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Master's Thesis - Water Science and Management

Community-Based Water Management in the Moroccan High Atlas Mountains

Analysing operational and strategic barriers: A case study
in the Ounila Catchment

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Summary

This thesis analyses the formal and informal barriers faced by the Community-based Adaptation (CBA) programme implemented by the NGO PermaAtlas in the Ounila catchment, located on the Moroccan High Atlas Mountains. Placed in one of the most water stressed regions in the world, the subsistence of rural communities in the study area strongly depends on effective and efficient management of water resources. Although researchers and policy makers have promoted Community-based programmes as a panacea to tackle water management issues, analysis of such programmes is limited and poorly demonstrated. With focus on the management of water resources, the barriers to the programme implementation were assessed through multi-criteria analysis using the Adaptive Capacity Framework. According to this analysis, cultural and community barriers, although strong at the beginning of the programme, have been partially overcome reaching now a fragile equilibrium. Currently, financial barriers are the main problem facing the expansion of the programme, as lack of sufficient funds could trigger latent disputes among different communities of the catchment. With this, the lack of adequate and complete monitoring also represents a major issue considering future infrastructure works and the increasing climate uncertainties of the region. Based on this evaluation, recommendations have been made to facilitate the dialogue among communities in order to reduce social unrest and to implement a reliable monitoring programme to quantify changes induced by the project.

Key concepts

Community-Based Adaptation: *“Community-led process, based on communities’ priorities, needs, knowledge and capacities, which should empower people to plan for and cope with the impacts of climate change”* Reid et al., (2009, p.13).

Barriers to adaptation: *“Factors that make it harder to plan and implement adaptation actions or that restrict options”* Birch (2014a, p. 1758). While limits are considered *“absolute or unsurpassable”*, barriers are possible to overcome with correct planning, sufficient effort, and enough resources (Eisenack et al., 2014, p.867; Moser and Ekstrom, 2010).

Operational barriers: Barriers that *“include relatively straightforward technical and financial requirements, (...) formal political leadership through department or ministry directives, the existence of a reasonably well-defined legal and administrative basis, (...) and the social receptivity to community-based management efforts”* (Armitage, 2005, p.708).

Strategic barriers: *“... largely informal attributes that have a fundamentally powerful influence on opportunities for collective action attributes (...) related to power, scale, knowledge valuation, culture, and the nature of community”* (Armitage, 2005, p.708).

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1. Introduction

1.1. Background information: Water management in Morocco

The High Atlas Mountains in Morocco are located in one of the most water stressed regions worldwide. Records since the 1980s have shown an intensification of the hydrological cycle in the region, with more recurrent dry periods as well as more extreme and unpredicted rainfalls (Rochdane et al., 2012; Marchane et al., 2017). According to different projections, an increase in temperature of 2°C to 3°C along with a decrease in precipitation of 20% to 50% is expected in the region by the year 2050 (Fouss & Douar, 2012; Rochdane et al., 2012; Marchane et al., 2017). Accompanying the existing problem of droughts, the increase in frequency and intensity of flood events has posed a new threat for the already vulnerable population (Zkhiri et al., 2017; Fouss & Douar, 2012; Marchane et al., 2017).

To deal with these extreme climatic conditions, Morocco has undergone several water-policy reforms since 1914 (Doukkali, 2005; Zkhiri et al., 2017). With primary focus on agriculture, a pillar of the Moroccan economy, the government concentrated resources on large-irrigation schemes to allow a massive expansion of the sector (Kadiri & Mahdi, 2009). The so-called policy of dams implemented in 1967 has defined the current national water infrastructure, expanding the number of large dams from 16 at the time to 140 in 2016 (Fay, 2000; Choukr-Allah, 2011; Gourfi & Daoudi, 2019). Even though the construction of large dams never stopped, international loan agencies forced Morocco to move into a more participatory, small-scale management of water resources in order to continue receiving allocated funds (Alaoui, 2013, Riaux, 2006a).

Pursuing this small-scale participatory management approach, the Water Law enacted in 1995 marked a turning point in the country's water management (Alaoui, 2013; Kadi & Ziyad, 2018). The Law 10/95 enacted by the national government reorganized the water sector under an Integrated Water Resources Management (IWRM) framework with the intention to achieve a more effective and efficient management of water resources (Choukr-Allah, 2011). Initiated in the 1980s by development agencies and confirmed in 1995 by the Water Law, the focus shifted towards the small and medium hydraulics of the country (Riaux, 2006b; Molle et. al., 2019). The Small and Medium Hydraulic Programme, implemented by the Moroccan government with the assistance of international donors looked for a stabilization of imbalances caused by the previous large hydraulic schemes (Tanmia, 2012; FAO, 2012, World Bank, 2009; AFDB, 2009; Riaux, 2006a). Despite outstanding reforms in administrative and legal aspects and positive changes at the infrastructural level (e.g., improvement of irrigation canals and equipment purchase) several authors have remarked flaws in the implementation regarding participation, legitimization, and transparency among local communities (Freyburg et al., 2009; Faysse et al., 2014).

The small and medium hydraulics, which had historically been characterized by the usage of non-regulated water and traditional community management were now under the influence of national ministries and international development agencies (Molle et al., 2019). As a consequence of the shifting power dynamics, customary rules were affected, natural resources depleted, and previously non-existent tensions were created (Riaux, 2006a; Riaux, 2006b; Kadiri & Mahdi, 2009; Azemzi & Erraoui, 2021). This, among other changes ushered in by the Moroccan water and agricultural sector can be understood as a common misstep in policy transfer, where the gravity of societal components such as cultural, political, and economic factors are undervalued by policy makers (Stone, 2017).

1.2. Community-Based Adaptation and its barriers to success

As a response to the faults within top-down policies and the complexity of the local context, Community-Based Adaptation (CBA hereafter) emerged globally as a novel approach to deal with climate change (van Ittersum & van Steenberg, 2003; Corburn, 2003; Allen, 2006). In particular, developing countries such as Morocco are more exposed to the effects of climate change due to specific intersections of geographical and socio-economic conditions (Roberts, 2013; Bathiany et al., 2018). Despite many systems of collaborative work have historically been in place in communities from the global south, increasing climatic pressure and socio-economic concerns have cast doubts about what communities can do on their own, demanding the necessity of more planned adaptation programmes (Spires et al., 2014). However, the singularity of each local context has made of the implementation of planned CBA projects a convoluted task, in which scholars have detected several barriers to its implementation.

In the field of barriers assessment to CBA programs, grey literature carried out by donor and implementation agencies tend to dominate the literature. However, in the last decade, academic analysis has been growing and contributing to more critical evaluation (Spires et al., 2014). Despite the specificity of each intervention, a plethora of barriers to successful CBA implementation in developing countries have been identified at the different stages of various projects (Moser & Ekstrom; 2010). A systematic literature review on CBA conducted by Spires et al., (2014) (focusing on academic research) and Piggott-McKellar et al. (2019) (focusing on donor agencies' reports) clustered the detected barriers under three main themes. The three main themes identified are *socio-political*, *resource*, and *physical* barriers; and each of them is possible to be further broke down into categories to facilitate its comprehension. Table 1 shows the categories ranked in terms of frequency.

Table 1: Barriers to Community-Based adaptation (CBA) interventions. Adapted from Piggott-McKellar et al., (2019), complemented by Spires et al., (2014)

Barrier	Category	Examples
Socio-political	Cognitive and behavioural	Unwillingness from the community to implement novel technologies
		Disinterest to support CBA activities by governmental agencies
		Disputes within the community
	Government structures and governance	Clash of CBA programmed activities with cultural beliefs from the community
		Miscoordination of objectives between governmental agencies
		Lack of appropriate agencies at multiple levels
	Communication and language	Unwillingness to adopt national policies at the local context
		Lack of clear and understandable explanation towards the community
		Confrontation of local and western knowledge
	Inequity, power, and marginalisation	Lack of clear roles and responsibilities within the CBA programmes
		Elite groups that seize decision-making control
		Silenced voices of marginalised groups
Resources	Financial	Disparages in access to the benefits of CBA
		Lack of funds
		Slow release of funds
	Human resources	Travel costs and staff expenses
		Lack of capacity from staff to perform tasks without supervision
		Lack of both technical and soft skills to reach the community
	Access to information and technology	Unavailability of staff due to extreme conditions
		Limited access to relevant information
		Limited access to technology to facilitate the works of the staff
	Time	Limited access to equipment to develop appropriate infrastructure
		Lack of time to create bonds and capacity building among stakeholders
		Limited time to build necessary capacity for the community to work autonomously
Infrastructure	Limited assessment of long-term initiatives due to lack of time	
	Poor design of infrastructure	
		Hamper of natural resources owning new infrastructure

Barrier	Category	Examples
		Contamination due to poor planning of infrastructure
Physical	Man-made	Human actions deploying nature-based solutions
	Increasing climatic conditions	Climatic conditions pushing beyond adaptation limits

1.3. Knowledge gaps, problem definition and research objectives

Knowledge gaps

The analysis of barriers to CBA programmes still presents certain gaps. First, research on barriers to CBA interventions have mostly focused on developed countries, primarily evaluating the participation of relevant stakeholders rather than the whole range of barriers (Spires, et al., 2014). Second, CBA programmes analysis in developing countries has been mainly carried out by donor agencies and there is a striking lack of academic work (Moser & Ekstrom, 2010; Piggott-McKellar et al., 2019). In this regard, peer-reviewed research is seldom carried out by professionals who work in a context of vulnerability, and even when assessed by scholars, socio-political barriers are often understudied (Adger et al., 2007; Jones, 2012; (Spires et. al., 2014). Considered this, Piggott-McKellar et al., (2019) and Spires et al., (2014) have highlighted the existing gap for more critical academic work in the evaluation of CBA interventions in developing countries.

