MADFORWATER

Contract no. **688320**

MADFORWATER

DevelopMent AnD application of integrated technological and management solutions FOR wasteWATER treatment and efficient reuse in agriculture tailored to the needs of Mediterranean African Countries

Deliverable No.	**5.1**
Deliverable Full title	**Review of the use of economic instruments in water management in Egypt, Morocco and Tunisia**
Work Package No. and Title	**WP5 - Strategies and economic instruments for basin-scale water resources management**
Lead beneficiary (extended name and acronym)	**Universidad Politécnica de Madrid (UPM)**
Authors **(Acronyms of beneficiaries contributing to the deliverable)**	**UPM (Marta Suárez-Varela, Irene Blanco Gutierrez, Consuelo Varela-Ortega, Paloma Esteve).** **UTM (Atef Jaouani, Raoudha Gafrej)** **UMA (Yasmine Souissi)** **NWRC (Alaa Abdel-Motaleb)** **FAORN (Faycel Chenini)** **IAV (Redouane Choukr-Allah)** **ALTER (Philippe Ker Rault)**
Planned delivery date	**28/02/2018 (M21)**
Actual delivery date	**28/02/2018 (M21)**
Dissemination level: **(PU = Public; PP = Restricted to other program participants; RE = Restricted to a group specified by the consortium; CO = Confidential, only for members of the consortium)**	**PU**
Project website	**www.madforwater.eu**
Project start date and duration	**Start date of project: 01 June 2016** **Duration: 48 months**

This project has received funds from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 688320

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1 Introduction

The Mediterranean is a region comprising 22 countries that display significant disparities. Regarding water management, it is characterized by increasing pressures over its natural resources. Within the Mediterranean, the MENA region is particularly vulnerable, being currently the most arid region and one of the most important climate change hotspots in the world (FAO, 2016; Giorgi, 2016). In fact, water crises are already a major threat in the region, and they are expected to worsen in the forthcoming future (World Bank, 2018). Since irrigated agriculture is the principal water user in the area and it contributes significantly to regional GDP - with agriculture's share of the GDP ranging from more than 5% to up to more than 20% for some countries in the region (FAO, 2015) -, water scarcity could be expected to represent a limiting factor to agricultural activity, also posing an indirect risk to food security and socioeconomic development (FAO, 2016) and increasing the risk of conflicts in the region.

To respond to these challenges, the MADFORWATER project aims to *"develop an integrated set of technological and management instruments for the enhancement of wastewater treatment, treated wastewater reuse for irrigation and water efficiency in agriculture, with the final aim to reduce water vulnerability in selected basins in Egypt, Morocco and Tunisia"* (MADFORWATER Document of Action – part B – page 1). Currently, the main sources of abstraction in Egypt, Morocco and Tunisia are the conventional ones - e.g. surface or groundwater-, with only a small proportion of supply coming from non-conventional sources. Therefore, it is expected that MADFORWATER contributes to exploit the potential of non-conventional sources in the region as to deal with the problems of water scarcity in the region.

In this context, the main objective of Work Package 5 (WP5) is to develop two open access decision support tools (DSTs) in order to integrate the technologies of WP2 and WP3 into basin level wastewater strategies and water and land strategies respectively. Moreover, in this Work Package, strategies for wastewater management, water reuse and water and land management in agriculture will be developed for the 3 basins studied in MADFORWATER (Souss-Massa, Cap-Bon and Miliane North Eastern Nile Delta) by means of the identification of effective economic and regulatory instruments that are able to enhance the implementation of the MADFORWATER technologies. For that purpose, this Deliverable (D5.1) "Review of the use of economic instruments in water management in Egypt, Morocco and Tunisia" aims at exploring the use of economic instruments and policies in the current water management approaches in Egypt, Morocco and Tunisia. Particularly, special attention has been payed to the adoption of the principles of Integrated Water Resources Management (IWRM), such as the consideration of equity and efficiency issues and the introduction of economic principles in water management.

This activity (Task 5.1) was coordinated by UPM (leader of WP5), that received inputs by the MAC partners (NWRC, UTM, UMA, NWRC, FAORN, IAV) in terms of data and experiences on their respective countries. Information on current practices, need and gaps obtained from the Stakeholders Advisory Board (SAB) during the initial Stakeholders Consultation Workshop (SCW) was also provided by ALTER (T7.3) and incorporated into this Deliverable (D5.1). Moreover, the assessment of Deliverable 1.1 provided baseline information on international cooperation agreements on water management that contributed to the review of country specific water policies with regard to the use of economic instruments for water management (task 5.1).

