Morocco’s economy is growing at a sustained pace involving critical development activities in sectors like: Industry; agriculture; tourism; and energy. The water demand of these sectors will have to be met against the backdrop of shrinking water resources and amidst rapidly growing competition for water use. For the country, adaptation to climate change is the cornerstone of any program or policy on sustainable development. Some economic sectors or ecosystems are more sensitive than others are to climate change and groundwater depletion is at the centre of all these concerns.

FAO/WB Cooperative Programme. Nationally determined contribution support on the groundwater, energy and food security nexus in Morocco.

Final Draft

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The opinions expressed in this report remain solely those of the authors and not of the Government of Morocco.

CONTENTS

EXECUTIVE SUMMARY

Rising demand for water, particularly for irrigation, has put increasing pressure on Morocco's groundwater aquifers. A growing population and increasing agricultural production have contributed to a widespread overexploitation of groundwater resources beyond their renewal capacity, decreasing available resources and leading to problems such as water quality decline. The Government has emphasised the importance of adaptation to climate change for the already vulnerable water and agricultural sectors. Additionally, Morocco is seeking to mitigate climate change impact by relying in large part on an important transformation of the country's energy sector. This transformation is primary goals are by reaching over 52 % of installed electricity production capacity from renewable sources by 2030; reducing energy consumption by 15 % by 2030; reducing public fossil fuel subsidies, building on reforms already undertaken in recent years; and increasing the use of natural gas, through infrastructure projects allowing liquefied natural gas imports.

Over-abstraction and depletion of groundwater resources are not new issues, a complex set of interlinked state institutions, programmes, strategies and policies have developed over time to tackle this. At the same time, agricultural output and production intensity have increased; encouraged by a supportive policy environment that recognises the key socio-economic role of agriculture in Morocco. Therefore, whilst groundwater over-abstraction has already proved to be a difficult challenge to address, climate change and continued agricultural growth are expected to exacerbate existing problems, highlighting the need for policy tools to coordinate or balance competing challenges.

In this context, a better understanding of the dynamics of the water, energy and food sectors is an essential step for the development of effective strategies for the use of these resources. The water-energy food nexus offers an approach that: combines understanding the complex relationships and interactions between the three sectors; incorporates knowledge of dynamic local conditions and context; and aims to produce policy-oriented and practical resource management results.

The relevance of the adaptive decision-making approach to the water-energy-agriculture/food nexus has been highlighted, particularly in the context of climate change adaptation strategies. Policy dialogue is central to the adaptive decision-making approach and finding sustainable solutions from an environmental, political, social and economic perspective. Policy dialogue brings together all stakeholders, including policy and decision makers and farmers, to improve understanding of past stresses, current trends and future risks. The policy dialogue is done with a view to elaborate a common understanding of the existing conditions and a shared common future vision agreed by all watershed stakeholders. This in turn can lead to a more ambitious programme to assess the impact of possible strategies and ensure their adoption.

The present report reviews the linkages and interactions between groundwater governance, energy and agriculture, to motivate a sub-national or basin level policy dialogue to address the water-energy-food nexus, as well as to highlight data gaps, risks and limitations to groundwater governance.

In terms of the legal and institutional context, the 2016 water law sets out the framework for regulating Moroccan water resources sector with an integrated, participatory and decentralised water management approach. Water resources planning has three main elements: (1) integrated water resources management plans are developed by each watershed agency; (2) the national water plan is the main vehicle for strategy implementation, setting out investment programmes until 2030; and (3) aquifer contracts establish groundwater governance and management responsibilities, as well as financial and technical agreements between stakeholders (agriculture, industry and urban supply). The high water and climate council provides a national level forum and advisory body.

The framework for energy governance and regulation has prioritised the promotion of renewable energy, motivated by the high level of dependence on imported energy (oil) and the contribution the sector can make to climate change mitigation. For example, the provision of solar-powered water pumping for small farmers reduces non-renewable fuel use and changes the cost structure and therefore farmers' incentives which encourages farmers to increase water use. With solar pumping, farmers face high upfront capital costs and close-to-zero marginal costs, which increases their incentive to use up groundwater resources, as long as there is no opportunity cost for doing so (e.g. if there is no possibility of selling the electricity produced from the PV panels to the power grid) and no enforced regulation to limit water withdrawals.

The agriculture sector is, on the other hand, underpinned by the 2008 green Morocco plan (PMV) which combines: supporting the expansion of a modern competitive agriculture sector, including support and targets for more widespread use of irrigation and support for small scale and traditional farmers; and recognising their important social role.

Policies affecting groundwater use in Morocco are broken down into four different approaches: (1) regulatory; (2) economic instruments; (3) collective management; and (4) supply-side. The four approaches are used to investigate where there are policy interactions in areas such as drip irrigation, water pricing, groundwater abstraction control, as well as agricultural intensification and in terms of the coherence of water policy.

An overview of three value chains (olives, citrus fruit and tomatoes) displays how government support and policy has been an important factor in their expansion since the launch of the PMV. It highlights how all three sectors have either increased production (olives, citrus) or intensity (tomatoes) over the past ten years. PMV support has encouraged an expansion in the irrigated area or in production intensity. A review of the factors driving each value chain, as well as their possible future evolution is an important component in understanding how water, energy and agriculture interact ultimately to the design of measures that enable a dynamic agriculture sector with sustainable water use.

There is also a high degree of heterogeneity both across and within sectors, which needs to be taken into account when assessing the impact of policy changes. There has been a growth in the modern commercial farming sector; which, while supported by pillar I of green Morocco plan, its capacity to invest and develop would appear to be driven by economic considerations rather than water sustainability issues through the current set of water management policies.

There are important areas where improved data would help to better understand policy interactions including at the level of water accounting, the extent of groundwater-based private irrigation, how government support is coordinated across the wide range of ministries, public institutions and authorities; and sub-national, basin, farm or sectoral level agricultural data to enable a better understanding of the potential impact of different policies.

Key issues for policies that impact on groundwater are assessed in terms of their risks and limitations, e.g. the degree of coordination between different institutions and agencies responsible for water management at national, watershed and aquifer level. There are also weaknesses that can serve to reduce the effectiveness of groundwater such as: the current management and regulatory systems; the competition for scarce resources and budgets between different ministries and agencies; and the difficulties in data management and access to information. There is scope to improve information available to water users, including farmers, to better inform their decisions. There is also scope to better the agricultural sectors' economic and water management interests.

Currently, there is a lack of balance between groundwater abstractions and replenishment rates in many water basins. The review of policies affecting groundwater and their interactions in the water, energy, and agriculture nexus highlights several issues that merit further development in improving the sustainability of groundwater resources. This includes: reinforcing the capacity of watershed basin agencies, including the work they undertake on data collection and dissemination; supporting improved coordination and coherence across the diverse set of institutions and policies that impact on groundwater; ensuring that policy dialogue can help to develop effective solutions; and ensuring the participation and engagement of the private sector.

ACRONYMS

ABH: Agence de Basin Hydraulique

ADEREE: Agence de Développent des Energies Renouvelables et de l'Efficacité Energétique

CESE : Conseil Économique, Social et Environnemental

EU: European Union

FAO: United Nations Food and Agriculture Organization

FDA: Agriculture Development Fund

GIZ: German Agency for International Cooperation

IPCC: Inter Governments Panel on Climate Change

MAD: Moroccan Dirhams

MEF : Ministère de l'Economie et des Finances

MENA: Middle East and North Africa

MW: Mega Watt

NDC: Nationally Determined Contribution

PDAIRE : Plans Directeurs d'Aménagement Intégré des Ressources en Eau

PMV : Plan Maroc Vert

PNE: Plan National de l'Eau

PNEEI : Programme Nationale de l'Economie d'Eau d'Irrigation

PNUD: Programme des Nations Unies pour le Développent

WB: World Bank Group

RAP: Regional Agricultural Plans

SIDA: Swedish International Development Cooperation Agency

USD: United States Dollars

INTRODUCTION

BACKGROUND AND CONTEXT

Morocco's vulnerability to climate change due to its geographical location makes it prone to water scarcity, declining agricultural production, desertification, flooding and rising sea levels. For the country, adaptation to climate change is the cornerstone of any programme or policy on sustainable development. Some economic sectors or ecosystems are more sensitive than others are to climate change, namely water and agriculture.

As stipulated in the nationally determined contribution document, Morocco ought to first minimise the risks of climate change impacts and invest in adaptation compared to mitigation actions. Morocco forecasts that, between 2020 and 2030, the implementation of adaptation programmes will cost at a minimum USD 35 billion for the most vulnerable sectors (water, forestry and agriculture) (Morocco's NDC, 2016). On the mitigation side, Morocco has set a target to limit greenhouse gas growth through a major transformation of the energy sector but also through economy-wide actions based on strategies and sectoral action plans designed, amongst others, for the following areas of intervention: agriculture, water, waste, forests, energy, industry and housing.

Agriculture, deforestation and other land use account for roughly 25 percent of all greenhouse gas emissions (IPCC, 2014). When the share of industry related to agriculture is included, the agriculture sector is an even greater contributor to climate change. It is thus crucial to identify technologies and practices that ensure a high and sustainable level of agricultural production while reducing greenhouse gas emissions from the sector (FAO-b, 2016). Groundwater depletion is at the centre of all these concerns. The groundwater situation and increasing water scarcity will strongly influence farmers' and especially small-scale farmers' capacity to adapt to climate change. In Morocco, achieving sustainable use of groundwater has become one of the most pressing issues in water resource management, as many of the major aquifers of the country are already overexploited.

Currently there are a series of potentially conflicting policies and incentives across Moroccan ministries that may influence the achievement of its nationally determined contribution targets from an adaptation standpoint. In terms of adaptation at a local scale, the incentives farmers face is often a trade-off between increasing crop production and reducing energy and water consumption. Recent policy reforms[1] have incentivised the use of solar water pumping technologies to reduce energy consumption from more centralised sources of power. However, as energy-efficiency rises and the productivity of water rises, farmers may increase productivity[2] further through increased water use (i.e. a rebound effect). Subsidies for solar water pumping (an energy efficiency improvement), may come at the cost of depleting water resources (despite the advances in more efficient drip irrigation techniques).

The United Nations Food and Agriculture Organization (FAO) and the World Bank Group (WB) have initiated many efforts in the recent years to address groundwater governance challenges in Morocco. In November 2016, FAO assisted the ABHBC[3] for the diagnosis of the governance of the Berrechid aquifer (FAO-b, 2018). In September 2017, the FAO investment centre division prepared a draft diagnostic of groundwater governance and economic

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[1] Ministry of Finance and the Ministry of Agriculture signed in April 2013 with the AMEE (formerly ADEREE) and Crédit Agricole (CAM) an agreement extending the support of efficient irrigation projects to pumping solar. (PNUD, 2016)

[2] As energy efficiency rises the cost of on-farm water use falls which may encourage farmers to increase: production intensity; the area farmed; or switch to a crop with higher water requirements. All of which can increase water use. The farmer will be looking at on-farm application of water and its cost/availability.

[3] Agence de Basin Hydraulique de Berrechid et Chaouia

incentives as part of an FAO/WB collaboration on groundwater governance (FAO/WB, 2017). Another study conducted as part of the FAO initiative (shared vision for sustainable food and agriculture) focused on the convergence of policies/strategies for sustainable agriculture and food and their implementation in the case of water management in Morocco (December 2017). As part of the same initiative, FAO produced a report about the effects of economic sectors' policies on water management in Morocco (March 2018). In January 2018, a three years Swedish international development agency funded project was launched with the assistance of FAO to implement the 2030 agenda for water efficiency/productivity and water sustainability in middle east and north Africa countries with major components reserved for nexus analytical tool development and water accounting (FAO-a, 2016). These are just some examples of the projects carried out during the last few years targeted at supporting the Moroccan Government to address the constraints created by the overexploitation of its groundwater resources in the context of the looming threat of climate change.

The present study builds on these efforts and the lessons learned from all these activities to contribute to the better understanding of the current set of incentives facing farmers in designing policy packages to relieve groundwater pressure while maintaining the path of greater energy efficiency and improve the income of farmers. This activity is a part of the climate change adaptation analytical support to Morocco's nationally determined contribution. It serves to inform a dialogue on the options for adapting the existing incentive systems to encourage more sustainable water and energy uses in agriculture. Moreover, one of the pillars of the upcoming World Bank-Morocco country partnership framework will be the water-energy-agriculture nexus and this study aims to provide some insights on the actions required to mitigate cross-externalities of competing sector policies.

GROUNDWATER GOVERNANCE CHALLENGES

The large spatial and temporal variability in the distribution of rainfall in the country translates to a large disparity of water resources availability between the different watersheds. The resources are becoming increasingly scarce because of water stress, climate change and due to increasing demand for water to meet domestic, industrial and agricultural needs.

In recent decades, farmers have intensified the exploitation of groundwater encouraged by an active policy of agricultural intensification and the development of private irrigation through individual pumping. Groundwater offers many benefits for agriculture production. It is primarily more reliable source compared to surface water and is less vulnerable to drought than surface water sources (groundwater having a delayed response to changes in precipitation). In addition, groundwater faces fewer losses of water by evaporation. As a result, crop production is also possible during dry periods and drought periods. With less risk of poor or variable yields, reduced plant stress and increased crop quality when using groundwater, farmers tend to invest more to increase their productivity further. Another benefit of groundwater is that it provides on-demand irrigation, giving farmers the freedom to use water when their crops need it the most. For rain-fed crops, particularly in arid and semi-arid areas, groundwater is an important source for supplemental irrigation when rainfall is insufficient. Consequently, effective governance of groundwater is a critical and urgent challenge.