Although the analysis of such programmes is highly context and time dependent, an increase of critical research is necessary to contribute to the complex challenge of such interventions (Forsyth 2013; Pelling 2010; Schipper et. al., 2014). For Morocco in particular, Choukr-Allah (2011), Houdret (2012), and Faysse et al. (2014) advocate for an inclusion of often-neglected underlying drivers of water management to address current and future water issues in a more holistic way. These drivers: (i) customary practices, (ii) interpretation of the Islamic law, and (iii) contemporary legislation, define water management at local scales where sacred '*water from heaven*' competes with '*state water*' (Doukkali, 2005; Allen, 2006; Kuper et al., 2009, p.2).

Besides contributing to the existing body of scientific literature, the present thesis also aimed for a strong societal impact. The research was carried out in partnership with the Moroccan-Dutch NGO PermaAtlas, whose main objective is to provide sufficient food and drinking water to the communities of the Ounila catchment¹, in line with the Sustainable Development Goals 2 (zero hunger) and 6 (clean

¹ The Ounila catchment is located in the High Atlas Mountains in Southeast Morocco, within the Drâa Basin, one of the nine hydraulic basins defined in the Water Law of 1995 (Figure 1).

drinking water and sanitation). PermaAtlas was founded in 2015 as a response to an aid-request from the population of Anguelz (the main village of the study area) after being struck by an extreme flood suffering the loss of human lives and massive economic damages. PermaAtlas works through holistic land regeneration as a way to reconnect ancient Berber resilience to contemporary society². With this, they tackle issues of water infrastructure and land deterioration to anticipate problems such as land erosion and consequent floods (Figure 2 and Figure 3) (PermaAtlas, personal communication).

Problem definition

Recent success on the works carried out by PermaAtlas and the community has caught the attention of local authorities and neighbouring communities with the intention of expanding such activities, triggering two main concerns. First, the potential association with local authorities (scale-up), considering the mistrust of the community towards the local government. Second, the expansion of the programme to neighbouring villages (scale-out), potentially unleashing latent disputes among local communities. These concerns, however, are not exclusive of PermaAtlas and lie within a broader scientific debate. For the last decade, how to accurately scale out and up CBA projects has been a central debate among experts in the field. For this, scholars have demanded further studies on formal (i.e., inadequate political and economic context) and informal (i.e., social and cultural perspectives) aspects, particularly in developing communities, to facilitate the expansion of such projects (Schipper et al., 2014; Piggott-McKellar et al., 2019; Kirkby et al., 2015; Fouss & Douar, 2012; Pandey & Okazaki, 2005; Hiwasaki et al., 2014; Houdret, 2012; Armitage, 2005; Moser & Ekstrom, 2010; Piggott-McKellar et al., 2019; Spires et al., 2014).

Research objectives

The objective of this thesis is to contribute to the knowledge gaps in CBA programmes barrier analysis in global south countries by researching the barriers that could hamper the potential scaling (out and up) of the programme already being carried out in Anguelz. To do so, the following research questions are asked.

- What barriers can be expected to the community-based water management programme implemented in the ***Ounila Catchment***?
 - Which **stakeholders** are involved in the water management?
 - What **challenges** do locals face regarding water and water management?
 - What are the **operational and strategic** barriers to the implementation of a community-based water management program?

² PermaAtlas objective is to transfer old techniques such as Permaculture and gabions to newer generations to overcome land erosion also developing cooperation within the community.

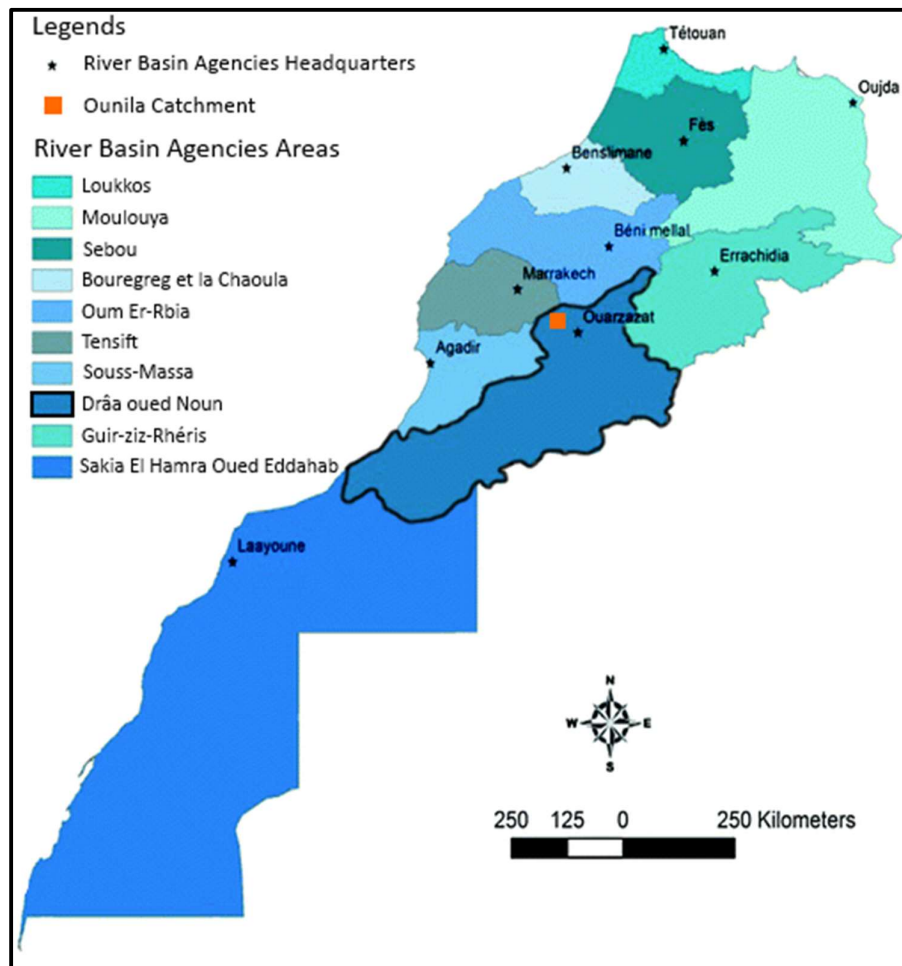


Figure 1: Hydrological Basins in Morocco and the Drâa basin. Adapted from Kadi & Ziyad (2018).



Figure 2: A worker from PermaAtlas contemplating the greening of the hillslopes to avoid land erosion. Retrieved from Perma-atlas.com (2021).



Figure 3: Villagers learning how to build gabions to slow down runoff and minimize land erosion. Retrieved from Perma-atlas.com (2021).

2. Methods

2.1. Study area

The Ounila Catchment

The Ounila Catchment is located in the dry eastern regions of the High Atlas Mountains, in Ouarzazate province, covering an extension of 730 km² (Figure 4). The watershed boundaries are defined by the Asif Ounila and Asif Mellah drainage divides, starting at the peaks of the High Atlas Mountains in the north and ending at the outlet in Aït-Ben-Haddou (Figure 5). Due to its topographic characteristics, the climate in the catchment varies from cold-dry in the higher part of the catchment to warm-arid at the outlet. In recent years, more extreme and unpredictable rainfalls have intercalated with more intensified periods of droughts that can last up to five months (Benassi, 2008). Benassi (2008) has shown a decrease in precipitation by 15% when the period 1961-2000 is compared against the 1971-2010 period.

Despite the seasonal variability of the region, the inhabitants of the High Atlas Mountains have learned to adapt their activities by regulating agropastoral activities through a strong traditional institution called *Agdal*. The *Agdal* assisted in the sustainable management of the ecosystem by administering the periods for pasture considering the adaptive capacity of the environment. In the last sixty years, however, the population of the High Atlas Mountains has undergone several socioecological changes that impacted their livelihoods (El Aich, 2018). The shift from a nomadic to sedentary lifestyle increased the intensity of grazing activities and reduced the quality of available land. Additionally, sedentarism

lead towards a more individualistic system which weakened the authority of *Agdal* and turned the ecosystem to an “open system”, without sufficient means to control it (El Aich, 2018). The increasing climatic pressure along with a heightened grazing activity has eroded the slopes and led to more recurrent floods and landslides in the region (PermaAtlas, personal communication).

The community of Anguelz, where PermaAtlas works began, is the biggest village of the study. Anguelz is characterised by a strong, traditional Berber culture, with a hierarchical religious and political delineation. Its residents can be widely defined as young and low educated with high percentages of illiteracy, and most of the 1200 inhabitants perform as farmers or craftsmen and live by the day (PermaAtlas, personal communication). According to Nieboer (2019), almost the entire population are farmers, with 75% owning their land, while 25% are without land ownership, and a variable of 1-5% of the population works outside of the village. Additionally, the region suffers from high levels of poverty, which has pushed the youngest to emigrate in search of opportunity. The villages of Timsal and Tourassine, where PermaAtlas is planning to expand, are also part of the current study. The characteristics of these communities resemble to Anguelz closely, and the location of all settlements can be seen in figure 5.