This Deliverable also sets a reference framework and knowledge base for different activities in the MADFORWATER project. This report (as a results of Task 5.1) will be used in subsequent WP5 tasks, particularly in tasks 5.2 and 5.3, where basin-scale strategies and economic instruments for waste water treatment, water reuse and water and land management in agriculture have to be proposed. The proposed strategies will then be combined into basin scale integrated water and land management strategies (IWLMSs) in WP6.

This document is organized in 5 sections:

Following the introduction (Section 1), Section 2 characterizes the current situation of the Mediterranean region, focusing on socioeconomic and climatic issues, and paying special attention to the current state of its natural resources. Main future socioeconomic and environmental trends affecting water management in the Mediterranean countries are also outlined using several socio-economic and climate change scenarios (e.g., IPCC scenarios, SCENES scenarios and MEDPRO scenarios).

In section 3 of this Deliverable, "Main instruments to deal with water scarcity in the Mediterranean and potential impact", a general overview on management tools and institutional framework in the Mediterranean countries is first performed. Afterwards, an exhaustive review of the main water management instruments at disposal for policy makers is conducted, including a description of the current state of those instruments in the Mediterranean countries and an assessment of the most suitable ones for tackling the detected challenges. Particularly, instruments were classified in several categories; namely economic, technical and command-and-control instruments, as well as planning and coordination bodies and strategies, and training and awareness raising actions affecting IWRM.

Section 4 is devoted to the assessment of water management policies and instruments in the MACs included in MADFORWATER (Egypt, Morocco and Tunisia). First, a general overview of the water management policies included in the previous section is conducted for the three MACs. Moreover, for each country an extensive research was performed in order to assess the legal and institutional background, and the economic and policy instruments that are currently in place in each of the target countries (Egypt, Morocco and Tunisia).

Finally, potential needs and gaps in terms of the design and implementation for water management policies and economic instruments in Egypt, Morocco and Tunisia, have been detected, and incorporated into a broader discussion included in Section 5 "Concluding remarks".

2 Water resources in the Mediterranean region: brief review on current state and short-term prospects

The Mediterranean is a region comprising 22 countries[1] that surround the Mediterranean Sea, stretching along 46,000 km of shared coastline (EEA, 2015). With a population of 480 million inhabitants, it encompasses three different continents (Africa, Europe and Asia) and a wide variety of cultural and institutional backgrounds.

In socioeconomic terms, the Mediterranean region accounted in 2011 for 11.5% of the world's GDP and 7% of the total global population. However, the region is also extremely diverse in this respect. With EU Mediterranean countries contributing up to more than 69% of the total Mediterranean GDP, the gap between Southern[2] and European Mediterranean countries remains substantial (EEA-UNEP/MAP, 2014). The Mediterranean is also the first global touristic destination (European Commission- DG Environment, 2009). Tourism is, therefore, one of the main economic activities in the region. Moreover, as an historical trade route, it is still now-a-days one of the busiest shipping routes in the world (EEA, 2015). As a consequence of these and other socioeconomic features, around one third of the population dwells now-a-days in coastal areas, and in the Southern region the percentage of population concentrated in coastal hydrological basins amounts to 65% (EEA, 2015).

Regarding environmental issues, the Mediterranean is also characterized by an extraordinary wealth of ecosystems and biodiversity with large economic and social value (EEA-UNEP/MAP, 2014). However, some species and ecosystems are under threat and critical levels of habitat loss are being experienced (UNEP/MAP-Plan Blue, 2008). Moreover, constant forest fires and chronic water shortages are expected, mainly due to the degradation of the coastline under increased construction and the abandonment of ancient pastoral regimes and rural areas (Natura 2000 programme).

Although usually favorable, climatic conditions in the region are also fairly diverse, with availability of water resources being very variable across countries and time (EEA, 2015). Constrained by limited land, and water resources that are unevenly spread, the Mediterranean region is therefore characterized by increasing pressures over its natural resources (UNEP/MAP, 2016). Water crises are already a major threat in the region, and they are expected to worsen in the forthcoming future. In this respect, the MENA region is particularly vulnerable. With per capita renewable freshwater resources that represent only 10% of the world average, it is the most arid region in the world (FAO, 2016).