The complexity, variability, and uncertainty surrounding groundwater systems have proved it far less amenable to effective governance than other natural resources systems. Morocco is facing a particularly challenging situation in terms of managing groundwater resources. The complexity of the challenges vary between the watersheds but common issues surface throughout the country: conflicts of use; risks of shortage; water quality degradation; and groundwater overdraft. These challenges are aggravated in a context of climate change thus generating a financial, social and environmental cost.

The use of groundwater to secure irrigation water supply and meeting the drinking water needs of a growing population has led to an almost widespread over-exploitation of groundwater aquifers, with the exploitation of nearly 800 million cubic meters of water per year beyond the aquifer renewal capacity (FAO-a, 2018).

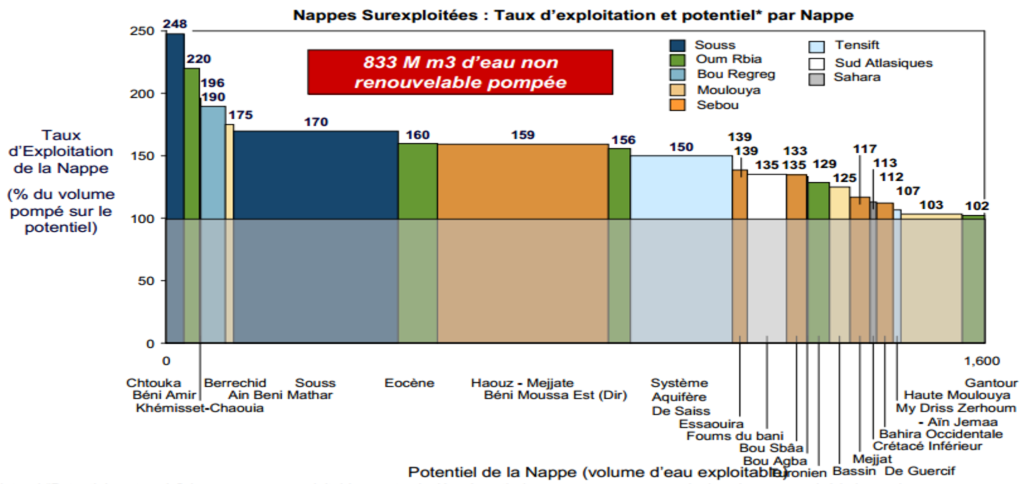

Figure 1: Taux d'exploitation et potentiel par nappe au Maroc (Source : SNE – Monitor)

This overexploitation resulted in: a decrease in aquifers' water levels that reached up to 2 metres per year (M. Ait Kadi & A. Ziyad, 2018); a decrease of spring flows and even the drying up of some springs and Khettara; a reduction of the water supply to traditional[4] irrigation schemes; and a deterioration and decline of traditional irrigation depending on groundwater resources.

A significant decrease in the quality of surface and groundwater mainly due to diffuse pollution generated by agricultural activities, discharges of urban and industrial effluents, and landfills, further negatively affects the availability of water resources.

These issues are not new and the Moroccan government has already initiated numerous programmes, strategies and projects dedicated to solving the problems of groundwater depletion and the challenges they pose. In general, the different instruments deployed or envisioned to deal with the unsustainable use of aquifers include those targeted at increasing conventional and unconventional water resources and those aiming at encouraging a reduction in water withdrawals. Today, the solutions that have historically been favoured in Morocco to provide additional resources are very expensive. It is therefore important to innovate in this area by developing governance policies and mechanisms that are supported by local actors.

WATER-ENERGY-FOOD NEXUS APPROACH

Understanding the dynamics of the water, energy and food sectors is essential for developing effective strategies for the sustainable use of these resources. We are confronted with the challenge of effectively managing resources to better achieve sustainable outcomes, such as those emphasized by the sustainable development goals. In recent years, the water-energy food nexus (the nexus) has taken centre-stage as a vehicle to better understand the complex interactions among multiple resource systems. Studies on the nexus frequently acknowledge the need to: address complex relationships, interactions and feedbacks among water, energy and food sectors; incorporate the

[4] Small and medium irrigation schemes

dynamic context of local conditions; and produce results usable in policy-making and resource management (T.R. Albrecht & al 2018). Within this area, developing approaches that provide useful and relevant information to guide inter-sectoral policy coordination is crucial. While many studies offer decision-support, nexus assessments can better link with policy outcomes by drawing from diverse knowledge bases and deeply engaging both stakeholders and decision-makers (A. Bhaduri & al, 2015). Any strategy that focuses on one part of the nexus without considering its interconnections risks serious unintended consequences (World Economic Forum, 2011). Hence, it is necessary to improve policy coordination and harmonization to account for trade-offs and to build on the increased interconnectedness of water, energy and food. Part of this process is promoting, identifying, and eliminating competing or contradictory policies.

The relevance of the adaptive decision-making approach to the nexus has been highlighted, particularly in the context of climate change adaptation strategies. Policy dialogue is central to the adaptive decision-making approach and finding sustainable solutions from an environmental, political, social and economic perspective (refer to box 1).

Box 1: The adaptive decision-making approach, policy dialogue and groundwater governance

Adaptive decision making approach offers a set of tools to look for a consensus based solution (all stakeholders involved) combined with economics/modelling to try to get to a sustainable outcome. Policy dialogue is central to the adaptive decision-making approach, which has been highlighted as a tool that can help to integrate climate change adaptation and mitigation measures into national development strategies[5]. (Ringler et al. 2013) note that the adaptive decision-making model can be applied to the nexus problems. Within the adaptive decision-making framework, policy dialogue would address the following steps for the nexus approach looking at climate change adaptation (Bizikova et al., 2013): (1) improve understanding of past stresses, current trends and future risks; (2) build a shared understanding of existing conditions and the most influential drivers of these; (3) elaborate a shared common future vision agreed by all watershed stakeholders; (4) isolate key future uncertainties; (5) analyse different long-term adaptation strategies; (6) communicate the future vision with stakeholders; and (7) develop an investment strategy and scaling mechanism to deliver the approach. This process can also help to ensure that strategic targets are politically and socially acceptable. Adaptive decision-making relies on engaging decision makers and stakeholders to set out their priorities, preferences and criteria for adaptation strategies[6]. This is supported by modelling assessments of potential future conditions, including climatic, socio-economic, land use changes and how the different sectors are interlinked[7]. Strategies developed through this process have a greater chance of garnering political support than strategies with large or irreversible consequences (Bhave et al., 2016).

[5] Bassole, EIS-Africa, how information for adaptation decision making can be collected and disseminated?, accessed from World Resources Institute Website. https://www.wri.org/

[6] The literature on adaptive decision making emphasises on the need to involve policy/decision-makers and the water-users to ensure that the results of the dialogue can be adopted at policy level and that the farmers 'buy-in' to the process; which, reduces the chances of stakeholder 'fatigue'.

[7] To support this, data are often collected from diverse sources for sectors such as: water, agriculture and land use; transport; infrastructure; energy; and natural resources. Given that in practice there are often data limitations and resource constraints, the analysis can be supported through relatively fast, flexible and simple models coupled with expert judgement rather than more intense quantitative data analysis. However, in order to analyse the potential consequences of a large number of scenarios, such as in assessing climate change adaptation strategies, there are more substantial data and computational needs.

Morocco needs to reconcile four overlapping conditions: (1) substantial reliance on imported energy[8]; (2) a growing population; (3) recurrent drought; and (4) groundwater overexploitation. In addition to the need to increase socio-economic growth. In this context, the expectation is that agriculture sector plays a key role in improving the country's overall economic growth and earnings from exports, as well as in improving food security and poverty alleviation. For example, agriculture employs 40 percent of the national labour force and 75 percent in rural areas (MEF, 2015). Public agriculture policies mainly aim to improve food security outcomes, create employment opportunities and increase value added and exports. These policies are oriented toward the intensification of production. They require considerable investment and natural resources and rely largely on irrigation. Despite higher energy consumption and rising energy prices, agriculture policies and water policies are still disconnected from energy policies, which may result in conflicting objectives and inconsistent development policies (M.R. Doukkali & C. Lejars, 2015).

STUDY DEVELOPMENT OBJECTIVE

Understanding sectors policy interactions through the lens of the nexus approach is a very complex task that goes beyond the scope of this report. At this stage and given the allocated time, an overview and description of the complex set of policies that impact on energy, water and agriculture would provide one of the building blocks for initiating policy dialogue with Moroccan stakeholders, including the different government entities and ministries whose responsibilities influence the nexus.

Engagement with these stakeholders would encourage the identification of policy [reform] issues to incentivise increased energy efficiency, reduce groundwater extraction and maintain agricultural productivity, as well as seeking to establish where consensus for future policy directions can be possible. Hence and in connection to the adaptive decision making approach as exposed earlier, a key issue to resolve is getting political support for the approach and include national decision makers or delegate powers to the process/commitment to support. In Box 1, we have highlighted seven steps of which five are a standard policy dialogue approach. Steps 1 and 3 (plus partially 4) look to integrate firstly data at basin (or similar) level and model potential outcomes. This approach would take time (3-5 years) with results towards the end rather than the beginning. The rewards, however, for a working process would be results and approach that can be applied elsewhere in Morocco and a solution to agriculture and water running on different tracks as it is the case at the moment.

Building on past and ongoing analysis by the WB and FAO on groundwater governance in Morocco, the present document aims at: identifying current energy, water and agriculture policies; and setting out a descriptive review of their relationships.

[8] While energy demand grew at a rate of 6 percent from 2004 to 2011, 96 percent of energy was imported over the same period, with oil accounting for 27 percent of total imports in 2014 (Source: Ministère de l'énergie, des mines, de l'eau et de l'environnement, 2014, Analyse des indicateurs énergétiques).

LEGAL AND INSTITUTIONAL FRAMEWORKS

WATER SECTOR[9]

Since 2016, the water law no. 36-15, an update to the law no. 128-95 previously in effect for 20 years, is at the heart of the Moroccan legal framework regulating the country's water resources. It consolidates integrated, participatory, and decentralized water resources management. The Moroccan legal framework clearly establish water as a public good (with some few exceptions of acquired rights before 1914) that should be accessible to all citizens. It also establish decentralized institutions for individual or grouped river basins: the watershed agencies created in the late 1990s to govern water with the participation of its stakeholders. The three principal responsibilities of these agencies are: (1) development of water resources; (2) allocation of water as defined by the master plan; and (3) control of water quality.

The legal framework also establishes that, the planning of water resources (groundwater and surface water) is undertaken through three main elements:

- Integrated water resources management plans established under the aegis of the ABH for each of the main country's watersheds. These plans sets the scope and modalities of water resource management in the watershed.
- National water plan, formulated through the integration of the different integrated water resources management plans, is the vehicle for strategy implementation and serves as the framework for investment programmes until the year 2030.
- Aquifer contracts that define the form of coordination and responsibilities in groundwater governance and management at the aquifer level. They are financial and technical agreements between the government and users, and between the users themselves (from agriculture, industry and urban supply sectors) of a given aquifer.

Concerning the institutional set-up, the ABH reinforce the network of existing institutions in charge of the different water management functions based on the principle of consultation and accountability between the actors involved. In general, tasks related to the governance of the water sector are divided between the advisory function, the political and regulatory function, the management function and the enforcement functions:

- The consultative function is carried out, mainly by: the Higher Council for Water and Climate (CSTC), the National Environment Council (CNE), the Inter-ministerial Water Commission (CIE), and the Council Superior of Territorial Development (CSAT). These institutions have a mandate to review the various water strategy and planning documents and to make recommendations for its adaptation to the challenges of national development. The inter-ministerial water commission is supposed to ensure the coordination of water sector programmes between the various departments concerned. The status and the role of the high water and climate council has also been enhanced as the higher advisory body and a forum on national water policies and programmes. All the stakeholders from the public and private sectors, including water users' associations, sit on this council.
- The political and regulatory function: it is the primary and essential function of the Ministry in charge of water for the policy, planning, supervision and control aspects of the water sector. But other government departments have jurisdictional plots and mandates that influence the development and adoption of policies and regulations related to the management of the water sector. This applies to ministries in charge

[9] Source of information : www.water.gov.ma/

of environment and finance, and ministries that can be described as water "consumers", such as agriculture, industry, and the local authorities. Through their decisions, these ministries can contribute to the adoption of measures and authorize the decentralized and decentralized bodies to use and implement the instruments necessary for the management of water resources, including financial, environmental, technical and financial instruments planning.