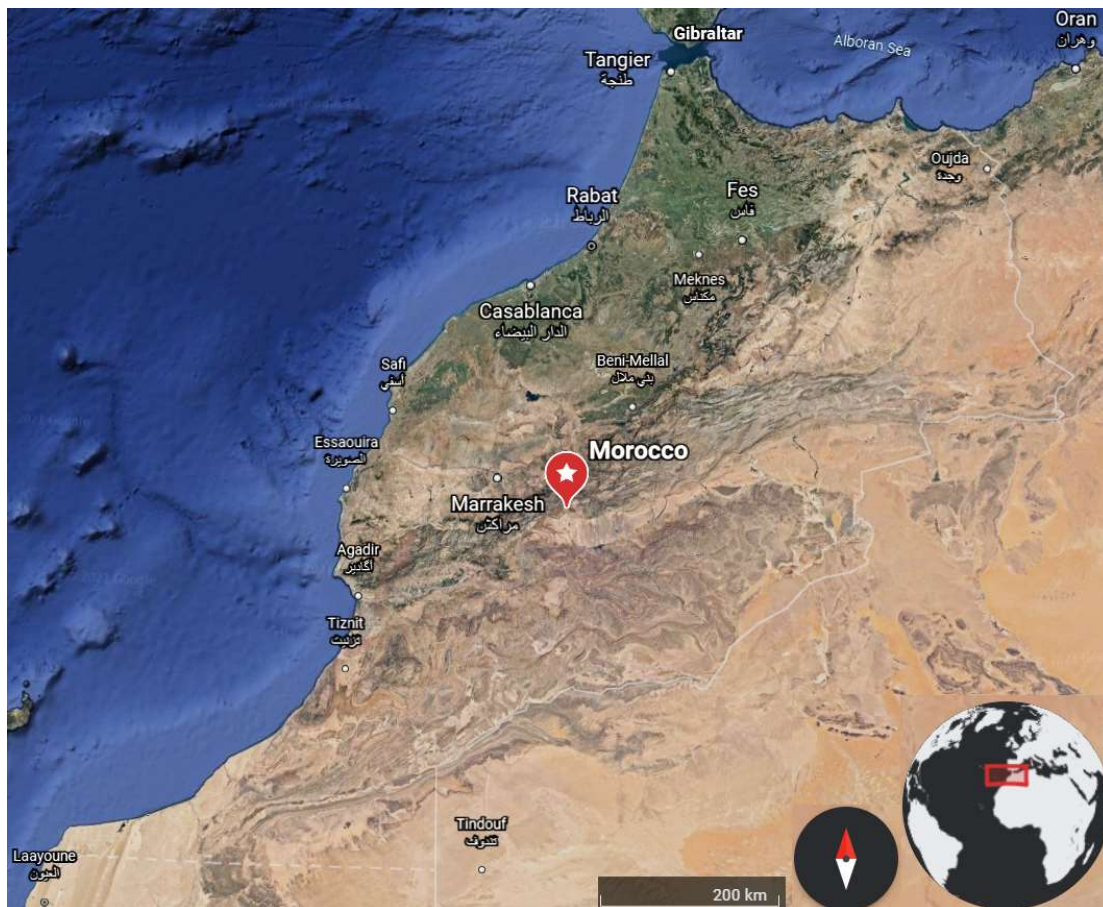


Figure 4: Google satellite image. Location of the study area.



Figure 5: Google satellite image. The Ounila Catchment delimited in red and the location of Anguelz, Timsal, and Tourassine

2.2. Analytical Framework - Adaptive Capacity Framework

For the purpose of this research, the Adaptive Capacity Framework developed by Armitage (2005) was used. Building on the works from Adams et al. (2003), Folke et al. (2003), and Pretty (2003), Armitage (2005) developed the Adaptive Capacity Framework to conduct a thorough analysis of underlying factors that leverage the functioning of community-based management of natural resources programmes. Armitage (2005) developed this analytical framework as a response to other analysis that tend to simplify the complexity of Community-based programmes, easing their study but leading to biased and unsatisfactory results that often ignore socio-cultural complexities (Leach et. al., 1999; Li, 2002; Armitage, 2005). On the one hand, some studies assumed unity and homogeneity within the community, ignoring existing social complexities and power structures (Pomeroy et al., 2001; Thorburn 2002; Leach et. al., 1999). On the other hand, studies idealized CBA as an equitable and sustainable process aligned with nature, ignoring overexploitation of natural resources by the community (Kellert et al., 2000; Leach et. al., 1999).

According to Armitage (2005), the production of adaptive capacity within community-based resources management relies, primarily, on a meticulous analysis of *Operational and Strategic issues* that forge participants' behaviour, shape the system, and define problematics. This framework serves thus to analyse if the Community-based intervention possess: (i) clear goals and objective, (ii) sufficient economical and technical capabilities, and (iii) aligned social relationships and values, in order to achieve good performance (Armitage, 2005). The variables and qualitative indicators used in this research are defined below in Table 2.

Table 2: Adaptive Capacity Framework. Armitage (2005)

Barrier	Variable	Qualitative indicator
Operational	Technical	Trained personnel, specialized staff (technical and planning skills)
		Data management, standardization, sharing
	Political	Leadership within Community-Based Natural Resources Management organizations
		Motivation of decision makers
		External leadership, political support to Community-Based Natural Resources Management
		Continuity of political support
	Institutional	Clear definition of roles, responsibilities (e.g., organizational property rights)
		Institutional conflict
		Enabling legislation to support Community-Based Natural Resources Management
	Financial	Organizational accountability
		Sufficient funds to support Community-Based intervention
		Stability, consistency of funds
	Social	Control over resources and funds (internal or external)
		Awareness and understanding about Community-based resources management among resource users

Barrier	Variable	Qualitative indicator
Strategic	Power	Differential power relations among resource users in an institutional/organizational and property rights context
		Implications for rule creation, adjudication, enforcement and distribution of rights and benefits
	Knowledge	Control, ownership of knowledge
		Use, misuse of different knowledge frameworks (western, traditional)
		Challenges bridging knowledge systems
Community	Ethnic, religious, class differentials within communities Impact of misinformation, misconception, mistrusts within heterogeneous community	
Culture	Consistency, inconsistency of norms, values, worldviews among resource users / interests across scales	
Strategic	Scale	Scale mismatch among resources and resources users (local and external)
		Cross-scale socio-political and economic effects Changing livelihood systems (subsistence to commodity)

2.3. Data Collection and analysis

To assess the variables presented in the Adaptive Capacity Framework this thesis employed literature review, document analysis, and semi-structured interviews as sources of data collection. This combination of multiple data collection methods was used to obtain exhaustive results and reduce potential biases (Patton, 1990).

Literature review

The search engines used to collect relevant literature were Google Scholar and Scopus. The search started with broad terms as '*water governance in Morocco*' and '*water management in Morocco*' to access critical academic work in the country's water sector. The search was continued by more refined search terms as '*participatory water management in Morocco*' and '*Community-based water management in Morocco*'. Later, the term '*Morocco*' was replaced by the term '*Drâa basin*', the hydrological basin where the study area is located. Further on, studies meeting these criteria were excluded: (a) bibliography before the year 1995, with the intention to access literature that addressed changes introduced by the Water Law of 1995; (b) studies not performed in Morocco or only using the

country as an example within broader topics such as ‘*water in Islam*’; (c) studies not related to water management; (d) studies not addressing participatory or community-based water management; and (e) studies that were performed in markedly different socio-political contexts than the one in the Ounila catchment (e.g., coastal or urban areas). The final literature consisted in thirty-one papers that addressed the topics under study.

Given the socio-ecological nature of the study topic, the ‘*five-stage grounded-theory*’ method presented by Wolfswinkel et. al., (2013) was chosen to perform the literature review, as it allowed a holistic appraisal of the papers (Boell & Cecez-Kecmanovic, 2015). This method follows a rigorous process of research, interpretation, and classification to assess the literature under evaluation. These steps can be seen in *Appendix 1: Five-stage grounded-theory methodology*. Wolfswinkel et al., (2013).

Document analysis

The document analysis procedure presented by Bowen (2009) was applied to perform the document analysis. The laws 10-95 and 36-15, as well as documents from the Souss Massa – Drâa water basin agency (Agence de Bassin Hydraulique de Souss-Massa or ABHSM) were studied. These governmental documents provided significant data on the definition of institutional roles, financial planning, and technical capacity, as well as contributed with an overview of the topic in the eyes of local water authorities. Analysis of official documents provided better comprehension of the formal institutions and allowed further contrast to answers obtained during interviews and literature review.

Semi-structured interviews

To perform the interviews, potential interviewees from local authorities, villagers of the catchment, and experts were identified in advance based on their relevance on the topic of discussion, in line with the purposeful method presented by Koerber & McMichael (2008). In particular, villagers with key roles in the water management of the study area were selected based on previous research in collaboration with PermaAtlas. The guideline from deMarras & Lapan (2003) was used to prepare the interviews, as it dives into methods for inquiry as well as ethnography, a highly relevant lens for this study. The interviews were performed in English and Berber according to the interviewee, with translation assistance from PermaAtlas for Berber language. A total of 15 interviews were conducted on: (a) eight villagers from Anguelz, one villager from Tourassine and one villager from Timsal (b) one ex-worker of the water department of Morocco, (c) one researcher of the Drâa Basin specialised on land and water conflicts, and (d) two staff members and one external technical advisor of PermaAtlas. A list of questions was prepared based on the 10 major variables of the Adaptive Capacity framework to guide the interviews without restraining the opportunity to expand on topics not included but considered relevant for the development of the research (*Appendix 2: Questionnaire for interviewees*).

