second group of incentives aims at B) providing technical and financial support to participants to increase and protect their economic benefits while promoting a shift to more sustainable crops. Finally, the aquifer contract aims at C) promoting trust among water users and between water users and the government through creating a sharing information system and engaging the water users in reporting and monitoring actions in Faija.

The incentive to promote compliance with the limit of 1 ha imposed by Zagora Province on watermelon and melon farms is punitive: the authorities are instructed to destroy the crops that exceed this limit. The local commission responsible for monitoring rule compliance is composed of representatives of the Caidat, municipalities, the royal gendarmerie, auxiliary forces, and farmers. It was appointed by ABH-DON and Zagora Province and may impose additional sanctions on rule-breakers.

3.5.1.4 Faija's focal action situation: outcomes and interactions

In this section we present the outcomes that the Faija SES produces in terms of groundwater management institutional performance, the state of groundwater resources, and in terms of inequality in resource access and capacity to benefit from it. We explain these outcomes as results of particular patterns of actor interaction.

Outcomes

Our investigation finds lax monitoring of groundwater abstraction with no sanctions for violators or water use accountability. Information sharing occurs privately among farmers, lacking formal institutionalised mechanisms to share information between users and the government in aquifer states. Records of private wells are outdated due to a lack of water meters. Users rely on empirical knowledge for groundwater availability.

Faija Aquifer faces an annual deficit of -5Mm³/year, with 34% abstracted from non-renewable reserves. Groundwater levels declined by 12 to 30 meters between the 1980s and 2020 and 34% of groundwater is abstracted from the non-renewable reserve of the aquifer (ABH-DON, 2020). Agricultural pollution degrades groundwater quality, increasing water salinity and treatment costs for drinking water production.

Diminishing groundwater exacerbates social inequalities in resource access. Deeper well requirements raise infrastructural costs, challenging farmers with limited capital. Access to collective land requires mobilising tribal organisations for land-use rights, but farmers have different influence and power to do this within the tribe. Excessive watermelon production depresses prices, leading to financial losses for farmers.

Interactions

Actors in Faija bypass both customary and statutory rules, notably the 2 hectares limit on watermelon farms set by tribes. Despite a monitoring commission, the tribes lack authority to enforce sanctions, leading to increased rule-breaking. Moreover, different tribes lack shared arrangements for controlling groundwater abstraction, fostering rule non-compliance: interviewees emphasised that it is not worth it for them to follow rules if they have no means to verify whether neighbouring tribes are complying with the rules.

Other actors benefit from watermelon production by maintaining the status quo. Despite being prohibited by the tribe, farmers clandestinely rent land to non-tribal investors on watermelon, while intermediary merchants profit from watermelon overproduction by negotiating better prices. Local authorities allegedly benefit from groundwater exploitation through bribes. These bribes are paid by drip-irrigation infrastructure providers and well-drillers who work as intermediaries between farmers and authorities. Drip-irrigation providers help with the application process for subsidies provided by the

government. Bribers are to speed up the process to get the required documents. Well-drillers allegedly pay bribes to local authorities to be allowed to dig illegal wells.

Despite a 2022 provincial decision limiting watermelon production, control measures were lacking. Testimonies of interviewees suggest a connection with conflicting interests within the government, which also hinders rule enforcement. While the water sector aims to restrict groundwater abstraction, the Ministry of Agriculture fosters agricultural development, increasing water demand. In turn, the Ministry of Interior Affairs does not strictly enforce the rules because they fear political and social instability in the area as a consequence.

3.5.2. Characterisation of the M'hamid case

3.5.2.1 Resource System and Resource Units

In contrast with the Resource System of Faija, the boundaries of the M'hamid aquifer system are diffuse (RS2). For instance, the aquifer recharge does not depend solely on the rain captured and drained in its immediate surroundings, but also on water released from Eddahbi Dam into the Drâa River. In addition, the volume of water allocated to M'hamid Oasis depends not only on the water stored in the dam but on the water, demand estimated for the other upstream oases. As a consequence, despite M'hamid Oasis representing an area of 145 km2, it can be argued that the M'hamid Aquifer Resource System should include the public infrastructure composed of Eddahbi Dam and the system of irrigation canals that distribute the water along the MDV. According to our interviewees, the absence of water in the river has supposed an important reduction in the aquifer recharge rates (RS5). Other sources of aquifer recharge are water infiltrated due to irrigation and the groundwater flow from upstream oases. This groundwater flow affects the quality of M'hamid groundwater by the cumulative pollution created by upstream water users. Groundwater is used for irrigation, in hotels and touristic facilities, and for drinking water production by the National Office of Water and Electricity (ONEE) (RS1) (see quote N°1, appendix 3.4).

The predictability of the system dynamics is low for the users (RS7). In addition, groundwater availability and quality in Mhamid is spatially heterogeneous (RU7). Aquifer average inflows were determined at 1.3 Mm3, highly variable water depth (between 79m and 1.60m depth), and low productivity (RS5), with values ranging from less than 0.5 l/s to 12 l/s, with an average of 3 l/s (ABHSMD, 2010). To abstract groundwater for irrigation some farmers dig private wells, but, because for most farmers it is difficult to find groundwater due to scarcity of the resource and the high costs involved in prospecting and digging wells most farmers resort to collective wells (RS4). There are currently five collective wells built in collaboration with "The Mohamed 5 Foundation for Solidarity" in partnership with the Regional Office of Agriculture Development. Other groundwater users, such as hotels, rely exclusively on private wells (See quote N°2, appendix 3.4).

3.5.2.2 Actors

Groundwater users in M'hamid exhibit a diverse profile. This includes domestic users who receive drinking water from ONEE's operated well, farm households, and owners of tourist businesses with varied facilities (A2). While these categories differ in their economic reliance on groundwater resources (A8), individuals within each category share similar interests, contributing to a more cohesive understanding of their specific needs and concerns.

3.5.2.3 Governance system

a. Rules-in-use and rule-making organisations

As in Faija, access and use of groundwater in M'hamid is regulated by customary rules and statutory rules. Customary rules were made by irrigator communities (GS5) gathered around collective wells (Table 3.2). These organisations are built over former communities of irrigators that used to share a surface water irrigation canal and the institutions for water management they used. These organisations have a maximum of 40 members. They agree on the rules to organise the allocation of groundwater abstracted through these wells: the collective well members should pay a membership contribution; water volumes differ per farmer based on previous surface water rights and monthly membership contributions; members should pay a pumping tariff. The collected money is used to cover the costs of fuel and electricity, infrastructure maintenance, and the salary of the well guardian.

Table 3.2. Collective wells rules in M'hamid (GS6) (*source: interviews with farmers in M'hamid*).

Rules	**Explanation of the rule**
A mandatory contribution fee is levied upon individuals seeking to become potential water users of the communal well.	If a person wants to use water from a communal well, they have to pay a required fee. This fee is used to cover well construction and operation costs, including buying the land to set up the well.
Abstraction fee per hour	Users of the collective-well agree together on a set price, considering what's fair and acceptable to everyone.
Penalties imposed for unauthorised water abstraction	Specific fines are in place for people abstracting more water than established, without paying the fee, or not respecting the quotas established during periods of water shortage.
The funds generated from the abstraction charges are invested in infrastructure maintenance	The money collected from the charges for using the collective well is set aside for the specific purpose of maintaining and improving the shared well for everyone's benefit.

The way these rules were created and implemented fits into the typology of self-governance. These rules are the same in all collective well initiatives within M'hamid according to interviewees involved in the rule-devising process (See quote N°3, appendix 3.4). Collective well organisations are independent from each other and there is no overarching organisation to articulate all these collective wells. Neither to coordinate between collective wells and other actors benefiting from groundwater in M'hamid, such as owners of tourist facilities and ONEE. Statutory rules are the same as described in the case of Faija (water laws n° 19-95 and n° 36-15, hierarchical governance).

b. Identification of Incentives

Within the collective well rules proposed by the local communities, two incentives to limit groundwater use were identified. First, the abstraction fee per hour is an incentive and a motivation for water users to abstract only as much as needed and sufficient for their production. The more they abstract, the more they will need to pay. Second, penalties. These are proposed by the local board of communities for those who engage in unauthorised pumping from collective wells without fulfilling the requisite pumping fee obligations. This rule aims to discourage and control illegal water abstractions from the collective well.

3.5.2.4 M'hamid focal action situation: outcomes and interactions

Outcomes

According to interviewees, the state of the M'hamid aquifer is degrading. The salinity of the M'hamid water table varies, increasing in downstream direction, reaching a maximum level of 12.16g/l, (O2) (ABHSMD, 2010: 107). The groundwater inflows and outflows were estimated in 2010 at a balance point of 225.4 l/s (ABHSMD, 2010: 107), however, interviewees reported a constant decrease in the levels of groundwater tables in wells (see quote N°4, appendix 3.4).

Interviewees reported that most landholders in M'hamid do not have access to irrigation water. Their gardens have dried up, the household's economy has deteriorated, and several families have been forced to migrate. Emigration has altered the local social dynamics in the villages since only women, children, and old people are left behind. Young men live and work in cities (O1, O2). Interviews report that in recent years agricultural yields have decreased significantly and farmers are reducing the number of crops. As a consequence, monetary incomes from agriculture have reduced significantly and farmers produce mainly for self-consumption. Because cash is necessary for inputs in each agricultural campaign, households depend on other sources of income such as family members' remittances, retirement pensions, or salaries from other activities. The main economic activity is shifting from agriculture to tourism.

In terms of institutional performance, there is a notable absence of formal mechanisms for regular and systematic information exchange regarding the condition of the aquifer between users and authorities. The only existing platforms for information sharing regarding groundwater availability and infrastructure maintenance responsibilities are the collective well organisations dedicated to irrigation. However, these platforms are limited to communication among users associated with each specific well. Within these collective well organisations, the appointed board receives reports from the well guards regarding unauthorised water extraction and determines appropriate penalties or sanctions. Nevertheless, there is a lack of overarching institutions to monitor and disseminate information regarding aquifer conditions and groundwater extraction practices among users of different collective wells. This absence hampers comprehensive decision-making processes that incorporate input from all groundwater users concerning the M'hamid Aquifer as a unified entity remains severely limited.

Interactions

Collective-well organisations for irrigation provide a platform to share information about the availability of groundwater, the resources used by users, and the fulfilment of users' responsibilities in the infrastructure maintenance, but only among the users of each well. The designated collective well board receives reports on unauthorised water extraction and decides on suitable penalties or sanctions for each case. There are no overarching institutions to monitor and share information about the aquifer state and groundwater abstraction practices between users of different collective wells or to facilitate decision-making that includes all groundwater users sharing the aquifer. As a consequence, information about the impact that the different groundwater abstraction practices have on the resource or decision-making regarding the M'hamid Aquifer as a unit is very limited.

3.5.3. Characterisation of the Fezouata case

3.5.3.1 Resource System and Resource Units

Fezouata is an alluvial aquifer located South of Zagora City (RS9) and extends over an area of 167 km². Its catchment has an area of 447.6 km² (RS3) (ABHSMD, 2010: 77, 80). However, similar to M'hamid, the

recharge of Fezouata aquifer is affected by water availability in the Drâa River, which is directly affected by water releases from Eddahbi Dam and the water consumption of upstream users. In Fezouata, groundwater is used for irrigation of diversified agriculture, drinking water production carried out by ONEE, and domestic usage (RS1). Local inhabitants use private wells, while ONEE works with public infrastructure (RS4).

Middle and long-term groundwater availability is very uncertain for the users (RS7). In addition, groundwater flow rates are unequally distributed in Fezouata, facilitating better groundwater access for some farmers (RU7). Recharge rates vary from less than 1 l/s to 15 l/s, with an average of 5 l/s. High-productivity areas (over 10 l/s) are generally located along the valley close to the flow axis of the river (RS5). Abstraction for drinking water supply was estimated at 21.9 l/s for a population of 34,162 inhabitants, while agricultural withdrawals were estimated at 13.86 Mm3 (ABHSMD, 2010).

3.5.3.2 Actors

Groundwater users of Fezouata present a heterogeneous profile. There are farm households, hotel owners, and households using groundwater for basic needs which don't include domestic water users. However, there is no official record of the exact number of relevant users (A2). Interviewees estimate the number of farmers between 3000 and 4,000 people. Due to the scarcity of surface water, it can be assumed that all farmers have access to groundwater (RU3). Groundwater is used to irrigate market-oriented crops (date palms, almonds, alfalfa) (RU6) and vegetables for self-consumption (A8). Access to groundwater in Fezouata does not depend on resource availability only, but also on access to the capital to build and deepen wells. For this purpose, local inhabitants count on the commerce of dates and other crops (RU4), remittances from family members, and side jobs (i.e. construction sector) as income sources. As a consequence, some water users have better access to groundwater than others.

3.5.3.3 Governance system

a. Rules-in-use: Statutory laws

There are no community-based institutions aimed at regulating the use of groundwater. The only regulatory framework in place over access and use of groundwater is the laws provided by the Moroccan government (hierarchical governance) (GS5). Individual private groundwater exploitation within Fezouata adheres to the state regulations (Table 3.3) defined in the Moroccan water laws n° 19-95 (1995) and n°36-15 (2016) (GS6). These rules were in place for decades and according to interviewees, the majority of the water users in Fezouata are well-informed of these regulations.

Table 3.3. State regulations for groundwater exploitation in Fezouata (GS6).

Rules and regulations (water laws n° 19-95 and n° 36-15)	Explanation of the rule
Obtaining official authorisation from the Basin agency before any groundwater utilisation (Article 26, law 19-95).	The rule states that before using groundwater, you need to get permission from the Basin agency (ABH-DON).
Authorisation has to encompass parameters such as water discharge rate, volume allocation, agricultural area designated for exploitation, and associated financial dues (Article 39, law 19-95; Article 27 and 31, law 36-15).	The rule states that the permission request needs to cover specific details such as how much water can be used, how it will be distributed, the areas that will be irrigated, and the fees or payments associated with using the water.
The Basin agency retains the authority to remove authorisations under circumstances defined within the legal framework (Article 39, law 19-95; Article 32, law 36-15).	The rule means that the Basin agency has the power to cancel or take away the permission they previously granted for using groundwater if certain conditions described in the law allow them to do so.
Certain violations can lead to sanctions being imposed in alignment with the established guidelines (law 36-15).	The rule states that if certain rules were broken, water users may face penalties according to the rules that have already been set.

b. Incentives identified within the rules

Incentives in law n° 19-95 and n° 36-15 include primarily penalties. The penalties are imposed in the event of owning an unauthorised well, serving as a deterrent against illegal water extraction practices. In addition, legislation 36-15 promotes the adoption of water-efficient technologies as part of the national water strategy 2020-2025. For instance, the government offers financial support for the installation of solar panels under specific conditions, aimed at encouraging sustainable practices among farmers. To grant this support, farmers are required to have authorisation for their wells, which, in theory, should encourage farmers to declare their wells and comply with the rules presented in Table 3.3.

3.5.3.4 Fezouata focal action situation: outcomes and interactions

Outcomes

In relation to the state of the resource, in 2010 ABHSMD reported that inflows and outflows of the Fezouata aquifer were in balance (542.3 l/s). However, interviewed local inhabitants (2021-2023) explain that the water table of the aquifer has dropped significantly during the last years due to prolonged droughts, that reduced the aquifer recharge rate, and over-abstraction of groundwater by farmers (O2).

Groundwater is unequally distributed in Fezouata's territory, which leads to unequal access to this resource among local inhabitants (O1). In addition, access to groundwater depends on access to capital to dig deeper wells and social networks to avoid sanctions for unauthorised wells. Interviews suggest that this is leading to widening social gaps.

Concerning the institutional performance, the statutory regulation in place is loosely monitored and there are no actual sanctions for infractors. Consequently, there is no accountability for groundwater use. Formal institutions dedicated to the dissemination of information among local water users on the aquifer's condition, water table levels, and areas within Fezouata experiencing water scarcity are conspicuously absent. This information is regularly exchanged through informal conversations among neighbours and friends based on their empirical observations. The Jemaâ, a local community board, is not particularly focused on groundwater management. In collaboration with the Moqadem in each douar, the Jemaâ assumes the primary responsibility for resolving conflicts of any nature that may arise within the area.

Interactions

In Fezouata, groundwater is treated as a private good. Interviewees report that the reduction in water levels has been steady over the last decades, however, they used to have enough water to share with friends and neighbours. Collective wells were not necessary. It has been only in recent years, according to these testimonies, that the situation of groundwater scarcity is turning critical. Water sharing has reduced dramatically because well owners can barely get enough water for themselves. Interviewees foresee a scenario similar to that of M'hamid: emigration and abandonment of farms.

In summary, the three SESs studied exhibit varying governance systems, responding to different challenges under varying conditions (Table 3.4, Appendix 3.5). M'hamid faces the most severe degradation among the three, characterised by markedly high salinity levels, groundwater scarcity, and low recharge rates. Consequently, accessing groundwater becomes challenging, encouraging the urgency for joint efforts and shared extraction sources. Fezouata also displays depletion signs through decreased agricultural production, numerous dry and abandoned farms, and wells. Despite these signs, private wells persist and no groundwater management collective action has been developed. In contrast, the Faija Aquifer presents better water quality and, despite the aquifer being declared in deficit, farmers are still able to abstract significant water volumes. In M'hamid and Fezouata, the aquifer systems boundaries are fuzzy, making it difficult to identify the relevant stakeholders that should participate in governance institutions, hindering the establishment of concrete management mechanisms oriented to achieve resource sustainability. The diffuse user community also contributes to this challenge in Fezouata. Each governance system pursues varied objectives, not necessarily aligned with resource sustainability. For instance, M'hamid users prioritise resource access and allocation, while in Faija and Fezouata rules aim at sustainability within their regulations.

Table 3.4. Summary of key differences among the three SESs.

Case	Groundwater institutions	The objective of groundwater institutions	System boundaries/size	Perception aquifer state
Faija	Aquifer contract	Resource sustainability; Protection of agriculture.	Clear aquifer boundaries; Clear user community	. Awareness of drop in water tables by farmers; . Farmers still find enough water for their farming activities.
Fezouata	Statutory laws (No self-governance)	Resource sustainability	. Diffuse aquifer boundaries; . Diffuse user community;	. Aquifers show signs of depletion; . Farmers are still able to find water in private wells;
M'hamid	Self-governance organisation of collective wells.	Provide access to groundwater and a fair water allocation	. Diffuse aquifer boundaries; . Clear user communities.	. Farmers find it very difficult to find enough groundwater of good quality.

3.6. Discussion

3.6.1. Adequacy analysis of the incentives: Factors affecting rule-compliance

The analysis of incentives reveals challenges in achieving rule compliance in both Faija and Fezouata. In Faija, farmers express concerns about the immediate financial impacts of aquifer regulations, fearing constraints on groundwater access, debt settlement, and profits. Studies indicate that farmers base their water use decisions, crop selection, and adherence to regulations on perceived risks and cost-benefit assessments (Vignola et al., 2010; Michetti et al., 2019; Alcón et al., 2019; Vásquez, 2020; Mitra et al., 2021; Bagheri and Teymouri, 2022). Notably, farmers openly oppose the government's initiative to install water meters in their wells as part of water quota enforcement efforts (see section 3.5.1). Our analysis suggests that imposing significant legal penalties (Table 3.1) could encourage compliance with water quota limits. However, if the benefits of breaking the rules outweigh the penalties, farmers may choose to pay the penalties regardless. Weak monitoring and rule circumvention, as reported by interviewees, undermine the efficacy of penalties, aligning with previous findings in other regions in Morocco (Houdret & Heinz, 2022). This underscores the limited effectiveness of penalties as legal incentives for groundwater rule adherence. Scholars have argued similarly that state-centred groundwater governance and penalty imposition often yield limited success (Theesfeld, 2010; Holly and Sinclair, 2012; Greiner et al., 2016; Schoengold and Brozovic, 2018; Molle and Closas, 2020; Penny et al., 2021).

Furthermore, incentives providing technical and financial support to promote sustainable practices could mitigate the impact of water restrictions on farmers by improving water efficiency and economic returns. Specifically, farmers in Category I (Appendix 5.3) expressed the need for assistance and guidance to identify and rectify bad farming practices (See Molle and Tanouti, 2017). Therefore, educational initiatives could enable governments to impose modest water restrictions on Faija farms. Greiner et al. (2016) reached a similar conclusion in their study on irrigation water use in Australia, highlighting that education and information foster spontaneous compliance among a majority of water users (See also Sullivan et al., 2003; Ostrovskaya et al., 2013; Euler et al., 2018; Petit et al., 2021). Additionally, challenges encountered by farmers in the watermelon market, such as the proliferation of intermediaries and profitability optimisation difficulties, suggest that streamlining markets and assisting with marketing strategies could enhance farmers' economic outlook, incentivising compliance with regulations outlined in the aquifer contract.

Our analysis reveals that in Fezouata there is a disconnection between statutory regulations and conditions of farmers, which result in a poor capacity to comply with the rules. Farmers find the process of getting well licenses time-consuming, costly, confusing, and often unproductive. In addition, weak monitoring and sanctioning reduces the intended effectiveness of penalties as rule-compliance incentives. Interviewees among farmers and governmental representatives report that this situation leads to the proliferation of illegal wells. Recent research on the topic has reached similar findings about the effects of administrative burdens as primary barriers to rule compliance among California’s farmers (Bodwitch et al., 2021). In addition, our data also shows that the access to water-efficient technologies promoted through the national water strategy (2020-2050), has limited capacity of local authorities to incentivise compliance, as farmers could access them without legalising their wells. This aligns with similar challenges in other Moroccan regions (Kuper et al., 2016; Houdret & Heinz, 2022).