Consequently, water resources management in the region has taken a prominent role in the past decades. Actually, Water Demand Management (WDM) is a concept particularly developed in the Mediterranean to serve as a useful tool for the achievement of sustainable development and dealing with the acute water scarcity in the region. Recognizing the complexity

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[1] Mediterranean countries would include Albania, Algeria, Bosnia-Herzegovina, Croatia, Cyprus, Egypt, European Community, France, Greece, Israel, Italy, Lebanon, Libya, Malta, Monaco, Montenegro, Morocco, Slovenia, Spain, Syria, Tunisia and Turkey.

[2] The southern region comprises Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, Palestine, Syria and Tunisia (EEA, 2015)

of the multiple factors and objectives influencing water resources management, it is conceived as a set of measures aimed to improve the efficiency of the different water uses in its diverse dimensions (technical, social, economic, environmental and institutional).

The implementation of such strategies necessarily demands for coordination among the countries in the region. Thus, the establishment of agreements and joint collective actions has been propelled as a means to foster cooperation and political commitment. Since the mandate of Plan Bleu was established in 1977, in the context of the Mediterranean Action Plan (MAP) of the United Nations Environment Programme (UNEP), numerous have been the efforts towards a more comprehensive framework of cooperation in the Mediterranean. Following the Rio Conference in 1992, the Mediterranean Commission on Sustainable Development (MCSD) was created. Afterwards, several regional workshops were celebrated, culminating in 1995 in the Barcelona Convention for the Protection of the Marine environmental and the Coastal Regions of the Mediterranean and its Protocols, and the Europe-Mediterranean Partnership (EUROMED). In 2005, the Contracting Parties of the Barcelona Convention adopted the Mediterranean Strategy for Sustainable Development (MSSD), further committing to the reduction of pollution in the Mediterranean by 2020. This initiative became known as “Horizon 2020”, aimed at developing the necessary strategies to achieve the intended objectives.

2.1 Mediterranean climate and water resources.

Mediterranean climate is characterized by hot dry summers and mild wet winters. However, it brings together a group of countries with very different morphological and geographical features. Therefore, climatic conditions in the region are very diverse, particularly between arid and semi-arid regions, mainly located in the south, and mountainous regions located in the north[3] (Plan Bleu- GWP, 2012) (Figure 1). Levels of aridity4 can be exacerbated in summer months, with the southern and some regions of the northern countries becoming arid during this period (Figure 2).

[3] Northern Mediterranean countries are Spain, France, Italy, Greece, Monaco, Slovenia, Croatia, Bosnia-Herzegovina, Serbia, Montenegro, Albania, Cyprus and Malta. Southern Mediterranean countries are Egypt, Libya, Tunisia, Algeria and Morocco. Eastern Mediterranean countries are Turkey, Syria, Lebanon, Israel and the Palestinian Territories.

[4] Aridity in this context is measured through the De Martonne aridity index. This index is calculated according to the formula: I = P / (T+10) where P denotes total annual precipitation and T, the annual mean temperature.