Semi-structured interviews provided not only answers to the pre-selected questions, but also organic reactions, attitudes, and ideas on behalf of the interviewee (Bryman, 2016).

To analyse the interviews, the *'six-phase guide for thematic analysis'* presented by Braun & Clarke (2006) was used. The objective of this analysis was to identify, analyse, and report themes (i.e., variables according to the analytical framework), to answer the research questions. The six-phases described in **Appendix 3: Six-phase guide for thematic analysis**. Braun & Clarke (2006) were followed through a constant iteration process to obtain more concise, coherent, and unbiased results (Maguire & Delahunt, 2017; Braun & Clarke 2006).

3. Results

3.1. Stakeholders involved in the water management of the study area

The management of water resources in the Ounila catchment is managed at the village level, with little interaction occurring amidst neighbouring communities or local authorities. With respect to management, Anguelz, Tourassine, and Timsal present some similarities. For example, each community elects one person to be representative of the village with local authorities, while two or three people represent and negotiate with neighbouring communities when necessary. In the case of the irrigation system, the three villages organise themselves through traditional rules of 'turn-taking'. In which a "turn" is demarcated as a certain period of time or amount of water received, after which each farmer receiving the water closes the access and passes the turn to the neighbour. However, these irrigation rules, as well as other rules and authorities, varies according to the community and the water system under study with more marked differences. To illustrate this, management strategies and stakeholders involved in each village are explained below.

In Anguelz, due to the presence of PermaAtlas (and thus a greater number of available interviewees), it was possible to go into further details of decision-making processes of the different water systems. For the irrigation system, representatives of each family (usually the oldest man of the family) meet at the mosque or a large common area and discuss future works needed. Once the works have been decided, each family must provide a member to work on the agreed projects. In case none of the family can attend, the household is responsible to pay someone to work on their behalf. For the overview of these works, a committee of six people is elected once a year by the heads of each family. The members are elected based on a number of criteria, for example, their presence in the village and the aid provided to the farmers. The turns for irrigation in Anguelz are controlled by neighbours, and the committee only intervenes in case rules are violated. The committee is also responsible to overview the 'turn-taking' of water from the river with neighbouring villages. When canals are open to access

water from the river, one member of the committee from each village conducts timing to ensure that no extra water is taken by peers from other villages.

However, what may seem as a fair election democratically choosing people to overview the works, has been questioned by the villagers during the interviews. Interviewees stated that the future selection of the members is already known in advance by all the community, as they are always the same old men from the richest and most traditional families of the village. These families earned their power in the past through linkages with the government and, although those linkages have eroded with time, their position of power in the village has remained. Corruption the night before the election was mentioned as frequent, where people visit different houses and offer 100 dirhams for the next day voting. Even if during the election process someone outside this powerful group is elected, the committee is later formed by members of these families anyway. The fairness of the committee was also questioned by the villagers, where corruption and mismanagement are acknowledged by all the community and openly discussed, even by the committee itself. During the interviews, one ex-member from last year committee openly disclosed stealing water when overseeing the turn-taking process. Additionally, the irrigation committee has a strong power of veto, and the selection of works will depend on the committee's needs rather than on the community's demands. The committee is considered as the guardian of the oldest and most traditional rules, and, although the fairness of the committee was questioned, villagers understand their presence as a stabilizer of potential conflicts.

The drinking water system in Anguelz is also managed by a committee, different from the one for irrigation. Most of the drinking water is obtained from a well, but only accessible to people who can financially afford it, while the rest of the village must drink water from the irrigation canals. The access to drinking water in Anguelz is not managed by customary rules, but by water meters, and to control the water meters and the necessary work, a committee of seven people is elected. The positions in these committees are also seen as a source of power and prestige rather than a place to solve village's drinking water problems. Although on paper the committee is formed by seven members, a current member of the committee stated that not all of them work.

In the village of Tourassine, the irrigation system is also organized around a 'turn-taking' system and the water is supplied from a tank that collects water from the river. Unlike Anguelz, there is no irrigation committee in Tourassine and the respect for the rules is controlled by the neighbors themselves. Every fifteen days a different farmer is responsible to overview the irrigation system and solve any problem that could emerge. Regarding drinking water, Tourassine does not count with water wells nor water meters but relies on water from close springs as a source. To manage the usage of

drinking water, the village open the pipes from 12h to 18h, and the women of each family approach the center of the village and take what is needed.

The village of Timsal also organizes their irrigation system around the traditional 'turn-taking' system. The enforcement of the rules is managed by the villagers of the community without the presence of a committee. Interestingly, however, the organization around the drinking water system differs greatly from Anguelz and Tourassine. Timsal counts, as Anguelz, with water meters to control the access to drinking water and later collection of the water bill. However, the overview is in charge of three people hired by the village and paid with money collected from the water bills. Two of the three people oversee the water consumptions of each household, while the third person opens the tap for the entire village at an accorded time.

Finally, the role of the local authorities in the area is seldom visible but holds a strong influence when involved. The local government is seen by the villagers as a coercive institution with the power to allow or reject any action in the region, as well as a potential enforcer of new rules. The local government is reached out when disputes regarding customary rules cannot be settled at the community level, although this rarely occurs. All villagers have claimed that customary rules of irrigation are seldom broken by farmers, whether of fear to Allah or respect to the oldest traditions. With previous violations, the conflicts were solved almost immediately within the communities and the presence of the government was not needed. Three of the villagers interviewed (two from Anguelz and one from Tourassine) have demanded the presence of the government to enforce new rules to solve emerging concerns such as the pollution of the Asif Ounila River. As discussed with a researcher of the Drâa basin who specializes in land and water conflicts, the government seems to have a policy of *laissez-faire* or "do-nothing" policy, in which they allow the community to solve the conflicts on their own, avoiding any kind of responsibility in local disputes. Additionally, when works were carried out in the villages by local authorities, these lack of correct planning and execution, as villagers have complained about wells providing silted water, and gabions and bridges collapsing after rainfall events.

3.2. Main water problems faced by the population in the study area

Of the ten villagers interviewed, seven (six from Anguelz and one from Timsal) stated lack of continuous access to drinking water as the main problem while other two (both from Anguelz) expressed floods, and one (from Tourassine) considered both problems at the same level of importance.

From the seven villagers who stated lack of continuous water supply as the main problem, six claimed the mismanagement of the drinking water system as responsible for the lack of water rather than actual scarcity. Pipes breaking, for example, was cited as the most recurrent issue. This idleness by the

wealthiest people in Anguelz relies on the fact that lack of drinking water does not affect them directly. In case of stoppages in the water supply, the wealthiest people in the village access water from further distances as they own vehicles, while other villagers need to walk over an hour to access a different source. The continuity of drinking water supply is of course also dependent on the availability of water from the springs or the wells. Although water scarcity was mentioned as a pressing issue, it was not considered as the main cause for the lack of water supply, and, as stated by some villagers, they have learned to deal with seasons of water scarcity.

When asked about floods, villagers in Anguelz stated that since the works of PermaAtlas began, the new infrastructure was sufficient, and thus, floods were not a concern anymore. On the other hand, pollution of the Asif Ounila River was mentioned as an emergent concern but not considered as a pressing issue.

3.3. Barriers to Community-Based Water Management in the study area

Based on the Adaptive Capacity Framework, Table 3 summarizes the results obtained when assessing the potential operational and strategic barriers to the future expansion of the CBA programme carried out by PermaAtlas. Below the table, each of the barriers are presented in depth.

Table 3: Operational and strategic barriers to the implementation and future expansion of the CBA programme detected in the study area.

Barrier	Variable	Results
Operational	Technical	Although workshops have been given, it is impossible to ensure even and sufficient knowledge on behalf of the staff in both technical and planning skills. Monitoring and data management of the works in close to null and a main concern for PermaAtlas.
	Political	The political support to the implementation of the program has been limited but fundamental to the kick-off of the program. However, continuity of support cannot be ensured. Research in Morocco have shown that political support to this kind of programs has been limited and poorly implemented.
	Institutional	The presence of PermaAtlas has disrupted ancient traditional institutions which hampered the functioning of the program at the beginning. However, the roles and responsibilities within the programme are now clearly delineated. From the legal perspective, the Moroccan state does not recognize any kind of customary power nor accepts the existence of traditional institutions or practices for the management of natural resources.
	Financial	The funds provided to PermaAtlas so far have been sufficient. However, given the current budget, a potential expansion would represent a reduction of the current works in Anguelz, which could potentially trigger tribal disputes. The consistency of the funds is not secured, as some donors work through output-based grants,

Barrier	Variable	Results
Strategic		and the monitoring of the works in Anguelz is scarce. The communities' budget is not enough to tackle water issues and they heavily rely on government's aid to perform restauration works.
	Social	The awareness of the importance of collective work has been eroded during past years as the societies have turned more individualistic. Awareness of the importance of water resources is oscillating. While for irrigation water the rules are strictly respected, rules that regulate the drinking water system or the conservation of the river are often disregarded.
	Power	Power structures in the villages under study are clearly delineated. Wealthy families in Anguelz hold the seats of the irrigation committee, overseeing the works and monitoring the enforcement of the rules. The committees have a strong power of veto, and the selection of works will depend on the committees' needs, rather than on the community's demands.
	Knowledge	The knowledge brought by PermaAtlas, although based on traditional skills, needed to be bridge with the current way of working of the community, which changed in the past years. Concepts from western knowledge such as climate change are introduced but always under a religious umbrella, where causes and consequences are "Allah's will".
	Community	Class and ethnic differentials are relevant in the implementation and potential expansion of the programme. The wealthiest and more powerful families dominate all the water systems in Anguelz, with little to no influence in the decision-making process by the rest of the community. At the catchment level, the expansion of PermaAtlas to other communities could trigger latent disputes between the indigenous and the new communities of the study area.
	Culture	The norms and values in the villages under study have changed substantially during the past years. The community has adopted a more individualistic lifestyle and many changes have occurred in the way of grazing and working the lands. These changes hamper the sustainable use of the ecosystem.
	Scale	The water management in the Ounila catchment is characterised by the necessity of both local (drinking water) and transboundary (irrigation and contamination of the river) agreements among villagers. NGOs in the area have induced a change of scale from local to global introducing changes to the lifestyle present at the time. Also, many farmers are thinking about increasing the yield to export by accessing governments' subsidies which could potentially affect the socio-ecological status quo of the community.