- The management of the resource is mainly entrusted to the Basin Agency for the overall management of water resources on the territory entrusted to it. The tasks assigned to it by Law 36- 15 and the implementing regulations in force are important and their implementation will enable the deployment of the policy of sustainable management and conservation of water resources as defined in IWRM. The Basin Agency has administrative and management bodies (Board of Directors and Hydraulic Basin Council) which include representatives of stakeholders and users in the decision making process and works to implement participatory approaches to take the expectations and demands of all these stakeholders in its planning and activities. It manages water resources in accordance with a Master Plan for Integrated Water Resources Management (PDAR), which it develops and has approved by the Ministry in charge of water to ensure compliance with the PNE. Finally, the ABH has the power to conclude groundwater contracts with the users and some agencies already have them. At the regional level, the ABH is the legal institution responsible for ensuring good coordination in the field of water management between the different actors, within the framework of the provincial/prefectural water commissions for which it provides the secretariat.
- The level of implementation: the Moroccan institutional model of urban water management is decentralized in terms of policy implementation missions. Thus, with the recent creation of the region, the mission of ensuring the "proper use of natural resources, their valorization and their safeguarding" is entrusted to the Region under Organic Law 111-14 of 2015. The Regional Council sees itself to develop a "regional strategy for the conservation of energy and water in accordance with the National Sector Strategy. This innovation will certainly complement the institutional framework that includes the prefectural and provincial water commissions. These committees have an important mission to approve local water management plans and, above all, to contribute to water management during periods of shortages in order to ensure the satisfactory supply of populations and to contribute to raising awareness the protection of water resources and the preservation of the hydraulic public domain and its optimal use. Finally, the task of organizing and carrying out the tasks relating to the supply of drinking water to the population and sanitation are the responsibility of the municipality under the municipal charter. However, municipalities can entrust these two substantial water supply and sanitation missions to ONEE, municipal, semi-public or private institutions that are given a critical role in the use rational and efficient use of water resources and their conservation by deploying appropriate management instruments (technologies, finance, control). Just as ORMVAs have a similar role in supplying irrigation water to farmers. It should also be noted that, at the regional level, since 1995, the Moroccan government has established Regional Environmental Councils (CRE), as well as at the local level, the governor or the wali may establish Vigilance Committees whose mission seems to be limited to monitoring and controlling water wastage in urban centers.

ENERGY SECTOR (RENEWABLE ENERGY)[10]

Over the past two decades, Morocco set out a legislative framework for the promotion of investments, establishing a procedure for the authorization of renewable energy installations as well as production, distribution and trade. Thereby opening a new market segment in which certain industrial customers are allowed to freely choose their

[10] Source of information : www.mem.gov.ma/, (M. Hochberg, 2016), (SERN, 2014) and (T. Ameqroud, 2015)

electricity suppliers. In early 2010, relevant legislation and regulations were defined. Among these, the following laws should be noted:

- The renewable energy law 13-09. This law provides a legal framework for the development of renewable energy projects in Morocco. It aims at: fostering and promoting renewable energy; regulating the commercialization and exportation of renewable energy; outlining a procedure for the authorization of renewable energy installations; regulating the electricity sector and creating an authorization/declaration system, depending on the capacity of the facility; and allowing the supply and export of the electricity produced to the local market and/or through the national grid and interconnections with other countries.
- Law 58-15, amending the existing law 13-09: raises the minimum capacity of hydro power projects from 12 MW to 30 MW; introduces a net metering scheme for solar and wind power plants connected to low voltage level; and opens access to low voltage distribution networks. In particular, the law calls for regulation detailing the conditions for investors in solar-PV to benefit from opening of the low-voltage grid to renewable power installations. Private investors in renewable power in general will be able to sell their surplus output to the grid, but no more than 20 per cent of their annual production. The decree 2-15-772 of October 28, 2015 specifies the conditions and processes of access to medium voltage grid (5.5 Kilovolts and 22 Kilovolts).
- Law 16-08 sets self-production thresholds to 50 MW (from 10 MW) and grants access to the grid; while law 54-14 modifies the provisions on self-production for all generation-sources and opens access to self-producers with global capacity of more than 300 MW.

The ministry of energy, mines and sustainable development is in charge of developing and implementing government policy in the areas of energy, mines and geology. It also supervises companies and public institutions that come under its jurisdiction.

In order to achieve its ambitious renewable energy targets for 2020, the government decided to create two dedicated governmental agencies: (1) the Moroccan agency for solar energy in charge of implementing the Moroccan solar plan; and (2) the national agency for the development of renewable energy and energy efficiency. As per the new law 13-09, the Moroccan agency for solar energy is now in charge of the realization of all renewable energy projects and ADEREE is renamed “Moroccan agency of energy efficiency” and focus on energy efficiency. Other supporting institutions includes:

- Energy Investment Company created in 2009 to help accelerate deployment of efficient energy solutions. It is at the heart of the national energy strategy and represents the financial arm of the Government for the execution of the energy mix by 2020. It operates both in investment and in the development of renewable energy projects and energy efficiency.
- Institute for research in solar energy and new energies founded in 2009 to promote research, development and innovation of renewable energy technologies.
- National authority for electricity regulation created in April 2016 to ensure the good functioning of renewable energy market and regulate access to the grid.

AGRICULTURE SECTOR

The PMV was launched in 2008 to make agriculture a driving force for equitable economic growth. The plan has two pillars: (1) pillar 1 targets modern, high value-added agriculture and is concerned with facilitating the integration of commercial farmers into domestic and international markets. This pillar is expected to be driven by the private sector to develop competitive and efficient supply chains; and (2) pillar 2, or ‘solidarity agriculture’, focuses on poverty-reduction and improving and diversifying traditional, small-scale agriculture in less favourable production areas with a more significant role for the public sector. Projects within this pillar typically focus on: intensification, crop switching and diversification; finance; on-site processing; storage facilities; and input provision. They also support capacity development and promote farmers' participation, organisation and their linkage to the market. In addition, aggregation aims to bridge the two pillars and accelerate the modernisation of the agricultural sector.

Concerning agricultural water use, there are three key programmes: (1) national irrigation water saving Programme started in 2009 to modernise 550 000 hectares by 2020 with water-saving irrigation techniques and localised irrigation systems [11]; (2) irrigation development Programme to connect dams with irrigation schemes. The programme targeted improving water supply and developing localised irrigation systems; and (3) national watershed management Programme to enhance soil conservation and reduce erosion. It was launched in 1996 with the objective of recovering about 570 000 hectares over the following 20 years.

The PMV sets out detailed objectives and policies, and programmes to help meet them. The value chain examples presented below highlights selected sectoral targets of the plan, such as doubling olive area and production by 2020, which are supported by a wide-ranging series of polices and measures.

The government's commitment to support agriculture production and sectoral resilience is underlined by the 2017 finance law, which includes four development pillars: (1) accelerating economic transformation through industrialization and exports; (2) strengthening competitiveness and promoting private investment; (3) improving human resources and reducing disparities; and (4) building institution and good governance.

[11] Through a system of subsidies raised to the level of 80 percent of the investment cost for areas over 5 hectares converted to drip irrigation and 100 percent for farms below 5 hectares.

POLICIES AFFECTING AGRICULTURAL GROUNDWATER USE

Morocco is proceeding with a core economic growth path involving critical development activities in industry (emergence plan), agriculture (green Morocco plan), tourism (azure plan) and energy (renewable energy plan). The demands of these sectors will have to be met against the backdrop of shrinking water resources and amidst rapidly growing competition for water use. The mobilisation and rationalisation of water resources constitute a constant of Morocco's economic policies. This is especially true since historically, the government has given priority to agriculture and more particularly to irrigated agriculture transforming this sector into the engine of economic development of the country. Thus, the water sector has benefited from a particular interest of the public authorities and has been at the centre of the preoccupation of economic policies and investments in infrastructure. Policies established in Morocco to manage groundwater use in agriculture has focused on four main approaches: (1) Regulatory approaches; (2) Economic instruments approaches; (3) Collective management approaches; and (4) Supply side management approaches.

Regulatory approaches	• Groundwater abstraction control • Energy market regulations
Economic instruments approaches	• Water pricing policies • Energy pricing and subsidies • Solar pumping program • Water savings policies • Agriculture intensification • Agricultural trade policies
Collective management approaches	• Integrated Water Resources Management • Aquifer contracts
Supply side management approaches	• Aquifer recharge programs • Alternative water supplies programs

Figure 2: Main policies affecting agriculture groundwater use

REGULATORY APPROACHES

Groundwater abstraction control: The water law provides for a number of legal obligations, such as: registration of existing wells and authorization for digging new ones, obtaining groundwater abstraction licenses; and the installation of water meters in all wells. Controlling groundwater abstraction has proven to be one of the greatest water governance and management challenges. Currently there are no defined entitlements for the use of groundwater. There is a restriction on the pumping of groundwater (i.e. no deeper than 40 m below the soil surface) although in practice this is rarely enforced. Besides, the weak enforcement of the well/borehole authorization regulations resulted in an increase in illegal water withdrawals and the continued decline in groundwater levels and water quality. Creating an exhaustive inventory of groundwater abstraction points is crucial but is a complex task to accomplish. <u>There is actually no reliable inventory of wells in Morocco</u> and a significant number of farmers install wells without obtaining the required authorization. In addition, the government is facing a pushback when it comes to the implementation of the regulation imposing the installation of meter by wells' owners. The law requires that the wells' owners install a meter at their own expense and declare the consumption once a year and pay a water bill based on the rate of 0.02 MAD/m^3. If the experience with the registering of wells and installation of meters in the MENA region is anything to go by, Morocco is far away from having the situation under control (F. Molle, 2017).

Energy market regulations: The Government created, in April 2016, an independent regulator to ensure a well-functioning renewable energy market and regulatory access to the grid. The new regulatory framework was opened up to the private sector with the adoption of law 13-09. The production of electricity from green energy has since been opened to private enterprise. Law 16-08 on self-production authorizes for the first time any natural or legal person to produce electricity for his own needs. Law 13-09 allows any natural or legal person to produce energy from renewable sources. This may be self-production or production intended to be injected into the high or medium voltage network and sold to buyers with adequate connections. Law 58-15 includes the low voltage network but for the moment prevents large-scale decentralized injection by private individuals or small businesses. In the medium to long term, this market will also be opened, which should give considerable push to the production of electricity by small photovoltaic power plants (GIZ, 2016).

ECONOMIC INSTRUMENTS

Water pricing policies: The water law provides for the application of polluter and user-pay principles. Water price for irrigation (surface or underground) is set through the formula established by a joint ordinance of the ministry of economy and finance, the ministry of water and the ministry of agriculture ('arrêté n. 548-9"). Under the water law, the ABH is empowered to impose a tax on each volume of water extracted from individual wells. The Law requires farmers to pay the ABHs the official fee (established at 0.02 MAD/m^3) for the groundwater they abstract. By envisioning a volumetric pricing system, policy-makers also make it conditional upon the identification of existing wells and the thorny prerequisite that the use of each farmer should be volumetrically known. Morocco is far away from being in a position to control (let alone tax) water abstraction at the well level (F. Molle, 2017).

Energy pricing and subsidies: Morocco currently subsidises the butane gas for domestic use fixing its price at around 42 MAD for a bottle of 12 kg – compared to 90 MAD on the world market (FAO/WB, 2017). These low prices caused the illegal use of butane gas by farmers to power wells throughout the country. Even if there are no official statistics, it is understood that a large part of diesel water pumps have been converted by farmers to use butane gas because of its largely subsidised price[12].

Solar pumping programme: A national solar pumping programme was launched in 2013, the fruit of a partnership between the ministries of energy and agriculture, ADEREE and the "Crédit Agricole" group. This programme aims to enable small and medium farmers (exploitation of less than 5 hectares) to equip themselves, to improve their yield and production while saving water[13] and energy, using a subsidy from the energy development fund for water pumps running on electricity produced from solar panels. The programme targets exploitations that already have a pump running on diesel or butane gas. Electric pumps are not eligible (PNUD, 2016).

Water savings policies: The department of agriculture launched in 2002 the national programme for irrigation water saving - consolidated by the PMV in 2008 - which aims to modernise irrigation systems over nearly 550 000

[12] Doukkali and Grijsen, 2018, note that the ministry of energy estimated the agriculture sector accounted for one third of total butane gas consumption in 2011.

[13] Saving water through the adoption of drip irrigation.

hectares (L. Toumi, 2008). The PMV also consolidated the agriculture policy of encouraging, through the granting of agricultural development fund's subsidies. An important aspect of the PMV is to increase irrigation efficiency by replacing much of the flood and sprinkler irrigation systems with drip irrigation. Subsidies were provided to farmers wishing to improve irrigation infrastructure and technology, and install drip irrigation systems (primarily based on groundwater). Subsidies were also allocated to the digging of wells and boreholes for the development of irrigated agriculture. The PMV raised the level of subsidies to 80 percent for areas over 5 hectares and 100 percent for farms below 5 hectares (FAO/WB, 2017).

Agricultural intensification: Government policy through the PMV places a considerable emphasis on increasing agriculture output with a series of policies and subsidies to promote production through both increased area and intensification. Ambitious targets have been set to expand sectors such as olives, horticulture, fruit, sugar, oilseeds, dairy, beef and poultry. At the same time, the area planted to grains would be reduced by 20 percent to 4.2 million ha, 500 000 ha of which would be converted to high value-added crops.

For example, the PMV targets increasing the citrus area by 20 000 hectares to 105 000 hectares between 2009 and 2018 and increasing national citrus output from 1.3 to 2.9 million tonnes. It further targets increasing the proportion of citrus plantations that are irrigated from 47 percent to 85 percent. To achieve these targets, the PMV foresees the planting of 20 000 hectares to citrus production and the renewing of a further 30 000 hectares, as well as equipping 50 000 hectares with micro-irrigation. It is, however, unclear whether there is sufficient water availability to sustainably meet such targets across either the entire agricultural sector or at basin level. A series of subsidies were put in place to help meet these targets, including: support for new citrus plantings; subsidize 100 percent investment costs for small farmers (under 5 hectares) and 80 percent for larger farmers (more than 5 ha); and subsidize equipment of up to 70 percent. This is further reinforced by a 10 percent investment subsidy for downstream operations plus support for the development of an inter-professional and export assistance.