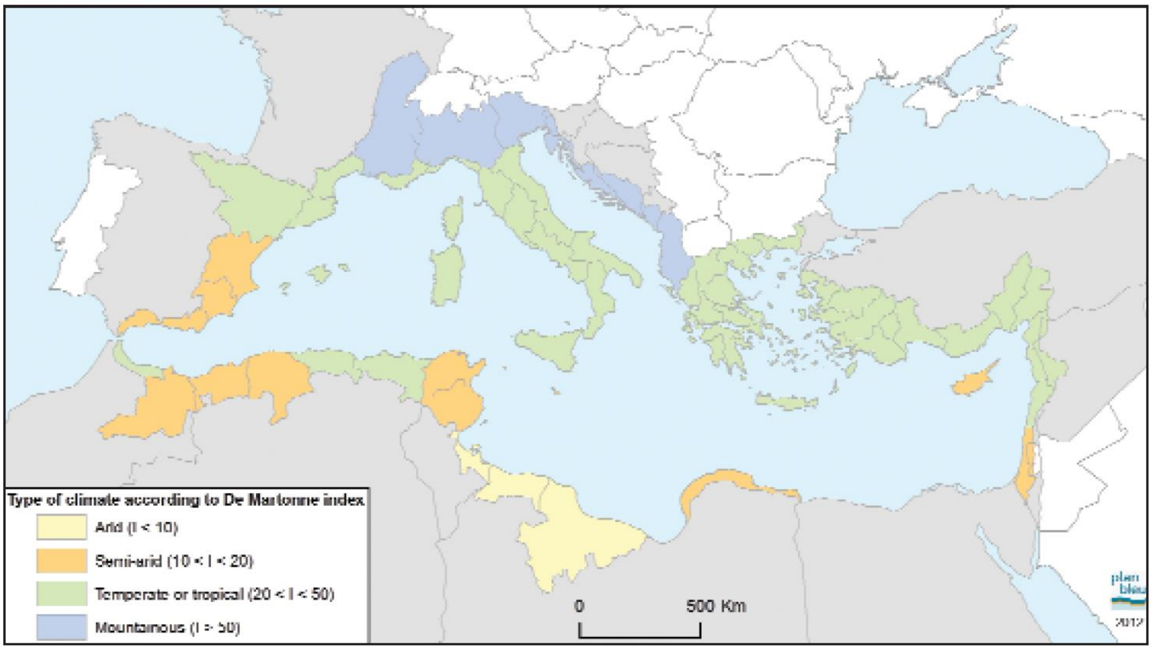


Figure 1. Average annual aridity indices of the Mediterranean watersheds.

Source: Fabre (2010). Taken from Plan Bleu (2012).

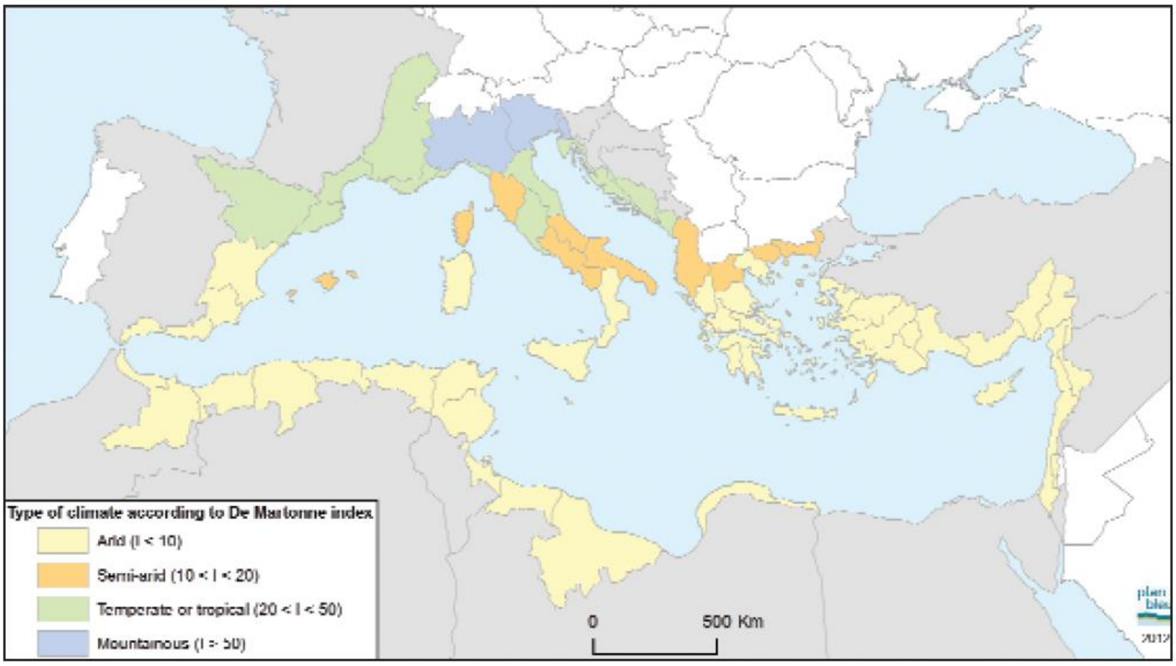


Figure 2. Aridity indices for the Mediterranean watersheds in the months of June, July and August.

Source: Plan Bleu (2012). Taken from Fabre (2010).

Average annual temperature usually ranges from the -5ºC in the Alps to more than 20ºC in the southern countries. Precipitation greatly varies across regions as well, with some northern Mediterranean areas reaching as much as 1,500 mm- 2,000mm per year, while some regions of the southern countries are receiving only 100mm (EEA/UNEP-MAP, 2014). Together, Turkey, Italy and France enjoy half of the total rainfall. Conversely, southern countries receive only 10% of the total precipitation (Plan Bleu, 2012).