3.3.1. Operational barriers

As stated by Armitage (2005), operational barriers are largely influenced by the institutional and policy context in which the community-based program is embedded. Faysse et. al. (2014) have shown the

importance of a strong water governance in the implementation of communal programmes in Morocco to ensure the presence of enough technical and financial requirements, as well as a solid political and institutional basis. Although the Ounila catchment is inhabited by rural communities situated on what might be seen as an isolated area, the availability of water resources and further success of the project is highly influenced by the context in which they are embedded. Below, the five operational barriers are assessed.

Technical

Since the start of the programme in 2015, the project has experienced several changes. The reparation works after the flood started as a self-organized activity, with financial assistance of PermaAtlas and with no further planning than restoring what was destroyed. Later in this process, PermaAtlas contacted different technical experts to tackle problems from their root. Since then, PermaAtlas has been advised in fields such as permaculture, architecture, and ecotourism. The assistance of technical experts, however, is not constant in the field and the presence of specialised staff has diminished since the beginning of Covid-19 pandemic.

Regarding training the locals, the community involved has received different workshops gaining some technical knowledge on the tasks carried out by PermaAtlas. According to staff from the NGO, however, it cannot be ensured that all staff possess the same or even sufficient knowledge to carry out all the planned tasks. While some people have worked on such projects their whole life, some others are learning, and some others do not possess the resources to comprehend what is being taught. Moreover, staff from PermaAtlas have stated that capacity building among participants is still lacking since, so far, the workshops have focused on technical aspects rather than on strengthen the water governance and the organizational infrastructure.

Regarding monitoring the works and managing climate change data, the situation of PermaAtlas is worrisome. Records of the works being done and of the workshops taught by the NGO are barely existent. Even technical advisors did not report the works done, yet it was part of their responsibilities. Although villagers stated that results are visible (e.g., more water is infiltrating, springs have more water, and more soil is retained behind the gabions), no data is being collected. Staff from PermaAtlas on the field claim to have *'everything on their heads'* but almost nothing is being reported. Even during the workshops, only the younger educated people can take notes given the high rate of illiteracy present in Anguelz.

From a governmental perspective, control and monitor of water resources are full responsibilities of the River Basin Agencies (RBAs) since 1995. However, RBAs lack financial and human resources to perform such activities (Del Vecchio & Barone, 2018). As it was stated by Molle & Tanouti (2017), the

current monitoring performed by Moroccan authorities, although advanced compared to other countries from the region, does not provide reliable information to ensure adequate planning of water resources. Also, the number of human resources has decreased significantly on the water sector, lowering the personnel available for control and monitor of water flows (Faysse et. al., 2010).

Political

The political support at the provincial level to the implementation of the program has been limited but fundamental for the kick-off of the program in Anguelz. The intervention of the provincial government allowing PermaAtlas to work in the area was key to unlock the reluctance of a major part of the community. Nonetheless, this first step and the political interest in the works of PermaAtlas cannot be simply translated to future political support, and more important, the continuity of it. There have been major contradictions at the policy level between the institutional framework governing the water sector and the actual design and implementation of policies that favours the questioning of political support to community-based programmes. Namely, the promotion of stakeholders' engagement in decision making processes versus actual implementation of participatory programmes in the country (Molle & Tanouti, 2017; Azemzi & Erraoui, 2021).

Participatory programmes regarding water management in the country have been seen as international standards that need to be achieved rather than as a goal to support vulnerable communities (Romagny & Riaux, 2007; Kadiri et. al., 2010). Within the new legal framework of 1995, the creation of Water Users Associations (WUAs hereafter) displaced existing local institutions and earned the disapproval in the local communities (Azemzi & Erraoui, 2021). Political analyses have shown how WUAs in rural areas in Morocco are often overtaken by the elites rather than truly representing the farmers (Del Vecchio & Barone, 2018; Faysse et. al., 2010; Kadiri et. al., 2010). Further explanation of the role of Water User Associations is given on the *institutional* sub-section.

Regarding Leadership within the programme, PermaAtlas follows a fairly clear structure. The president, former citizen of the village, has now earned respect and a place of prestige within the community thanks to the success on the works carried out. On the field, this leadership is further represented by four local young men, staff from PermaAtlas. Although there is no distinction on paper, one of these four men has stronger influence within the community, as he has strong connections with the wealthiest families but without belonging to one of them. The president and this young man are highly respected among the workers of PermaAtlas and, in words of some interviewees, are considered the salvation of the villages.

Institutional

As stated by an external technical advisor, the presence of PermaAtlas in the catchment has undoubtedly disrupted traditional institutions and ancient tribal governance structures. Local institutions such as the irrigation committee have been disrupted by the works of the NGO and see the presence of PermaAtlas as challenging their own activities. These committees have been historically characterised by being the guardian of irrigation works and advocating the most ancient rules. These institutions only oversee the rules that have been created in the past by their ancestors and see the new works as unnecessary and out of their scope and responsibilities. As a consequence, this has generated two institutions working in parallel following different techniques and rules but with the same intentions.

Concerning legal purview, the Moroccan state does not recognize any kind of customary power nor accepts the existence of traditional institutions for the management of natural resources, as all water is considered property of the state (Dahir n°1-95-154, 1995; Romagny & Riaux, 2007). However, enabling legislation to participatory programmes has been put in place to avoid conflict with customary practices. Under the umbrella of the Integrated Water Resources Management framework, a decentralised organization with actors at the national, regional, and local level was created. New basin authorities were constituted to address the upcoming challenges regarding water resources in Morocco and favouring the formation of WUAs (Dahir n°1-95-154, 1995; Choukr-Allah, 2011; Kadi & Ziyad, 2018; ABHSM, 2014).

This division of authorities and responsibilities, however, has encountered several issues when implementation took place (Freyburg et. al., 2009). As stated in Del Vecchio & Barone (2018), the new River Basin Authorities changed little compared to previous agencies, where structure, personnel, and resources remained intact. Additionally, River Basin Authorities' activities have often been restrained by the influence of the Ministry of Agriculture and foreigner donors, clashing with the alleged independence granted by the Water Law (Doukkali, 2005; Romagny & Riaux, 2007). At the lowest tier of the water management scheme, the WUAs, formed with the intention to create a participatory arena for farmers, have failed and proved unsuccessful into addressing day to day problems (Dahan, 2007). WUAs have lost all sense of legitimacy from their inception, as they are seen as imposed external institutions that compete with ancient water management institutions (Dahan, 2007; Azemzi & Erraoui, 2021). These institutions are communal processes based on heritage and, thus, inspire more confidence and greater involvement of the users than WUAs. As studied by Laamari et. al., (2011), and confirmed by the researcher of the Drâa basin, WUAs have become empty shells used by traditional institutions only to access subsidies from the government, which demands their existence to disburse the funds.

Financial

PermaAtlas currently receives financial support from different foundations as well as individual donors interested in financing small-scale projects with great impact. The funds are managed internally by the NGO, which reports the usage of the funds to their donors on a quarterly basis. While some of the funds are donated unearmarked, other foundations have an output-based donation scheme. So far, the fund support has proven to be sufficient in the purchase of construction material, clothes, and the wages of local villagers who work for PermaAtlas. However, staff from the NGO has stated that the current funds would not be sufficient in case of potential expansion of the works. In this regard, the consistency of funds is not secured, as it largely depends on grants from individual donors and the compliance with performance targets to access output-based donations. Considering the lack of monitoring of the project, this represents a major challenge in the future as it could substantially decrease the availability of economic resources.

For the works within the community outside those carried out by PermaAtlas, the budget comes from contributions from the families or the water bills. However, the loss of economic resources in past years has made this budget insufficient. The community possess restricted funds that only allows them to contribute with 20-30% of the total budget, relying on governmental authorities for bigger works. Furthermore, simulations in the Drâa basin performed by Heidecke & Heckelei (2010) have shown that under the current state, the income of farmers in the catchment will likely decrease by 2% in upcoming years under current conditions, with a risk of decreasing between 6-15% under more drastic climate change scenarios, enhancing the loss of sufficient funds.