In order to access the subsidies for irrigation investments, farmers are required to: provide proof of their land title; register their wells; provide authorization for groundwater abstraction; and install water meters. The land title requirement effectively excludes some small farmers from accessing subsidies, but is not typically a barrier for larger and commercial scale farms. Molle (2017) notes that the well registration and abstraction authorisations have not served as effective constraints for irrigation development, and whilst these are provided by the local ABH, there exist loopholes and work around for farmers to effectively install new wells.

Under PMV pillar 2, there are conversion and intensification projects aimed at smaller or traditional farmers. Conversion projects aim to transform current production systems, particularly cereal production into high value-added crops (e.g. olives, almonds and figs). The objective is to replant 400 000 hectares divided between 200 000 farms. Intensification projects look to improve both livestock and crop production, with training and extension provided to improve productivity and the value of small farmers' production.

Agricultural trade policies: The continuous liberalization of the cereals market along with the PMV incentives to cereals land reconversion have translated into a decrease in the area of cereals and its substitution by (more water demanding) tree crops (FAO/WB, 2017).

In a scenario of lower olive oil prices through a phasing-out of domestic prices support for olive oil (reducing import tariffs) and a continuous government investment support, a share of traditional/extensive orchards (rain fed) could be abandoned and another share would see an intensification of the land use. Although this shift represents an important opportunity to develop the sector, net demand for irrigation water from the olive oil sector can increase significantly with market liberalization (FAO/WB, 2017).

The European Union is the primary destination for Moroccan agriculture exports, with EUR 3.4 billion exports in 2017. Moroccan tomato exports provide an example of the impact of trade policy changes. The EU is the primary market for agricultural exports, which are strongly influenced by the complex EU import arrangements that govern some of the most important Moroccan agriculture sectors, in particular, fruit and vegetables. EU tomato imports are regulated by tariff rate quotas, seasonal tariff variations and the entry price system. Ninety percent of Moroccan tomato exports to the EU occur during the tariff rate quota season, which runs from October to May. Roughly three-quarters of Morocco's 366 000 tonnes (2012-14 average) of tomato exports to the EU enter under the tariff rate quotas of 285 000 tonnes in 2015/16. Over quota exports benefit from a tariff reduction but are assigned a standard import duty. So, whilst Moroccan tomato exports have been price competitive for out of quota exports, there is a degree of risk from potential changes to the import rules which discourages further investment in tomato production. The EU and Morocco have been negotiating a deep and comprehensive free trade agreement since 2013 to deepen trade integration beyond the existing free trade agreement. Further liberalisation under the new agreement would create export opportunities for Moroccan producers, and hence encourage investment and output growth. Using a gravity model, it is estimated that less than 40 percent of Moroccan fruit and vegetable export potential has been reached; which, means that there is scope for significant growth in exports under a liberalisation scenario (FAO, 2015-b).

In 2019, the United Kingdom will leave the EU[14]. In 2017, Morocco exported tomatoes worth USD 71 million to the United Kingdom (11 percent of United Kingdom tomato imports). Although the future United Kingdom tariff and import rules are not yet known, there could be a substantial increase in exports under a scenario of full trade liberalisation for Moroccan tomato exports to the EU (no quotas, seasonal restrictions or import price mechanisms). Supermarkets, the main sales channel require produce to have quality assurance certification, which de facto ensures that only large, modern producers can export. This group of producers are capable of investing in intensive production techniques highlighted in the tomato value chain example. This would therefore encourage a greater degree of intensification and increased use of inputs such as plant protection chemicals. If seasonal limits are removed, the pattern of irrigation water demand could also change as output is increased during the summer months.

COLLECTIVE MANAGEMENT APPROACHES

Integrated Water Resources Management: Morocco has always considered surface and groundwater in conjunction when establishing plans and strategies for the management of water resources either at national or local level. When the ABHs were created they were tasked with the preparation of strategic water management plans for each watershed integrating the needs and views of all water user categories and groups. These plans are strategic documents setting the scope and modalities of water resources management in the watershed based on: previous evaluations of available water resources (in terms of quality and quantity); expected demand for water; a proposal of alternatives for the integrated management of water resources in the watershed; and an economic and environmental evaluation of the proposed alternatives. The different PDAIREs are then used as a base for the establishment of the national water plan. However, the "collective" nature of the PDAIRE at its inception is lacking

[14] It's an example of possible future policy change that would stimulate agriculture intensification with a little further breakdown to see how it might in practice work (benefits primarily large operations). The timing of that is not known at this stage but likely in early 2020s.

as the other relevant actors (including relevant agencies from agriculture, energy sector, and water users) are not involved in the preparation and implementation of the PDAIREs.

Aquifer contracts: Morocco's experience with aquifer contracts began in the region of Souss-Massa in 2007. In 2013 an inter-ministerial notification, signed by the ministers of agriculture, interior and water expressed political support and provided guidelines for the establishment of aquifer contracts. In 2014, a national workshop on the management of groundwater resources again put aquifer contracts at center stage (F. Molle, 2017). The aquifer contract is conceived as a new mode of governance that encourages stakeholder participation and allows them to take responsibility within a negotiated contractual framework to regulate and improve groundwater management at the aquifer level. This type of decentralized engagement is included within a broader river basin management framework to ensure consistency between the objectives and actions implemented across the different management levels. The idea of aquifer contracts stems from the evidence that top-down groundwater governance, overly reliant on regulation and control measures, is not effective. The way forward is seen as the co - management of aquifers between the users and the administration. Although this is probably insufficient, it is deemed necessary to involve all stakeholders in the design of shared solutions and collective rules (F. Molle, 2017). A lot still needs to be done with regard to the involvement and engagement of relevant actors and water users during the formulation and implementation of aquifer contracts.

SUPPLY SIDE MANAGEMENT APPROACHES

Water policy in Morocco has long focused on supply, including increased efforts and investments to ensure the mobilisation of sufficient resources. Morocco continues to invest in supply to respond to its growth targets and face the risks imposed by increased water scarcity and rainfall variability.

Aquifer recharge programmes: Most of Morocco's aquifers are naturally recharged at varying rates and few are what might be called fossil aquifers and non-rechargeable. Natural recharge maintains the existing flows but there are plans to augment these resources using artificial recharge schemes (FAO, 2009). Yet, the perspective of groundwater recharge has not been fully explored.

Alternative water supply programmes: the Government is working on expanding surface water storage through the pursuit of surface water mobilisation by large, medium, and small dams. The plan is to construct three storage dams per year bringing the total storage capacity from 17.6 billion cubic meters (BCM) at present to 25 BCM by 2030 (M. Ait Kadi & A. Ziyad, 2018).

Alternatively, efforts are underway to transfer water from surplus basins in the north-west to the central-west basins experiencing deficit. A target is set for a transfer of 800 million cubic meters by 2030 (FAO/WB, 2017).

Another option is to explore seawater desalination possibilities. By 2030, through the realization of large-scale projects, desalination will cover nearly 16% of drinking, industry, and tourism demand (FAO/WB, 2017). Desalinization target is at 400 million cubic meters per year (first plant in Agadir with a capacity for 100 million cubic meters per year (drinking and irrigation)). The project of Agadir alone is budgeted to cost 4 billion MAD (FAO/WB, 2017).

Recycled water is also considered. The new law fills the regulation vacuum on re-used water, but additional regulation will need to be issued on key aspects such as management responsibilities or attribution of water shares. Attaining the objective of reusing around 325 million cubic meters per year by the horizon of 2030 requires the investment in 162 projects in the nine watersheds (FAO/WB, 2017).

DESCRIPTIVE REVIEW OF SECTORAL POLICY RELATIONSHIPS

The existing policies and regulatory frameworks were largely developed without considering the cross-sectoral consequences. With implementing agencies working in isolation, there is a significant disconnect between the agriculture, water and energy sectors. This coordination failure results in cross-sectoral externalities and a failure to take into account social, economic and environmental costs. Most recently, the issue of "coherence of public policies", including in the field of water, was cited as one of the levers identified by the Moroccan government to accelerate the economic and social development of the country (FAO-c, 2017).

In this context, it becomes important to examine policy coherence by taking into account their effects on other sectors. It also becomes crucial to bring projects into line at the territorial level by looking at the interactions between the three components of the system. In Morocco, the question imposes itself acutely in the context of the reform of subsidies to certain sources widely used by the agriculture sector. It also arises in terms of arbitration, as it is the case in the Oum Errabia Basin between low-cost hydro electricity generation and the need for modernization of irrigation systems. It finally arises in the southern basins between cost-effective investment solutions based on transfer and expensive local energy solutions (e.g. desalination, deeper aquifers) (N. Faysse et al, 2012).

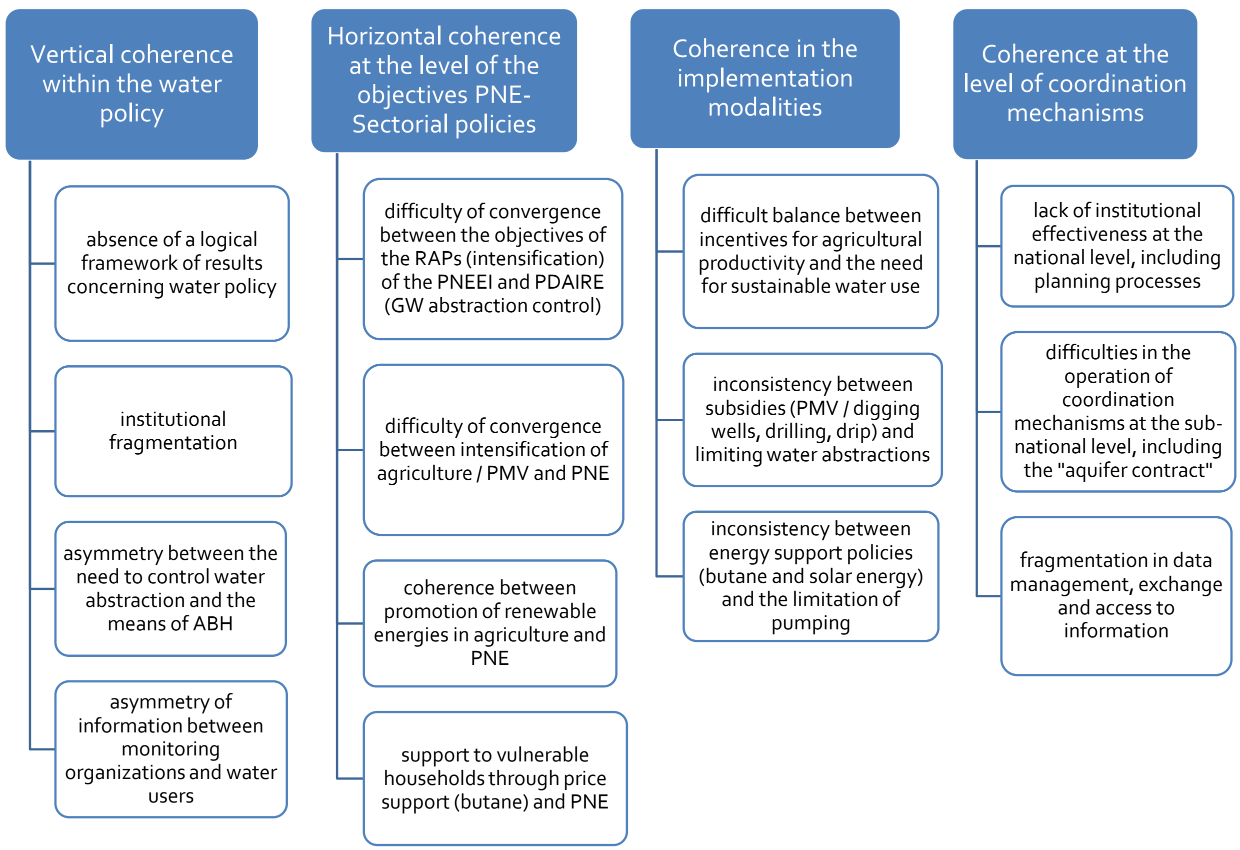

Figure 3: Coherence between sectoral policies vis-à-vis water and within water policy (FAO-c, 2017)

The analysis carried out by FAO and the Moroccan Government (FAO-a, 2018) suggests that there is a need for arbitration: within the water policy itself; between its implementation instruments and those of the number of sectoral policies; and at the level of existing coordination mechanisms. Some instruments indirectly favour behaviour by water users and economic sectors that influence their growth in demand that translates into overexploitation of water resources under conditions of scarcity or over-allocation further decreasing the quantity and quality of the water. The increased uncertainty and variability with climate change, the demographic pressure coupled with rapid urbanization and economic development are likely to pose a significant risk to food security and livelihoods for the living conditions of a million people in the rural areas of Morocco.

It is beyond the scope of this report to consider the relationship between all sectoral policies relevant to water use. Thus, the focus will be on selected sectoral strategies and programmes and their implementation instruments based on the importance of their impact/predictable effect on the actions of groundwater users and consequently the sustainable use of groundwater.