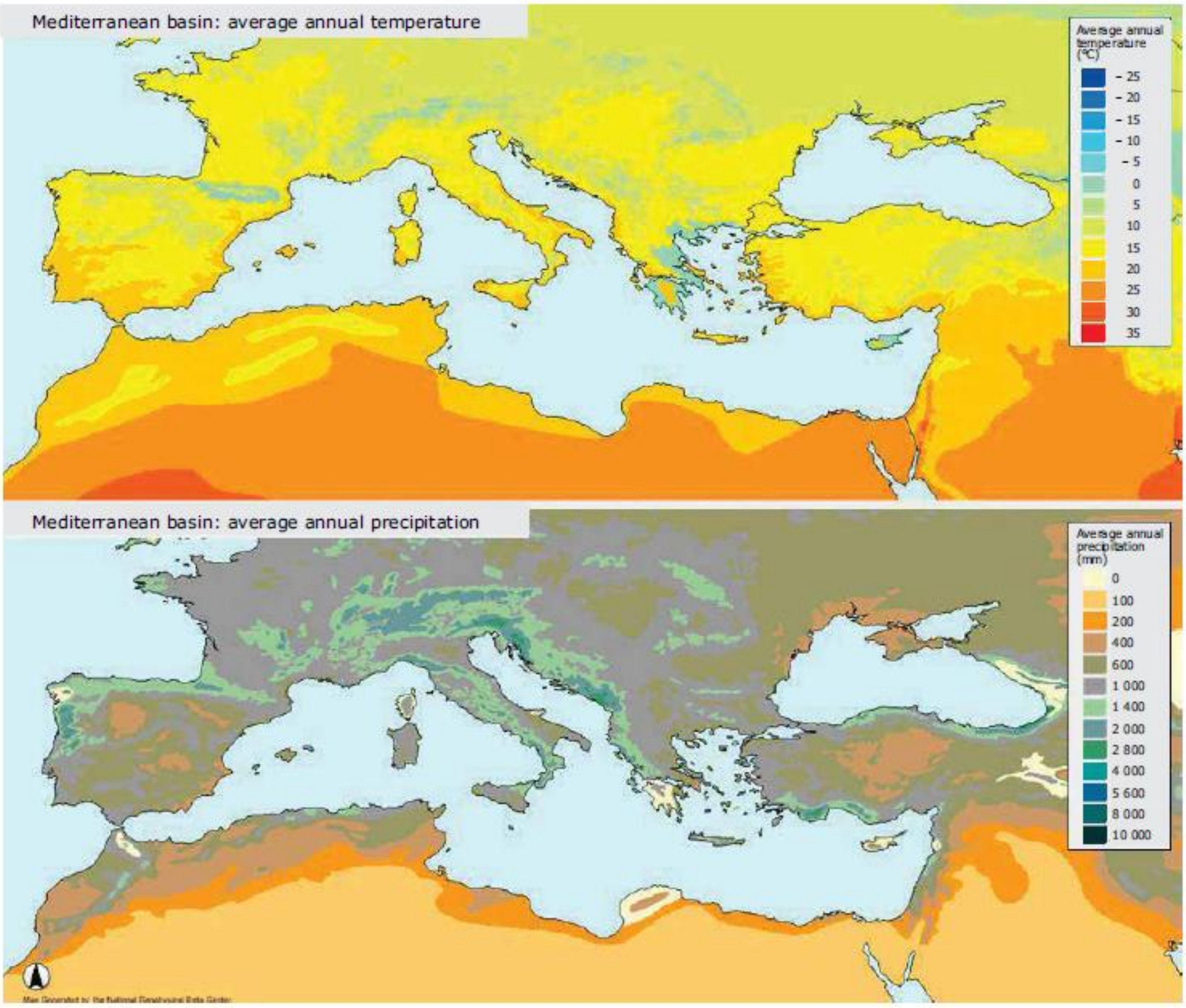


Figure 3. Map for average annual temperature and average annual precipitation.

Source: EEA-UNEP-MAP, 2014.

As a consequence of the combination of high temperatures and low precipitation, the pressure over water resources is high in most regions of the Mediterranean. More than two-thirds of the countries in the region are considered to be under water stress (See Figure 4). In fact, it is considered as the most arid region in the world (Kibaroglu, 2017), with 60% of the total population suffering from water poverty[5] residing in the Mediterranean (Benoit and Comeau, 2006). Furthermore, the distribution of water resources is extremely uneven. A 72% of freshwater resources are located in the North. On the contrary, the endowment in the South is only a 5% of the total resource, the remaining 23% being in the Eastern countries (Burak, 2008). Together, the six countries with the lowest level of the resource (Cyprus, Israel, Libya, Malta, the Palestinian Territories, and Tunisia) would only represent a 1% of the total allocation (Plan Bleu, 2012).