At the governmental level, local agencies lack of sufficient financial resources to implement and enforce Basin Management Plans (Houdret, 2012; Laamari et. al., 2011; Azemzi & Erraoui, 2021; Del Vecchio & Barone, 2018). So far, provincial authorities have not granted economic or human resources to PermaAtlas. The likelihood of the government providing funds seems close to none according to interviewees, as the government operates through private companies or with their own resources. At the present time, the community is preparing itself to apply for subsidies granted by the Ministry of Agriculture to access drip irrigation and solar energy, which could potentially fill a financial gap.

Social

After generations of managing their commons in a collective way, the communities of the High Atlas have understood the importance of working together. However, as a consequence of societies turning more individualistic, this awareness has eroded during past years. In the last years, the work of PermaAtlas has seen to awaken this sense of community, diminished in the past years. The works carried out by the community involved with the project has turned the attention of those who rejected

it at first, from inside and outside the village, and people now are eager to stay and work for their community as far as an income is secured.

The awareness of the importance of water resources among the communities of the Ounila catchment could be described as oscillating. The understanding of the issues among villagers varies depending on the source and the time of the year in which these are discussed. Traditional rules for sustainable usage of irrigation water seems to 'activate' in times of scarcity, while if there is enough water, villagers tend to over-irrigate disregarding the turn-taking process. Interestingly, the higher awareness regarding water for irrigation does not translate into other sources of water. Villagers stated that when it comes to the irrigation system everyone knows they must contribute. However, when it comes to the contamination of the river, it is impossible for the rest of the community to understand the emerging problem. Even when solutions were proposed, the community could not agree on working towards solving the problem. A similar case occurs within the grazing system. Although to avoid floods in Anguelz the work of PermaAtlas heavily relies on re-greening the hillsides, shepherds continuously take their cattle to graze in the mountains reducing available vegetation.

3.3.2. Strategic Barriers

Experts in the field of socio-hydrology have remarked the importance of understanding water systems as influenced by social dynamics and vice versa (Sivapalan et. al., 2012; Di Baldassarre et. al., 2013). Thus, to understand the management of water resources in the Ounila catchment, an analysis on endogenous factors that influence the behaviour of the programme's participants is highly necessary. Armitage (2005), thus, proposes to also focus on more determinant aspects of community-based management of natural resources such as *power, knowledge, community, culture, and scale*, analysed below.

Power

Power structures in the villages under study are clearly delineated. Villagers of Anguelz, where most information could be obtained, stated the existence of four ancient and powerful families who exert control over most of the water resources in the village. Wealthy families in Anguelz hold the seats of the irrigation committee, overseeing the works and monitoring the enforcement of the rules. As previously mentioned, these families are considered as the founders and guardians of the oldest, most traditional rules. These power asymmetries regarding water issues are strong, where members of the committee can openly disclose stealing water suffering no consequences.

Furthermore, the irrigation committee has a strong power of veto, and the selection of works will depend on the committee's needs, rather than on the community's demands. Any new work proposed by the younger villagers is often despised and stopped as a matter of pride and prestige. This authority

is never confronted by the other families, as villagers fear for violent reprisals by these powerful actors. This does not only occur against other villagers but was also the case of PermaAtlas. When the project started, the wealthiest families intended to stop the project by different means. While formally they demanded the local government to stop the works, at the same time they threatened and physically assaulted members of PermaAtlas. However, PermaAtlas has gradually challenged some of the power dynamics present in Anguelz. Interviewees claimed that people now earn power based on the works they perform and get paid equally, which unsettles the most powerful families. Over the years with thanks to the success of the works, people from the irrigation committee are now relying on and intending to work with PermaAtlas to continue the work in the irrigation canals. Although members of the committee recognize the importance of PermaAtlas, advice is still asked in indirect ways, as receiving aid from the younger villages and women would represent a major blow to the pride and traditions of such institutions.

Knowledge

The knowledge brought by PermaAtlas, despite based on traditional skills, was mistrusted by the community at the beginning of the project. Villagers stated that this indeed used to be their way of working but much further in the past and never executed so proficiently. Even the older people who remembered this way of working were no longer accustomed to collective practices and skills to overcome soil erosion. Despite being local and introduced through recurrent workshops, the knowledge had to be tested on the field. People from the villages have the need to experience the results before accrediting for the new techniques. Initial mistrust was only overcome when the positive consequences of the new works were in sight. In this regard, villagers remarked the need of more experts to work along with them, not only on the technical aspect, but also on changing the community's mindset to avoid repeating mistakes. The necessity of learning how to think in the long term and within a planned structure was a recurrent topic throughout the study brought up by the villagers.

The knowledge implemented in the Ounila catchment by PermaAtlas departs from the more western structures, where religion and science are often decoupled. While only some of the interviewees seem to understand the causes and consequences of the more recurrent floods in the region (e.g., overgrazing), almost all of them are familiarized with the ways to mitigate the effects. The community and PermaAtlas understands this under a religious umbrella, where causes and consequences are always Allah's will. In a determinist religious cosmology such as Islam, Allah's will can have different meanings. The programme aims to make people understand that Allah's will is to work towards solving the problems of the village rather than merely accepting the changes and consequences over the ecosystem.

Community

Several differences exist within the communities under study. Class inequalities within communities and ethnic differences among the various villages have been the most recurrent topics regarding this barrier. The difference in social classes becomes more evident in the access to drinking water in the case of Anguelz. The piping system that brings water from the well can only be afforded by a handful of families in the village. Even within these families, the ones living further uphill from the well do not receive enough effective water pressure and suffer the consequences of the piping system deterioration. The poor people from Anguelz who cannot access the piping system rely on the irrigation canals as their main source of drinking water and are exposed to the risks of consuming polluted water from the river. Wealthy people are not only the most benefited from the access to the drinking water system but are also accused of often not paying for the service they receive. Given the fact that they can easily travel further distances to access drinking water, they do not feel the need to invest in upgrading the current piping system, which increases the tension among classes.

The level of mistrust within the village was considered high by the staff of PermaAtlas at the start of the project and, although diminished, it is still present in the area. Rumours are commonplace in Anguelz, and at the start of the project, the wealthiest families spread that PermaAtlas had come to keep the village to themselves. The works of PermaAtlas have had an effect in the community, where misinformation and class differentials are slowly being challenged. As stated by some villagers, once the results were in sight, it was very difficult to receive opposition, and the people who wanted to dismantle the works of PermaAtlas had little to do.

Additionally, disputes among the different villages of the Ounila catchment is a latent issue. Although villagers were reluctant to delve into such a topic, staff of PermaAtlas considered it as determinant in case of future expansion. When consulted, villagers claimed having no issues with neighbouring villages regarding water conflicts or of other kind. However, it was found out that rivalries exist between the indigenous villages and the new communities, sometimes even escalating to violent fights. Anguelz is the biggest and most ancient village in the Ounila catchment, while Tourassine and Timsal are smaller and newer communities. In words of staff from PermaAtlas, people from Anguelz consider themselves superior to the other communities of the valley. Relatives of people from Anguelz working for PermaAtlas suggested them that assisting other villages would be considered a great offense to their family and their community.

Culture

The norms and values in the study area have changed substantially during the past years. According to some villagers, the lack of assistance between habitants of the region has changed compared to two

or three generations ago, when resources were shared with the people most in need. Added to this behavioral shift in the way of relating, many changes have also been seen in the way of working the lands and cattle in the catchment. As stated by a farmer, the deteriorated situation is a consequence of lack of interest of the community in a sustainable management of the environment, in contrast with ancient grazing practices when shepherds used to restore eroded lands.

Different worldviews have also been detected as relevant during the research. When the project started in 2015, the conflict emerged mostly within the clash of powerful local institutions unwilling to change the status quo of the village against part of the community who worked towards the common good. While in some aspects such as irrigation progress has been made, examples such as waste disposal and drinking water show the opposite. Villagers have stated that, in the case of waste disposal for example, people would rather avoid an advantageous agreement only to aggrieve other villagers.

Scale

The scale barriers in the area under study can be assessed from different perspectives. First, the water management in the Ounila catchment is characterised by the necessity of both local as well as transboundary agreements among villagers. For example, while drinking water in the villages is managed at the local level, issues involving the river are undoubtedly a transboundary issue. However, scale does not seem to be the source of the problem. While transboundary issues should be more conflicting in theory, most of the problems are encountered on the drinking water and waste disposal systems, both managed at the local level.

The change of scale from local to global has also been perceived in the village of Anguelz. The presence of different NGOs in the area such as PermaAtlas has brought a change in the lifestyle present at the time. The empowering of the more vulnerable population is disrupting the governance structures that have managed natural resources until recent, where NGOs are involving the younger villagers in the development of new works through participatory approaches that clashes with existing hierarchical structures.

At Last, although most of the villages are highly reliant on agriculture for own consumption, globalization has also affected the economic context of the basin in which the region is embedded in. As expressed by the researcher of the Drâa basin, shifts in agricultural methods to increase the export market has generated massive changes at the socio-ecological level in the rural sector of the Drâa basin and could soon impact in the Ounila catchment. Encouraged by the government through the plan Maroc Vert (Green Morocco), the ministry of agriculture has engaged the farmers into a more water-intensive way of agriculture, hindering the water resources and increasing the social inequalities among farmers (Moumen et. al., 2019; Azemzi & Erraoui, 2021). This has been facilitated through the

subsidies provided by the Ministry of Agriculture to install drip irrigation and solar energy. The access to subsidies and how these impact at the socio-ecological scale becomes relevant to the study area since, as it was expressed by PermaAtlas staff, the community is soon to apply for such subsidies.