GROUNDWATER AND ENERGY LINKS

Water scarcity makes access to the resource directly dependent on energy though pumping, transfer, treatment and desalination. This system of interactions (nexus) is particularly critical in a country like Morocco, that uses groundwater and pressure irrigation, speeds up the mechanization of agricultural work, produces hydroelectricity, and is launching desalination and water transfer projects. So far, energy supply and pricing for groundwater pumping constituted enabling conditions for aquifer depletion.

Energy subsidies: The cost of energy for abstracting water may have an influence on how much water farmers abstract and what crops they grow. Energy cost in Morocco is set at a low level through state subsidies. Currently, the only energy subsidy is for domestically used butane gas through the compensation fund to support households' energy expenditure. However, the artificially low prices encouraged the illicit use of butane gas for other uses than domestic across the country. Although there are no official statistics, butane gas remains the most commonly used energy source for groundwater pumping for irrigation in the country (Kévin Del Vecchio, 2016). Consequently, the butane subsidy policy ends up supporting the overexploitation of groundwater. Energy cost policies could be more effective in reducing groundwater abstraction than water pricing, particularly as the aquifer level lowers and costs increase. Whatever the choice, both water pricing and energy costs can have large political implications and result in greater inequality in the access to groundwater, and often need adjustment through other compensatory measures (F. Molle, 2017). In the case of butane gas, the possibility of diverting the subsidy by farmers and others requires more control and better targeting mechanisms.

Solar water pumping technologies: Recent policy reforms have incentivized the use of solar water pumping technologies to reduce energy consumption mainly of gasoil and butane gas. The logic used by this programme is that energy saving through solar pumping will allow the farmer to have access to very cheap energy and thus indirectly for the Government to reduce the expenses of the compensation fund allocated to butane gas. The savings on these charges from the compensation fund could allow the Government to recover the amount of aid granted under this programme over three to five years (PNUD, 2016). Yet, this programme will help reduce recurrent pumping loads and may have potentially negative effects on water use. This is because the low price of energy can be a powerful driver to encourage groundwater pumping. The subsidy to solar energy may well simply replace that with butane gas, whose effects on groundwater were mentioned earlier. Henceforth, solar powered pumps for irrigation may entail a great risk, if not adequately regulated. The government should offer alternatives to users and look at the solutions taken in other countries. For example, farmers can sell electricity (become energy producers) and if the price is attractive, reduce their pressure on resources. However, the connection options to the grid by small farmers are not yet clear and the possibility to allow farmers to receive a price for energy produced from solar requires further development. There is also a need to promote and improve pumping equipment for better energy and water efficiency.

Non-conventional sources of water: Options using solutions such as treated wastewater and seawater desalination to alleviate the pressure on groundwater use has been at the forefront of the water strategy in Morocco. These solutions are energy intensive and involve a high environmental risk. The wastewater treatment and desalination plants are still at an initial stage of development/deployment and their investment and operational costs, as well as demand for their water, are still uncertain. From the preliminary data available, production costs of treated wastewater may well be above irrigation water price/cost. For example, the first desalinization plant in Agadir is expected to provide water for irrigation at MAD 5-7/m^3, whereas estimates for diesel powered pumping costs to remain below MAD 1/m^3 for static lifts of around 30 meters (FAO-b, 2016). However, even if the ambitious targets materialize, the supply will still be limited when compared to the estimated demand in the long run, and therefore will contribute, but not be sufficient to avoid further and faster groundwater depletion. Consequently, the promotion of these solutions should not be only technical but should go beyond to include other measures that would improve access to the water produced to all farmers.

GROUNDWATER AND AGRICULTURE LINKS

While the existing agricultural policy framework has helped increase agriculture production in the short-term, it has weakened the long-term sustainability of agriculture in Morocco because of the unsustainable exploitation of groundwater.

Water-saving policies: Although the PNEEI and PMV policies to promote water savings through drip irrigation imply a significant financial effort from the government of Morocco, these policies may have produced opposite results to those desired. In the large majority of cases, drip irrigation does deliver in terms of land productivity (yield), total production and farm income. Whether by adopting cash crops, through intensification or expansion, farmers' net benefits increased and with it production at the national level (FAO-d, 2017). However, the downside of the process is that these private benefits come at a huge environmental and social cost: the massive shift to drip irrigation has been accompanied by a more pronounced deficit of aquifers, the very opposite of the 'savings' that were foreseen based on the projection. It has also contributed to an increase in energy consumption. The promotion of drip irrigation, with its potential to increase water productivity, is not necessarily prejudicial to the long-term economic efficiency of groundwater use – although, experience has proven that if enacted as a standalone policy, it is likely to accelerate groundwater depletion. It is indeed possible to achieve higher levels of efficiency with policies such as that of the PNEEI and PMV, but they need to be used together with other indirect and direct demand control measures. Some of these measures include: regulated cropping patterns and planting time through a combination of positive and negative incentives for their adoption; and strengthened regulation of irrigated surfaces, compensatory measures for land fallowing (FAO/WB, 2017).

Water pricing for irrigation: Experience shows that overly high prices would push farmers to shift to groundwater, where aquifers are not too deep. Indeed many already do so not to reduce costs but because groundwater is available on-demand and escapes the uncertainties in the irrigation water service. The recognition that with the establishments of ABHs, the main part of their budget comes from water users which has enhanced the necessity to recover costs from users. Yet, a very limited percentage of farms currently pay the official fee (established at 0.02 MAD/m^3) for the groundwater they abstract. The monitor group (Monitor Group, 2008) proposed an increase in the price of groundwater as well as the establishment of a premium (higher) price for water abstracted in overexploited aquifers. This is implicitly based on the idea that administered prices could be high enough to encourage lower abstraction. However, raising administered prices as a water demand management tool is a measure that is doomed to failure. Strikingly, the ministry of agriculture and the ministry of energy not only fail to address the issue of the subsidies that go to groundwater pumping but they have also set up a 40 million Euro programme to subsidize solar energy for farmers which is likely to be detrimental to groundwater conservation (F. Molle, 2017).

Groundwater abstraction control: Charging farmers or limiting their use of groundwater by other means requires information on their wells and farming activities. As long as the percentage of illegal wells remains very high it is unrealistic to envision controlling the amount of water abstracted. Yet the issuing of subsidies to individual farmers is based on the condition of acquisition/possession of a permit for groundwater abstraction issued by the ABHs. Because of the PMV, regulation tasks performed by ABHs are superseded by the agricultural intensification policy, highlighting two seemingly contradicting objectives: while the objective of ABHs is the preservation of water resources, agricultural intensification policy brings in incentives for their expanded use (Kévin Del Vecchio, 2016). A decree of 2009, in application of the 1995 water law, provides for a procedure more flexible (simple declaration) for the regularization of existing wells and boreholes. This form of bypass was and continues to be used for grant applications to drip irrigation. The most common practice is to dig the well before declaring it then to regularize it by simple declaration (Kévin Del Vecchio, 2016). All the government actions to control groundwater abstraction fail to grasp the difficulty of the task. The degree of organisation of farmers should also be taken into account, whether through cooperatives, associations or sectorial level, such as an inter-professional groups, as it affects the ability of farmers to engage with water management authorities and to influence their behaviour. There may also be differences in both representation and water abstraction patterns between different groups in the same basin, for example, those operating on land they own themselves or leased land and by the size and intensity of the operation.

Agricultural trade policies: The PMV prioritised an expansion of exports including increasing olive oil exports from 16 000 tonnes to 120 000 tonnes and table olive exports from 60 000 tonnes to 150 000 tonnes, expanding horticulture exports from 0.75 to 1.7 million tonnes and citrus exports from 0.54 to 1.3 million tonnes. The policy environment to promote exports also serves to increase water demand by encouraging sectors which typically have a higher level of water use.

Border protection (tariffs) for olive oil provides support for domestic olive oil prices. Under a scenario of tariff liberalisation, domestic prices would be reduced, which coupled with support for investment, could impact on traditional (400 000 hectares) and modern extensive (280 000 hectares) olive production areas which are rain-fed. It could encourage either the abandonment of land or more intensive development, which would impact water demand (FAO/WB, 2017).

There is potential for tension between agricultural trade policy and sustainable water management. Free trade agreements, such as the association agreement with the EU, can create opportunities for increased exports, with modern, intensive operations best placed to take advantage of new market development opportunities. There are a range of export promotion, logistics improvement and quality development policies, all of which, if successfully implemented have the potential to increase demand for irrigation. When the Morocco-EU deep and comprehensive free trade agreement, which has been under negotiation with the EU since 2013, is concluded, it is likely to create agricultural export opportunities. There is scope to integrate water sustainability concerns into the negotiator's demands from the EU[15]. The world trade organisation agreement on agriculture, in practice provides little constraint to irrigation support (ICTSD, 2016).

[15] For example, are the trade liberalisation concessions requested by the Moroccan negotiators coordinated with water sustainability policies? Or, put more simply, are the negotiators seeking to expand trade opportunities for products which consume more water and do the water institutions take part in the negotiation strategy formulation?

Agricultural intensification policies: The PMV targeted: the creation of 600 000 jobs; and the increase of exports, particularly where Morocco has a comparative advantage, such as olives, citrus and others fruits and vegetables. Ambitious targets, like the ones for olive and citrus production described in the value chain analysis chapter of this report, are supported by investment subsidies and policies to: encourage the development of the downstream sector from processing to market and export development; and increase quality and value added. Policies are tailored to the needs of specific sectors, for example a lack of packing house capacity has constrained some fruit value chains. A policy to support packing house development (see the citrus value chain section) will in turn encourage the growth of citrus supply due to the higher prices for fruits handled by a modern packing house. Higher prices and increased downstream capacity encourages additional investment in primary production. This example indicates the government's ongoing commitment to agriculture development. These actions ultimately point towards increasing demand for agriculture water use.

Support for the more widespread adoption of drip irrigation encourages farmers to increase the intensity of production, adopt mix cropping or change crops. The PMV encourages a shift away from grain production towards olives, fruit, sugar beet and fodder (alfalfa), all of which have higher water requirements. In practice, farmers are also encouraged to deepen wells whenever necessary (Molle, 2017). He also highlights that support for drip irrigation under the PMV may lead to unused or extensively used areas being brought into more intensive production which may be exacerbated by large commercial farms, particularly where there is lax application of water licensing and abstraction rules.

AGRICULTURAL VALUE CHAIN ANALYSIS

The evolution of the three value chains briefly presented in this section displays how government support and policy has been an important factor in their expansion since the launch of the PMV. In contrast to the water related policies highlighted in previous sections, the primary aim of the PMV and related policies has been to increase each sectors' competitiveness and growth, leading to increased demand for irrigation water. A review of the factors driving each value chain, as well as their possible future evolution is an important component in understanding how water, energy and agriculture interact ultimately to the design of measures that enable a dynamic agriculture sector with sustainable water use.

The olive sector's output has more than doubled since the launch of the PMV, the citrus sector is close to doubling whilst the tomato value chain has seen a substantial increase in its production intensity. All three value chains also have scope for further expansion. It is notable that some sectoral studies of these value chains barely mention water at all.

OLIVE VALUE CHAIN

Since the launch of the PMV in 2008, there has been an increase in: the area planted to olives; the investment in irrigation encouraged by subsidies; and the share of olive groves which are irrigated. The olive area increased by 93 percent from 523 000 hectares in 2006 to one million hectares in 2016. Over the same period, olive production more than doubled from 631 000 tonnes to 1.42 million tonnes. Over the past ten years, there has been an intensification of olive production as well as an increase in planted area.

Ministry of agriculture data for 2012 presents that 364 000 hectares of olives are irrigated, 40 percent of total olive area. This is an increase of 80 percent over the 2005 irrigated area of 200 000 ha[16]. This represents around 20 percent of the total irrigated agricultural area in Morocco[17].

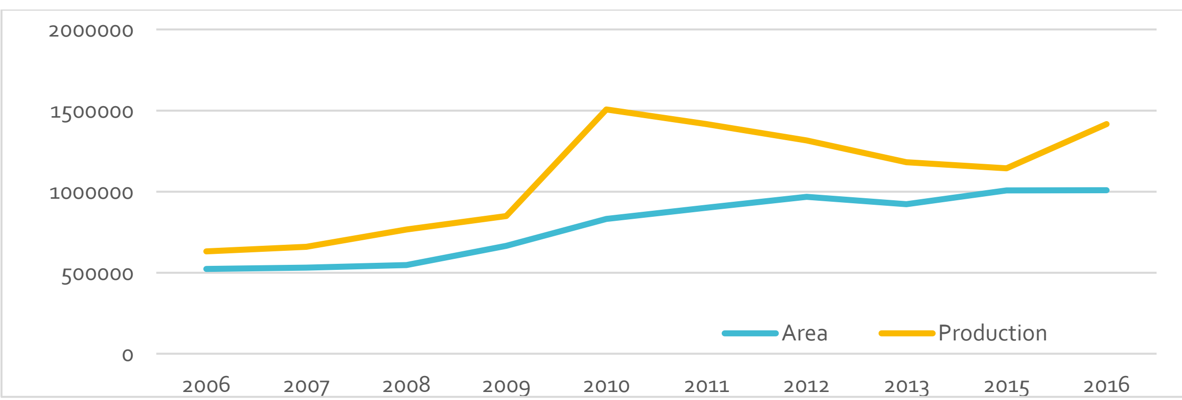

Figure 4: Moroccan olive area (hectares) and production (tonnes) - 2006-2016 (Source: FAOSTAT)

Ministry of agriculture data for 2010 (with regional breakdowns) indicates that more than half of the Moroccan olive production (58 percent) is concentrated in three regions (Taza - Al Hoceima - Taounate region, Tanger - Tetouan

[16] In contrast, the irrigated share of the olive area in Greece, Italy and Spain ranges from 21 percent to 28 percent. In addition, roughly half of the Moroccan olive area is in disadvantaged areas.
[17] Ministry of agriculture data for 2011, reported in AQUASTAT

region and Marrakech – Tensift - Al Haouz region) which also account for over half (55 percent) of the area dedicated to olives.