[5] Defined as an availability of less than 1000 m3 of water per capita annually.

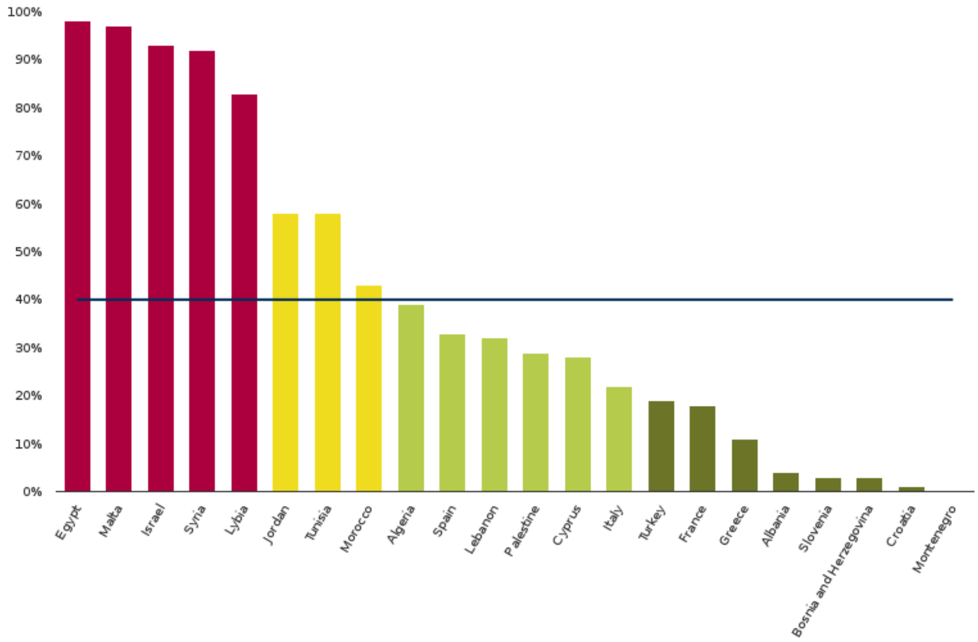


Figure 4. Water Exploitation Index for Natural renewable freshwater resources in the Mediterranean countries (2005-2010).

Source: Plan Bleu - UNEP/MAP , 2013
* Water Exploitation Index is defined as the ratio of the volume of annual abstraction on renewable natural water resources and the annual average volume of avabilable renewable natural water resources, expressed in percentage.
** The blue line represents the threshold for water stress.

Following the Falkenmark water stress indicator (Falkenmark, 1989)[6], Malta, Lybia, Palestinian Territories, Israel, Algeria and Tunisia would be considered as experiencing water shortage, with annual resources under 500 m3/capita/year. Morocco, Egypt, Cyprus and Syria would be ranked among the water-poor countries, while for the rest of countries water would not entail a limiting factor for human well-being and economic development (Plan Bleu - UNEP/MAP, 2013). Figure 5 shows the Falkenmark indicator obtained at the watershed level.

[6] According to this indicator, below 500 m3/capita/year, water availability could be a main constraint to live. Between 500 and 1000 m3/capita/year it is a limitation to economic development and humal health and well-being. The threshold of under 1,700 m3/capita/year would imply regular appearance of water stress. Over that amount, water shortages would occur only irregularly or locally.