Molle and Closas (2019) highlight constraints in state-centred groundwater governance, citing challenges in monitoring diffuse users, financial and logistical challenges, as well as conflicting private

interests that are inconsistent with the longer-term common good. Interviews with farmers and governmental officials echoed similar limitations, citing financial and human resource constraints, as well as the political and social costs of stricter rule enforcement. Resolving financial and human limitations might involve increased budget allocation, but addressing political and social costs, tied to broader national agendas, poses greater challenges (Houdret, 2012).

The incentive adequacy analysis for M'hamid shows that the shared perceptions of resource scarcity drive compliance with self-governance rules, fostering strong community engagement and reducing reliance on penalties. Interviewees stressed that the collective-well rules balance and address the interests of the user groups reliant on the communal well. According to the interviews, penalties hold a minimal but effective role. This is primarily because penalties always outweigh the potential benefits of breaking the rules. Second, small group size dynamics ensure monitoring and easy identification of free-riders, which discourages rule violations. Third, penalties emphasise the importance of rules, ensuring fairness and equity. This aligns with findings from similar contexts (Cody et al., 2015). Overall, penalties are viewed as a last resort, with community engagement as the primary approach for voluntary compliance.

3.6.2. Opportunities and limitations of groundwater self-governance

According to the Common Pool Resources (CPR) literature, self-governance often emerges from the presence of a credible threat to the existing status quo (of the SES) if no action is taken (Ostrom, 2009; Cody et al., 2015; Molle & Closas, 2020; Shalsi et al., 2022). Sustainable resource use, in turn, emerges as a result of implementing rules limiting over-use and from the fact that most users believe in the necessity and efficacy of the rules (Ostrom, 2009). In our three cases, all interviewees voiced aquifer degradation concerns, yet Fezouata stands out for lacking self-governance organisations. This difference might indicate that groundwater users of Fezouata perceived a lesser threat over the resources and lesser urgency to act compared to users of M'hamid and Faija. Alternatively, it may suggest that a perceived threat to the status quo is not enough to trigger a self-governance organisation.

In M'hamid, farmers' struggles to access groundwater coupled with acute surface water scarcity, which results in an immediate need for collective action to secure access to water. However, the focus of this collective action is primarily on locating groundwater and establishing affordable means of extraction rather than achieving resource sustainability. For instance, collective wells do not include mechanisms to ensure that total abstractions do not exceed aquifer recharge. Results show that in Faija, declining groundwater levels play a smaller role in the emergence of self-governance compared to M'hamid, highlighting instead tribal identity and pre-existent collective institutions' importance. Through a process of "commoning", tribe members rally under a narrative of safeguarding the shared Faija aquifer against outsiders who overabstract the resource (Bossenbroek et al., 2023). Yet, enforcing rules promoted by tribe members remains a challenge, limiting the effectiveness of this self-governance approach (see section 3.5.1). Additional factors likely influencing the emergence of self-governance organisations in the MDV necessitate further investigation.

Following this rationale, Fezouata's lack of groundwater self-governance might be attributed not just to a lower urgency in limiting groundwater use but also to its privately-owned land regime. Unlike areas where tribal permissions regulate land access and groundwater use, Fezouata lacks this organisational structure, leaving farmers without a coordinated platform to discuss or monitor groundwater activities in the territory. In comparison to Faija, Fezouata suffers from ambiguous community and resource boundaries, which hinder the emergence of self-governance, as described in CPR theory (Cox et al., 2010).

Both Fezouata and M'hamid face complexity in their big groundwater systems due to the influence of the Eddahbi Dam and connection with upstream aquifers, leading to unclear system boundaries.

3.6.3. Limitations for developing a unified groundwater governance system

The results indicate that groundwater users in the M'hamid and Faija aquifers have established self-governance organisations to formulate and oversee rules. However, these organisations operate independently of each other, lacking the ability to coordinate rule creation, monitor compliance, enforce sanctions against violators, and implement conflict resolution mechanisms across broader spatial scales. Consequently, effectively limiting groundwater extraction for all users sharing the same aquifer remains challenging. CPR studies offer extensive evidence emphasising the importance of coordination and information sharing in fostering trust among resource users, legitimising governance systems, and ensuring rule compliance (Ostrom, 1990; Cox et al., 2010).

As a response to groundwater depletion problems, the Moroccan government is promoting aquifer contracts along the country as an institutional framework to integrate the actions of localised self-governance organisations with the actions of governmental organisations. As part of these contracts, water user associations (WUAs) are meant to play the role of local groundwater management organisations in charge of allocating water quotas among their members and monitoring water use. By participating in this institutional framework, farmers are expected to gain access to information on the state of the aquifer and the behaviour of other aquifer users, which is intended to increase trust in the management system and its legitimacy and enhance rule compliance. It is not clear if WUAs will also monitor the water use of other associations.

For this approach to succeed, effective coordination among Water User Associations (WUAs) within each aquifer and between these WUAs and government institutions is essential. Achieving this coordination necessitates strong incentives or a high level of trust (Baldwin et al., 2018). One potential motivation for downstream users to engage in aquifer contracts is their belief that upstream water extractions impact them, thus requiring rules to regulate and monitor these extractions. However, our interviews indicate a very limited understanding of aquifer dynamics among users, which may impede consensus on the need for coordination among localised self-governance organisations. Additionally, upstream users may not perceive the need to participate if their water usage remains unaffected by downstream actions. Prior research indicates that upstream user involvement often stems from the need to establish mechanisms to prevent and resolve water conflicts (Baldwin et al., 2018). In the Faija, inter-tribal conflicts primarily revolve around collective land control rather than water resources. This history of conflict could hinder trust-building for water governance rather than fostering awareness of the benefits of aquifer contracts. Interestingly, there have been no recorded water conflicts between different collective wells in M'hamid. However, both cases indicate a lack of inherent motivation among upstream users to engage in institutional coordination with downstream users. Therefore, simply establishing monitoring systems may not suffice to encourage upstream participation; more detailed implementation plans are required.

5.1.1. The SESF application

The use of the SESF in characterising the aquifer cases has been pivotal in our research. It has enabled us to identify relevant variables crucial for explaining institutional arrangements within the three SES analysed, while navigating the complexities and capturing necessary interactions for our analysis.

Moreover, augmenting the SESF with an incentive structure analysis has significantly enriched our exploration. In the CPR literature, the SESF is often used alongside Ostrom's design principles (1990) to evaluate the emergence of sustainable self-governance systems, including conditions motivating rule compliance—similar to the incentive analysis approach. However, while design principles focus on self-governance regulations, incentive analysis extends its applicability to various types of regulations across self-governance, hierarchical governance, and co-governance systems. This versatility makes the combination of SESF with incentive structure analysis advantageous and has strengthened our analysis.

We acknowledge the blind spots that scholars, notably critical institutionalists, have pointed out for the application of the SESF. First, this analytical framework relies on the assumption that individuals and organisations act rationally based on costs and benefits. However, human behaviour may be influenced by a myriad of factors beyond a simple rational choice model, such as emotional, moral, and social rationalities informed by differing logics and world views (Cleaver, 2000; Cleaver & de Koning, 2015). Furthermore, the SESF and incentive analyses may not fully capture how power dynamics shape decision-making and rule compliance (Herdt and Sardan, 2015). Finally, the frameworks' static nature, focusing on a singular point in time, raises concerns about their ability to capture the dynamic evolution of SESs and the impact of incentives over time (Cleaver & de Koning, 2015). To better understand these aspects, further research is required.

3.7. Conclusions of the chapter

Our analysis indicates that while groundwater users in each case study face typical common pool resource governance challenges such as equitable water allocation and resource sustainability, they have developed distinct institutional responses. These differences in institutional arrangements are closely tied to the unique characteristics of each Social-Ecological System (SES), including biophysical attributes and actor characteristics. Consequently, the governance systems inherent to each SES possess specific limitations.

For instance, the hierarchical approach that prevails in Fezouata faces significant challenges in attaining rule compliance, which compromises in turn the capacity of the system to achieve resource sustainability and equitable resource distribution. This is primarily due to the discrepancy between state regulations and local realities, necessitating adjusting the design of the incentives, but also to weak sanctioning, which reduces dramatically the efficacy of incentives. In contrast, self-governance, observed in M'hamid and Faija, demonstrates an advantage in terms of rule compliance. This is attributed to well-defined user communities that have mutually agreed on the importance of regulating resource use in their best interest. However, self-governance organisations may not prioritise long-term resource sustainability (as evident in the M'hamid case) and may lack the authority and legitimacy to effectively sanction rule violators, compromising rule compliance (as seen in the Faija case). Consequently, users often demand state intervention in the sanctioning process. Secondly, the inability to sanction rule violators underscores the necessity of a unified governance system that coordinates the actions of these organisations with those of the state, supporting sustainable practices while enhancing the authority and legitimacy of local bodies for effective regulation enforcement.

Aquifer contracts could provide the institutional framework to develop a unified system as such at the aquifer level. However, engaging local actors in rule formulation is imperative, a vital yet missing aspect observed in the Faija aquifer contract, compromising its effectiveness. Overcoming this limitation demands active participation and co-creation of rules by local stakeholders. Nevertheless, implementing

a unified governance system in each aquifer also faces the lack of natural incentives among resource users to participate in such a system, particularly among upstream users. Addressing this challenge could involve the introduction of compensatory measures tailored to mitigate the lack of natural incentives and encourage broader participation across stakeholder groups, ultimately fostering a more inclusive and effective groundwater management system.

Finally, the diversity of governance institutional arrangements addressed in this paper advocates for context-specific analyses to inform effective groundwater management and incentive-based policies. In this sense, the application of the SESF proved valuable in addressing the particular problems of groundwater governance in the MDV. Its utilisation provided a comprehensive lens through which we could dissect and comprehend the interplay between key variables within the context of each study area. The SESF offered a structured and holistic approach, enabling us to identify, analyse, and ultimately navigate the complexities inherent to groundwater governance, thereby enriching our understanding and findings within this research.

Chapter 4

DRIVERS OF CONFLICT OVER CUSTOMARY LAND IN THE MIDDLE DRÂA VALLEY OF MOROCCO

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4.1. Abstract

Since the early 1980s, the Middle Drâa Valley (MDV) in south-eastern Morocco has seen agricultural expansion from oases into customary land owned by different tribes, creating the potential for conflict. Customary land conflicts are often depicted as obstacles to socioeconomic development. This article analyses the drivers of land conflict between the Mssoufa and Kaaba tribes, explaining how the conflict restructures power and authority relations to control resource access. We use an actor-based approach and access theory to analyse data from observations and 34 semi-structured interviews conducted between May and July 2021 and September and November 2022. Interviewees included members of the conflicting tribes, government representatives, and private sector actors. The conflict stems from unequal land access between tribes, rooted in historical power reconfigurations influenced by droughts, market dynamics, national agrarian development policies, and changes in customary land access rules. We argue that preventing further escalation of intertribal land conflicts in the MDV requires directing the actors' motivations and capabilities towards cooperation and resource sharing by implementing a third-party intervention model of conflict resolution in combination with a structural peacebuilding approach. Additionally, we discuss the implications of our findings for promoting sustainable development in the MDV, particularly focusing on Sustainable Development Goal (SDG) 16: Peace, Justice, and Strong Institutions, while also identifying implications for SDGs 1, 10, and 13.

4.2. Introduction

The study of conflict over customary land, particularly in Africa, lies at the heart of a broader debate on how to use land resources to achieve sustainable development (Asaaga, 2021; Balgley, 2017; Balgley & Rignall, 2021; Berriane, 2017; Bottazzi et al., 2016; Chinigò, 2016; Chitonge & Harvey, 2021; Kansanga et al., 2019; Mahdi, 2014; Peters, 2013). The centrality of land as a source of intra-state conflict is strongly linked to the crucial role this resource plays in economies worldwide, serving as a primary source of food, income, and employment in rural areas (Davis et al., 2017; Houdret et al., 2017; Ivanov & Sokolova, 2017; Kuper et al., 2016, 2017; Molle et al., 2019; Osabohien et al., 2019; Waha et al., 2017a). The economic significance of land is also reflected in the global increase in irrigated areas during the 20th century (Tilman, 1999) and projections estimating the further expansion of irrigated land in the coming decades (Meier et al., 2018; Puy et al., 2020). Particularly in arid regions, the promotion of irrigated agriculture has played a pivotal role in public policies for national socio-economic development, poverty alleviation, and achieving national and global food security (J. Venot et al., 2014; Birkenholtz, 2017; J.-P. Venot et al., 2017; Molle et al., 2019).

Public policies for agricultural development, but also processes such as population growth, rapid urbanisation, and industrialisation, contribute to increasing the demand for land and water and to the degradation of these vital resources (Boretti & Rosa, 2019; Hu et al., 2019; Hunke et al., 2015; Ilampooranan et al., 2022; Mendivil-Garcia et al., 2020; Mohammed et al., 2022; Tian et al., 2015). The resulting competition over land is expected to be exacerbated even further by the effects of climate change. Studies on climate change not only predict that dry areas in the world will become drier (El-Beltagy & Madkour, 2012), but also indicate a global trend of dryland expansion, particularly in the continents of the Eastern Hemisphere (Huang et al., 2016; Singh & Chudasama, 2021). The MENA region is emerging as a hotspot for worsening extreme heat, drought, and aridity conditions, where rural livelihoods are expected to deteriorate due to declining agricultural productivity (Waha et al., 2017).

In this context, competition for customary land has been increasing in Africa over the past 40 years, along with the potential for conflict (Berry, 2017). Before the 1980s, most African nations made smaller changes to the former colonial institutional frameworks for customary land management (Bottazzi et al., 2016; Chitonge, 2021). This situation evolved during the 1980s and 1990s when proponents of neoliberal reforms and structural adjustment determined that market reforms would not effectively promote development unless property rights were clearly defined and consistently enforced through land tenure reforms and the formalisation of land rights (Bottazzi et al., 2016; Chitonge, 2021). Scholars have highlighted that land conflicts are as much about who has the authority to allocate land and resolve disputes as they are about competing land uses and transfers (Berry, 2017; Seter et al., 2018). Furthermore, they argued that efforts to impose uniform rules on societies with multiple, overlapping land claims and shifting boundaries would exacerbate rather than clarify conflicts (Bromley, 2009; Boone, 2013; Berry, 2017; Spierenburg, 2020).

In countries with histories of multiple legal traditions and overlapping systems of authority, competition over land has sparked intense debates about land value, the validity of claims, and decision-making authority (Berry, 2017). One example is Morocco, where the creation of a single juridical category of collective property ownership during the French Protectorate aimed to eradicate the myriad ownership and usufruct rights layered over collective lands (Rignall 2021). However, many contemporary land conflicts can be traced to the French Protectorate's efforts to convert diverse forms of Moroccan collective

sovereignty into a unitary juridical category of collective property ownership (Ibidem, 109). Collective land has been central to national debates on human and economic development, with customary land conflicts often depicted as obstacles to socioeconomic development and national integration (Bouderbala, 1999; Berriane, 2017).

Recent changes (2019) in Morocco's legal framework for collectively owned land align with neoliberal economic policies that emphasise market-driven reforms. However, scholars have pointed out that these changes also respond to rural unrest and anti-government opposition stemming from state repression, lack of economic opportunities, and land ownership inequality (Balgley & Rignall, 2021). According to these authors, contemporary land disputes are rooted in the legacy of colonial land governance and current extractivist capitalism, which prioritise land commodification processes that dispossess historically marginalised landowners and managers in favour of capital interests (Balgley, 2017; Balgley & Rignall, 2021; Mahdi, 2014). Similar findings have been observed in sub-Saharan countries (Asaaga, 2021; Asaaga & Hirons, 2019; Spierenburg, 2020; Yaro, 2010).

Understanding land conflicts is crucial to preventing their escalation, which can cause harm to people and lead to inefficient resource use (Seter et al., 2018). Conflict resolution is an important function of resource governance systems (Pahl-Wostl, 2019a). In this sense, studying these conflicts offers valuable insights into the challenges of land governance and sustainable land-based development. However, empirical research on land governance has primarily focused on large-scale land grabbing, devoting relatively little attention to the drivers of intra-state and inter-community conflicts over customary land (Kansanga et al., 2019; Asaaga, 2021). Asaaga (2021) has also highlighted the need for a more nuanced and detailed contextual understanding of the operations of customary land tenure institutions and their limitations in providing effective mechanisms for land dispute resolution.

The empirical research in the MDV presented in this paper contributes to filling these gaps by exploring the links of customary land conflicts with the agrarian political economy in which they emerge. We pay particular attention to how land claims and authority relations evolve and interact over time, and to how the outcomes of these conflicts—whose claims are recognised and whose are ignored or denied—contribute to reinforcing and restructuring practices of power and wealth distribution in society (Berry, 2017). We use access theory (Peluso & Ribot, 2020a) to analyse how power dynamics influence access to customary land, and an actor-based approach to identify the links between the main drivers of conflict and broader social, political, and economic factors at local and national levels (Schilling, 2016; Schilling et al., 2018). We use the Sustainable Development Goals (SDGs) to discuss the implications of our findings for sustainable development in the study area. We identify implications, particularly for SDG 1 (No Poverty), 10 (Reduced Inequalities), 13 (Climate Action), and 16 (Peace, Justice, and Strong Institutions). Our results can serve as a reference for discussing customary land conflicts and sustainable development in arid regions, particularly in other North African countries.

We chose to analyse the conflict between the Mssoufa and Kaaba, two tribes disputing customary land in the Faija Plain, located near the city of Zagora in South-East Morocco. During exploratory fieldwork, the Mssoufa-Kaaba conflict was frequently mentioned by interviewees, who expressed concern about the potential degree of violence it could reach. Interviewees also explained that this conflict is well known in the region due to the fact that the Faija Plain, along with its underlying groundwater, is used for intensive watermelon agriculture. While this agricultural activity is a crucial means of economic development for local farmers, it has been criticised by scholars and the public for contributing to land and aquifer degradation (Bossenbroek et al., 2023).

A second reason to choose the Kaaba-Mssoufa conflict as case study is the possibilities it offers to explore the interconnection of land conflicts with historical processes affecting the region. According to the literature, in the late 20th century, a combination of population growth, overgrazing, and drought episodes (1979–1984, 1987, and 1993–1995) triggered the occupation of land on the periphery of the palm groves of the MDV (Karmaoui et al., 2014; Lamqadem et al., 2019). The lack of pasture forced former pastoralists to seek land for farming. At the same time, farmers in the oases lacked sufficient surface water and arable land to sustain their livelihoods. Consequently, they turned to collective lands outside the oases to access groundwater and fertile land (Karmaoui et al., 2014; Lamqadem et al. 2019; Moumane et al., 2021). More recently, the growing national and international demand for watermelons, coupled with public policy subsidising drip irrigation as part of 'Le Plan Maroc Vert' (The Green Moroccan Plan) 2008-2020 (Faysse, 2015; Mazouni & Kadiri, 2021), increasing interest in collective lands. In the Faija Plain, an agricultural boom began in 2007, driven by watermelon production (Bossenbroek et al., 2023). This contributed to tensions between tribes claiming rights over these lands (Lamqadem et al., 2019a; Moumane et al., 2021).

The next section 4.3, explains the conceptual framework. Section 4.4 introduces the study area, detailing its geographic and climatic characteristics, and outlines the methodology, including data collection and its limitations. Section 4.5 presents the results of our analysis, offering a background of the conflict and examining the actors' motivations and capabilities to engage in conflict, as well as the conflict drivers. Section 4.6 discusses these results. Finally, section 4.7 presents the conclusions of the chapter.

4.3. Conceptual framework

Our analysis moves away from a deterministic view of the link between resource scarcity and conflict (Detges, 2014; Homer-Dixon, 1994). Instead, we adopt the notion that resource-based conflicts emerge as part of historically-driven and multi-level socio-environmental processes that create an unequal distribution of benefits and burdens from resource-based production and environmental change (Le Billon & Duffy, 2018b; Robbins, 2020a). In these situations, conflicts arise when less privileged actors resist this inequality and struggle to enforce their interests over those they perceive as rivals (Schilling, 2016; Schilling et al., 2018). The historical approach to conflict reveals its dynamic nature, demonstrating how unequal power relations shaping access to resources are subject to reconfiguration over time. To operationalise this conceptualisation of resource-based conflict, we use the perception of incompatible interests (Froese & Schilling, 2019; Mitchell, 2002; Scheffran et al., 2012) expressed in the testimony of interviewed actors and the concrete actions taken by these actors to make their interests prevail. We analyse these actions in terms of the actors' capabilities (Ramsbotham. et al., 2016).

We use access theory, as developed by Peluso and Ribot (2020), to study how power relations affect access to land and water and how this can lead to conflict. Access refers to the ability to benefit from resources (in our case, land and groundwater) and people. We distinguish between actors who control access to these resources—those who mediate the access of others—and actors who try to gain and maintain access through relationships with those who control it. This approach shifts the analysis away from an emphasis on property rights, focusing instead on whether, why, and how particular benefits are derived from resources.

We use the actor-based conflict analysis by Schilling (2016) to examine the identified conflict in three steps: actor mapping, analysis of the socio-political and economic context, and analysis of conflict drivers. The actor mapping identifies all actors with a stake in the conflict at local and national levels, as well as

the motivations and capabilities of immediate or primary actors (in our case, Mssoufa and Kaaba). For these actors, the motivation behind their actions is identified, along with their capabilities to engage in the conflict. Following (Scheffran et al., 2012), we understand "motivation" as the result of the balance between the expected gain and the expected loss of a certain course of action for a given actor. Thus, for an actor to be motivated to engage in cooperation, the benefits of cooperation must outweigh the benefits of conflict. Additionally, the chosen course of action is linked to the actor's capabilities to execute it, including knowledge, power, resources, and manpower (Schilling et al., 2014, p. 161). Finally, we analyse how the conflict is connected to a broader environmental, socio-political and economic context. To do this, we focus on the actors' motivations to identify relevant drivers and see how they relate to environmental changes, public policies, or external interventions.