The olive sector in Morocco is heterogeneous and highly dependent on: climatic and soil conditions; groundwater availability; and social conditions of the individual farmer. It is helpful to assess the different farming systems, with the level of intensification and tree density being key factors. Density is a function of a farmer's financial and technical capacity, soil depth and characteristics, irrigation availability, mechanisation and climatic conditions, as well as whether production is focused on producing olives for olive oil or table olives. Moroccan olive production can be classified into three levels of density, as well as five different farm systems:

- **High-density systems**: (<u>hyper-intensive farms</u>: 10 000 hectares and <u>intensive farms</u>: 28 000 hectares) covering roughly 5 percent of olive area on farms typically varying from 150 hectares to 2 000 hectares. New trees enter into production only after three to four years, reaching optimum output within eight years. Tree densities vary between 400 and 2 000 trees per hectare. Yields are high, averaging 10 tonnes per hectare. There is scope for mechanising labour-intensive operations such as pruning and harvesting. Large volumes of olives produced enable downstream investments in processing and storage. The use of drip irrigation is widespread.
- **Medium density systems:** (<u>semi-intensive farms</u>: 63 000 hectares) medium scale farmers covering 8 percent of the olive area often involved in processing and marketing of their own olive oil on farms ranging from 25 to 500 hectares in size and an average tree density of 670 trees per hectare.
- **Low density, extensive systems:** (<u>modern-extensive farms</u>: 284 000 hectares and <u>traditional farms</u>: 405 000 hectares) the modern-extensive systems covering 36 percent of the olive area include smallholders, medium scale farmers as well as some large groups (such as Lessieur) due to lower quality land or limited water availability. The traditional extensive systems, often located in plains or mountainous regions, accounts for around half of the olive area. These are small farms ranging from 0.5 to 5 hectares in size. Farmers simply collect olives for consumption or olive oil production, with an ageing tree stock, only very limited investment, no mechanisation and rainfed trees. Yields average 1.7 tonnes/hectare.

Extensive systems account for 87 percent of the area planted to olive trees. While not directly comparable, in Spain, 76 percent of olive area is also modern extensive and traditional extensive systems, with low tree density and typically uses no irrigation. It should also be noted that traditional and modern extensive systems play an important social role.

Production costs. Intensive systems have the lowest production costs of USD 141 per tonne, followed by hyper-intensive at USD 165 per tonne. The modern and traditional extensive farms have slightly higher costs of USD 181 and 174 USD per tonne, respectively. By far the least competitive is the semi-intensive system at USD 209 per tonne of olives. These figures help explain why modern companies who were granted new land concessions tend to combine intensive with hyper-intensive systems, as the former is more profitable and the latter enables them to rapidly enter into production. All five Moroccan production systems have lower production costs than their Spanish counterparts, with notably lower costs for irrigation and labour.

Irrigation costs. In terms of production costs, the weight of irrigation varies by farming system. The irrigation costs as part of totals costs account for: 19 percent for hyper-intensive farms; 13 percent intensive farms; 10 percent for semi-intensive farms; and 7 percent for modern-extensive farms. In Spain, hyper-intensive and intensive systems irrigations costs are around USD 600 per hectare, compared to USD 320 and USD 180 respectively in Morocco, despite similar volumes of water being used. Moroccan irrigation costs typically include pumping, maintenance and labour costs, whereas in Spain farmers are also charged for water.

Outlook. PMV targeted 1.23 million hectares olive area by 2020, an increase of 550 000 hectares from 2009. In 2016, olive area was approximately 1 million hectares. Meeting PMV target yields of 2.1 tonnes per hectares would require a considerable increase from the 1.4 tonnes per hectare recorded in 2016.

The skills, know-how and capabilities of actors within the olive and olive oil sectors have been considerably enhanced over recent years, helping to give the combined sector a real potential for further development. However, expansion in olive production has been due to an increase in area rather than yield improvements. The processing sector has also seen important investments, both from domestic and international sources, leading to an upgrading in capacity and further development.

There is scope to increase the area planted to olive trees if land concessions were to be granted by the government or there is a conversion of land from other uses, such as wheat. There is also scope to improve the productivity of the existing area planted to extensive systems. There is still considerable room for improvement in the traditional and semi-traditional processing sector, particularly in terms of the quality of oil produced.

Policy. The PMV underlined the strategic importance of the Moroccan olive and olive oil sectors, with over 500 projects in the sector, one third of the total. This included targets to increase the sector's output, improve technology and raise both exports and consumption, as well as harness the dual role of both the traditional and modern sectors. Greater intensification and the expansion of olive production is a key tenet of the PMV. The targets specific to the olive sector through to 2020 are as follows[18]:

- Expand the cultivated area for olive production to 1.22 million hectares, involving the creation of 440 000 hectares of new orchards and the renovation of 300 000 hectares of existing olive plantations;
- Install micro-irrigation facilities on 136 000 hectares of existing and new olive orchards;
- Achieve an annual production target of raw olives of 2.5 million tonnes, equivalent to a 108 percent expansion in output from the 1.2 million tonnes produced over 2008-2012;
- Increase olive oil production from 85-90 000 tonnes to 330 000 tonnes and increase olive oil exports to 120 000 tonnes/year; and
- Raise annual domestic consumption to 4 kilogrammes per head, from 2.6 to 2.8 kg per head at present.

Land policies. In 2005, the government initiated a programme of long term leasing for public farm land covering an area of nearly 130 000 hectares. The public-private land release scheme has successfully helped to increase the area planted to olive trees, spurred new investment and encouraged the expansion of large operations.

Agriculture development fund support. The wide-ranging subsidies provided by the agriculture development fund have seen a significant level of planting activity undertaken since 2009. From 2008 to 2012, FDA funding supported the planting of around 4 000 hectares annually. During this period, the olive area expanded by around 80 000 hectare per year, suggesting that most plantings took place outside this scheme. A large share of FDA planting was for hyper-intensive and intensive large surfaces.

At the farm level, there are a number of support measures in place to improve productivity, including subsidies for machinery and equipment purchases. Larger operations have been the primary beneficiaries of this support, due in part to their better access to credit than small farms.

Agriculture development agency and PMV pillar 2. The agriculture development agency has been active in supporting and investing in a large number of projects for smallholders covering 172 000 hectares planted to olives.

Aggregation. The PMV has targets to expand areas, production and Morocco's export performance by 2020 through the concept of aggregation. Improving the position of Morocco's numerous small-scale producers is a priority in the plan which means that barriers to cooperation between traditional and modern systems will need to be better addressed. To date, uptake of aggregation has been limited.

[18] http://www.agriculture.gov.ma/pages/acces-fillieres/filiere-oleicole

CITRUS VALUE CHAIN

The PMV targeted to double citrus production and triple exports by 2018, underpinned by a 33 percent in the area planted to citrus to 122 000 hectares, a figure that was reached in 2016. Part of the area expansion was met by auctioning government owned land to be leased by investors to establish new citrus plantations. Van Berkum (2013) reports that the newly leased land led to a significant expansion in the area planted to oranges and clementines, with area increasing by 6 000 to 7 000 hectares in Agadir and in Berkane (Van Berkum, 2013).

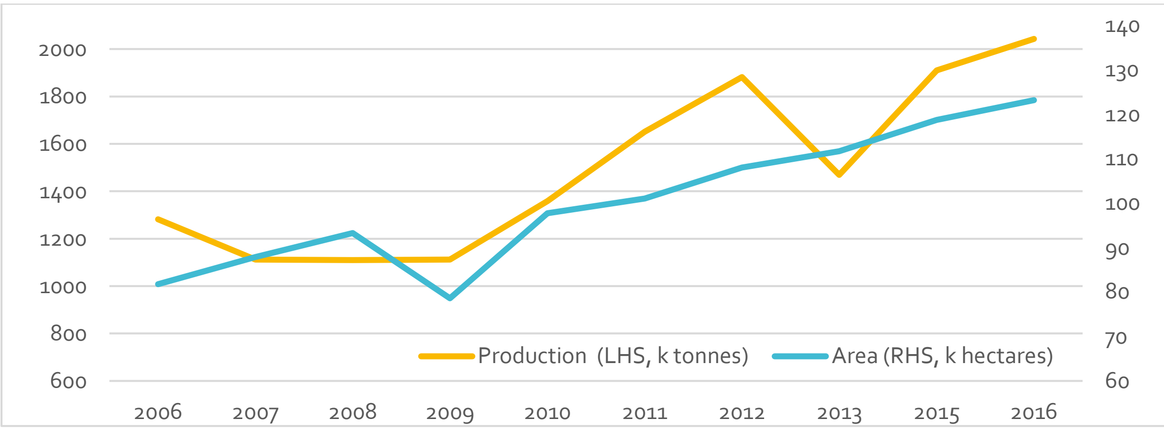

Figure 5: Moroccan citrus area (1 000 hectares) and production (1 000 tonnes) - 2006-2016 (Source: FAOSTAT). Note: Citrus includes oranges, clementines, tangerines, mandarins, grapefruit, lemons and lines.

According to the ministry of agriculture data, citrus production reached 2.3 million tonnes in the 2016/17 season, up 20 percent over the previous year, partly due to a significant rise in rainfall. Thus, the segment achieved 83 percent of the PMV goal to produce 2.9 million tonnes annually by 2018.

Citrus production in Morocco is partly export-oriented, with major production centres located in Béni-Mellal, Berkane, Gharb and North, Marrakech and Souss-Massa. The latter accounts for about 60 percent of the country's export potential (Ahmed Darrab, 2015) and groundwater accounts for 95 percent of water used (Molle, 2017). From 2011/12 to 2015/16, the citrus sector produced an average of 1.9 million tonnes annually, of which 488 000 tonnes were exported. Although citrus fruit accounts for a notable part of total Moroccan agriculture exports – over one-third in 2014/15 – they have yet to reach the PMV target of 1.3 million tonnes set for 2018. In 2014/15, Morocco exported 462 000 tonnes of citrus, rising to 520 000 tonnes in 2015/16. Estimates for 2016/17 exports are for 600 000 tonnes of exports.

Logistics improvements, both inland and at ports, are also needed to increase the country's export capacity of fresh fruit and vegetables. The sector struggles to take full advantage of expanding output due to a lack of packaging facilities, which has led to losses and a decline in quality. The authorities are promoting supply chain coordination and integration to address these issues (Oxford Business Group, 2015). For example, in Béni Mellal, despite output of 420 000 tonnes in 2016/17, there were only three packing stations. An investment of EUR 86 million in an agropole in the region aims to address these problems.

There are high levels of food losses and waste in the value chain, with FAO estimating that 40 percent of Morocco's citrus production destined to the local market is lost. There is little mention of water in some value chain studies, since, (Sausman et al. 2015), the primary focus is on economic development.

To improve exports, the "*établissement autonome de contrôle et de coordination des éxportations*", is working with the ministry of agriculture to consolidate traditional markets in the EU and expand into non-traditional markets in

Central and Eastern Europe, Africa and Asia (Moroccan directorate of financial studies and forecasts, 2014). Roughly 40 percent of exports go to each of the EU and the Russian Federation. Morocco has lost competitiveness in recent years to Egypt, Spain and Turkey in the orange sub-sector, while maintaining competitiveness in smaller citrus fruit such as clementines. Small citrus fruit (principally clementines) account for three quarters of citrus exports. Phytosanitary issues have also held back export growth, for example, with a temporary trade suspension for clementine exports to the United States.

TOMATOE VALUE CHAIN

Moroccan tomato yields rose by one third from 2006 to 2016, from 60 to 81 tonnes per hectare, meaning that despite a one quarter decline in area planted to tomatoes over the same period, production has moderately increased. Production levels at some larger companies can average 250 to 300 tonnes per hectare, of which 60 to 65 percent is of first quality. Policies to support input use such as on-farm equipment and irrigation have driven the intensification of tomato production. Roughly one third of Moroccan tomato production is exported.

Production is concentrated in the Souss-Massa-Draa and Doukkala-Adba regions, with lesser output in the Eastern regions, Oued-Eddahab-Lagouira, Greater Casablanca and Rabat-Zemmour-Zaer (Moroccan Directorate of Financial Studies and Forecasts, 2014).

Policy support for the sector includes FDA policies aimed at expanding the greenhouse area and fitting 28 000 hectares with irrigation systems, as well as aggregation projects and expanding downstream capacity (especially packing).

The production of tomatoes requires considerable amounts of water; how much depends on the location and other growing conditions. The production of one kilogram of tomatoes takes about 80 to 100 litres of water in Morocco; in Spain it might require 60 to 80 litres and in the Netherlands only 15 to 17 litres per kilogram of tomatoes. Tomato growing in Morocco's major production areas still needs an additional supply of irrigation water even in the rainy season (Van Berkum, 2013).