4. Discussion

4.1. Limitations

The Covid-19 pandemic present at the moment of this study limited the possibility to visit the study area. This limitation did not allow local appraisal of the community and its interaction, an important tool in the assessment of community-lead processes (Lara et. al., 2018; Mustanir & Lubis, 2017). All results transpired from the interviews without local evaluation of the social interactions or water infrastructure, possibly leading to a simplification of social dynamics (Harris, 2002). Also, the chances to contact local authorities were diminished, where only one authority was possible to reach out. The input of local authorities in the relationship with the communities from the Ounila catchment in various aspects would have added further value to the findings of this thesis. Additionally, given that Anguelz is the village where PermaAtlas is currently carrying out their works, the number of reachable interviewees there was greater. The difference in sampling size among villages could have impacted in the results. Last but not least, it is important to remark the limitations expected from the translation process during the interviews. Although measures were taken to reduce language barriers in translation, loss of information could have occurred during the translation from Berber to English (Squires, 2009). Despite the aforementioned limitations, the multiple data collection methods, the great number of people interviewed, and the amount of analysed bibliography provided reliable results to answer the research questions.

4.2. Analysis of the results: Scientific and societal implications, contribution to the theoretical debate.

By definition, the lessons learned from a CBA programme analysis is highly context and time dependent and they cannot be simply translated to other regions. However, the results obtained fall within and contribute to theoretical insights of CBA, Common Property Resources analyses, (Mehta, 2007; Mosse, 2006; Li, 1996; Bourdieu, 2007) and Sociohydrology (Sivapalan et. al., 2012; Di Baldassarre et. al., 2013).

Findings confirmed that socio-political barriers were the main challenge to water collective works in Anguelz at the kick-off of the programme. Before the involvement PermaAtlas, collective action was not driven by a sense of community, but rather by the costs and risks of adhering (or not) to the rules. Although lack of assistance and water grabbing from the wealthiest families was frequently

mentioned, stronger adhesion to the irrigation rules from most of the community exists in times of scarcity. This case study exposes lessons learned from Common Property Resources considerations. As researched by Mosse (2006) and Li (1996), when collective action is guided by costs and risks, people in power do not feel the need to associate nor follow the rules, and the pressure is put on the most vulnerable. Transgression of rules, thus, has different meanings depending on the one breaking them, where the people in power have the authority to trespass them without further consequences (Bourdieu, 2007; Mosse, 2006).

In addition to these power asymmetries that dominate the water allocation, villagers mentioned a stark difference between the respect for irrigation rules in opposition to rules concerning drinking water and waste disposal. This can be explained by two overlapping causes. First, the irrigation rules are ancient and almost everyone respects them *de facto*, while the rules dominating waste disposal and drinking water are still not consistently acknowledged at the village level. Second, the people's access to drinking water comes from various sources and so reaching a generalised consensus is unnecessary. Moreover, the contamination of the river only affects the lower classes who rely on it for drinking water, making it an inessential topic for portions of the community.

This is consistent with the main problem stated by the villagers. Lack of drinking water is an enduring issue that emerges from the technical problems in the piping system, managed by the wealthiest families, rather than actual water scarcity. As approached by Mehta (2007), scarcity thus invites a complex politically discursive lens that considers the equally complex matrix of lived experiences. These concerns put forth by Mehta (2007) are twofold. Most palpably, physical water scarcity, a real problem in the semiarid region of the High Atlas. With this, the constructed discourse and the resources available to deal with it. As far as the latter is concerned, wealthy families have different strategies to cope with periods of water scarcity and seldom need to cooperate with the rest of the community. Making water scarcity seem as a common problem benefits the interests of powerful people who then hold no responsibility to resolve such issues. With this political lens introduced by Mehta (2007), the reality of the situation materializes from objective conditions and constituted subjectivities.

The existent power structures, however, were challenged through the new ways of working introduced by PermaAtlas. In a community that needs to 'see to believe', the NGO has been overcoming the resistance from the powerful families through pilot projects and the success of the works done. These results illustrate and contribute to wider debates within CBA analysis. First, as stated by Roberts et. al., (2012), pilot projects have proven to be a strong weapon to reduce mistrust in closed and traditional communities. Second, PermaAtlas succeeded to penetrate the power groups opting for a '*co-opt-elite*

approach', in other words, partnering with old institutions rather than openly confronting them (Dodman & Mitlin, 2013).

Considering socio-political barriers as partially overcome at the time of the current study, the financial barrier seems to be the most pressing issue for the expansion of PermaAtlas. Given fund constraints, expanding the works to Tourassine and Timsal would imply a reduction of the works in Anguelz leading to societal unrest. As previously mentioned, helping neighbouring communities can be seen as an offense that potentially disrupts the weak equilibrium that has been reached at the time. It is, thus, not mainly a financial concern, but a necessity to maintain the region's stability. Decreasing funding for PermaAtlas could diminish the socio-political mitigation that took five years to develop. The major challenge towards the future seems to be, thus, the expansion of PermaAtlas to other villages, as the chances to reach transboundary agreements seems low in a context where even local agreements are hard to reach at the time.

Studies in the field of CBA have shown how the lack of monitoring and evaluation of activities can lead to failure of CBA programmes (D'Agostino & Sovacool, 2011; Meenawat & Sovacool, 2010; Ahammad, 2011). This presents a pressing issue for PermaAtlas, whose situation in this aspect is worrisome. As it transpired from the interviews, villagers do not consider floods as a hazard anymore and fully rely on the works done by PermaAtlas, with seemingly no reference to the past or the potential future. Without proper monitoring of the works done, it is impossible to assess if the changes made in the water infrastructure (which have proven successful so far) will be sufficient to buffer more recurrent and intense floods to come. This poses a risk since, as analysed by Dodman & Mitlin (2013), the result of a major structural setback within CBA programmes (e.g., failure of the water infrastructure against a flood) could lead to a complete loss of credibility from the community and could put at risk the entire project.

As in other CBA analyses, the lack of recorded data in Anguelz has two main causes. Most notable, this includes the high level of illiteracy among the participants of the programs (Meenawat & Sovacool, 2010). On the other hand, lack of consistent reports by professionals who worked for PermaAtlas, yet it was part of their responsibilities. This, however, is not due to a poor performance but, as Spires et. al. (2014) describes, professionals working on risk-education projects are focused on the practicalities of aiding vulnerable communities and do not consider reporting as a relevant task. At this point it is important to highlight that great efforts have been made by PermaAtlas to overcome the idleness of the population who relied on Allah's will to understand the problem of the community. This is remarkable since other research in communities of the High Atlas has shown how the population still has troubles to understand the benefits of future planning as they rely on Allah's will (Wyss et. al.,

2016). Considering that this mindset has been changed, PermaAtlas faces a generative opportunity for the implementation of a suitable monitoring and evaluation programme.

Concerning the political aspect, the potential access to subsidies by the villagers would imply the formation of a WUA, required by the Ministry of Agriculture, and could have many political implications for the villages. Examples in other communities from the Drâa and Souss-Massa Basin (Faysse et. al., 2010; Molle & Tanouti, 2017; Romagny, 2007; Kadiri et. al., 2010; Azemzi & Erraoui, 2021), and debates on collective action (Mosse, 2006), have shown that WUAs are often overcome by elites in areas where they are imposed. This poses a massive risk of reinforcing existing power structures by extending financial and political support from governmental authorities to powerful families (Mehta, 2007). Although Anguelz has already mitigated some aspects within these power dynamics, official support to the elites would have special influence in the village, where class discrepancies are visible when analysing collective works on water. In case of failure, this would reinforce the high mistrust against local authorities and could potentially undo all the progress made so far, a major barrier detected by other research projects in the High Atlas (Wyss et. al., 2016).

Lastly, from a technical perspective, access to subsidies for drip irrigation and solar energy poses as many benefits as cautions. As mentioned during the *results* section, the lack of access to drinking water is driven more by a lack of technical knowledge rather than actual water scarcity. In this sense, drip irrigation and access to more efficient technologies cannot be simply translated into more access to water. It is important to consider two aspects when addressing the inclusion of such technologies. Without the proper knowledge, the inclusion of drip irrigation could be a missed opportunity for local communities (D'Agostino & Sovacool, 2011; Dumar, 2010). Second, studies in Morocco have remarked how the switch to drip irrigation has led to overexploitation of water resources rather than to conservation of them (Molle & Tanouti, 2017; Del Vecchio & Barone, 2018). Drip irrigation tends to give a sense of abundance to the farmers, which often leads to the use of more water intense crop, exhausting water resources (Molle & Tanouti, 2017).

5. Policy recommendations and future research

Based on the main barriers detected, two policy recommendations are provided. First, Faysse et. al., (2014, 2018) have focused their research on ways to build dialogue when the governance is weak, management is poor, and minimal communication is relayed among water stakeholders in regions of Morocco. In this regard, useful recommendations can be provided given the current tension among villages and the local government. In a context of power disputes where sustainable use of water resources was seldom discussed, Faysse et. al. (in 2014 and successfully replicated in 2017) carried out a multistakeholder dialogue process among farmers and local authorities in rural regions of Morocco.

Success of this multi-dialogue process relied, according to the authors, on: (i) generating trust from the villagers by supporting their activities, (ii) performing separated workshops for farmers and local authorities to avoid initial failure in the dialogue and (iii) a final workshop where an analysis of the problem and potential gateways were discussed. This could be a potential way for PermaAtlas to facilitate the communication among villages as well as with the local government. Faysse et. al., (2014) observed that carrying out previous analysis of potential barriers (as the current research) facilitated the design of the workshops. Once the time for the final workshop had been reached, dialogue was easier, and stakeholders realised having similar viewpoints of problems and potential solutions.