We translate the term *kabila* used by our interviewees as tribe. Tribes are groups that believe they share a common male ancestor and use customary laws to decide on matters such as the division of group territory into large blocks (cultivated land, rangelands, residential areas), irrigation, and land distribution among members, among other things (Bouderbala, 2000). Our observations of the social organisation of tribes in the MDV align with (Adra, 2021) description, which the author asserts is valid for the entire MENA region. Adra (2021) explains that tribes are organised into segments of increasing size and scope, with the household as their central foundation. Some segments are named for putative kin (common in the MDV), while others are distinguished as numerical fractions of a whole, such as thirds, fifths, and eighths, or as parts of the body, such as thighs (also seen in the MDV). Other segments are identified by domicile or place names. Villages are often considered tribal segments, which is also common in the MDV.

4.4. Materials and Methods

4.4.1. Study area

The Faija Plain is located to the north of the Saharan Desert, in the province of Zagora, southwest of the city of Zagora in southeaster Morocco (Figure 4.1). This plain is adjacent to the six oases that compose the MDV. These oases cover 200 km and 26,000 hectares, with a population of about 240,000 inhabitants (Karmaoui et al., 2014; Lamqadem et al., 2019). The region is characterised by an arid to hyper-arid climate (Klose, 2012), with an annual average precipitation of 70 mm (Moumane et al., 2021). The hydrogeological basin of the Faija Aquifer spans an area of 2,270 km². The plain is surrounded by mountains that help collect and drain rainwater, recharging the aquifer beneath it. Additionally, the Faija Plain is crossed by a national road, facilitating its connection to national markets.

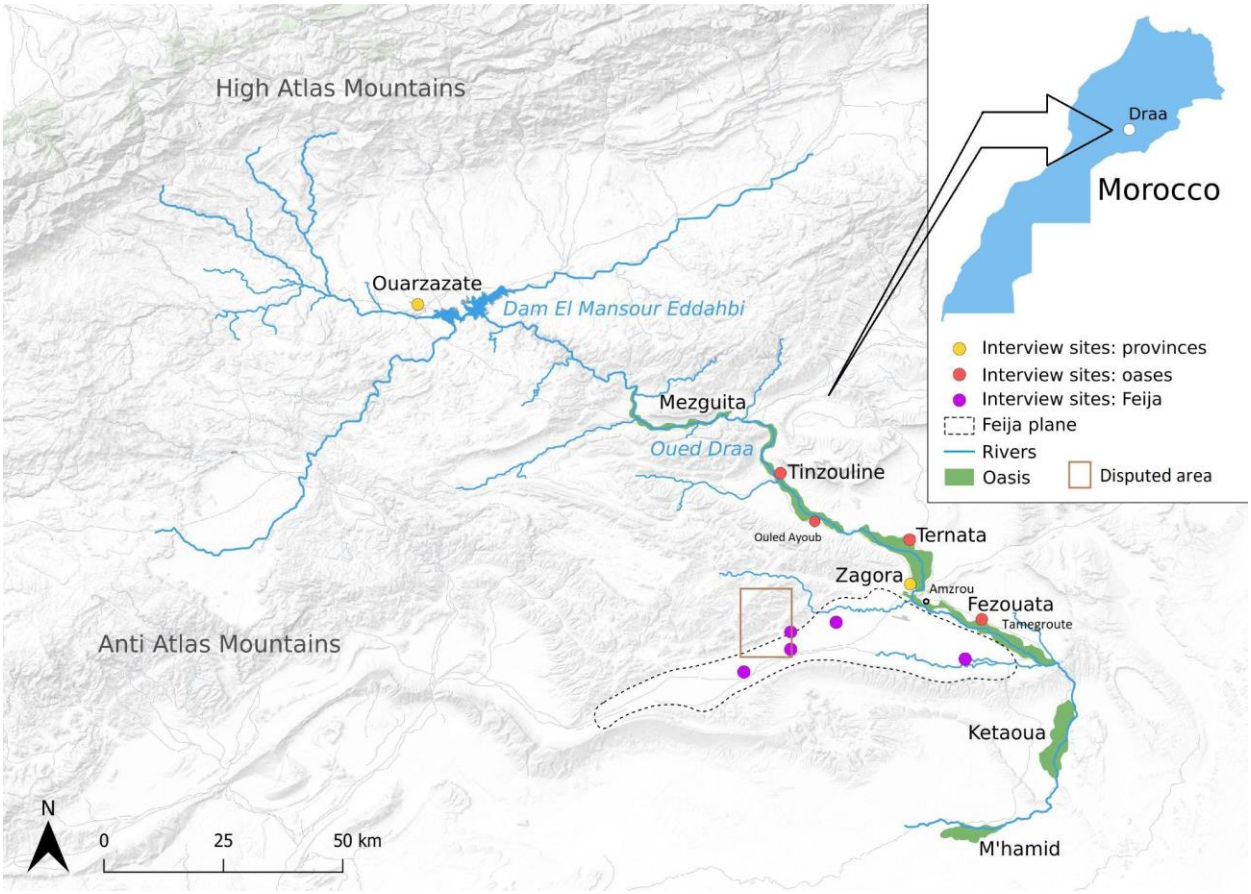

Figure 4.1. Study area. Including Faija plain, disputed area, and interview sites (elaborated by authors based on Terrain-Basemape© EOX). The area marked as "disputed area" is an approximation based on interviews and the map with the administrative division 379 of Kaaba collective land in Faija produced by the Moroccan government. We had access to this map through our interviews.

In the oases, farmers practise subsistence agriculture characterised by a stratified production system that combines date palms, fruit trees, and annual crops. Since the second half of the 20th century, factors such as population growth, overgrazing, and episodes of drought (1979–1984, 1987, and 1993–1995) have led to the occupation of rangelands on the periphery of palm groves (Karmaoui et al., 2014; Lamqadem et al., 2019; Bossenbroek et al., 2023). The depletion of pastureland compelled former pastoralists in these areas to seek land for agricultural purposes. Simultaneously, existing farmers in the oases faced challenges due to insufficient surface water and arable land to sustain their livelihoods. Consequently, they turned to collective lands outside the oases to access groundwater and fertile land (Karmaoui et al., 2014; Lamqadem et al., 2019; Moumane et al., 2021).

During 2008-2020, the increasing national and international demand for watermelons, coupled with the public policy of subsidising drip irrigation under the 'Le Plan Maroc Vert' (The Green Moroccan Plan), heightened interest in collective lands and sparking tensions between tribes asserting rights over these lands (Lamqadem et al., 2019; Moumane et al., 2021). Three such tribes are settled in Faija Plain: Ait Isfoul, Ouled Aissa, and Mssoufa. As we will illustrate in the following sections, Mssoufa controls the largest portion of land and is in conflict with two other tribes, Kaaba and Khchaa, who do not reside in the plain

but claim land that partially overlaps with Mssoufa's claims. In this paper, we analyse only the Kaaba-Mssoufa conflict; however, we include in the analysis interviews conducted with members of the Khchaa tribe who are knowledgeable about this case.

4.4.2. Data collection

We conducted semi-structured interviews and field observations. We supplemented this data with relevant government documents[3] and historical texts on tribal groups in our study area. Between May 2021 and November 2022, we conducted 34 semi-structured interviews, five with governmental representatives and 29 with members of local tribes. These tribes are Mssoufa (Faija), Kaaba (Tinzouline and Ouled Ayoub), Khchaa (Zagora city), Ouled Aissa, and Ait Isfoul (Tamegroute) (Figure 4.1). Among the tribe members we interviewed customary authorities, such as the Wakil-Aradi (land agents appointed by the moaineenin inside the tribes to manage collective lands)4, moaineenin (representatives of the sub-segments in the tribes), and moajih (official spokespersons of the tribe). All of them were men with knowledge about the conflict. Among representatives of government organisations in Faija we interviewed officials in the Caïdat5 Ternata and Tinzouline, the National Agency for Land Conservation, Cadastre and Cartography, the National Agency of Water and Forestry, and the Provincial Division of the Ministry of Agricultural in Zagora, and the Agriculture Development Agency in Ouarzazate.

Interviews were conducted in French, Amazigh, and Darija with a native speaker's help. Audio recordings were made if consent was given; otherwise, notes were taken and later revised and complemented by the translator. Given the sensitivity of the discussed topics, we protect the identity of our informants and use “Gov” referring to the government, “Kh.” for interviewees in Khchaa, “Ka.” for Kaabians, and “Ms.” for Mssoufians.

The software MAXQDA 2020 (VERBI Software, 2021) was used for content analysis. The coding process used a deductive approach with codes established beforehand. Most interviews focused on understanding access to land and groundwater, farming characteristics (size of the plots, cropping pattern, irrigation practices and equipment), actors involved, and collective land management. Additionally, some key informants spoke explicitly about the conflict. They were willing to discuss the conflict's causes, historical development, and argument for claiming land in Faija.

We do not seek statistical representativity. We use a single instrumental case study as a qualitative methodological approach to uncover explanations for specific outcomes and historically specific causal relationships (Burawoy, 1991; 31]. This approach is intended to reveal what insights the individual case can offer about the broader society in which it is embedded, rather than generalising about a population of similar cases (Burawoy, 1991). The number of conducted interviews results from employing snowballing and purposeful sampling techniques (Creswell, 2007). These techniques aim to identify and engage with individuals who have specific knowledge and experience regarding the conflict. Purposeful sampling allows

[3] Including Dahir 1919, law 62.17, 63-17, 64.17, Official Bulletin N°6842, and the Cartographic map of A.D.379-December 2018.

[4] In other regions of Morocco, this position is also referred to as Naïb, a representative of the tribe who is responsible for managing the tribe’s land and who is approved by, and liaises with, the Ministry of the Interior (Kadiri and Er Rayhany, 2019).

[5] This is an administrative institution belonging to the Ministry of the Interior operating at local level. It is responsible for supervising the implementation and functioning of projects related to health, education, energy and infrastructure, as well as managing security issues.

us to deliberately select participants who can provide rich, detailed information on the events that encompass the timeline of the conflict, the motivations and the capacity of the involved parties to enter into conflict, and to identify other actors involved and their role in the process (Creswell, 2007). On the other hand, snowballing is a common technique in social science research, particularly valuable in contexts where the population is hard to access or lacks formal registration, ensuring diverse perspectives and insights can be captured (Creswell, 2007).

To mitigate potential biases, we employ triangulation and cross-referencing of data collected from interviews, specialised literature, governmental documents, and satellite images from Google Earth. When discrepancies arise between testimonies from different interviewees or between interviewees and other sources, we revisit the interviewees to clarify these inconsistencies. However, one significant limitation of our research is that most of the fieldwork interviews were conducted by males. This severely limited our ability to interview women, not only because it is considered inappropriate in the MDV for women to talk to male strangers, but also because the translator himself was reluctant to address women with whom we had no previous relationship. Consequently, we were only able to interview two divorced women and a group of women from a cooperative. In both cases, the interviewees reported that they did not feel at ease sharing their insights with us about the conflict or the management of collective land in their tribes.

4.5. Results

The results are presented in four sections. We begin with an overview of the conflict background, followed by a description of the actors involved. Next, we examine the ability of the Mssoufa and Kaaba tribes to access and control land and water in Faija, which in turn determined their capability to engage in conflict. We utilise the concepts of "access," "motivations," and "capabilities." In the final section, we explain the drivers of the conflict and how the imbalance of power between the Kaaba and Mssoufa is the result of a combination of historical processes occurring at different levels. This, in turn, evidences how power relations between local patrilineal groups in the MDV are constantly being reconfigured.

4.5.1. Conflict background

The conflict over collective lands between the Kaaba and Mssoufa tribes is rooted in historical and political developments (Figure 4.2). We identified the management of the land tenure regime during the French protectorate and historical land claims as sources of tensions and contestations. During the French protectorate (1912–1956), French authorities passed the Dahir of 1919 to regulate "collective lands." The triangulation of the different historical sources consulted, along with our interviews, suggests that the creation of this category and the notion of "limits'' introduced with it, created opportunities for tribes to claim rights over land that, according to pre-colonial customary laws, may have belonged to other groups (Karsenty, 1995; Bouderbala, 1999; Bouderbala, 2000).

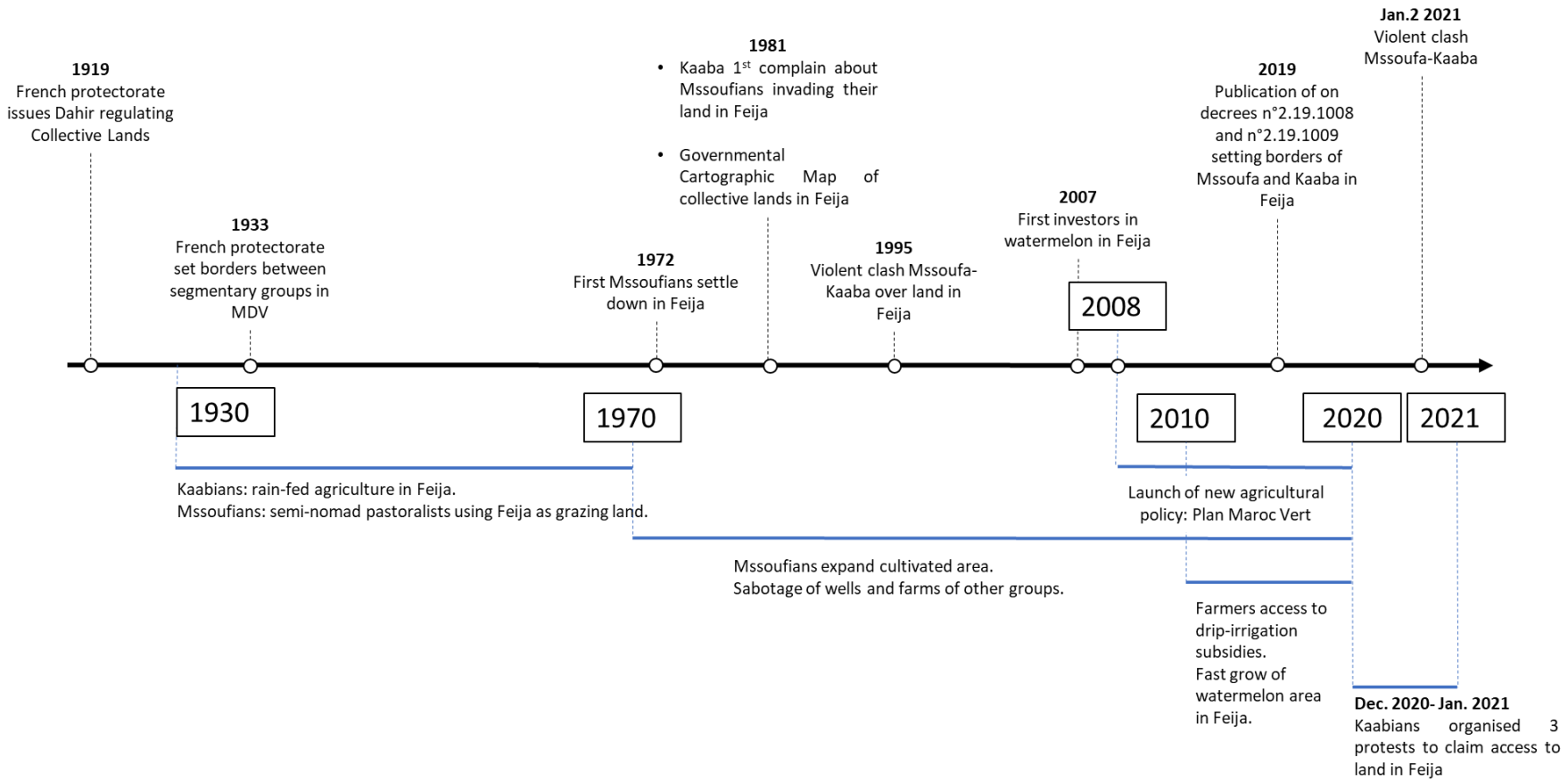

Figure 4.2. Timeline of the conflict. This timeline presents the main events that marked the evolution of the Mssoufa-Kaaba conflict from 1919 to 2021 (prepared by the authors).

The Dahir of 1919 was created to address rural discontent arising from land expropriation by colonists, aiming to protect local ethnic groups from further expropriation by making collective land inalienable (Balgley, 2017) and specifying ethnic collectivities as the owners of land held in common (Rignall 2021). As noted by (Karsenty, 1995) and (Bouderbala, 2000), the concept of "collective land" served two other purposes: first, to protect colonial property by setting strict limits on communities and keeping the peasantry in the countryside; and second, to organise 'the administrative supervision of indigenous communities,' placing them under the tutelage of the Directorate of Indigenous Affairs (Bouderbala, 1999). The governance of customary land was left to customary authorities, giving each tribe the freedom to apply their own rules (Balgley & Rignall, 2021).

After independence, the Moroccan state retained the legal and bureaucratic regime developed under the protectorate, transferring the administration of collective lands to the Directorate of Rural Affairs, a department within the Ministry of the Interior (Balgley & Rignall, 2021; Chitonge & Harvey, 2021). In 2019, three new laws restructuring the legal framework of collective lands were adopted (laws 62.17, 63.17, and 64.17). Among the main changes introduced by these laws are the explicit inclusion of women's rights to collective lands, the possibility of transferring private ownership of collective land for agriculture to members of the soulaliyat communities to encourage settlement and investment, and the potential transfer of parts of these lands to private or public actors for investment projects (Kadiri & Er-Rayhany, 2019).

Regarding the historical claims over Faija, Mssoufa interviewees reported that their tribe belongs to the Amazigh segmentary group Ait Atta (also referred to as a tribal confederation). Kaabian interviewees identify themselves as belonging to the Arab segmentary group Ouled Yahia. According to (Spillmann, 1936), Ouled Yahia consisted of various 'tribes' that built political influence in the Drâa region between the 16th and 19th centuries. Originally nomadic groups from the Anti-Atlas region settled in the Tinzouline Oasis on the right side of the Drâa River through protective military alliances with the sedentary farmers living in the oasis. After the death of Sa'adian sultan al-Mansour in the 16th century, Ouled Yahia groups were involved in conflicts with other nomadic groups from Ait Atta (Jacques-Meunie, 1972; Ouhajou, 1996).

Spillmann (1936) reported that during the 1930s, he found a situation of general conflict over control of territory between tribes in the MDV. Some of our interviewees mentioned that during the French protectorate, some tribes received collective land as compensation for services rendered, both in the military and in infrastructure construction or protection. According to these testimonies, this was the case with sections of land in Faija. Testimonies regarding which group this land was assigned to are contradictory, and we did not have access to governmental documents from this period that could clarify the allocation of land in Faija.

Interviewees from both tribes report that until the late 1960s, the Mssoufians were semi-nomadic pastoralists using Faija as grazing land and maintaining a settlement in the neighbourhood of Amazrou, in the northeast part of Fezouata Oasis. However, Kaabians and Khchaaians argue that the Mssoufians were not owners of land in Faija and that to cross through Faija, the Mssoufians needed a permit signed by the Cheikh of Kaaba and Khchaa.

> "… they [Mssoufians] did not have anything, the only land they had was the one in Amzrou, and they were known to travel a lot" … "In the past, they could not approach that land [Faija]. When

they [Mssoufians] wanted to cross the land, they would take a permit from the Cheikh to cross. And when you find them in your land and ask them why they came they show you the Cheikh's permit that allowed them to cross" (kh.03- Tinzouline, 01.10.2022).

The argument of Khchaaians and Kaabians is based on a customary rule that tribes can only own land on the same side of the river where they settled (Hammoudi, 1982). In other words, the Drâa River served as a border between the territories of tribal groups. Kaabians settled on the west side of the Drâa River (Pletsch, 1977), while the settlement of the Mssoufians (Amazrou) was located on the east side, in the Fezouata Oasis. Faija is located on the west side of the river. Consequently, Kaabians argue that, according to this rule, it would be impossible for Mssoufians to have owned any land in Faija.

By the early 1970s, a small group of Mssoufians (testimonies refer to originally five people) began subsistence farming and settled in the plain, progressively expanding their cultivated area. Our interviews reveal that this expansion provoked the first violent clash in 1995 when Kaabians and authorities attempted to expel Mssoufian farmers from what they considered Kaabian territory. Mssoufians gathered to protect their farms and attacked with slingshots, injuring the Kaabian Wakil-Aradi. Members of the national gendarmerie force had to intervene to help him escape.

Testimonies from both tribes reveal that tensions between the Mssoufa and Kaaba, which led to the violent clash of 1995, had already begun to escalate in the 1980s. Kaaba representatives made a formal complaint to the head of Caïdat of Tinzouline regarding the Mssoufians allegedly invading their land in Faija. In 1981, the Ministry of the Interior produced a map of all collective lands in Faija, resulting in administrative delimitation (AD) 378 belonging to the Mssoufa with 12,061 ha and AD 379 to the Kaaba with 86,579 ha (Royaume du Maroc - Secrétariat Général du Gouvernement, 2019: p. 11832–11833). This map shows an overlapping area of 5,217 ha between AD 379 and AD 378. To support their claim of ownership over the land, Mssoufians argue that they were the only group living in Faija at the time of establishing AD 378 and AD 379. Additionally, they contend that not all representatives of the Mssoufa were informed of the process. Therefore, they reject the legitimacy of AD 378 and AD 379 and claim that all of Faija belongs to them.