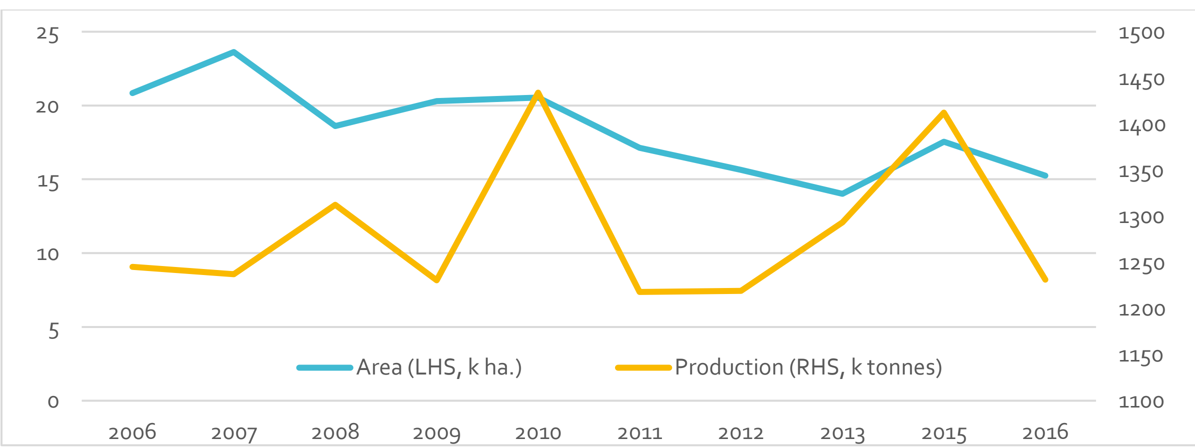

Figure 6: Moroccan tomato area (1 000 hectares) and production (1 000 tonnes) - 2006-2016 (Source: FAOSTAT)

Barriers to further export development include rising input costs, weather (in terms of delays to maturity of the tomato crop), logistics and trade rules, particularly for exports to the EU. There is little mention of water as a barrier to increased output (Moroccan directorate of financial studies and forecasts, 2014).

Further intensification of tomato production offers scope for increasing output: a switch to a (high tech) production model with improved light transmission, use of substrate, irrigation and climate control in glass greenhouses could lead to an increase of net production by a maximum of 400 percent, of which 85 percent would be first quality. Relatively small investments in simpler techniques could increase production significantly too. For example, improving light transmission in modern plastic greenhouses and the more efficient use of plastic tunnel surface areas could raise yields by 40 percent. Developing beyond the low tech/low cost model many producers use would require addressing bottlenecks such as: knowledge and finance gaps; improved input supplies; and access to product markets. Trade liberalisation with the EU did not spur any production response in Moroccan tomato production, with the PMV policies driving output growth (Van Berkum, 2013). However, FAO (2015-b) notes that out of quota tariff and non-tariff barriers have limited exports to roughly 40 percent of the level predicted by gravity models in a situation of full trade liberalisation. In 2015, changes to the EU tomato import standard pricing methodology threatened to restrict the roughly 25 percent of Moroccan tomato exports to the EU that are outside of zero duty tariff rate quotas, although a compromise was subsequently negotiated between the government of Morocco and the EU. Such uncertainty (and the awareness of EU producers' sensitivity to imports from North Africa) can act as a barrier to investment decisions.

DATA GAPS TO UNDERSTAND POLICIES INTERACTIONS

The lack of relevant information hampers the possibilities of establishing objective relationships not only between sectoral strategies related to water, but also between them and users. The declination at the regional level is simply disconnected from the vision advocated at the national level and relies more particularly on instant responses to the evolution of the "challenges of the day". One of the key limitations to tackling the issues raised above is better monitoring data and information which are declined hereafter:

Water accounting. Without a reliable water accounting system, there is no basis for evidence-informed decision-making and policy development. Although water data collection is quite advanced in Morocco compared with many other countries, it is increasingly inadequate in a situation of basin closure (F. Molle, 2017). The SIDA funded project - implementing the 2030 agenda for water efficiency/productivity and water sustainability in NENA countries - is actually working on developing an international standard and scientifically-sound 'water accounting system', based on advances in space technology (satellite remote sensing) and ground measurements in all MENA countries including Morocco. As enunciated in the project proposal, the water accounting system will provide not only the evidence base for the full water budgeting (supply, demand, uses and re-cycling, present and projected) but also the assessment of institutional effectiveness to govern water resources vis-à-vis the water-related SDGs (FAO- a, 2016).

Economics of groundwater depletion. The most striking thing when one reviews the economic literature on water degradation and overexploitation of groundwater in Morocco, is the meagre number of studies and published economic research that addressed these issues (M.R. Doukkali & J. Grijsen, 2018). This is even more striking when we know that the country has engaged in programmes and projects aimed at remediation or reduction of the pressure on water resources some of which are very expensive and mobilise substantial funding. For example, the average cost of water development mobilised varies: between 2 and 6 MAD per cubic meter for dams; between 10 and 20 MAD per cubic meter for desalination of water; and more than 3.5 MAD per cubic meter for inter-basin water transfer (CESE, 2014). There is a need to assess the aggregate impact of groundwater depletion under various scenarios and, in particular, looking at the impacts on specific subsectors (and/or value chains) of agriculture.

Extent of groundwater-based private irrigation. There is insufficient monitoring of groundwater-based irrigation (admittedly a difficult task). The figure of 441 430 hectares, which is invariably given, was originally reported in 2004 and is still in use today (F. Molle, 2017). This suggests that the continued expansion of private irrigation is not well accounted for and grossly underestimated. It is striking that the chart showing the magnitude of overexploitation in main aquifers given by the Monitor Group (Monitor Group, 2008) includes the category ''overexploitation not estimated''. This accounts for the high number of unknown illegal wells and the uncertainty on actual abstraction. Assessing irrigation needs, demand and use is indispensable for water resources planning.

Limitation of budgetary frameworks. The water sector directly or indirectly involves several bodies (the ministerial departments of the various sectors, public institutions under supervision, and local authorities and their groupings). Each sectoral organization establishes its budget programs according to its own budgetary (administrative) nomenclature and according to the procedures for drawing up and adopting its budget provided for by the legislation governing its legal status. The existence of several ministerial budgets in charge of water management or having an intervention in this sector is not sufficiently clear at the level of the functional nomenclature of the State budget (FAO-a, 2018). The current nomenclature does not allow for: a financial accounting of the water sector; a measure of the State's efforts in the water sector and its uses; or an analysis of the volume of its expenditures distributed according to the different domains of the State intervention in water policy. In a certain number of cases, budget lines are analysed in the general State budget without really consolidating them with the budget of the institutions, local authorities or bodies that are subsidized and where the actions really take place. It is difficult to have an overview of the reality of funding, to evaluate the costs and benefits of combining strategies and to inform public action. In an accounting effort, another question arises about the existence of cross references to water in different sectoral budgets (agriculture, tourism, energy) (FAO-a, 2018).

Basin and farmer-level behavioural research. In order to be able to understand and model or map irrigation demand at basin level and how farmers might respond to different policy incentives, a more detailed understanding of crop and livestock production practices at basin level, as well as the economics of farmers' planting and investment decisions would be helpful. This includes the current production model and intensity of production, in addition to the ability of the farmer to switch to different production intensities in the future. The design of measures to alter on-farm water demand need to take into account the farmers possible range of responses. It is also important to better understand whether land is operated by the land owners or through rental arrangements. These is evidence to suggest that farmers operating on rented land have less incentive to move towards more sustainable water use, therefore a clearer picture of water use by land ownership structure and ownership patterns would be helpful. Changes at processing, logistic, market and export level can also impact on farm level behaviour. Farm or regional level models could also be used to assess the impact of changes in water supply on production and revenues, as well as production (and water demand) responses to changing conditions, such as price, trade policy and water availability. Being able to assess past, current and future trends is an important facet of the policy dialogue component of the adaptive decision-making approach. Where local or regional data does not exist, proxies can be collected using simple techniques (such as fieldwork, interviews with farmers and input suppliers) and extrapolated to basin level. This could also be integrated into the policy dialogue process to encourage farmers to contribute and have a degree of ownership of the dialogue.

GOVERNANCE/INSTITUTIONAL RISKS AND LIMITATIONS

Coordination at national level. Three entities ensure the coordination of water-related policies at the national level: (1) the national council for water and climate; (2) the inter-ministerial commission for water; and (3) the national council for the environment. However, these organizations have not held internal meetings for several years, apart from a meeting of the commission in 2015 to review the national water plan. The national council for water and climate seems to suffer from communication problems and the insufficient integration of the representatives of the industrial sectors and the users themselves (FAO-a, 2017). Similarly, following the water crisis that affected parts of the country in October 2017, the inter-ministerial water commission met under the leadership of the head of Government (FAO-a, 2018). Despite the existence of a number of coordinating bodies, it has decided to create a new technical commission to design an emergency plan identifying cases of water deficit and proposing solutions to accelerate investment in water resources, drinking water and irrigation water. National level coordination also concerns the alignment of government institutions supporting economic development and those involved in sustainable water management.

Coordination at watershed level. At the watershed level, the ABHs are the key players. They are responsible, inter alia, for: coordinating the water sector among the various actors within the framework of the provincial/prefectural water commissions for which it provides the secretariat; and strengthening the role of basin committees and problem management at the local level (creation of local management plans). However, budgetary resources (consisting of state subsidy and royalties) remain insufficient. The problems of ABH’s functioning can be related directly to those of sub-sectoral policies of water, especially with regard to the application of the regulation and the provisions of the texts, for lack of means. The case of the still timid application of the principles of "user - payer" and "polluter - payer" is blatant; although, this measure should normally make it possible to contribute to the budgets of the ABH in a significant way.

Coordination at aquifer level. Aquifer contracts represent a potentially very useful mechanism for synergistic coordination and planning at the level of an aquifer system in a basin. Their development and implementation, however, require a wide range of different measures and instruments, including instruments that may address governance issues that contribute to groundwater over-exploitation. Yet, in practice, these instruments seem to be mainly focused on technical measures that on their own do not seem to bear fruit because of the current dynamics and relationships between different actors, governmental and non-governmental, whose interests and actions are often superimposed and not necessarily in line with the objectives of water conservation. Indeed, in many regions, aquifer contracts suffer from a lack of acceptance on the part of local stakeholders, including water users (FAO- b, 2018). The way forward is seen as the co-management of aquifers between the users and the administration. However, the four components of the aquifer contracts suggested a rather top-down approach. This approach largely consists of constraining measures. Alongside the need for improved coordination between the actors involved in groundwater management, and technical monitoring of the aquifers, emphasis was placed on strengthening the control system that includes: water police; self-control by water-user associations; involvement of the judiciary; registration of drilling companies; limitation of pumping from aquifers; water pricing; establishment of prohibition or safeguard zones; obligation to use water-saving irrigation techniques when authorizations are granted; and licensing of drilling companies. The differences in mandates and objectives of the various public agencies hamper the definition of goals for the aquifer contracts and agreement over the tools to use (Closas, A. & Villholth, K.G., 2016).

Management and regulatory system remain fragmented and weak. Water policy involves several actors, which requires a definition and clarification of the intervention of each actor. In this sense, the organisation of the water sector aims to implement an integrated management of water resources taking into account the quantitative and qualitative aspects, as well as a better coordination of stakeholders in the water sector. However, up to now, despite the existence of a strategic steering and regulatory body, which is the high council for water and climate, there is still no logical framework sufficiently precise to present the objectives, results, activities and their causal links in a vertical logical manner. Water management remains characterized by: the multiplicity of stakeholders; the complexity of the organization and skills; and the overlap of some of their responsibilities. These different skills are increasingly complex and mobilize considerable financial and human resources that generates interdependencies between the different levels of the State and must be coordinated to reduce fragmentation. Although there are several forums for consultation and coordination - both at national and sub-national level - their functioning is not optimal. At local level, there is a lack of coordination between the deputy ministry of water resources and ABHs, even after the creation of a new directorate dedicated to coordination between the different ABHs. The various organizations lack resources (staff and finance) to operate effectively and enforce regulations. Low levels of recovering water fees undermine the ability of agencies to carry out their mandates. Additionally, some ABHs have been operating without a framework agreement with the deputy ministry of water resources, and with no management accountability from the Government. Funds have been disbursed late (even after the financial year) and via automatic transfers, limiting the ministerial oversight of activities (N. Faysse et al, 2012). The overlap between ABHs in charge of providing drilling authorizations and regional agriculture development agencies responsible for providing abstraction permits is confusing and increases the chances for conflict between the two bodies, as subsidies for improvements in technology can be given by the regional agriculture development agencies without authorization from ABHs (N. Faysse et al, 2012).