Second, monitoring and evaluation in adaptation programmes are not an easy task. For that, Dumaru (2010) thoroughly studied how to successfully educate illiterate communities on the importance and the techniques of monitoring and evaluation tasks. In this experience, the focus was then set on teaching appropriate indicators and techniques of data gathering that accommodate to informal data collection that was already being carried out by the community. Additionally, a pending task for PermaAtlas is the assessment of the impact of implemented adaptation strategies. In this regard, Ford et. al. (2018) suggests that the lack of harmony between project schedules timescales of climate impact tend to difficult such tasks. For that, Ford et. al., (2018) proposes the usage of indirect measures or proxies to facilitate the evaluation of the success of the project. Through a more detailed and holistic process evaluation framework, it will be possible for PermaAtlas to assess not only physical changes but also progress in learning and decision making on the side of stakeholders involved.

Considering the results obtained, communal disputes between villages appears to be a complex and pressing issue when it comes to the expansion of PermaAtlas. Thus, future research should be carried out on this topic, expanding the complex portrait of conflict. Although this was impossible for the current study given the time constraints and the impossibility to travel, future research can benefit by interviewing a greater number of villagers and official authorities.

6. Conclusion

The findings of this research have shown that, despite their closeness, the rules and stakeholders involved in the water management of the study area vary according to the village under analysis. Although sharing some similarities when it comes to traditional rules, the village of Anguelz is characterised by two strong committees that overview the works and the enforcement of the rules, both dominated by the most ancient and powerful families. In Tourassine and Timsal the situation is different. For such responsibilities, the citizens organise themselves or hire people to overview and collect water bills. All cases are example of collective work yet organised through different rules and

methodologies. Regarding the government, the influence in decision making in the study area is little to null, intervening for large-scale projects or when disputes cannot be solved within the village.

The problems faced by the population in the study area are similar in all the three villages under analysis. Scarcity of drinking water presents as the main water-related problem suggested by the interviewees. However, it was interesting to understand that this problem was attributed more to the lack of proper organisation and infrastructure, rather than pressing water scarcity. Although people originally organised and requested the assistance of PermaAtlas in 2014 due to flooding, this issue has been barely mentioned as a problem. This can be attributed to two catalysts. First, the works done by PermaAtlas proven to be successful against rainfall events that occurred after the beginning of the program. Second, although infrastructure performed well against minor precipitations, no extreme rainfall event has occurred ever since.

At last, in the case of PermaAtlas, four barriers emerged as the most pressing ones. The *Community* and *Culture* barriers emerged as the most determinant in the kick-off of the programme. Through pilot projects and the success of the works, those barriers were partially overcome, and an apparent stability has been reached between the different social classes of Anguelz. At the present time, when PermaAtlas is facing expansion, the main barrier is *financial* as the current funds would only allow expansion by haltering the works in Anguelz. This could represent a risk considering the high levels of mistrust and the latent disputes among the different villages of the catchment. Stopping the funding to Anguelz would represent a risk to re-float old mistrusts in a situation of fragile stability. At last, the *lack of monitoring and evaluation* of the works done so far represent a potential barrier, as it would difficult the planning and funding of the project. So far, the works enacted have proven successful, easing the social tension found in the beginning of the project. However, a failure of the constructed infrastructure to more recurrent and intense flooding would represent a major blow to the trust of the community in the programme.

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Appendix 1: Five-stage grounded-theory methodology. Wolfswinkel et al., (2013)

Stage	Task
1. Define	1.1 Define the criteria for inclusion/exclusion
	1.2 Identify the fields of research
	1.3 Determine the appropriate sources
	1.4 Decide on the specific search terms
2. Search	2.1 Search
3. Select	3.1 Refine the sample
4. Analyse	4.1 Open coding
	4.2 Axial coding
	4.3 Selective coding
5. Present	5.1 Represent and structure the content
	5.2 Structure the sample

Appendix 2: Questionnaire for interviewees

Questionnaire for villagers

- Where do you live in Ounila?
- For how long have you lived in Anguelz/Timself/Tourassine?
- What do you do for a living?
- Where do you take the water from to irrigate/drink?
- What do you think are the main concerns regarding water in the village?
- Does everyone have access to water? For drinking or irrigation
- Why do you think x problem occurs?
- How do you work to solve that?
- Does the community organise together to solve these problems?
- Does everyone agree on the way of working?
- If not, what are the arguments about? What you discuss?
- Do you have enough men and money to do so?
- What happens when someone does not respect the rules?
- Why do you think some people do not like working together?
- Are there any disputes with other villages regarding water?
- If yes, what kind of problems? and how do you solve it?
- Can everyone be elected as part of the committee (if it exists)?
- Does the committee act in a fair way?
- Are there powerful/wealthy people that appropriate the water resources?
- Does the government come to assist in the works? How?
- Why do you think they never approached/approached little?
- What if they would work along with you? Do you trust them?
- How do you raise money now to perform the water infrastructure?

- The works you are doing with PermaAtlas, are they very different from the works you used to make?
- How are they different? Did you feel comfortable with the new way of working?
- What did you learn with the workshops and talks given by PermaAtlas?
- How did PermaAtlas changed the reality of the village?
- Do people understand the importance of working together?

Questionnaire for staff of PermaAtlas

- What do you think are the main concerns regarding water in the village?
- How does the community manage that now?
- Do you think the people working with PermaAtlas has enough technical knowledge on what they are doing?
- Do you keep track of the works you do with the community?
- How is the staff of PermaAtlas organised in the field?
- Are there enough funds to perform the works?
- If works were to expand, would there be enough funds?
- Does the community understand the importance of working together?
- Did you receive a lot of resistance at the beginning of the project?
- Are there many disputes within and outside the community? Or they all work in the same line?
- Do you think there are a lot of inequalities within the village?
- How would you define the voting and election of committees?
- Does the committee act in a fair way?
- Has the government approach to provide any kind of assistance?
- How do you think the reaction of the community would be if the government approaches?
- Are there any disputes with other villages regarding water?
- What would be the reaction of the community in case of expanding to neighbouring villages?

Questionnaire for worker of the Water Department of Morocco

- The government has gone through major reforms at the legal and institutional level almost 20 years ago. How would you say this transition went?
- Among these changes, the division into basin authorities. Did this represent an improvement?
- I have come across several papers stating that local basin authorities often lack resources to carry on their water plans and heavily rely on the national government. Is it like this?
- Where does the majority of the funds come from?
- Besides financial difficulties, do you observe technical difficulties? For example, people without the necessary skills or lack of available data?
- From your perspective, do you think responsibilities are clear or do you sometimes find overlapping with other departments or agencies?
- The new framework emphasises the implementation of Water Users Associations. What is your experience with this organizations if you have?
- In many areas, problems have been detected between the new Water Users Associations and traditional community-based management. Have you heard or experience this?
- Do you think the new planning adapted well to ancient traditions of water management?
- Is there mistrust when you as government try to implement a new project in rural areas?
- In your paper you describe that among the solutions to the problem of water scarcity, 50 big dams are being constructed or planned for the year 2030. Does the water department work or consider the use of green infrastructure?
- What is the relationship between the water department and the ministry of agriculture? Does the green Morocco plan sometimes clash with water conservation activities?
- Do you consider that water conservations receive enough political support?

Questionnaire for the researcher of Drâa Basin

For how long have you been working on the middle Drâa Basin?

What kind of land and water conflicts did you find in the area?

How do the communities in your research area solve conflicts regarding water?

How is the water management organized at the local level?

Does communal work regarding water management still exists at the communities of the middle Drâa?

Is there any difference between how the young and old generations organize to work towards water management?

How is the relationship with the government? Is there mistrust?

Do communities of the middle Drâa access subsidies from the ministry of Agriculture?

How is the creation of WUAs affecting the traditional water management at the local level?

Do you see a lot of inequalities on the field?

Does the population understand why there is less water, and understands the concept of climate change?

Appendix 3: Six-phase guide for thematic analysis. Braun & Clarke (2006)

Phase	Task
1. Familiarising with the data	Transcription of the interviews followed by an active reading. This implied the search for recurring subjects brought up during the interviews as well as notetaking of topics that brought the author's attention.
2. Generating initial codes	Codes were categorized according to the qualitative indicators presented in table 1 and labelled using different colours in Microsoft Word. A re-reading was performed after the first coding in order to check for missed relevant data as well as generating further codes than the ones determined by the qualitative indicators. Not every piece of text was coded.
3. Searching for themes	Codes (i.e., quality indicators) were classified into themes (i.e., variables according to AC framework). The definition of themes was 'theory-driven', that is to say, themes were predetermined rather than data determining them. Those topics which could not be labelled according to the predetermined indicators were grouped under 'miscellaneous themes', used as a category for further discussion as an emerging issue.
4. Reviewing themes	Themes that were not touched upon during the interviews due to different reasons (lack of response, time, or interest on the part of the interviewees) were excluded from the analysis. Additionally, all coded pieces were rearranged under the correspondent theme to facilitate the analysis and further writing.
5. Defining and naming themes	As themes were predetermined, these did not have to be defined or named. This step was skipped during the analysis of the interviews.
6. Producing the report	The sections of the current research were complemented or fully developed using the results obtained from this analysis in a complete, coherent, and concise way.