The publication of decrees n°2.19.1008 and n°2.19.1009 in 2019, which officially defined the borders of AD 379 and AD 378 set in 1981, triggered a resurgence of the conflict between the Mssoufa and Kaaba. With a legal basis for their argument, the Kaabians demanded the expulsion of the Mssoufians from AD 379. Members of the tribe participated in protests on the 3rd, 4th, and 10th of December 2020, and on the 16th of March 2021. One protest took place in Faija and the others in front of the Zagora Province headquarters and the Ternata Caïdat. A negotiation attempt mediated by the governor was unsuccessful, and on the 2nd of January 2021, a group of Kaabians was attacked with stones when visiting Faija to detect further expansion of Mssoufians in AD 379. Currently, everyday relations between the Mssoufa and Kaaba have deteriorated. "We can buy their products [watermelons from Mssoufians] so they also do the same [dates from Kaabians], but I noticed in their eyes they hate us. Especially lately, the tensions increased. They would take revenge on us" (Ka.02, 05.10.22). No mediation process is currently underway. The case is being heard in court, and a judge will decide to which tribe the disputed territory belongs.

4.5.2. Conflict actors

In this section, we describe the role of the key actors who control access to the resources that are needed to derive benefits from land and water in Faija. We have grouped these actors into five categories

based on their affiliations: actors within the Mssoufa tribe; actors within the Kaaba tribe; government actors; actors with dual affiliations (Mssoufa and government); and other relevant actors (Table 4.1). This categorisation helps to understand how these actors have influenced the development of the conflict and provides a basis for analysing the capabilities of the tribes to engage in conflict.

Our interviewees reported that Mssoufa has about 4,000 members, not all of whom live in Faija. The tribe is organised into four Ighssan (Amazigh for bones). These Ighssan are lineages, each of which is further divided into four sub-fractions consisting of extended families. Each lineage elects a representative known as Moaine. Kaabians interviewees estimated their numbers at 9,000 people and explained that they are organised into seven douars (villages), with each douar also electing a representative. Mssoufians have a Wakil-Aradi to manage Faija's collective lands, while Kaabians have seven Wakil-Aradi (one per douar) but none of them operates in Faija. According to access theory, the Wakil-Aradi and the Moaineenin are central actors controlling access to collective lands within the tribes[6].

Table 4.1. Conflict actors and their role in the conflict

Actor	Role in the conflict
Actors in Mssoufa	
Wakil-Aradi in Mssoufa	● Certifies land-use rights for tribe members.
	● He has been accused of granting land-use authorisations to Mssoufa members on disputed land with Kaaba.
Moaineenin of Mssoufa	● Represent the lineages within the tribe and elect the *Wakil-Aradi*.
	● They channel land-use-right claims from lineage members to the *Wakil-Aradi*.
	● Solve disputes and avoid multiple land claims.
Actors in Kaaba	
Wakil-Aradi in Kaaba	● They collect information about Mssoufa presence on their collective land.
	● They file formal complaints with local authorities.
Moajih in Kaaba	● Official spokespersons for the tribe.
	● Represented the tribe in the negotiation meetings with Mssoufa.
Actors in the Government	
Minister of Interior Affairs (MoIA)	● The MoIA has the legal tutelage of collective lands.
	● It preserves the peace and order in the territory.
Caïd	● Head of the Caïdat, an organisation that belongs to the MoIA.
	● Responsible for keeping peace and order in one or several Territorial Communes.
	● Certifies land-use rights on collective lands on behalf of the MoIA.
Governor of Zagora	● He oversees and manages the territory. The Division of Rural Affairs operates under his authority.
	● In 2020 he mediated a negotiation process between the tribes.

[6] Ms.06 - Zagora City, 02.11.21; Ms.02 - Zagora City, 08.11.2021; Ms.01 - Faija, 12.11.21; Ms.10 - Faija, 13.06.22; Ms.09 - Zagora City, 15.06.22; Ka.09 - Tinzouline, 01.10.22; Ka.02-Tinzouline, 05.10.22

Table 4.1. Conflict actors and their role in the conflict (continuation)

Actor	Role in the conflict
Actors with double affiliation: Government and Mssoufa	
Cheikh in Mssoufa (MoIA)	● Prominent member of the tribe.
	● Appointed by the MoIA as the aide of the Caïd within his tribe.
	● Reports on new farms, interactions between tribes, and any security-related events in Faija.
	● Assist the Caïd in the certification of land-use-rights
	● Verifies information provided by the *Wakil-Aradi* on land-use rights.
Moqadem in Mssoufa (MoIA)	● Aide of the Cheikh.
	● He provides information on land-use rights and security issues
	● He contributes to keeping peace in the area.
Other actors	
"Politicians" in Ternata Commune	● Democratically elected to the Ternata Community Council.
	● They allegedly exerted political influence to protect Mssoufians in Faija.
Drip-irrigation suppliers	● Local actors selling and installing drip irrigation infrastructure.
	● They provide topographical maps and civil engineering plans required to apply for subsidies.
Watermelon investors	● Non-members of the tribe that establish co-investment agreements with Mssoufians.
	● Provide capital, expertise, and market networks.
Tube-well drillers	● They provide drilling services and, allegedly, pay bribes to allow farmers to dig wells without a licence.

4.5.3. Motivation and capabilities of the conflict actors

In this section, we use the concept of access (Peluso & Ribot, 2020) to analyse the motivations and capabilities of the conflict actors. In this way, we provide some elements to understand the emergence and prevalence of the conflict. Our premise is that actors are more motivated to engage in conflict when they expect that the benefits derived from these relations will outweigh the benefits from cooperation and resource sharing (Scheffran et al., 2012; Schilling et al., 2014). While members of Mssoufa are interested in maintaining the access to the land and groundwater they have already gained in Faija, Kaabians are interested in gaining access to these resources. As a result, Kaabians are more motivated than Mssoufians to engage in resource sharing and cooperation.

In terms of mediating access to land, the MoIA through the Direction of Rural Affairs, the Caid, the Cheikh, the Moqadems and the Wakil-Aradi in Mssoufa hold strategic positions. The Direction of Rural Affairs and the Caidat produced a map with the current borders between Mssoufa and Kaaba, leading to the legalisation of Mssoufa's presence in Faija in 2019. By issuing land-use-right certificates, successive

Caids, the Cheikh, the Moqadems and the Wakil-Aradi in Mssoufa also provide a legal basis for Mssoufian occupation of land in Faija.

Land-use-right certificates do not automatically result in benefits from the land. For benefits to be realised, Mssoufians need access to irrigation infrastructure and markets, which in turn requires access to capital, expertise, and networks. Access to these resources are often obtained through collaborations with investors, and since 2008 capital has also been accessed as government subsidies. These subsidies are mediated by governmental actors in the Agricultural Development Office (ORMVAO). Representatives of the River Basin Agency, in turn, mediate access to groundwater through licensing and monitoring wells. Well-drillers facilitate access to groundwater by constructing the infrastructure and allegedly, by paying bribes to government authorities to allow farmers to extract groundwater without licences. Suppliers of drip irrigation systems assist farmers in obtaining the necessary documents from customary and statutory authorities to apply for subsidies. Interviewees reported that these suppliers offer money to authorities to expedite procedures and secure subsidies.

The data collected suggests that these actors may have vested interests in maintaining the current power relations mediating access to these resources. Table 4.3 presents these motivations and Figure 4.3, at the end of the section, illustrates the relations between conflict actors and their capabilities.

Table 4.2. Motivation of conflict actors

Actor	Motivations
Actors in Mssoufa	
Mssoufian Wakil-Aradi	● Allocate prime agricultural areas to family and political supporters. ● Accepts bribes to expedite land use rights certificates.
Moaineenin of Mssoufa	● Accept bribes and favours to endorse land-use rights applications.
Actors in Kaaba	
Wakil-Aradi in Kaaba	● Prevent the further expansion of Mssoufa in Kaaba's territory, ● Gain access to land and benefit from watermelon production.
Moajih in Kaaba	● Gain the support of government authorities to enforce Kaaba's right to land in Faija.

Table 4.3. Motivation of conflict actors (continuation)

Actor	Motivations
Actors in the Government	
Minister of Interior Affairs (MoIA)	● Dissuade Kaabians from visiting Faija to prevent further clashes. ● Expel new Mssoufian farms in disputed areas.
Caïds	● Allegedly, until 2019, Caïds used to accept bribes in exchange for certifying land-use rights.
Actors with dual affiliation: Government and Mssoufa	
Cheikh in Mssoufa (MoIA)	● He produces watermelon in a disputed area. ● Interested in consolidating land-use rights in this area.
Other actors	
"Politicians" in Ternata Commune	● Use the conflict as a political platform and gain votes.
Drip-irrigation suppliers	● Increase the number of farmers receiving subsidies in Faija.
Watermelon investors	● Access large tracts of land for watermelon production. ● Establish rental and co-investment agreements with Mssoufians.
Tube-well drillers	● Expansion of watermelon production in Faija to increase incomes.

Mssoufa and Kaaba have different capabilities to participate in the conflict. Mssoufians are in a stronger position as they have three advantages over Kaaba to maintain access to groundwater and land in Faija: (1) physical control of the space, (2) access to capital, and (3) political influence. On the other hand, Kaabians can only resort to legal actions and protests to try to stop further expansion of Mssoufians into territory that Kaabians claim as their own.

5.4.3.1 Physical control of the space in Faija

From the early 1970s until 2019, when the government formalised the border with Kaaba, Mssoufians gradually expanded the occupied area, building houses, mosques, and schools. This occupation required mediation by other actors. According to a witness (Ka.01 - Ouled Ayoub, 05.10.2022), the first Mssoufians to settle in Faija (initially only five) convinced the Caïd to mediate an agreement with the Kaabians. The Kaabians agreed to let them stay on the condition that a border be set to prevent further "invasions." During the 1980s, the Mssoufians continued to establish new farms in Kaaba territory with the complicity of a former Kaaba Wakil-Aradi. He informed the Kaabians that he was taking legal action to expel the Mssoufians from Faija, but instead, he allowed them to remain in exchange for bribes.

Triangulating information from different interviews reveals that the Caïd, Cheikh, and Moqadems cooperated with Wakil-Aradis of Mssoufa to grant land use certificates in disputed areas of Faija. This was possible due to a legal vacuum: before 2019, there were no official boundaries between Kaaba and Mssoufa. Once settled in the area, Mssoufians started to exert control over Faija, allegedly sabotaging Kaaba's rain-fed farms at night and repelling Kaabians by force if found in Faija.

Kaabians have their settlements in the Commune of Tinzouline, more than 30 km away from Faija, behind the Boujniba mountains (Fig. 1), which made it impossible for them to prevent the occupation of Faija by Mssoufians. When asked why he had not ploughed recently in Faija, a farmer stated:

> "Now we have been prevented from ploughing there, it has rained, but the Mssoufa tribe on the one hand and the authorities on the other, when you want to go there the authority prevents you by saying "You will create chaos and problems there", so they [Mssoufians] work there at their ease but when you want to go you are prevented" (Ka.01 - 05.10.2022, Tinzouline)

> "When one of our tribes show up in the land for any reason, they [Mssoufians] start attacking Kaaba with rocks and violence. This was since years" (Ka.08-Tinzouline, 01.10.22)[7].

4.5.3.2 Capital

Watermelon production in Faija requires investment in irrigation infrastructure. This includes wells, pumps powered by gasoline and solar energy, water storage ponds, drip irrigation pipes, rooms to protect the pumps, and solar panels. According to interviewees, most tribe members lack the capital to afford this investment. Consequently, some Mssoufians establish co-investment arrangements with non-tribe members[8]. The investors provide not only capital but also know-how and networks. We interviewed one of these investors, who provided approximate amounts of the money he invested in the farm we visited.

> Interviewer: how many wells do you have here? Respondent: there is that one there, and the other one there, and the last one lets go to see it [3 wells in total] (...) Interviewer: how much you paid for the solda (tubewell)? Respondent: it depends, sometimes 250 or 300 till 500 dh per metre (...) this well now is 102 metres deep (...) Interviewer: what about the solar system, how much does it cost? Respondent: I bought the transfer with 20,000 dh and there is other stuff. In total, I paid 140,000 dh (watermelon investor, Faija 23.10.2021)[9].

It is difficult to determine how many Mssoufians are involved in these co-investment arrangements because, since 2020, young Mssoufians have initiated a ban on this practice within the tribe (Bossenbroek et al., 2023). Consequently, interviewees did not provide details on this topic and emphasised that those involved in co-investment arrangements do so secretly.

> "Because mainly they are land right holders with access to land, but they don't have enough money to invest. If I am an investor, I give him [the right holder] a rent. The two of us work in hiding, so when I leave, I take my money [from the harvest] hidden, and the landholder invests next time with his capital" (Ms.03, Faija, 30.10.2021).

Other Mssoufians used their own capital from the beginning. In both cases, the accumulated capital gave them economic power. Allegedly, Mssoufians used part of the profits until 2019 to pay bribes to various authorities and local public administration agents in exchange for land use rights certificates within

[7] During fieldwork, some of the interviewees in Kaaba show a video of one Kaabian *Wakil-Aradi* being attacked with rocks in Faija. Interviewees explained this attack took place on January 2nd 2021, when some *Wakil-Aradi* were visiting Faija to monitor the presence of Mssoufians in their collective land. They identified the attackers as Mssoufians. The video was allegedly recorded by Mssoufians, then leaked to social media.

[8] Interviewees used the term *barani* to refer to investors that are non-members of the patrilineal group and, consequently, have no rights over land in Faija. Sometimes the term was translated as "intruders" or "non-locals", and interviewees explained these investors usually come from other provinces and regions in Morocco.

[9] At the time of the interview, the conversion rate from Moroccan Dirhams (DH) to Euros was 10 DH per Euro.

Kaabian territory (AD379) and to dig unlicensed wells. Capital is also used to expand the area cultivated with watermelons in Faija.

4.5.3.3 Political influence

Political influence is allegedly exerted through Mssoufa tribe members occupying various government positions and through politicians in Ternata Commune. Supposedly these politicians promise to protect the farms of the Mssoufians in Faija who vote for them. Interviewees highlight two ways this influence materialises. First, when authorities execute the destruction of illegal wells and evict illegal farmers in AD379, they supposedly never expel all the illegal Mssoufian farms. This allows Mssoufians to keep expanding the area under their control. Secondly, after the expulsion of Mssoufian farms from Kaaba territory, Mssoufians continue returning to the same area to open new farms. Kaabians believe that authorities could use the law to expel all these illegal farms once and for all, but due to Mssoufians' political influence, they do not.

> "The land in reality is already used by Mssoufa, they do exist in the area. Even if they are expelled, they come back. Even if the wells cost a lot of money to dig, they just dig more even when the authorities expel them by collapsing the wells. They just reinvest because they will always make more [profits]" (Ka.03, Zagora, 06.10.22).

Kaabians have been unable to gain access to this land because their farms are sabotaged and they are violently attacked by Mssoufians. The identified capabilities of Kaaba to engage in the conflict, as discussed below, are legal measures and protests.

4.5.3.4 Legal measures

According to the current regulatory framework (Dahir 1919; Decree No. 1.19.115), collective land cannot be acquired by occupation or prescription and cannot be subject to seizure. Members of tribes are entitled to usufruct the collective land of their tribe. Despite a partial overlap of AD379 and AD378, the government established clear borders on the map for AD379. According to this legislation, even though Mssoufians have occupied this land for several decades, it still belongs to Kaaba.

Three Wakil-Aradi, the Moajih, and five other members of Kaaba explained that the Wakil-Aradi in the tribe use this regulatory framework to periodically file complaints against illegal farms opened in AD379. This leads to the intervention of local authorities, who verify the presence of unauthorised farmers and proceed to destroy illegal wells, trees, and farms. While we could not establish the frequency of these complaints, interviewees stated that offenders are ordered to abandon the land. However, Kaabians report that when a Mssoufian farmer is evicted from AD379, it is common for someone in his family to return after some time to reopen a farm. The previous quotation in 4.3.3. illustrates this complaint.

4.5.3.5 Protests

So far, Kaabians have organised four protests between December 2020 and March 2021: one was a march to Faija, which triggered a violent clash with Mssoufians, and three were demonstrations in front of the Province headquarters and Ternata Caidat. These protests aimed to raise public awareness of the collective land conflict in Faija and to pressure local authorities to implement measures favouring Kaaba's interests. The measures implemented by authorities have aimed to stop the expansion of the Mssoufians into AD379, but according to Kaabians, these measures have had limited success.

“After the first march, the people who caused strife and problems started saying, "Let's do another march," and they initiated another one (...) By six in the evening, the authorities came and, may God reward them, said to us, "Go to your homes until tomorrow and come back again because we are in the Covid period and gatherings are prohibited”. (...) Eventually, the authorities used violence and sticks to disperse them. Since then, the situation has remained the same. That land has gone to waste, and that's it” (Ka.01, Ouled Ayoub, 05.10.2022).

“These are Kaabians who had to migrate to other cities to find jobs, and it is frustrating for them to see others making money with their land. Consequently, they decided to march to Feija in protest. In this context, the Governor of Zagora intervened and promised to expel the invaders in June, after the watermelon season was over. (...) not everyone was convinced by the promise. Sometime later, young people decided to protest again (...) Nothing has been done since then” (Ka.04, Tinzouline, 07.10.2022).

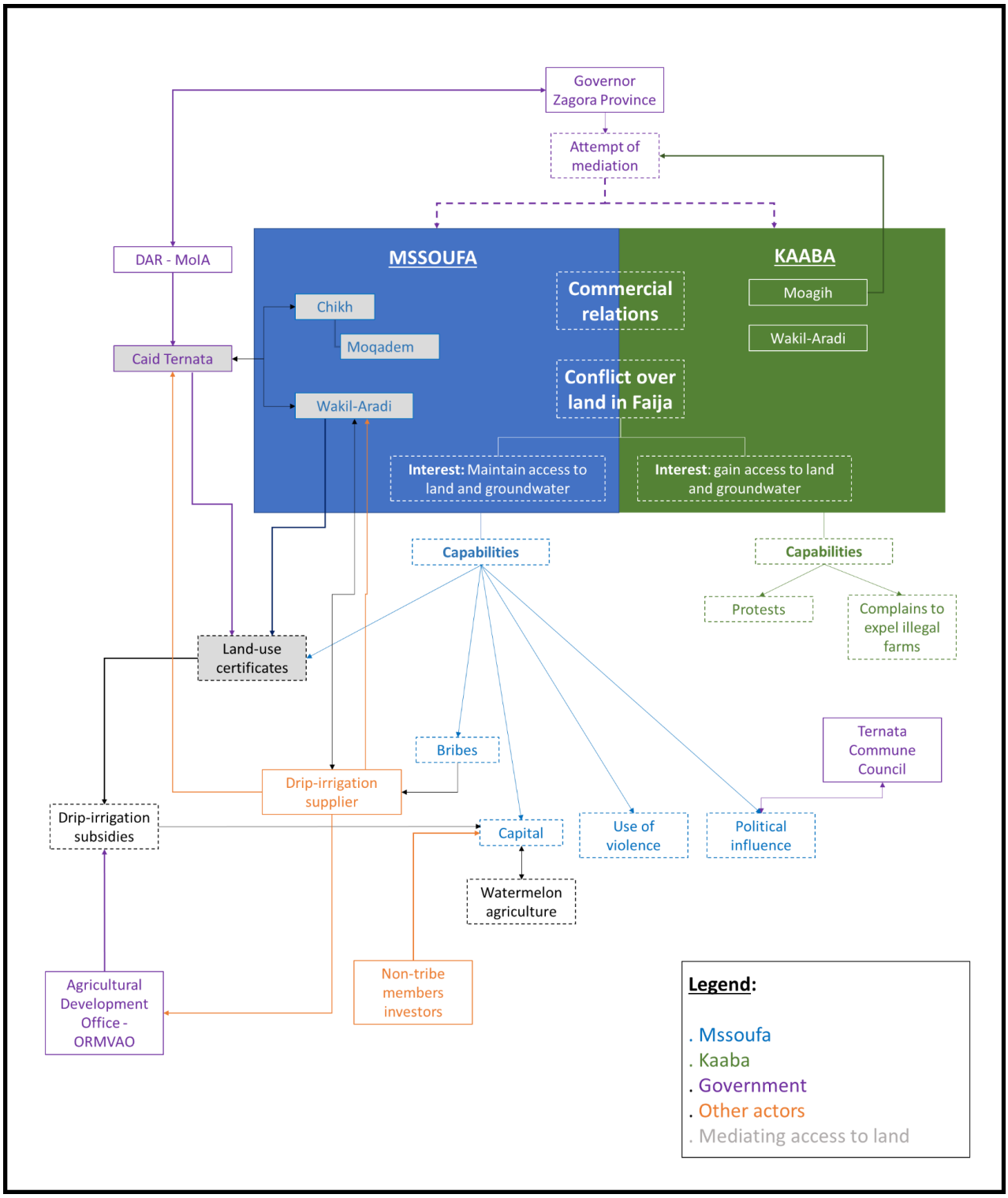

Figure 4.3. Relationships between conflict actors and their capabilities. This is a graphical summary of the relationship between actors, their role in the conflict and their capabilities

4.5.4. Conflict drivers

We identify different historical processes that have led to unequal access to land and groundwater between Mssoufa and Kaaba in Faija. Some factors are beyond the control of any particular actor, including the government, such as the increased frequency and severity of droughts due to climate change, population growth, and the influence of international and national markets creating a demand for watermelon. Other factors are directly produced by government actions, such as changes in national rules governing collective lands and the implementation of a policy of drip irrigation subsidies. These processes, in turn, triggered additional dynamics in the local area. Figure 4.4 summarises the drivers and effects of the conflict.