Competition amongst different ministries for available public resources. This does not encourage cooperation between different sectors. It also makes it difficult to organise coordinated actions involving multiple ministries and public agencies to address cross cutting issues, as is the case for water, in a coherent way that takes into account: the economic; social; environmental and political dimensions, especially knowing the budgets of the separate and independent bodies. Investment planning and strategies for each sector take place within the relevant ministry (agriculture, energy, etc.) and their regional agencies as well as local authorities (wilaya, provinces). Each institution formulates its own sectoral economic development plan and allocates its implementation and evaluation to its regional and provincial departments (FAO-a, 2018). To a certain extent, this process takes into consideration the potential impact of the proposed programs on the potential increase in water demand. However, there do not appear to be specific and effective mechanisms to ensure the implementation and evaluation in a systematic way of the different sub programmes and their combined effects on the use of water to: review and adapt them if necessary for preventing tensions and conflicts. The operation of the public sector means that even if the objectives of a set of policies are aligned, the implementation of these policies is not necessarily consistent. Hence the importance of coordination mechanisms between the different organs of the public administration to ensure policy coherence.

Data management, exchange and access to information. Law 36/15 proposes the establishment of an integrated information and monitoring system to track the data on resource withdrawals but the information is not readily available in the field. In fact, the available information is generally limited to data on the fill rates of dams announced sporadically. Data on water resources management and water quality are collected in detail (daily monitoring of production infrastructure for example, network for measuring water quality). However, these detailed data are not always public and are mainly used internally by national and local structures directly in charge of water management. The published data mainly concern the quality of the water distributed. Only the experts of the administration have a more precise knowledge of the sector. Moreover, there is no water accounting system per basin with consolidation at the national level as required by the national water strategy and the national water plan.

In any case, a large part of the water withdrawals for agriculture, industry and tourism is not recorded given the rather wide use of individual boreholes and the low percentage of reporters with basin agencies (FAO-a, 2018).

The lack of relevant information and advice for the user. The water law provides for integrated, deconcentrated, decentralised and participatory management of water resources. However, the lack of relevant information and advice for the user hampers the possibilities of establishing objective relationships between sectoral strategies related to water and users (farmers, population and industry). Such a reality reflects the asymmetry of information between water users and the administration with negative effects on the possibilities of setting up regulatory mechanisms. The declination at the regional level is simply disconnected from the vision advocated at the national level and relies more particularly on instant responses to the "challenges of the day" (F. Molle, 2017). Thus, there is much more expectation of "restorative adjustments" where the action concerns the sector most concerned. This situation also indirectly promotes the lack of responsibility for the collective management of the water resources. This results in individual utility behaviour that negatively affects water resources with a wide variety of effects on efficiency, well-being and resilience. The olive value chain analysis highlighted that private sector investment was a much more important factor than government programmes for the expansion in planting of new areas to olive trees. The information gaps highlighted above need to be addressed if agriculture stakeholders are to incorporate water issues into their decision-making processes. Also, as most solutions to alleviate groundwater depletion and support greater sustainability will involve farmers and other stakeholders (including research and extension services). To adapt their actions it is essential that they are at the very least aware of issues and developments.

Limited farmers' involvement. Even though the governing boards of the ABHs in Morocco are obliged by law to include water user representatives, the law does not clarify who should participate. The involvement of smaller farmers tends to be obstructed by the difficulty of setting up organisations with a local and river catchment focus (due to social impediments following limited local mobilisation and participation), and the ability to nominate capable representatives accountable to the farmers they represent (FAO-b, 2018). The current legal status of water users associations under the water law limits the increased empowerment of users and participation in water management policy. Hence, the decentralisation of management and enforcement tasks was not fully completed, resulting in a lack of structures and resources for mediation between users and the state. As a result, negotiations related to water allocation and use are conducted between poorly equipped and under-staffed ABHs and farmers (Kévin Del Vecchio, 2016).

Importance of groundwater in the regional and national economy. The attention actors pay to the problem of groundwater overuse is influenced by its relative importance compared to non-agricultural activities or to rain-fed agriculture. For example, the Souss is a much drier area than the Saiss, where many crops can be rain fed. In addition, in the Souss, citrus and vegetables are for export, which rank first in Morocco. They have required major investments, and are grown on large-scale farms with strong lobbying capacities vis-à-vis the public administration[19]. In comparison, the economic activities generated by the use of the Chaouia and Berrchid aquifers are only small components of the economy in the Doukkala Abda and Chaouia Ouardigha regions (N. Faysse et al, 2012). Therefore, motivation and capacities of actors to engage in policies for sustainable use of groundwater is different between the different regions. The motivation of public organisations to take an active stance in policies dealing with groundwater overdraft depends on the importance of the aquifer in the area they manage. Addressing the groundwater crisis was at the top of the agenda of both the Souss–Massa regional council and the ABHs. By contrast, the Saiss aquifer is shared between two regions, and neither of the regional councils took an active stance

[19] It should be noted that whilst the irrigated area covers 16 percent of total agriculture area, it accounts for 50 percent of agriculture value added and 75 percent of agricultural exports.

towards groundwater management. Souss farmers are mostly landowners and are strongly integrated in local communities. By comparison, in the Berrchid region, many farmers rent land, and villages are scarce, hence the farmers are much less attached to either the land or the community (FAO-b, 2018). In the Souss, some farmers' organisations were sufficiently organized to play an active role in negotiations with public organisations. In the Chaouia and Berrchid there are far fewer farmers' organisations and those that exist are much weaker.

Pressure from other water uses. Although the majority of water used in agriculture is for production, additional water use along the food chain is in food processing, quality and safety, washing, packing, marketing, transport, and other processes for which women and men perform differential roles along the value chain. Water is thus a component of value addition and food chain activities, with the water footprint of those activities being an important contribution to measuring the performance of the value chain. The pressure exercised by the economic development of many coastal and urban areas (azure plan and emergence plan) is also another factor that adds to the complexity of water management and groundwater in particular.

Aligning economic interests with sustainable water management practice. The example in box 2 underlines that the economic importance of agriculture is an important factor to address in long-term groundwater sustainability solutions. The agricultural sector, and larger, commercial operations in particular, has a degree of influence on policy-makers, both at national level and in the application or enforcement of measures at a more local level. For example, it is unclear whether measures linking access to PMV irrigation support and authorisations for new well and groundwater abstractions serve as hard constraints. There are loopholes and lax enforcement in some areas even where ABHs have placed restrictions on new wells to limit increasing abstractions. Well-connected individuals or enterprises, who have better access to finance and are in a stronger position to be able to develop more intensive agricultural operations, may also gain favourable access to land through political connections (Molle, 2017).

Box 2: The economic importance of agriculture in Almeria region and groundwater depletion

The Almeria region in southern Spain has developed a modern and productive agriculture sector, however, the government has struggled to curtail groundwater depletion. The Andalusian water agency was established in 2005 and presides over water distribution and pricing. In 2010, the Andalusian water law made groundwater public property and transformed previously private water rights into public concessions and required the registration of all wells. However, the use of illegal wells has continued. Attitudes to water use are still conditioned by the historically relaxed approach resulting in users arguing that present usage levels are justified. Water scarcity is not reflected in pricing which is derived from pumping and operational costs only. Moreover, water only represents 2.5 percent of a typical Almeria horticulture greenhouse production costs. Whilst the institutional, political, social and economic context varies across regions, sectors and countries, it is suggested that a more fruitful approach to supply management or control is to try to align farmer's economic interest with water sustainability (Juntti and Downward, 2017).

The PMV production and export targets have an important focus on promoting the development of crops with higher levels of water use, such as olives, citrus and horticulture, which have expanded output considerably over the past decade. This has helped to increase demand for on farm water use, even if the policy incentives are subsequently altered. It would be useful to compare the economics and policy incentives for crops with lower level water requirements. This should also take into account factors such as the ability to influence policy-makers and implementers (where for example large and commercial farms will typically have a greater degree of influence), access to credit, land tenure, the degree of farm organisation and cooperation.

Ensuring conditions for successful policy dialogue. There is a risk in any policy dialogue process that government participants may not be perceived by farmer representatives to have the ability to influence policy, particularly in systems where decisions are made centrally, and a dialogue process is held at sub-national level. To counter this, and the risk of farmers' perceiving the dialogue to have little influence and leading to a loss of participation, senior ministry officials should be involved, or follow the dialogue closely. It is also helpful if they devolve responsibility to adopt novel solutions, even if on a trial or pilot basis.

CONCLUSIONS AND DISCUSSIONS

Water law and water policy in Morocco have always considered groundwater and surface water together. However, a certain lack of attention to groundwater still manifests itself in piecemeal legislative approaches: inadequate institutional set-ups and insufficient implementation of water law. The encouraging developments with respect to law, institutions and administration need to be reinforced and embedded in supportive policies in other sectors, such as agriculture and energy. This will help achieve effective and sustainable improvements of groundwater governance and reverse the ongoing trend of groundwater depletion and degradation. It is necessary to promote the coordination and coherence between policy and measures in the water and relevant sectors (including agriculture, energy, land, and environment) given the wide range of stakeholders, their areas of intervention and the variety of their operational policies and procedures. The role of government should be to: facilitate dialogue among all relevant actors; promote the participation of users (especially men and women farmers); and promote the consensus among all stakeholders. The whole challenge in looking forward is to be able to establish a negotiated approach based on good data.

The Government is committed to adopt strategic planning in all of its action programs and to put in place mechanisms for: monitoring, control and evaluation. Several institutions are currently working in this direction: the economic, social and environmental council; the national observatory of human development; the high commissioner for planning; the ministry of general affairs and governance; and the ministry of economy and finance. It is also envisioned the creation of a permanent inter-ministerial commission to ensure the coherence of public policies and an integrated information system for monitoring and evaluating their impact, carried by the ministry of general affairs and governance (FAO-a, 2018).

There will inevitably be a degree of inconsistency between different policies that impact on water. The political sensitivity of the water issue, the existence of multiple and often contradictory institutional interests, and the complexity of implementation favor the possibility of conflicts between uses and users. Nevertheless, there is both scope, and the possibility to maximize synergies and convergence between water policy and relevant sectoral policies, which could be addressed through strong and well-coordinated measures at both the national and sub-national levels (FAO-a.2018). These include the following aspects: (1) sensitize the key actors to the stakes of water scarcity and build a shared vision of sustainable management of water in its multifunctional and multidimensional nature; (2) collect, harmonize and share data and information on water and its uses; (3) intensify dialogue on the trade-off between water policy and key sectoral policies; (4) accompany the commitment of all relevant stakeholders, including water users; and (5) improve existing coordination and seize new opportunities to strengthen policy convergence.

Regulation alone has not proved sufficient to prevent overexploitation of groundwater resources. To stop overexploitation and protect the aquifers, it is necessary to rethink governance mechanisms, and to introduce incentives to promote the voluntary protection of water and the environment, including through active involvement of actors, in particular water users, to find (local) solutions to the most pressing issues and identify priority intervention measures. Groundwater-dependent users need to halt overdraft and develop plans to bring groundwater basins into balanced levels through local planning efforts. Through the local efforts, ABH could provide guidance, plus financial and technical assistance to local agencies.

Economic instruments should be used to influence users' behaviors and water consumption patterns. Economic instruments should not only be used to raise the needed revenues but also to influence users' behaviors and water consumption patterns. It needs to be used as a demand management instrument to raise awareness on risks, signal scarcity and allocate water where it creates best economic, social and environmental value. It is important to address the contrast between the economic growth model of the ministry of agriculture and the water conservation priorities of the rest. Agriculture policy, including the PMV pillar 1 type policies to support commercially viable farming, could be better used as a tool to ensure that producers' economic decisions also take into account water scarcity issues. Much of the agricultural development in the past ten years, particularly in the modern, export-oriented sectors, has been driven by the private sector and economic imperatives. While government support has been an element in their growth, if the private sector is not involved in the work to look for policy solutions, and does not 'buy-in' to the proposed changes, policy actions are far less likely to be effective. Therefore, private sector involvement in any dialogue should be considered essential, and where there is insufficient or ineffective farmer representation, reflection should be given to supporting or developing capacity building to ensure their views are represented.

Deeper understanding of how farmers would practically respond to different policy proposals is needed. The value chain analysis touched on the heterogeneity of actors within each production sub-sector. A deeper understanding of how farmers (farms, farm types, subsectors, etc., as well as addressing data gaps in the extent and use of private irrigation) would practically respond to different policy proposals, would help to reinforce any dialogue process and the effectiveness of eventual solutions. There is room to build on the history of data collection, monitoring, and reporting already engaged in by the ABHs to feed into an increased need for local agencies and the public to easily access water data in order to make informed management decisions. This could be done through a curated set of data, interactive mapping tools, and reports, which are important resources to inform sustainable groundwater management decision-making.

Nexus approach recognize that we have many goals, all legitimate, and that addressing them all may in some cases be synergetic (poverty reduction and food security) or antagonistic (produce more and consume less water), in which case the art of the dialogue is to find acceptable solutions (trade-offs). We need to look for a consensus based solution (all stakeholders involved) combined with economics/modelling to try to get to a sustainable outcome. We need to integrate firstly data at basin (or similar) level and model potential outcomes. Example, farm level data for agriculture and water use characteristics (including both official and unofficial abstractions), including current and future planting and investment options (including gross margins, revenue, water use etc.). Over time, the quality and coverage of data can be improved to eventually look at sophisticated modelling of both agriculture and water. Initially, local sampling, surveys, official data, interviews etc. can build up a picture. Another key issue to resolve is getting political support for this approach. This does not appear to be such an obvious thing to put in place. Such exercise would take time (3 to 5 years). The rewards, however, for a working process would be results and approach that can be applied elsewhere in Morocco and a solution to agriculture and water running on different tracks, as it is the case now.

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