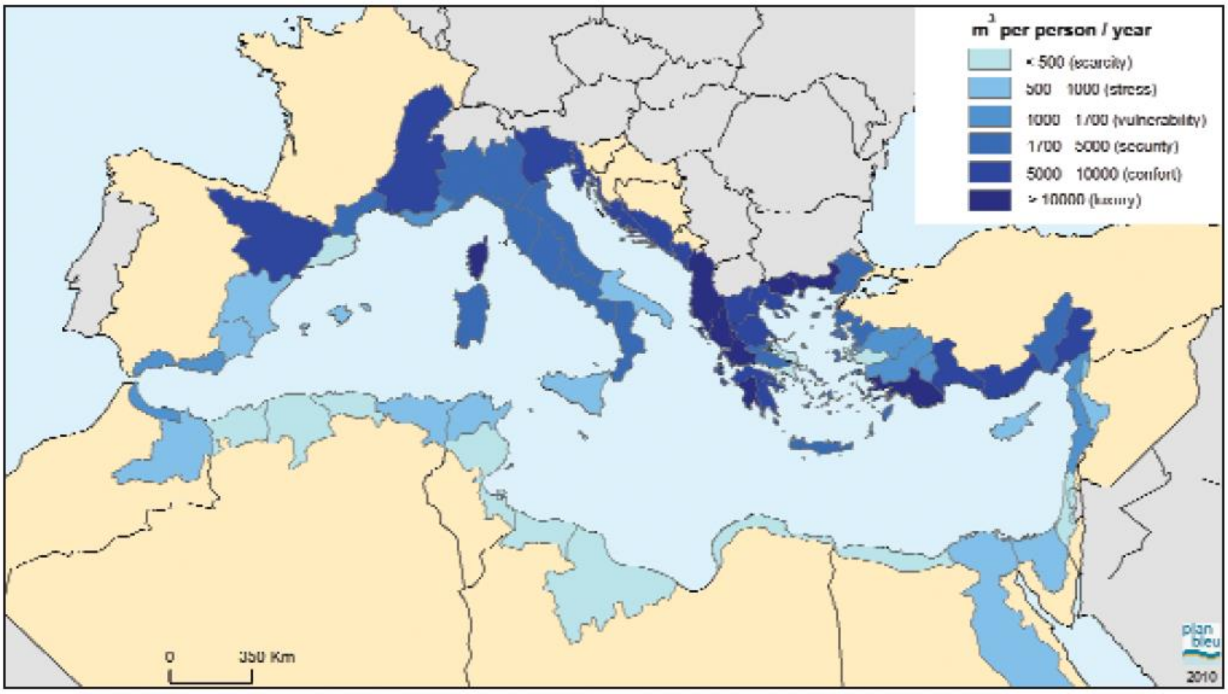


Figure 5. Natural annual renewable freshwater resources per capita in the Mediterranean watersheds.

Source: Plan Bleu, based on national sources (2010).

Water-related problems in the region may be further aggravated by the fact that in some countries, a substantial proportion of water is abstracted from aquifers that are for the most part non-renewable. The distinction is important, as it may represent an indication of further availability issues in the medium-long term. Figure 6 displays unsustainable water production indices for Mediterranean countries.