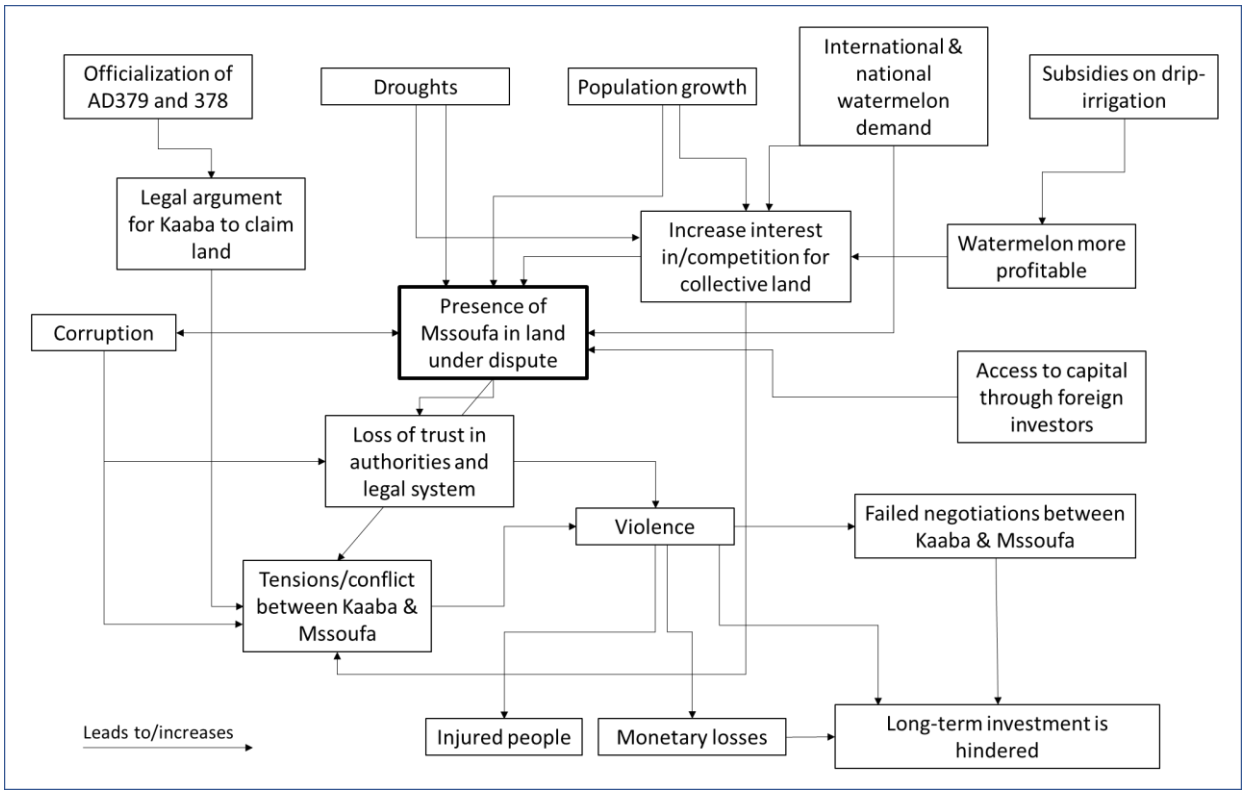

Figure 4.4. Drivers and effects of the conflict

4.5.4.1 A change of rules governing collective lands

In 1981, when the Moroccan government first traced the borders between Mssoufa and Kaaba in Faija, the customary rule that patrilineal groups could only own land on the same side of the river as their settlements (section 3.1) was not considered. According to this rule, Mssoufians settled in Amzrou, on the east side of the Drâa River, could not be rightful holders of land in Faija, located on the west side of the river. For this reason, Kaabians question the legitimacy of these borders, arguing that the Mssoufian occupation of Faija was illegal from the start and that Mssoufians should not have been considered rightful holders by the government in 1981. Given the undocumented nature of customary land borders before the 1980s, it is difficult for Kaabians to prove that Mssoufians were not originally present in Faija.

> "Those Mssoufa came from a place called Zaouit Ahenssal in the Atlas Mountains in the first place and they are not nomads from the Sahara like we used to be, Khcha and Kaaba" (…) "They settled in Amzrou as protectors of the original people of Amzrou. This is how they got some land there. In the 70s they started digging some wells in the Faija. Was in this period when the first fights started, because they [Mssoufians] occupied it even though the lands did not belong to them" (Kh.06 – Zagora city, 11.11.21).

The borders of AD378 (Mssoufa) and AD379 (Kaaba) were established by the government in 1981 based on testimony from representatives of each tribe (Wakil-Aradi, Moaineenin, Moqadem). These representatives relied on toponymic and oral traditions rather than geographical coordinates. Consequently, the areas reported by each tribe show overlapping sections. However, Mssoufians claim that the consultation process to settle the borders was not publicly known among Mssoufians, and they were unable to object to the borders in time. They assert that all the land they occupy rightfully belongs to Mssoufa and that Kaaba has no land in Faija.

> "This division was waiting to be certified by the Minister on Interior Affaires from 1981 until 2018" … "So, the authorities did it in a rush after no kabila opposed to this division in the middle of the process, since no one knew what was done and no authority has explained to the kabila what was done so they can't oppose in the right time" (Ms. 06 – Faija, 24.10.2021).

Although the Mssoufians do not accept the borders set by the government, these borders benefited the group by legitimising its presence in Faija. The official recognition of these borders through the promulgation of decrees n°2.19.1008 and n°2.19.1009 reactivated the conflict and led to the protests organised by Kaabians during 2020 and 2021.

4.5.4.2 Droughts, population growth and new farming opportunities

Our analysis indicates that the early 1980s marked the period when interest and competition for land in Faija between Kaaba and Mssoufa began to intensify. Interviewees linked this to a series of droughts and population growth, which resulted in a shortage of surface water and fertile land within the oases. In this context, people turned to collective lands outside the oases as a reservoir of groundwater and land, offering an opportunity to continue farming.

Historically, Kaabians' activities in Faija were limited to seasonal rain-fed agriculture. They never needed to establish permanent farms in Faija because, within the Oasis of Tinzouline, they traditionally had sufficient water and fertile land to sustain their families. However, conditions of self-sufficiency changed during the 1980s. Population growth and worsening scarcity of surface water in the oases compelled young Kaabians to migrate to cities in search of employment to support their families. Gradually, Kaabians' interest in Faija grew as they recognised it as an area with fertile land and access to good-quality groundwater. Yet, Kaabians report that since the early 1990s, Mssoufians have not allowed them to farm in Faija anymore. The following testimony from an elder member of Kaaba illustrates the impact of droughts on the livelihoods of farmers in the oasis:

> "Because of the droughts, it became hard to stay in the area. All families rely on remittances from their children working in the cities! [Surface] water stopped, the groundwater is expensive to reach, it will cost too much. Besides the solar panels needed to pump water, this cost too much! Small farmers can't afford it" (Ka.03 - Oulad Ayoub, Tinzouline, 06.10.2022).

As detailed in section 4.1, Mssoufians began settling in Faija by the late 1960s or early 1970s. These pioneers were former pastoralists who transitioned to agriculture due to the scarcity of grass for their animals. They also supplemented their incomes by working on the land of other tribes in the oasis. In the 1980s, the Mssoufian population in Faija increased due to droughts and related surface water shortages. The Faija aquifer provided a source for irrigation when the drought posed challenges for tribe members reliant on agriculture-based incomes.

In the early 2000s, the expansion of global markets created international demand for watermelons. The plain of Faija offers perfect conditions for early-season watermelon production, giving Moroccan producers the advantage of supplying European markets before competitors. Investors from various regions of Morocco recognised a significant business opportunity, leading to a watermelon boom in Faija around 2007 (Chelleri, et al., 2014; Bossenbroek et al., 2023). These investors established themselves in the region by renting land or entering into co-investment agreements with Mssoufians. Mssoufians provided land and labour, while investors brought capital, access to markets, and business expertise. Observing the potentially lucrative nature of watermelon farming, which allows for financial returns within short periods of three to five months, more and more Mssoufians became interested in this agricultural activity. Consequently, the cultivated area with watermelons began to expand rapidly.

For Mssoufians, Faija represents a pathway to social mobility, enabling them to transition from semi-nomadic pastoralists to farm owners equipped with modern drip irrigation technology (Bossenbroek et al., 2023). Watermelon production has allowed them to accumulate capital, increase social status, educate their children for better job opportunities, and establish connections with local politicians. On the other hand, interviewees from Kaaba expressed a sense of injustice seeing the development and prosperity in Faija, while they are compelled to migrate to other towns in search of work. This sentiment is particularly strong among young people seeking opportunities. They hope that by establishing irrigated farms in Faija, they can earn significantly more than their current income as unskilled labourers in urban areas. Moreover, this opportunity would enable them to return to their ancestral land, where they can live with their families once again.

4.5.4.3 Convergence between national and local interests around a drip-irrigation policy

Historically, policies promoting agricultural development have played a crucial role for the monarchy in Morocco in securing the political support of rural elites (Swearingen, 1987; Bouderbala, 2000; Houdret et al., 2017; Balgley & Rignall, 2021; Houdret & Amichi, 2022). Additionally, groundwater-based irrigated agriculture has contributed to creating a chain of additional jobs across the country (Kuper et al., 2017). These factors, at least in part, explain why promoting irrigated agriculture plays a strategic role in the government's plans for rural development and socio-political stability. This has been reflected in the policy of subsidies for drip irrigation infrastructure implemented through the Plan Maroc Vert (Faysse, 2015).

Despite the Plan Maroc Vert started in 2008, according to our interviews farmers in the MDV began to gain access to these subsidies around 2010. The interviews also reveal that the availability of subsidies for drip irrigation not only benefited several farmers but also other local actors in the private and public sectors, which may have indirectly stimulated the expansion of the area occupied by Mssoufians in Faija (section 4.3). Despite several farmers reporting using their own resources to fund drip-irrigation infrastructure, a study commissioned for the elaboration of the Faija Aquifer Contract by the Drâa-Oued Noun River Basin Agency found a significant increase in irrigated surface area in Faija since 2010, suggesting a correlation between access to subsidies and the rapid expansion of cultivated areas in Faija

during this period (Royaume du Maroc - Agence du Bassin Hydraulique Draa Oued Noun, 2020: p. 70; Lamqadem et al., 2019).

One of the private actors indirectly benefiting from the subsidies were small companies providing the service of selling and installing drip irrigation infrastructure. Dependent on their clients gaining access to subsidies, these suppliers began assisting farmers in preparing all the necessary documents for the application process. To expedite the process, suppliers allegedly paid money to governmental officials and the Wakil-Aradi of Mssoufa. Interviewees also reported that government officials responsible for overseeing the construction of illegal wells received payments from farmers through individuals providing tube-well drilling services (similar to findings in Houdret & Heinz, 2022).

> "Yes, they [drip-irrigation suppliers] do anything as facilitation. They [authorities] make it easy for the supplier because the Wakil-Aradi can ask for money from the supplier, but he would feel ashamed to ask the farmer. The supplier pays a lot of money as corruption to make the procedures easy. And he pays all that from the amount of the subsidies" (Ms.05 – Faija, 03.12.2021).

In this section, we have presented several historical processes that have shaped the current unequal access to land, groundwater, and productive resources between the Mssoufa and Kaaba, setting the stage for the escalation of conflict in recent years. In 1981, the government established new territorial borders that delimited the land claimed by Kaaba and officially recognised the Mssoufian presence in Faija. Although both tribes question the legitimacy of these borders, this recognition allowed the Mssoufians to capitalise on agricultural subsidies and engage in profitable watermelon farming, solidifying their economic advantage. Droughts and land scarcity, exacerbated by population growth, strained resources within the oases, prompting both tribes to seek benefits from new farming opportunities driven by global market expansion and increasing demand for watermelons in Faija. This increased competition for land, with Kaabians marginalised and unable to compete due to initial access constraints and subsequent restrictions imposed by the Mssoufians. This disparity in land access and economic opportunity fostered a sense of injustice among Kaabians, leading to protests and ongoing tensions. Additionally, the policy of subsidised drip irrigation created economic incentives and vested interests among various actors who mediate access to land, groundwater, and other resources, benefiting from the expansion of watermelon cultivation in Faija. Their actions have indirectly reinforced the Mssoufian presence in Faija, intensifying the conflict between the two groups.

4.6. Discussion

This paper aims to investigate the drivers of conflict over customary land between tribes in the MDV and understand how this conflict reinforces and restructures power and authority relations to control access to this resource. In this section, we contextualise our findings within the broader historical processes by referring to other studies on customary land in Africa. We argue that preventing further escalation of intertribal land conflicts in the MDV requires attention to the factors influencing the motivations and capabilities of the conflict actors to engage in either cooperation and resource sharing or conflict. Additionally, we discuss the implications of our findings for promoting sustainable development in the study area. While we identify implications for SDGs 1, 10, 13, and 16, we focus our discussion particularly on SDG 16: Peace, Justice, and Strong Institutions.

Our research shows that intertribal land conflicts in the MDV restrict access to land for marginalised ethnic groups, thereby limiting their economic opportunities. In this sense, these conflicts pose a challenge

to attaining SDG 1 (No Poverty), especially for the implementation of target 1.4[10], and have implications for SDG 10 (Reduced Inequalities). Our results also explain that increasing surface water and arable land scarcity in the traditional oases compelled farmers to start working on collective lands, as these lands were perceived as reserves of land and groundwater. We argue that surface water scarcity is a significant driver of increased competition over customary land in the MDV, creating potential for conflict. This scarcity, partially caused by governance choices, is also linked to climate change processes. Therefore, our research highlights the importance of adaptive measures to climate change as a means to prevent and mitigate land conflicts in arid regions like the MDV, linking these conflicts to SDG 13 (Climate Action). Finally, our findings show how land conflicts are strongly linked to SDG 16 (Peace, Justice, and Strong Institutions). We will explore this link in what follows.

Our findings reveal persistent challenges in the MDV in achieving several targets of Sustainable Development Goal 16, particularly targets 16.1 (reduce all forms of violence), 16.3 (promote the rule of law), 16.5 (reduce corruption and bribery), 16.6 (develop accountable and transparent institutions), and 16.7 (ensure inclusive, participatory, and representative decision-making). McDermott et al. (2019) emphasise that the implementation of SDG 16 can vary significantly depending on whether the focus is on a strong, centralised nation-state enforcing state laws and regulations, or a more pluralistic governance approach where power is distributed among various scales and institutions, including states, market-based initiatives, and locally driven processes. They argue that the implementation of SDG 16 is also affected by the interpretation of governance concepts and the differing perceptions of the legitimacy and appropriateness of formal versus informal governance, and state-based versus market-based and customary institutions (McDermott et al., 2019). Our findings shed light on the complex interplay between land conflicts and these two issues, the distribution of power and authority in society, and the perception of the legitimacy of customary and statutory land governance institutions. Additionally, we provide insights into the structural limitations of the land institutional framework for resolving land conflicts.

Similar to previous studies (Peters, 2013; Bottazzi et al., 2016; Chinigò, 2016), we find that struggles over customary land in Faija are also struggles over the authority to allocate and regulate access to this resource. This is linked to the fact that the outcome of these conflicts— whose claims are recognised and whose are ignored or denied—plays a significant role in reinforcing and reshaping power dynamics and wealth distribution in the MDV (Berry, 2017). As a result, by contesting who has the right to control land, these conflicts influence not only the boundaries of ethnic territories but also perceptions of the legitimacy of statutory and customary laws at the local level.

Currently, the Mssoufa-Kaaba land dispute is under litigation. While awaiting the court's verdict, Kaabians complain that despite the formalisation of territorial boundaries in 2019, they are still being prevented from accessing parts of their land that do not overlap with Mssoufa's. This situation is viewed by Kaabians as a clear violation of the rule of law. This outcome underscores two significant implications for conflict resolution. First, it reinforces among Kaabians the perception that statutory legal processes lack transparency and are biased, thereby undermining their perceived legitimacy. This perception could potentially compromise the effectiveness of the court's forthcoming verdict in resolving the conflict.

[10] Target 1.4: By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance.

Second, the conflict evidences how the current institutional framework for land governance, and particularly land conflict resolution, is incomplete. Customary dispute resolution institutions often have several advantages over statutory ones, such as strong legitimacy linked to greater accessibility, in-depth knowledge of local tenure issues by traditional authorities, and more affordable and expeditious resolution of disputes (Kasaaga, 2021). This is also the case in Faija, however, customary institutions only have authority among the members of each tribe, and the rules can change from one tribe to another. Consequently, the intervention of statutory institutions is needed to address inter-tribal conflicts. Today, the legitimacy of statutory institutions to regulate access to customary land, however, is questioned by members of both tribes in conflict. This suggests that addressing intertribal conflicts in the MDV requires a structural peacebuilding approach, in which institution building and the strengthening of governance capacities contribute to preventing the conflicts from escalating into violence (Ramsbotham, O. et al., 2016).

The poor coordination between customary and statutory land governance institutions is a common challenge in various African countries (Asaaga, 2021). One issue under debate is how to effectively integrate customary dispute resolution mechanisms into the formal statutory framework across different socio-spatial contexts (Asaaga, 2021). Concepts such as co-governance, co-management, and polycentricity have been proposed as potential solutions to integrate customary self-governance with statutory institutions into a unified resource governance system (Amaruzaman et al., 2022; Kooiman et al., 2008; Molle & Closas, 2020; Ostrom & Cox, 2010; Pahl-Wostl, 2019). It is important to note, however, that research suggests polycentric approaches may succeed under certain conditions but may face challenges in other contexts (Baldwin et al., 2018). Further research is required to identify the potential benefits and challenges of implementing a polycentric land governance system in the MDV.

One particular aspect that our research has revealed is that the access, use, and sustainability of land and groundwater resources in Faija are inherently linked. Groundwater in Faija serves a dual purpose: irrigation for agriculture and drinking water production for urban areas in the Zagora province. Therefore, the inclusion of drinking water users in the analysis adds complexity but is essential to address and anticipate the possible feedback between inter-tribal land conflicts and conflicts between irrigators and drinking water users in the province. Further research is necessary to identify the benefits and challenges of developing a resource governance system that effectively manages the interconnectedness between land and water in the region. Such a system could play a key role in promoting sustainable practices and mitigating conflicts that arise from competing demands on land and groundwater.

Our findings also highlight that the current outcome of the land conflict in Faija has led to a specific distribution of power and wealth among the involved actors. Their vested interests in maintaining their power and benefits create barriers to addressing the unequal access to land between Kaaba and Mssoufa, which we argue is the root cause of the conflict. For example, we illustrate how land conflict serves as the arena for asserting and competing for authority at the local level, heightening the significance of localised identities (Peters, 2013). In Faija, politicians from Zagora Commune purportedly support Mssoufians in exchange for votes and political backing. However, these alliances have also fostered divisions within Mssoufa, as competing politicians align with different factions. Consequently, the Wakil-Aradi of Mssoufa does not enjoy unanimous support within his group, making his position precarious and subject to potential replacement. The Wakil-Aradi consolidates his political influence and authority through the issuance of land-use certificates, even in disputed areas. As noted by Peluso and Ribot (2020), "controlling

access to a resource through physical enforcement can confer legitimacy, and, when acknowledged, reinforces their ability to control (allocate, enforce, and adjudicate) access" (p. 301).

Another significant finding from our research is that the Mssoufa-Kaaba conflict stems from historical processes that have reshaped the power dynamics between tribes, thereby influencing the unequal access to land and water in the MDV. Understanding these historical roots is crucial for comprehending the underlying causes of the conflict and can guide more effective strategies for its resolution. We argue that conflict resolution strategies should focus on influencing the motivations and capabilities of the parties to engage in cooperation rather than conflict (Schilling, 2012). According to this reasoning, the negotiation process that the Zagora governor attempted to mediate in 2020 did not fail due to the inadequacy of the conflict resolution model per se. This model can be described as a third-party intervention to promote negotiation process as part of a "conflict settlement" approach or "elite peacemaking" (Ramsbotham, O. et al., 2016). Rather, it failed because the implemented third-party intervention model did not seek to change the motivations and capacities of the parties in a way that would lead them to prefer cooperation and resource sharing to conflict. In other words, to change the expected gain and expected loss from conflict as a course of action. Understanding and addressing these motivational and capability factors are crucial steps towards fostering sustainable conflict resolution and promoting equitable resource sharing in the MDV.

The social mobilisation of the Mssoufians—from former semi-nomadic pastoralists to modern agricultural entrepreneurs— is key for understanding the motivations and capabilities of the tribe to opt for conflict over cooperation. The social mobilisation of the group is closely intertwined with significant historical processes occurring not only in Morocco but also in other former British and French colonies in Africa. These processes triggered social changes that reconfigured local hierarchies, reshaped local governance structures, and promoted social mobility for some actors (Balgley, 2017; Balgley & Rignall, 2021; Berry, 2017; Bottazzi et al., 2016; Chinigò, 2016). We focus on changes in the rules governing customary land ownership, the effects of a "migration economy", and the expansion of globalised markets that facilitated the watermelon boom in Faija during the 2000s.

In the MDV, farmers faced increasing severity and frequency of droughts, population growth, and scarcity of agricultural land. In this context, access to land in Faija became crucial for the livelihoods of the Mssoufians. Our findings show that, similar to other ethnic groups in Africa, access to this land was first made possible by changes in the rules governing customary land ownership and use during the colonial and post-independence periods (Balgley, 2017; Balgley & Rignall, 2021; Berry, 2017; Bottazzi et al., 2016; Bouderbala, 2000; Kansanga et al., 2019; Karsenty, 1995; Mahdi, 2014; Peters, 2013; Rignall, 2015; Rignall & Kusunose, 2018). The Mssoufians utilised the manoeuvring space that the plurilegal post-independence contexts opened, consolidating their control over collective land in Faija and claiming land rights that, according to customary laws, they did not possess but which the government recognised in 1981 (Agheyisi, 2019; Kansanga et al., 2019).

Another crucial factor for the Mssoufians to settle in Faija was the remittance money sent periodically by their relatives from other cities in the country and Europe. This financial support allowed them to invest in wells, facilitating their transition from pastoral to agricultural activities. The literature shows that this was a common trend in Morocco during the economic crises, droughts, and land scarcity of the 1970s and 1980s, which led people in different regions to engage in domestic and international migration strategies (de Haas, 2006; Aït Hamza et al., 2010; Rademacher-Schulz, 2014; Rignall, 2015; Rignall & Kusunose, 2018). According to this literature and our interviews, migrants often invested their earnings in purchasing land

and water rights in their hometowns, contributing to the modification of old social hierarchies and power relations. In the Atlas and Anti-Atlas regions, this "migration economy" dismantled sharecropping as an institution of domination (Rignall, 2015). Revisiting our data in light of this literature suggests something similar happened with the Mssoufians in Faija. While they were not sharecroppers like the Draoua people (Rademacher-Schulz, 2014), interviews suggest that their social status was lower and their resources were more limited than other tribes in the valley. This social status started to change for the Mssoufians during the 1980s and 1990s with their increasing capacity to engage in agriculture in Faija.

Finally, during the 2000s, their presence in Faija began to consolidate through contacts with investors from other regions who introduced watermelon cultivation to the area (Bossenbroek et al., 2023). The watermelon boom in Zagora province during this decade was facilitated by the expansion of globalised markets that created demand for the crop. In Faija, more and more Mssoufians started to accumulate capital through this activity. From 2010 onwards, several farmers began to access government-granted drip irrigation subsidies. As we showed in section 4.3, this has strengthened Mssoufian control over land in Faija by providing them with both capital and political influence.

The use of remittances to invest in agricultural infrastructure and the subsequent economic opportunities created by globalised markets have been instrumental in altering the socio-economic landscape in Faija. These investments have enabled Mssoufians to transition from labourers to landowners, consolidating their presence and influence in the province. This transformation underscores the significant impact of migration and economic policies on local power dynamics and resource access, contributing to the ongoing land conflict between Mssoufians and Kaabians.

4.7. Conclusions of the chapter

Our analysis of the conflict between Mssoufa and Kaaba shows that changes in land and water availability alone do not explain the emergence of this type of intertribal conflict in the MDV. Instead, the Mssoufa-Kaaba case illustrates how these conflicts are political struggles where some groups attempt to address unequal access to key productive resources. This unequal access results from historical, social changes that reconfigured the distribution of power and authority among local actors in the MDV. Therefore, the first conclusion is that these conflicts create opportunities for consolidating power and authority, not only between competing tribal groups but also among other local actors who mediate access to productive resources. These actors include the Moaineenin, the Wakil-Aradi, the Cheikh, Moqadems within tribes, and the Caid, Khalifa, and officials controlling unauthorised wells and approving agricultural subsidies in the local administration.

Secondly, given the competing views of the tribes about the "right" boundaries between their territories, the government's demarcation is unlikely to effectively mitigate these conflicts. Considering that the current situation in Faija has resulted in a specific distribution of power and wealth among various actors, we suggest that effective conflict resolution strategies should focus on changing the motivations and capacities of the parties in a way that encourages them to prefer cooperation and resource sharing over conflict. In other words, it is essential to alter the expected gains and losses from conflict as a course of action. To this end, one option could be to continue with the previously implemented third-party model of conflict resolution, where the third parties are representatives of the government. The advantage of this approach is that, in addition to fostering new patterns of communication and behaviour between the conflicting parties through good offices, mediation, and negotiation, government representatives can apply a degree of coercive power through positive and negative incentives (carrot and stick) aimed at

changing the motivations and capabilities of the parties. The disadvantage of this option is that governmental authorities may lack legitimacy among the tribes in conflict. An alternative would be to include unofficial mediators who do not have the power to implement "carrots or sticks". However, they can work with the parties and their constituencies to facilitate agreements, encouraging the parties to see conflict as a lose–lose situation and cooperation as a win–win situation. In addition, our findings highlight the need for further development of land and groundwater governance institutions to address intertribal conflicts. Therefore, we consider that the third-party model, a conflict settlement approach useful in contexts of increasing tensions between the parties, should be complemented with a structural peacebuilding model focused on institution building, strengthening the legitimacy and capacities of the institutional governance system.

Thirdly, the social mobilisation of the Mssoufians—from former semi-nomadic pastoralists to modern agricultural entrepreneurs—is closely intertwined with historical processes in Morocco and broader trends observed in former colonies during the 1980s, 1990s and 2000s. These processes have altered traditional land governance systems and social hierarchies, often creating new opportunities for certain groups to enhance their socio-economic status while restricting access to productive resources to other groups. The Mssoufians' ability to navigate these changes and secure land rights in Faija exemplifies how historical processes can reshape local power dynamics and resource access, creating conditions for contemporary conflicts and governance challenges in the region.

Regarding the implications of customary land conflicts for achieving sustainable development, our analysis leads us to three additional conclusions. First, given the connection between surface water scarcity linked to climate change and water allocation politics (Bossenbroek and Ftouhi, 2024) and the increased competition over customary land in recent years in the MDV, implementing adaptive measures to climate change and specifically droughts, can help prevent and mitigate land conflicts in arid regions like the MDV, linking this type of conflict to SDG 13, Climate Action. Second, intertribal land conflicts in the MDV restrict access to land for specific marginalised ethnic groups, thereby limiting their economic opportunities. Consequently, these conflicts pose a challenge to attaining SDG 1 (No Poverty) and have implications for SDG 10 (Reduced Inequalities). Third, the current customary institutional framework for land governance lacks an effective mechanism to address inter-tribal land conflict resolution. The judicial system, currently the alternative, is costly, leads to longer processes, and is perceived as less transparent for tribe members. Therefore, to implement SDG 16 (Peace, Justice, and Strong Institutions) it could be beneficial to develop an additional institutional level to process these cases, using elements of customary dispute resolution institutions and formally integrating them into the statutory framework to prevent further escalation of land conflicts.

Finally, finding how this institutional integration can be implemented requires further investigation. Exploring the potential of polycentric resource governance systems might be a starting point. A second question identified during this research is how land governance can be linked to (ground)water governance in a unified resource governance system. Further research into these areas will be crucial for developing effective conflict resolution strategies and promoting sustainable development in the MDV.

Chapter 5

SYNTHESIS, CONCLUSIONS, AND RECOMMENDATIONS

This chapter is divided into three subsections. First, I summarise the main findings of each chapter (5.1). Then, I present the general conclusions of the research, along with some recommendations (5.2). Finally, the last section of this chapter presents ideas for possible future research activities (5.3).

5.1. Synthesis of main research findings

Research on water resources indicates a pervasive trend of rapid resource degradation worldwide, driven by the twin forces of over-abstraction and pollution. Notably, the intensification of agricultural practices is a pivotal factor exacerbating this alarming scenario. The prevailing socio-economic development paradigm that prioritises incessant economic growth not only disregards the constraints imposed by planetary boundaries but also presents challenges in determining equitable water allocations across various economic sectors and among diverse populations. The compounding effects of climate change add another layer of difficulty for striking a balance that facilitates economic development while ensuring resource sustainability and social equity. This is particularly the case in arid regions across the globe.

The inability to reverse the degradation of water resources has sparked growing criticism towards the advocacy of managerial-focused paradigms that neglect the context-specific and political nature of water governance processes. In my dissertation, I embarked on this research journey by acknowledging the importance of context and inherently political aspects of governance processes. Striving to make a meaningful contribution, my study sought to address the following question: what are the water governance challenges in the MDV?

To answer this question, the first part of my research focused on understanding how the national water policy in Morocco during the last 25 years has responded to or even provoked the main water-related problems reported by both local inhabitants of the valley and local governmental representatives. I tried to establish this relation by combining the analysis of empirical data from the MDV with the analysis of official governmental policy documents.

A critical examination of the Moroccan water policy (Chapter 2) unveils a prominent discrepancy hindering the achievement of its primary objective: ensuring sufficient water for national socio-economic development. The policy primarily centres on augmenting water supply and enhancing efficiency in water utilisation, leveraging techno-infrastructural solutions derived from economic and engineering perspectives. However, a significant limitation emerges as the policy overlooks crucial factors influencing actual water access, particularly for marginalised groups. This oversight curtails the policy's potential to foster inclusive and equitable socio-economic development. Furthermore, the analysis highlights the political nature of the prevalence of engineering and economic perspectives shaping the way policy problems are defined and framed and consequently in selecting policy solutions. This finding emphasises the need to recognise, illuminate, and understand power dynamics and interests shaping policy-making and the importance of breaking compartmentalisationbetween government sectors to develop effective

solutions for water-related problems. Additionally, the findings reveal contradictions in Morocco's water policy, particularly the tension between pursuing environmental sustainability and indefinite economic growth.

The following stage of my research (Chapter 3) focused on analysing the groundwater governance challenges faced in Faija Plain and Fezouata and M'hamid oases. For this purpose, the concept of governance modes proved useful as the starting point for describing the type of governance institutions and organisations in place in these three cases. The Social-Ecological Framework (SESF) was used to illustrate further how governance institutions, their history, their goals, and their functioning are linked to the particularities of the socio-ecological systems of each case. In this way, I not only identified opportunities and limitations for groundwater governance in each case but contextualised these limitations in their socio-ecological particularities, shedding light on why it is challenging to introduce changes that may lead to more sustainable resource use.

The main findings in Chapter 3 illustrate how, on the one hand, the hierarchical governance approach that prevails in Fezouata faces difficulties in promoting rule compliance due to mismatches between state regulations and local realities and the absence of effective governmental monitoring and sanctioning. On the other hand, self-governance in M'hamid and Faija is associated with greater incentives among local water users for rule compliance. However, in M'hamid self-governance organisations do not focus on achieving resource sustainability as the main goal, while in Faija, water user organisations lack authority to sanction free-riders. The incapability to effectively enforce rules compromises long term resource sustainability.

In Faija, the evidence suggests a need for a governance system capable of coordinating actions supporting sustainable practices between self-governance organisations and the state. Aquifer contracts could provide the institutional framework for such a system, but the Faija contract lacks local stakeholder engagement due to a very limited delegation of decision-making power to users as part of the contract's design process. Consequently, the aquifer contract's effectiveness in promoting a unified governance system that facilitates cooperation between self-governance organisations and the state is compromised. Overcoming this limitation requires active participation and co-creation of rules by local stakeholders. In addition, the Faija aquifer contract faces challenges in generating natural incentives for participation, particularly among upstream users, suggesting that additional legal incentives must be introduced to motivate upstream users to actively participate in the aquifer contract. The Moroccan government's declaration of intent to implement aquifer contracts across the national territory underscores the significance of drawing insights from the Faija case.

In Chapter 4, I used an actor-based analysis in combination with access theory to analyse the drivers of conflict between Mssoufa and Kaaba tribes in Faija Plain. The findings of this analysis illuminate how access to land and groundwater is embedded in power relations and rooted in broad historical processes affecting the North African region. After presenting the historical background of the conflict, Chapter 4 identifies the actors involved, their roles, motivations to engage in the conflict and capabilities to pursue their interests, as well as the power relations between actors. The actor-based conflict analysis allowed me to describe the dynamics of the conflict and its roots in a broader historical process that took place at different levels. Among these processes I identify climate change altering regional precipitation patterns, the expansion of global markets, increased affordability of infrastructure allowing groundwater exploitation, changes in national regulation on collective lands, neoliberal reforms affecting water management paradigms, the construction of large-scale infrastructure affecting the availability and

distribution of surface water in the MDV, and the reconfiguration of old social hierarchies and power relations between ethnic groups.

My analysis indicates that the surge in conflicts over collective land in the Middle Drâa Valley (MDV) cannot be solely attributed to fluctuations in land and water availability. Collective land and groundwater are critical resources for engaging in watermelon farming. This pursuit is not merely tied to the potential for substantial profits in a brief timeframe, but also to the opportunity to attain social status as a modern agricultural entrepreneur and enhance political influence within the local sphere. The existing disparity in resource access between these groups results from a social transformation process that has reshaped the distribution of power and authority among local actors in the MDV. In this sense, the case of Mssoufa-Kaaba underscores that this type of conflict represents political struggles and the importance that networks based on tribal and ethnic identities have in the valley.

5.2. General conclusions and recommendations

Several conclusions can be drawn from these findings. First, policy reforms may be needed to initiate the development of a holistic approach to better address the complex links between the social, political, economic, and environmental dimensions of water-related problems. Two main factors hamper the development of this holistic approach: the prevalence of a disciplinary approach informing the national water policy of Morocco, which is based on economic and engineering perspectives, and the compartmentalisationbetween governmental sectors.

My recommendation on this point is to devote efforts to finding ways to adopt more transdisciplinary approaches in policy-making processes, especially when defining and framing policy problems. This does not only imply bridging different disciplines (interdisciplinarity) but including civil society in these processes. In theory, adopting transdisciplinary approaches can contribute to breaking down the compartmentalisationbetween sectors since it should help create broader consensus among government institutions on the policy problems and, consequently, the best ways to address these problems. However, as follows from the work of Del Vecchio and Barone (2018), this pathway implies altering the power balance between governmental sectors (which is reflected in the budgets assigned to each sector) and between the disciplines that prevail within governmental institutions (which is reflected in the profile of the decision-makers and professionals that influences the ways of "doing things" and in the way institutions frame and deal with policy problems).

The analysis of the Moroccan water policy unveiled a tension between the aim of achieving environmental sustainability and, at the same time, pursuing indefinite economic growth. My recommendation on this point is to recognise this tension explicitly. Including explicit explanations of the meaning given to the terms "development" and "sustainability" can open the door for acknowledging and specifying the unavoidable trade-offs expected to emerge between economic growth and environmental degradation as a consequence of implementing particular policy solutions.

Evidence presented in Chapter 3 leads me to the conclusion that self-governance organisations in the MDV represent an important opportunity to create conditions for more sustainable groundwater use in the region. However, these organisations face important limitations in imposing sanctions and coordinating with other local self-governance organisations. They also face limitations in improving their knowledge about the state of the aquifers and how their water use practices impact the resource. This suggests that currently, self-governance organisations are not sufficient to ensure groundwater sustainability. To overcome these limitations, self-governance organisations need to cooperate with

governmental institutions, but in such a way that their capacity to create rules regulating water use and their capacity to monitor themselves is not compromised.

Concerning the analytical framework used, the conclusion is that the Social-Ecological Systems Framework (SESF) is a valuable tool for structuring an analysis aiming to shed light on how water governance institutions in place are linked to broader socio-ecological contexts. It provides a list of variables to characterise social-ecological systems whose relevance has been empirically supported. I did not use this list of variables as a checklist to predict sustainability, but as a starting point to conduct a structured and systematic analysis. However, this analytical framework has some limitations in providing further means to study how water management institutions are affected by power relations. To face this limitation, in Chapter 4 I used an actor-based conflict analysis in combination with access theory to analyse the conflict over land in Faija between Mssoufa and Kaaba tribes.

The analysis concludes that land conflicts in the MDV function as political arenas where authority is produced, legitimised and contested at the local level, resulting in distributive outcomes that determine the power to control access to land and groundwater, but also to define rights subjects, and what are the proper resource uses. In this sense, the analysis shows that authority formation and the control of the territory of collective lands are co-constitutive. This, in turn, suggests that it can be fruitful to address these conflicts over collective land and the violence that emerged as part of the struggles to control these spaces as a territorialisation process. This, in turn, may shed new light on the processes of institutional change and the drivers behind rule compliance. For instance, the conflict analysis reveals that farmers are not the sole beneficiaries of groundwater use; rather, a diverse range of actors, such as customary and statutory authorities, as well as private agricultural providers, also derive advantages. Frequently, these actors indirectly capitalise on groundwater by circumventing and bending existing water management regulations and employing various practices, including the payment of bribes. This highlights that numerous local actors have vested interests in maintaining the status quo, posing a challenge to the enforcement of limits on groundwater abstractions.

Finally, the conflict analysis has shed light on the interrelation between land and groundwater in the Drâa Valley by revealing how norms governing access and use of collective land in the region establish the prerequisites for accessing groundwater. These regulations empower specific actors to mediate access to these crucial resources. The conclusion is that governmental institutions overlook this intrinsic connection between land and water.

5.3. Outlook for future research

The research presented in this dissertation has shed light on a list of relevant topics for future research. In this section I present these topics, starting by highlighting the importance of widening the way policy problems are defined and framed. One potential alternative is to promote the adoption of transdisciplinary approaches in the formulation of public policies. In this line of thought, Zwarteveen et al., (2021) are developing an interesting research approach focused on documenting and learning from community initiatives that care for, share or recharge the aquifers they depend on for livelihoods and incomes. In their plea for pluralising groundwater governance scholarship, these authors propose to look beyond accepted science-based expertise and solutions to (re-)appreciate and learn from the wisdom, technologies and institutions that communities have devised (Zwarteveen et al., 2021). The MDV has a long tradition of water self-governance organisations and communities are using their social capital to adapt to the new challenges that the changes in the surface water flows are triggering. The collective wells

of M'hamid are an example of this adaptation. It will be important that further research put in value the local knowledge and expertise as a source of inspiration for policy making. Research adopting this approach should pay particular attention to the question of how to integrate academia and community into processes of policy making.

In addition, I recognise the potential of interdisciplinary research projects that integrate the Social-Ecological System Framework with other approaches focused on unveiling the role of power dynamics in shaping water governance arrangements and their operational dynamics. Neglecting an in-depth examination of how governance institutions function daily poses the risk of reducing governance systems to institutional "designs" and intended purposes. This portrayal treats governance systems as black boxes, revealing only the general characteristics and outcomes without a clear understanding of the underlying mechanisms. Consequently, gaining insights into the operational challenges and dynamics becomes crucial for comprehending the implications of introducing changes in water governance institutions aimed at enhancing the sustainability of socio-ecological systems. The study of the Faija aquifer contract evolution presents a compelling opportunity for interdisciplinary research. The objective is to track the implementation of the aquifer contract over time and contextualise the emerging challenges within the power relations of the involved actors.

As part of this research, it becomes important to identify the composition of water user associations, understand participation patterns, cooperation networks and discern reasons for non-participation. It is also important to understand the role that these associations may play in other spheres beyond water and the consolidation of power relations in the local space. Questions such as how water user associations interact with local politics, with tribal organisations, and how associations comprising members from different tribes engage with each other, are pivotal. Drawing on the insights of Houdret and Heinz (2022), who emphasise the influence of ethnic and cultural identities on the implementation of groundwater rules and sanctions in the Souss-Massa Valley, is recommended to investigate how different identities may hamper the implementation of the aquifer contract in Faija.

Researching the connections between collective land and groundwater governance is particularly relevant in the current debates taking place in Morocco about the benefits that promoting a land privatisation process will bring to the country's socio-economic development. I believe that employing the concepts of frontier production and territorialisation of resource control (Rasmussen & Lund, 2018) holds promise in addressing the current trend of commodifying collective land and groundwater. These conceptual frameworks offer insights into institutional changes, governance dynamics, and the implications of resource commodification, including shifts in resource access and control, the potential for conflicts and displacement, and the legitimisation of authority for both governmental and non-governmental actors.

Finally, this research has clearly illustrated how groundwater-related conflict emerges from the value that this resource represents for irrigation. However, in the MDV, groundwater is also very important for drinking water production. Currently, the Moroccan government is implementing a policy denominated Generation Green, aiming at creating a middle class of young agricultural entrepreneurs in the country through financial and technical incentives. This policy could exacerbate even more the competition between irrigation and drinking water production in the valley. Future investigations into the trade-offs between water use sectors can offer valuable insights into navigating and addressing this intricate issue.

REFERENCES

ABH - DON: Agence du Bassin Hydraulique Draa Oued Noun (2020). Etude D'elaboration du Contrat de Nappe de Faija. Mission I-II-III: Etat Des Lieux, Tendance de L'Évolution Future et Identification d'Axes Stratégiques d'Amélioration de la Situation Actuelle.

Abson, D.J. ; Fischer, J. ; Leventon, J.; Newig, J.; Schomerus, T.; Vilsmaier, U.; Von Wehrden, H.; Abernethy, P.; Ives, C.D.; Jager, N.W.; Et Al. (2017). Leverage Points for Sustainability Transformation. *Ambio*, 46, 30–39.

Adra, N. (2021). Decolonizing Tribal "Genealogies" In the Middle East and North Africa. *International Journal of Middle East Studies*, *53*, 492-496. Https://Doi.Org/10.1017/S0020743821000805

Agheyisi, J. E. (2019). Inter-Communal Land Conflicts in Benin City, Nigeria: Exploring the Root Causes in the Context of Customary Land Supply. *Land Use Policy*, *83*, 532-542. Https://Doi.Org/10.1016/J.Landusepol.2019.02.027

Aït Hamza, M., El Faskaoui, B., & Fermin, A. (2010). Les Oasis du Drâa au Maroc : Rupture des Equilibres Environnementaux et Stratégies Migratoires. *Hommes & Migrations*, *1284*, 56-69. Https://Doi.Org/10.4000/Hommesmigrations.1241

Allan, T. (2003). IWRM/IWRAM: A New Sanctioned Discourse. *Occasional Paper*, *50*, 1-27.

Allouche, J. (2016). The Birth and Spread of IWRM – A Case Study of Global Policy Diffusion and Translation. *Water Alternatives*, *9*(3), 412-433.

Amaruzaman, S., Trong Hoan, D., Catacutan, D., Leimona, B., & Malesu, M. (2022). Polycentric Environmental Governance to Achieving SDG 16: Evidence from Southeast Asia And Eastern Africa. *Forests*, *13*(1), 68. Https://Doi.Org/10.3390/F13010068

Arrifi, E.-M.; Ingénieru Principal du Génie Rural; Chef de Service à l'Administration du Génie Rural, Ministère de l'Agriculture et de la Peche Maritime. L'économie et la valorisation de l'eau en irrigation au Maroc : Un défi pour la durabilité de l'agriculture irriguée. In Proceedings of the

Sympusium International Agriculture durable en Région Méditerranéenne (AGDUMED), Rabat, Morocco, 14 May 2009; pp. 48–54.

Baldwin, E., Mccord, P., Dell'Angelo, J., & Evans, T. (2018). Collective Action in a Polycentric Water Governance System. *Environmental Policy and Governance*, *28*(4), 212-222. Https://Doi.Org/10.1002/Eet.1810

Balgley, D. (2017). Agrarian Capitalism and the Privatisation of Collective Land In Morocco. *Journal of Undergraduate Research*, *8*, 51-58.

Balgley, D., & Rignall, K. (2021). Land Tenure in Morocco: Colonial Legacies, Contemporary Struggles. In H. Chitonge & R. Harvey (Eds.), *Land Tenure Challenges in Africa: Confronting the Land Governance Deficit*. Springer International Publishing. Https://Doi.Org/10.1007/978-3-030-82852-3

Benouniche, M., Kuper, M., Hammani, A., & Boesveld, H. (2014). Making the User Visible: Analysing Irrigation Practices and Farmers' Logic to Explain Actual Drip Irrigation Performance. *Irrigation Science*, *32*(6), 405-420. Https://Doi.Org/10.1007/S00271-014-0438-0

Berriane, Y. (2017). Development and Countermovements. Reflections on the Conflicts Arising from the Commodification of Collective Land in Morocco. *Revue Internationale de Politique de Développement*, *8*, 247-267. Https://Doi.Org/10.4000/Poldev.2319

Berry, S. (2017). Struggles over Land and Authority in Africa. *African Studies Review*, *60*(3), 105-125. Https://Doi.Org/10.1017/Asr.2017.96

Biswas, A. K. (2004). Integrated Water Resources Management: A Reassessment: A Water Forum Contribution. *Water International*, *29*(2), 248-256. Https://Doi.Org/10.1080/02508060408691775

Bolding, A., Mollinga, P. P., & Zwarteveen, M. (2000). Interdisciplinarity in Research on Integrated Water Resources Management: Pitfalls and Challenges. *Unpublished Paper Presented at the UNESCO-WOTRO International Work Conference 'Water for Society', Delft, The Netherlands*, 8-10.

Bossenbroek, L., Ftouhi, H., Kadiri, Z., & Kuper, M. (2023). Watermelons in the Desert in Morocco: Struggles Around a Groundwater Commons-in-the-Making. *Water Alternatives*, *16*(1).

Bottazzi, P., Goguen, A., & Rist, S. (2016). Conflicts of Customary Land Tenure in Rural Africa: Is Large-Scale Land Acquisition a Driver of 'Institutional Innovation'? *The Journal of Peasant Studies*, *43*(5), 971-988. Https://Doi.Org/10.1080/03066150.2015.1119119

Bouderbala, N. (2000). La Loi Nationale entre Ciel et Terre. *Études Rurales*, *155-156*, 107-116. Https://Doi.Org/10.4000/Etudesrurales.18

Bouderbala N. 1999. Les Systemes de Propriete Fonciere au Maghreb.Pdf. (S. F.).

Chelleri, L., Minucci, G., Ruiz, A., & Karmaoui, A. (2014). Responses to Drought and Desertification in the Moroccan Drâa Valley Region Resilience at the Expense of Sustainability? *The International Journal of Climate Change: Impacts and Responses*, *5*(2), 17-23.

Chinigò, D. (2016). Rural Radicalism and the Historical Land Conflict in the Malawian Tea Economy. *Journal of Southern African Studies*, *42*(2), 283-297. Https://Doi.Org/10.1080/03057070.2016.1141514

Chitonge, H., & Harvey, R. (Eds.). (2021). *Land Tenure Challenges in Africa: Confronting the Land Governance Deficit*. Springer International Publishing. Https://Doi.Org/10.1007/978-3-030-82852-3

Cleaver, F., & De Koning, J. (2015). Furthering Critical Institutionalism. *International Journal of the Commons*, *9*(1), 1-18.

Cox, M., Arnold, G., & Villamayor Tomás, S. (2010). A Review of Design Principles for Community-Based Natural Resource Management. *Ecology and Society*, *15*(4), Art38. Https://Doi.Org/10.5751/ES-03704-150438

Creswell, J. W. (2007). *Qualitative Inquiry and Research Design: Choosing Among Five Approaches* (Second). Sage Publications. Http://Journals.Sagepub.Com/Doi/10.1177/1524839915580941

De Haas, H. (2006). Migration, Remittances and Regional Development in Southern Morocco. *Geoforum*, *37*(4), 565-580. Https://Doi.Org/10.1016/J.Geoforum.2005.11.007

Detges, A. (2014). Close-Up on Renewable Resources and Armed Conflict: The Spatial Logic of Pastoralist Violence in Northern Kenya. *Political Geography*, *42*, 57-65. Https://Doi.Org/10.1016/J.Polgeo.2014.06.003

Froese, R., & Schilling, J. (2019). The Nexus of Climate Change, Land Use, And Conflicts. *Current Climate Change Reports*, *5*(1), 24-35. Https://Doi.Org/10.1007/S40641-019-00122-1

Hammoudi, A. (1982). Droits D'eau et Société: La Vallée Du Dra. *Hommes, Terre et Eaxu*, *48*(12), 105-120.

Heidecke, C., & Heckelei, T. (2010). Impacts of Changing Water Inflow Distributions on Irrigation and Farm Income Along the Drâa River in Morocco. *Agricultural Economics*, *41*(2), 135-149. Https://Doi.Org/10.1111/J.1574-0862.2009.00431.X

Hinkel, J., Cox, M. E., Schlüter, M., Binder, C. R., & Falk, T. (2015). A Diagnostic Procedure for Applying the Social-Ecological Systems Framework in Diverse Cases. *Ecology and Society*, *20*(1), Art32. Https://Doi.Org/10.5751/ES-07023-200132

Homer-Dixon, T. F. (1994). Environmental Scarcities and Violent Conflict: Evidence From Cases. *International Security*, *19*(1), 5. Https://Doi.Org/10.2307/2539147

Houdret, A., & Amichi, H. (2022). The Rural Social Contract in Morocco And Algeria: Reshaping Through Economic Liberalisation And New Rules and Practices. *The Journal of North African Studies*, *27*(4), 641-662. Https://Doi.Org/10.1080/13629387.2020.1848560

Houdret, A., Kadiri, Z., & Bossenbroek, L. (2017). A New Rural Social Contract for The Maghreb? The Political Economy of Access to Water, Land and Rural Development. *Middle East Law and Governance*, *9*(1), 20-42. Https://Doi.Org/10.1163/18763375-00901003

Jacques-Meunie, D. (1972). Notes Sur L'histoire des Populations du Sud Marocain. *Revue De l'Occident Musulman et de La Méditerranée*, *11*(1), 137-150. Https://Doi.Org/10.3406/Remmm.1972.1148

Kadiri, Z., & Er-Rayhany, H. (2019). La Politique Foncière de Privatisation des Terres Collectives a L'Épreuve des Réalités d'Appropriations et des Conflits. *Alternatives Rurales*, *7*, 111-129.

Kansanga, M. M., Arku, G., & Luginaah, I. (2019). Powers of Exclusion and Counter-Exclusion: The Political Ecology of Ethno-Territorial Customary Land Boundary Conflicts in Ghana. *Land Use Policy*, *86*, 12-22. Https://Doi.Org/10.1016/J.Landusepol.2019.04.031

Karmaoui, A., Ifaadassan, I., Messouli, M., & Yacoubi Khebiza, M. (2015). Sustainability of the Moroccan Oasean System (Case Study: Middle Draa Valley). *Global Journal of Technology and Optimisation*, *06*(01). Https://Doi.Org/10.4172/2229-8711.1000170

Karmaoui, A., Messouli, M., Yacoubi Khebiza, M., & Ifaadassan, I. (2014). Environmental Vulnerability to Climate Change and Anthropogenic Impacts in Dryland, (Pilot Study: Middle Draa Valley, South Morocco). *Journal of Earth Science & Climatic Change*, *05*(04). Https://Doi.Org/10.4172/2157-7617.1000193

Karsenty, A. (1995). *The Invention of the Moroccan «Terres Collectives» Or the Retardation of a Rural Society*. 9.

Klose, S. (2012). *Regional Hydrogeology and Groundwater Budget Modeling in the Arid Middle Drâa Catchment (South-Morocco)* [Dissertation]. Rhenish Friedrich-Wilhelms University of Bonn.

Kooiman, J., Bavinck, M., Chuenpagdee, R., Mahon, R., & Pullin, R. (2008). Interactive Governance and Governability: An Introduction. *Journal of Transdisciplinary Environmental Studies*, *7*(1), 1-11.

Kuper, M., Amichi, H., & Mayaux, P.-L. (2017). Groundwater Use in North Africa as a Cautionary Tale for Climate Change Adaptation. *Water International*, *42*, 725-740.

Kuper, M., Faysse, N., Hammani, A., Hartani, T., Marlet, S., Hamamouche, M. F., & Ameur, F. (2016). Liberation or Anarchy? The Janus Nature of Groundwater Use on North Africa's New Irrigation Frontiers. In *Integrated Groundwater Management: Concepts, Approaches and Challenges.* (Pp. 583-615). Springer.

Kuper, M., Hammani, A., Chohin, A., Garin, P., & Saaf, M. (2012). When Groundwater Takes Over: Linking 40 Years of Agricultural and Groundwater Dynamics in a Large-Scale Irrigation Scheme in Morocco. *Irrigation and Drainage*, *61*(S1), 45-53. Https://Doi.Org/10.1002/Ird.1653

Lamqadem, A. A., Saber, H., & Pradhan, B. (2019). Long-Term Monitoring of Transformation from Pastoral to Agricultural Land Use Using Time-Series Landsat Data in the Feija Basin (Southeast Morocco). *Earth Systems and Environment*, *3*(3), 525-538. Https://Doi.Org/10.1007/S41748-019-00110-3

Le Billon, P., & Duffy, R. (2018). Conflict Ecologies: Connecting Political Ecology and Peace and Conflict Studies. *Journal of Political Ecology*, *25*(1). Https://Doi.Org/10.2458/V25i1.22704

Mahdi, M. (2014). *Devenir du Foncier Agricole au Maroc. Un Cas d'Accaparement des Terres*. *4*, 2-10.

Mcdermott, C. L., Acheampong, E., Arora-Jonsson, S., Asare, R., De Jong, W., Hirons, M., Khatun, K., Menton, M., Nunan, F., Poudyal, M., & Setyowati, A. (2019). SDG 16: Peace, Justice and Strong Institutions – A Political Ecology Perspective. In C. J. Pierce Colfer, G. Winkel, G. Galloway, P. Pacheco, P. Katila, & W. De Jong (Eds.), *Sustainable Development Goals: Their Impacts on Forests and People* (Pp. 510-540). Cambridge University Press. Https://Www.Cambridge.Org/Core/Books/Sustainable-Development-Goals-Their-Impacts-On-Forests-And-People/Sdg-16-Peace-Justice-And-Strong-Institutions-A-Political-Ecology-Perspective/3A5345A210D52EF76A0C0BF13A8AF22E

Mcginnis, M. D., & Ostrom, E. (2014). Social-Ecological System Framework: Initial Changes and Continuing Challenges. *Ecology and Society*, *19*(2), 30. Https://Doi.Org/10.5751/ES-06387-190230

Mehta, L., Movik, S., Bolding, A., Derman, B., & Manzungu, E. (2016). *Introduction to the Special Issue – Flows and Practices: The Politics of Integrated Water Resources Management (IWRM) in Southern Africa*. *9*(3).

Mitchell, C. (2002). Beyond Resolution: What Does Conflict Transformation Actually Transform? *Peace and Conflict Studies*, *9*(1), 1-23.

Molle, F. (2008). Nirvana Concepts, Narratives and Policy Models: Insights from the Water Sector. *Water Alternatives*, *1*(1), 131-156.

Molle, F. (2017). *Conflicting Policies: Agricultural Intensification Vs. Water Conservation in Morocco* (P. 48) [Report of Research]. Gestion De l'Eau, Acteurs, Usages G-Eau. Http://Www.G-Eau.Net/

Molle, F., & Closas, A. (2020). Comanagement Of Groundwater: A Review. *Wires Water*, *7*(1). Https://Doi.Org/10.1002/Wat2.1394

Molle, F., & Tanouti, O. (S. F.). *La Micro-Irrigation tt les Ressources en Eau Au Maroc: Un Coûteux Malentendu*.

Molle, F., Tanouti, O., & Faysse, N. (2019). Morocco. In *Irrigation in the Mediterranean. Technologies, Institutions and Policies* (Vol. 22, Pp. 51-88). Springer. Https://Link.Springer.Com/Chapter/10.1007/978-3-030-03698-0_3

Moumane, A., El Ghazali, F. E., Al Karkouri, J., Delorme, J., Batchi, M., Chafiki, D., & Karmaoui, A. (2021). Monitoring Spatiotemporal Variation of Groundwater Level and Salinity Under Land Use Change Using Integrated Field Measurements, GIS, Geostatistical, And Remote-Sensing Approach: Case Study of The Feija Aquifer, Middle Draa Watershed, Moroccan Sahara. *Environmental Monitoring and Assessment*, *193*(12), 769. Https://Doi.Org/10.1007/S10661-021-09581-2

Ostrom, E. (2007). A Diagnostic Approach for Going Beyond Panaceas. *Proceedings of the National Academy of Sciences*, *104*(39), 15181-15187. Https://Doi.Org/10.1073/Pnas.0702288104

Ostrom, E. (2009). A General Framework for Analyzing Sustainability of Social-Ecological Systems. *Science*, *325*(5939), 419-422. Https://Doi.Org/10.1126/Science.1172133

Ostrom, E., & Cox, M. (2010). Moving Beyond Panaceas: A Multi-Tiered Diagnostic Approach for Social-Ecological Analysis. *Environmental Conservation*, *37*(4), 451-463. Https://Doi.Org/10.1017/S0376892910000834

Ouhajou, L. (1996). *Espace Hydraulique et Societe au Maroc. Cas des Systemes d'Irrigation Dans la Vallee du Dra*. Faculté Des Lettres et des Sciences Humaines - Université Ibn Zohr.

Pahl-Wostl, C. (2015). *Water Governance in the Face of Global Change: From Understanding to Transformation*. Springer International Publishing. Https://Doi.Org/10.1007/978-3-319-21855-7

Pahl-Wostl, C. (2019). The Role of Governance Modes and Meta-Governance in the Transformation Towards Sustainable Water Governance. *Environmental Science & Policy*, *91*, 6-16. Https://Doi.Org/10.1016/J.Envsci.2018.10.008

Partelow, S., Senff, P., Buhari, N., & Schlüter, A. (2018). Operationalizing the Social-Ecological Systems Framework in Pond Aquaculture. *International Journal of the Commons*, *12*(1), 485-518. Https://Doi.Org/10.18352/Ijc.834

Peluso, N. L., & Ribot, J. (2020). Postscript: A Theory of Access Revisited. *Society & Natural Resources*, *33*(2), 300-306. Https://Doi.Org/10.1080/08941920.2019.1709929

Peters, P. E. (2013). Conflicts Over Land and Threats to Customary Tenure in Africa. *African Affairs*, *112*(449), 543-562. Https://Doi.Org/10.1093/Afraf/Adt047

Pletsch, A. (1977). Eléments Traditionnels et Evolution Récente dans l'Oasis Du Dra (Maroc). *Méditerranée*, *29*(2), 35-43. Https://Doi.Org/10.3406/Medit.1977.1726

Rademacher-Schulz, C. (2014). *The Making of the Social Order – Migration, Resource and Power Conflicts in the Moroccan Drâa Valley*. 173-183.

Ramsbotham, O., Woodhouse, T., & Miall., H. (2016). *Contemporary Conflict Resolution, 4th Edition | Wiley*. Wiley.Com. Https://Www.Wiley.Com/En-Us/Contemporary+Conflict+Resolution%2C+4th+Edition-P-9780745687216

Rignall, K. (2015). Land and The Politics of Custom in a Moroccan Oasis Town. *Anthropological Quarterly*, *88*(4), 941-968. Https://Doi.Org/10.1353/Anq.2015.0056

Rignall, K., & Kusunose, Y. (2018). Governing Livelihood and Land Use Transitions: The Role of Customary Tenure in Southeastern Morocco. *Land Use Policy*, *78*, 91-103. Https://Doi.Org/10.1016/J.Landusepol.2018.03.035

Robbins, P. (2020). *Political Ecology: A Critical Introduction* (3rd Ed.). John Wiley & Sons.

Scheffran, J., Brzoska, M., Kominek, J., Link, P. M., & Schilling, J. (2012). Climate Change and Violent Conflict. *Science*, *336*(6083), 869-871. Https://Doi.Org/10.1126/Science.1221339

Schilling, J. (2012). *On Rains, Raids and Relations: A Multimethod Approach to Climate Change, Vulnerability, Adaptation and Violent Conflict in Northern Africa And Kenya. Dissertation*. Universität Hamburg.

Schilling, J., Akuno, M., Scheffran, J., & Weinzierl, T. (2014). *On Raids and Relations: Climate Change, Pastoral Conflict and Adaptation in North-Western Kenya*. 27.

Schilling, J., Saulich, C., & Engwicht, N. (2018). A Local to Global Perspective on Resource Governance and Conflict. *Conflict, Security & Development*, *18*(6), 433-461. Https://Doi.Org/10.1080/14678802.2018.1532641

Schilling, J. (2016). Actor-based Conflict Analysis Applied to a Case Study in Northwest Kenya. *Paper Submitted to Workshop „Konflikte analysieren – wie, was und wozu?“* 28th to 29th October 2016 in Augsburg, Germany.Spillmann 1936. Ait-3atta.Pdf. (S. F.).

Swearingen, W. D. (1987). Terre, Politique et Pouvoir au Maroc. *Revue de l’Occident Musulman t de la Méditerranée*, *45*(1), 41-54. Https://Doi.Org/10.3406/Remmm.1987.2169

Woodhouse, P., & Muller, M. (2017). Water Governance—An Historical Perspective on Current Debates. *World Development*, *92*, 225-241. Https://Doi.Org/10.1016/J.Worlddev.2016.11.014

APPENDIX

Table S 1. List of interviewees 1

N°	Institution/occupation	Date of interview	Location
1	TechniquesIrrigation etDrainage (BTI) - Services Gestion duRéseau d'Irrigationet de Drainage (SGRID) - ORMVAO	25.02.20 16.07.21 18.10.21	Ouarzarzate
2	ONEE - technitian of laboratory in water treatment plant Zagora	20.02.20	Zagora
3	Watermelon farmer in Feija	20.02.20	Feija
4	Agence Nationale de developpement des zones Oasiennes et d'Arganier (ANDZOA)	20.02.20 02.03.20	Zagora
5	Amis de l'environment (NGO)	20.02.20	Zagora
6	Farmer of Ternata Oasis Secretary of the Marousse Association (irrigation)	21.02.20 10.03.20	Ternata
7	Member Ternata Municipal Council (position???)	21.02.20	Ternata
8	President of Fezouata associations of irrigators; Naib of Habus lands Tamegrout	Friday 21.02.20	Fezouata
9	President association of irrigators (tale of Fezouata)	21.02.20	Fezouata
10	Vicepreseident of commune Tagounite	22.02.20	Ketaoua
11	President of association of irrigators Tagounite.	22.02.20	Ketaoua
12	Direction Regional du Turism (DRT)	24.02.20	Ouarzazate
13	ABH-Ouarzarzate	24.02.20	Ouarzazate
14		18.10.21	
15	Directeur de l'ONEE M'hamid	27.02.20	M'hamid
16	Farmer - M'hamid Oasis	27.02.20	M'hamid
17	Teacher in M'hamid	27.02.20	M'hamid
18	Teacher in M'hamid	28.02.20	M'hamid
19	Hotel agent in M'hamid	28.02.20	M'hamid
20	Gesthouse owner M'hamid	28.02.20	M'hamid
21	Aumsoufa tribe Chikh	29.02.20 28.10.21 18.05.22 13.06.22	Feija
22	Watermelon farmer in Faija	29.02.20	Feija
23	Watermelon farmer		Feija
24	Chef de la Subdivision Agricole OMVAO-Zagora	04.03.20	Zagora
25	Oasis farmer, Tinfou village.	05.03.20	Fezouata (Tinfou village)
26	Technitian of CMVA Tagounite (Ktaoua). Responsible for Tagounite, Ketaoua, M'hamid.	09.03.20	Tagounite (ktaoua)

Table S 1. List of interviewees (continuation)

N°	Institution/occupation	Date of interview	Location
27	Head of Agence Nationale de developpement des zones Oasiennes et d'Arganier (ANDZOA)	09.03.20 17.12.20 14.07.21	Zagora
28	Famer with well in Lblida, Ktaoua.	09.03.20	Lblida (Ktaoua)
29	Farmer Lblida, Ktaoua	09.03.20	Lblida (Ktaoua)
30	2 brothers, farmers in Oasis, Tissergate, Ternata	10.03.20	Tissergate, Ternata
31	ABH-Ouarzarzate	16.07.21	Ouarzazate
32	ONEE/Branche Ouarzazate Zagora Tinghir. Chef de secteur (PI) de Production	18.10.21	Ouarzarzate
33	Chef de la Subdivision Agricole OMVAO-Zagora [succesor of Ismaili Alaoui]	02.06.22	Zagora
34	Foreigner investor	24.10.21	Faija
35	Farmer in family farm. Land-holder	25.10.21	Faija
36	Land-holder of tribe. Big farm	26.10.21	Faija
37	Land-holder of tribe. Big farm	30.10.21	Faija
38	Ex Moaaine (family?)	02.11.21	Faija
39	Chef de la Subdivision Agricole OMVAO-Zagora	01.11.21	Faija
40	Director of CMVA	05.11.21	Faija
41	Secretary of (TODNA?) WUA Bouzougar	10.11.21	Faija
42	Secretary or president of WUA in Rgab Ntal	10.11.21	Faija
43	Land-agent Khchaa	11.11.21	Faija
44	Maqadem Oulad Issa	12.11.21	Faija
45	Farmer	18.11.21	Faija
46	Director of CMVA	19.11.21	Faija
47	President of WUA Tamegroute	02.12.2021	Faija
48	Tarmer-oasis (Ait Brahim Tribe)	04.12.2021	Faija
49	Head of corporative "futur of daraa" for henna	06.12.2021	Faija
50	Farmer -Tinfu	03.12.2021	Tinfu, Fezouata
51	Farmer -Tinfu	03.12.2022	Tinfu, Fezouata
52	Topographic	09.12.2021	Zagora
53	Tamegroute	08.12.2021	Fezouata
54	Farmer Mezguita	08.05.2022	Mezguita - Agdz

Table S 1. List of interviewees (continuation)

N°	Institution/occupation	Date of interview	Location
55	Farmer	09.05.22	Mezguita
56	Farmer	11.05.22	Faija
57	Farmer	12.05.22	Faija
58	Farmer	12.05.22	Faija
59	Farmer	14.05.22	Faija
60	Farmer	15.05.22	Fezouata
61	Farmer	15.05.22	Fezouata
62	Farmer	15.05.22	Fezouata
63	Farmer	16.05.22	Fezouata
64	Farmer	17.05.22	Faija
65	Farmer	18.05.22	Faija
66	Farmer	19.05.22	Faija
67	Farmer	19.05.22	Faija
68	Farmer	21.05.22	Faija
69	Farmer	23.05.22	Faija
70	Farmer	26.05.22	Faija
71	Farmer		Faija
72	Farmer	26.05.22	Faija
73	Textile workshop	28.05.22	Amzrou, Fezouata
74	Seller in Artesanal workshop	28.05.22	Amzrou, Fezouata
75	Traditional handycraft cooperative Amzrou	28.05.22	Amzrou, Fezouata
76	Farmer	31.05.22	Mhamid
77	Farmer	01.06.22	Fezouata
78	Farmer	06.06.22	Fezouata
79	Farmer	07.06.22	Fezouata
80	Farmer	08.06.22	Fezouata
81	Farmer	09.06.22	Fezouata
82	Farmer	10.06.22	Fezouata
83	Farmer	11.06.22	Fezouata
84	Farmer	12.06.22	Fezouata
85	Moaine of Imsoufa	15.06.22	Feija
86	Farmer	16.06.22	Rabat, Mezguita
87	Farmer	16.06.22	Rabat, Mezguita
88	Farmer	16.06.22	Rabat, Mezguita
89	Farmer	17.06.22	Taliouine, Mezguita
90	Farmer	17.06.22	Intliten
91	Farmer		
92	Farmer		
93	Farmer		
94	Farmer	18.06.22	Intliten

Table S 1. List of interviewees (continuation)

95	Secretary in ANCFCC	19.06.22	Ouarzazate
96	Farmer	02.12.2021	Faija
97	Maqadem (Bouzougar)	08.11.21	Faija
98	Farmer Mssoufa	26.10.21	
99	Farmer Mssoufa	02.11.21 03.12.21	Faija
100	Farmer Mssoufa & Secretary of (Tudma) WUA Bouzouga	10.11.21	Faija
101	Land-agent Khchaa	11.11.21 22.09.22	Zagora
103	Farmer & Maqadem Oulad Issa	12.11.21	Faija
104	Farmer Mssoufa	11.05.22	Lamaghadre-Feija
105	Farmer Mssoufa	18.05.22	Rba N'tal-Feija
106	Farmer Mssoufa	21.05.22	Lamaghadre-Feija
107	Farmer Mssoufa	23.05.22	Lamaghadre-Feija
108	Farmer Mssoufa	26.05.22	Bouzougar-Feija
109	Farmer Mssoufa	26.05.22	Bouzougar-Feija
110	Caid and Khalifa of Ternata	23.09.22	Ternata Commune
111	Community mobiliser Khchaa		Tansita (neighbourhood in Ternata city)
112	Member of Khchaa	23.09.22	Tansita
113	Moaine Khchaa	23.09.22	Ternata
114	Wakil Aradi Khchaa and member of Red Cross	24.09.22	Zagora
115	Farmer Kchchaa	24.09.22	
116	Online reporter - Khchaa	24.09.22	Zagora
117	Farmer Kchaa	25.09.22	Faija, Bou Tious
118	Businessman, spoker Kaaba	29.09.22	Tinzouline
119	spokerman Kaaba (Moajih)	01.10.22	Timzouline
120	Moaine Khchaa	01.10.22	Ternata
121	Wakil Aradi Kaabak and Abdelmajib Moamim	01.10.22	Tinzouline
122	Wakil Aradi Kaaba	05.10.22	Tinzouline - oasis
123	Farmer Kaaba	05.10.22	Timzouline
124	Taxi driver, ex militar	05.10.22	Zagora
125	Businessman Kaaba	06.10.22	Zagora
126	Moaine Afra-Kaaba	06.10.22	famer Tinzouline
127	Wakil Aradi Kaaba (Lghmad Kasba)	07.10.22	Tinzouline
128	Head Subdivision Agricole Zagora	11.10.22	Zagora
129	CMV dierctor	14.10.22	

Table S 1. List of interviewees (continuation)

130	Khalifa Tinzouline	20.10.22	Tinzouline
131	President WUA Nassar Beni Ali, Fezouata	30.05.23	Fezouata
132	Farmer	30.05.23	Fezouata
133	Farmer	31.05.23	Fezouata
134	Farmer	31.05.23	Fezouata
135	Chikh Beni Khlouf	31.05.23	Fezouata
136	Ailem Beni Ali	01.06.23	Fezouata
137	farmer Beni Khlouf	01.06.23	Fezouata
138	Farmer	02.06.23	Fezouata
139	Farmer	03.06.23	Fezouata
140	Chikh Ait Aissa Oubrahim	03.06.23	Fezouata
141	Ailem Ait Aissa Oubrahim	04.06.23	Fezouata
142	Farmer in Ait Aissa Oubrahim	04.06.23	Fezouata
143	Ailem Beni Khlouf	05.06.23	Fezouata
144	Farmer	05.06.23	Fezouata
145	Farmer	05.06.23	Fezouata
146	Moqadem Ouled Brahim & Ex Pt. Of WUA	05.06.23	Fezouata
147	Pt. Of Federation of WUAs in Feija	06.06.2023	Fezouata
148	Farmer	09.06.2023	Fezouata
149	Farmer	09.06.2023	Fezouata
	Focus group - Menasfi & Mssoufians	10.06.2023	Faija
	Focus group - Oum Lachaar	10.06.2023	Faija

Table S 2. 1. Analysed policy documents in Chapter 2

Year of release	Policy Instruments	Documents
1995	Loi n° 10-95 relative à l'eau	Kingdom of Morocco. (1995, September 20). Loi n° 10-95 relative à l'eau. Bulletin officiel n° 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.
		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 of November, 2008. Retrieved on 28.10.2020 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". Retrieved on 11.02.2021 from http://www.agriculture.gov.ma/
2009	National Water Strategy	Royaume du Maroc (2009). *Stratégie National de l'Eau*. Retrieved on 18.02.2021 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. Retrieved on 18.02.2021 from http://81.192.10.228/ressources-en-eau/politique-de-leau/
2016	Loi No. 36-15 relative à l'eau	Kingdom of Morocco. (2016, August 10). Loi n° 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 18.02.2021 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

Table S 2. 2. Codebook of research Chapter 2

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, mobilisation or changing of rules, and organisational 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 3. 1 First and second-tier variables of a social-ecological system. (Source: McGinnis and Ostrom, 2014)

First-tier variable	Second-tier variables
Social, economic, and political settings (S)	S1–Economic development S2 – Demographic S3 – Political S4 – Other governance S5 – Markets S6 – Media organisations S7 – Technology
Resource systems (RS)	RS1 – Sector (e.g., water, forests, pasture, fish) RS2 – Clarity of system boundaries RS3 – Size of resource system RS4 – Human-constructed facilities RS5 – Productivity of system RS6 – Equilibrium properties RS7 – Predictability of system dynamics RS8 – Storage characteristics RS9 – Location
Governance systems (GS)	GS1* – Policy area GS2*– Geographic scale of governance system GS3* – Population GS4* – Regime type GS5* – Rule-making organisations GS6*– Rules-in-use GS7* – Property-rights systems GS8*– Repertoire of norms and strategies GS9* – Network structure GS10* – Historical continuity
Resource units (RU)	RU1 – Resource unit mobility RU2 – Growth or replacement rate RU3 – Interaction among resource units RU4 – Economic value RU5 – Number of units RU6 – Distinctive characteristics RU7–Spatial and temporal distribution

Appendix 3. 2 (Continuation)

First-tier variable	Second-tier variables
Actors (A)	A1– Number of relevant actors A2 – Socioeconomic attributes A3 – History or past experiences A4 – Location A5 – Leadership/entrepreneurship A6 – Norms(trust-reciprocity) /social capital A7– Knowledge of SES/mental models A8– Dependence on the resource A9 – Technologies used to access the resource
Action situations: Interactions (I) → Outcomes (O)	I1 - Harvesting I2 – Information sharing I3 – Deliberation processes I4 – Conflicts I5 – Investment activities I6 – Lobbying activities I7 – Self-organising activities I8 – Networking activities I9 – Monitoring activities I10 – Evaluative activities O1 – Social performance measures (e.g., efficiency, equity, accountability, sustainability) O2 – Ecological performance measures (e.g., overharvested, resilience, biodiversity, sustainability) O3 – Externalities to other SESs

Appendix 3. 3 Incentive categories scheme (Adapted from Kerr et al., 2012; Rapoport et al., 2001; Travers et al., 2011; Vatn, 2009).

Incentives included	Definition of the incentive
FINANCIAL/ECONOMIC INCENTIVES	
Tax Breaks	Regulations may offer tax incentives to aquifer users who demonstrate responsible water use practices or invest in water-saving technologies. These tax breaks reduce the financial burden and encourage users to adopt more sustainable approaches.
Environmental permits	Users who comply with environmentally friendly practices and adhere to specific guidelines may receive permits that grant them greater access to groundwater resources or other benefits.
Subsidies	Financial support from governments or organisations can be provided to aquifer users for adopting technologies or practices that promote water conservation and sustainable resource management.
Rebates	Users who reduce their water consumption or implement water-saving measures may receive rebates on their water usage fees or related expenses.
Performance-Based Rewards	Aquifer users who achieve predefined conservation or sustainability targets may be rewarded with financial incentives or grants as a recognition of their efforts.
Legal Incentives	The legal incentives are provided through the regulatory frameworks, including penalties for non-compliance, property rights, and enforcement mechanisms.
NON-FINANCIAL INCENTIVES	
Social Incentives	The social incentives embedded in the regulatory frameworks, such as community recognition, reputation, or social pressure for adhering to rules. These may influence users' behavior and cooperation
Information Sharing	Stakeholders are encouraged to share data, knowledge, and experiences related to aquifer management. Transparent information exchange fosters trust, collaboration, and informed decision-making.
Joint Monitoring	Collaborative monitoring programs involve stakeholders in data collection and analysis. This shared responsibility enhances understanding and ownership of groundwater management processes.
Performance-Based Contracts	Agreements may include performance-based contracts where users commit to specific conservation or sustainability measures. Meeting these targets can lead to benefits such as extended water use permits or priority access to resources.
Technical Assistance	Access to technical expertise and support can be provided to aquifer users to help them adopt sustainable practices, implement water-saving technologies, and address challenges effectively.

Appendix 3. 4 Actor Mapping for the MDV cases

Case	Actors	Profile/Characteristics	Interests	
Faija case	Collective land-right-holders	**Category I** "Farmers" settled in Faija or Zagora city	Land-holders and members of tribes in Faija that express attachment to the land. They plan to work in Faija in the long-term and have high dependence on agriculture. They mainly grow watermelon but they tend to diversify crops (date palms, other trees, vegetables). Farmers differ in the irrigated area (<0.5ha; <2ha; <5ha; <10ha; >10ha), water volume abstracted per year (ranging from 205m3 to 230,000m3), access to capital and irrigation infrastructure, and education level.	. Secure groundwater supply to continue with farming activities in the long-term. . Government should simplify the process to get licenses for wells. . Prevent control of the government over water abstraction because that would reduce their autonomy to make decisions about which crops to farm and changes in size of cultivated area. . Some farmers have debts with agricultural input suppliers and merchants. These debts discourage farmers to reduce their watermelon cultivated area. . Replacement of watermelon is only possible if the government finances this transition. . Legitimise the use of groundwater for those who have a long-term interest in the area (those planting trees) and delegitimise those who are only doing seasonal watermelon using a lot of water. . Farmers want more dams to capture rain water and increase water supply in Faija.
		Category II "Businessmen"	These are landholders and members of the tribes in Faija. Some are settled in Zagora, some in other cities. They don't identify themselves as farmers but as businessmen. They invest in watermelon seasonally as a line of business. They have other sources of income & agriculture in Faija is not necessarily the main activity. They do not have an attachment with land in Faija and are not interested in working in agriculture in the long term.	. Make as much gains on watermelon business as possible during the agricultural campaign (Dec-Apr/May).
		Category III Land-holders renting the land	Some land-right holders do not have the capital to finance the watermelon production by themselves or are not interested in engaging in watermelon production directly. These land-holders work with non-tribe members (denominated “barrani” in Amazigh) who work as investors in watermelon production in Faija.	. Some land-holders start renting land or establishing co-management arrangements with investors as a way to form their own capital to continue working as farmers in the long-term. In this sense, they have a short-term interest in capital formation. Limits on area to cultivate watermelon can go against this interest. . Other landholders are not interested in engaging in farming activities. They have other sources of income and their economic dependence on Faija groundwater is minor. However, rules that limit the area cultivated with watermelon can also go against their interest to rent land, which is mainly rented by foreign investors.

Appendix 3.3. Actor Mapping for the MDV cases (continuation)

		Category IV Private land-right-holders	Most are residents of Zagora City. Some have professions (i.e. school teachers), or are businessmen in different sectors. These farms were bought from the Mssoufa tribe during the 1990s and are devoted to growing date palm as the main crop. However, these private owners have increased the irrigated area with watermelon in recent years.	Interviewees expressed their desire to continue practicing agriculture in the long term in Faija and caring for the sustainability of the aquifer
		Category V Non-land-holders working as investors in Watermelon	They either rent the land in Faija from landholders or engage in co-farming arrangements with them. Some work with several land-holders at the same time, which gives them access to big extensions of land. They do not have an attachment to the land and identify themselves more as businessmen than farmers. Most of them are not settled down in the area. Not interested in resource sustainability in the long-term. They show a "groundwater mining behavior".	Make as many gains on the watermelon business as possible during the agricultural campaign (Dec-Apr/May).
		Category VI Providers of agricultural inputs	Irrigation infrastructure, well-diggers, solar panels providers, fuel providers.	These actors benefit indirectly from watermelon production. They are interested in the continuity of this activity that is a source of income for them.
		Category VII Intermediary merchants	People buy the harvest of the farmer and transport it to the markets. Commonly, these merchants play the role of funders, paying in advance for the harvest.	These actors are interested in the continuity of watermelon farming in Faija.

Appendix 3.3. (Continuation)

		Category IX Governmental organisations	The National Office of Water and Electricity (ONEE in French) operates in Faija several wells for drinking water production. Ministry of Interior (MININTER) through Chikh and Mokadem in tribes. They represent the Caid in the area. Their role is to ensure security and order in the local area by monitoring and enforcing statutory rules.	Secure the production of drinking water. Chikh and Moqadems are representatives of the government but also members of the tribe, also working on watermelon farming. Their interests combine their role of preventing and solving conflicts in Faija and their personal interests as farmers and tribe members.
M'hamid case	Farmers		Farmers in M'hamid are practicing agriculture for subsistence mostly for the last 7 to 10 years. Most of them are practicing other activities besides farming since farming can't be guaranteed to bring income to the household all the time. They have low dependency on farming and water.	. Secure some groundwater supply to continue with subsistence farming activities as long as possible. . Secure a source of food while making their main income from other activities such as construction. Secure their identity as farmers of the oasis.
	Touristic facilities owners		Owners of touristic facilities such as hotels, campings,	. Secure water supply for their touristic facilities and guarantee offering proper and full services for visitors, to secure their income.
Fezouata case	Farmers	Household farming	Local inhabitants practiced subsistence farming and selling a small part of it in the local markets. This is practiced besides other activities either inside the area such as teaching or construction, or outside the area in big cities. The farming activities are usually financed by remittances from family members working abroad and income made from other activities.	. Secure water and income to continue practicing farming and guarantee their well-being in the area. . Secure a source of income that will help finance their farming activities and other expenses. Secure their identity as farmers of the oasis.
		Business farming	Local inhabitants practice farming as a primary source of income. They are owners of farms and produce dates and other products that are sold on local and national markets.	. Secure groundwater supply to continue practicing farming and making profits from dates mainly. . Secure their identity as farmers of the oasis.

Appendix 3. 5 Quotes from interviews supporting the characterisation of the SESs

SES variable	Quotes
Resource System and Resource Units of M'hamid	**N° 1**: *"If we want everything to get back to normal, we need rain up there, in the mountains. I'm talking from Ouarzazate, the dam of Al Mansour Eddahbi until down here, because if rain water reached the dam of Al Mansour Eddahbi, it would eventually reach the Oued [river] here. If there's a great amount of rain water, it would pass from the dam through the Oued, and then the water would get to the phreatic zone, which would be absorbed by the roots of the palm trees"* (Manager collective well, Talha, 2022).
	N°2*: "There's a canal, and the releases from the dam, about three times per year. But lately, the dam has become empty so we got just one or two releases in these last two years, and the well. There are some people who built their own wells, but for me, I didn't build my own well. I get water from this* [collective] *well with solar panels* (Manager collective well, Talha, 2022).
The governance system of M'hamid	**N°3:** *"The first collective well was made in Talha village that has been for 7 years now. In Ouled Mahiya village, two more collective wells were constructed this year, and are not operating yet. One in Mhamid village, another in Zaouia Al hana village, and another one in Lahnanich village. One is in the process in Ragabi village. You can see it once you enter Mhamid. They all follow the same community rules." (Collective well manager, Talha, 2022)*
Outcomes of M'hamid	**N°4:** *Yeah, the problem is the quantity of water, the water went down, we rely on the Palm trees … but the roots of the palm trees can't reach the water anymore, this year you can't find water underground until you reach 12m, and last year it was 11m, so for only one year the water went down by 1m"* (Manager collective well Talha, 2022).

Appendix 3. 6 SES complementary variables

Case study	Institution	SES key characteristics				Outcomes	
		Water infrastructure	**Sector**	**System boundaries/size**	**Harvesting levels**	**Interactions**	**State of the aquifer**
Faija	Aquifer contract	Private wells	Commercial agriculture Drinking water production	Clear system boundaries Clear user community	Farmers are still finding enough water of good quality for their productive activities.	Information sharing: informal, empirical, not systematic. Monitoring: no water meters installed. Monitoring of illegal wells is loosely implemented and is circumvented by users. Deliberative processes: no formal mechanisms for co-decision-making between state & users. Decisions made by the government. Conflict: between tribes over control of land. Experience between local farmers and government over public drinking-water wells.	Deficit of 5Mm3/year due to over-abstraction and quality deterioration due to agricultural pollution.

Appendix 3.5. (Continued).

Case study	Institution	Water Infrastructure	Sector	System Boundaries/size	Harvesting Levels	Interactions	State of the aquifer
Fezouata	Statutory laws	Private wells Eddahbi Dam and canal system affects recharge rate of aquifer	Commercial (dates) and subsistence agriculture	Diffuse system boundaries. Diffuse user community	Water tables are dropping and salinity concentration increases but farmers are still able to find water in wells.	Information sharing: no formal institutions in place. Empirical information is collected by water users and shared with friends in informal conversations. Monitoring: no water meters installed. Monitoring of illegal wells in charge of government authorities but it is loosely implemented and is circumvented. Deliberative processes: Decisions on groundwater abstraction are taken individually. No collective action in place.	Interviewees report: that sectors of the aquifer show signs of depletion and palm trees are dying.
M'hamid	Self-governance organisation. Limited intervention of the state.	Collective wells Eddahbi Dam and canal system affect the recharge rate of the aquifer.	Subsistance agriculture	Diffuse system boundaries . Clear user communities	Farmers find it very difficult to find groundwater.	Information sharing: no information sharing between users and government. No sharing between users of different collective wells. Monitoring: users monitor water availability in wells and unauthorised abstractions. Sanctions based on customary rules. Deliberative processes: decisions made by collective wells boards, whose members are elected by voting.	The groundwater inflows and outflows at a balance point (ABHSMD,2010) of 225.4l/s Salinity concentration reaches a max. of 12.16g/l, with an average of 5g/l (ABHSMD, 2010).

AUTHOR CONTRIBUTIONS

Publication I - Chapter 2

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