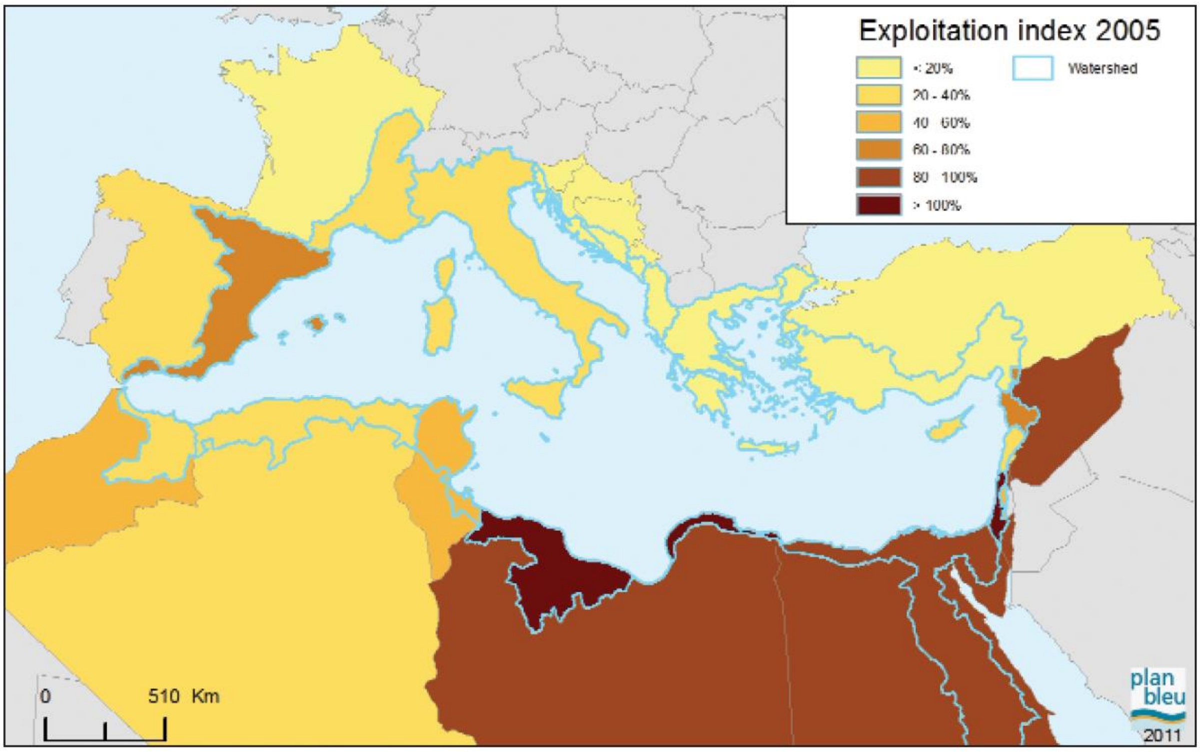


Figure 6. Unsustainable Water production Indices for Mediterranean countries.

Source: Plan Bleu, based on national sources (2010).
*The index is computed by Plan Bleu as the percentage ratio of water withdrawn from non-renewable aquifer reserves to the total volume withdrawn.
** An index of between 20 and 60% may indicate local or cyclical strains. 60-80% would imply the existence of major risks of structural constraints in the medium and long-term. More than 80% may be signaling severe limitations on water resources in the medium-long term.

In addition to restrictions on quantity, a decreased quality due to contamination of surface and groundwater resources represents an additional constraint on water resource availability in the region (Hamdy, 2001).

With respect to the allocation of available resources among the competing uses, irrigation is the main consumer in the area, accounting for around 63% of the total demand. The demand for energy generation and the residential sector entail very similar proportions of up to 13% each. The rest (11%) would be allocated to industry (Plan Bleu, 2012). Since irrigated agriculture is the principal water user in the area, water is expected to pose a limiting factor to agricultural activity and development in the region, particularly in the MENA (Middle East and North Africa) countries, where it already represents an indirect threat to food security (FAO, 2016).

Taking into account the abovementioned facts and figures, and given extraordinary diversity of climatic conditions, in the Fréjus Workshop (1997) following the creation of the Mediterranean Commission on Sustainable Development (MCSD), a classification of countries was proposed in order to tailor policies to the specific problems and needs faced by each group of countries.

Table 1. Classification of groups after the Fréjus workshop in 1997.

Type of instrument	Calification	Countries included
Group 1	Countries **not at risk** of shortage	Albania, Bosnia-Herzegovina, Croatia, France, Greece, Italy, Monaco, Slovenia, and Turkey
Group 2	Countries mostly at **localised risk** of cyclical shortage	Cyprus, Spain, Lebanon, **Morocco**, and Syria
Group 3	Countries with **cyclical and/or structural shortage** from 2000, despite low demand for water	Algeria, Palestinian Territories, Israel, Malta, and **Tunisia**
Group 4	Countries with **structural shortage** from 2000, aggravated by strong demand for water	**Egypt** and Libya

Source: Adapted from Plan Bleu - GWP (2012).

Within this classification, the MAC's countries (Morocco, and Tunisia), that are the main focus of this report, would be included in Groups 2 (Morocco), 3 (Tunisia) and 4 (Egypt), indicating that they should be granted particular attention.

Boxes 1, 2 and 3 gather some key factors about water resources in the selected MAC countries.

Box 1. Brief summary of the state of water resources in Egypt: Key facts.

State of water resources: Key facts (Egypt)

- **Total population:** 91,508,000 inhabitants
- **Freshwater availability per capita:** 637 m^3/inhab/year
- **Total renewable surface water resources:** 56 (10^9 m^3/year)
- **Total renewable groundwater resources:** 2.3 (10^9 m^3/year)
- **Yearly total water withdrawals on total actual resources:** 78 km^3/year
- **Water demand by sectors:** Absolute (in 10^9 m^3/year) // in %
    - **Households:** 9 // 11%
    - **Agriculture:** 67 // 81,8 %
    - **Industrial:** 2 // 2.4%
    - **Cooling water:** 4 // 4.8%
- **Water exploitation index:** 134%
- **Other sources of water supply** (in 10^9 m^3/year)
    - **Agricultural drainage:** 2.7
    - **Treated waste water:** 1.3
    - **Desalination:** 0.2
    - **Importation:** 0

Source: Burak and Margat (2016). FAO-Aquastat (2016).

Box 2. Brief summary of the state of water resources in Morocco: Key facts.

State of water resources: Key facts (Morocco)

- **Total population**: 34,378,000 inhabitants.

  Freshwater availability per capita: 844 m^3/inhab/year
- **Total renewable surface water resources:** 22 (10^9 m^3/year)
- **Total renewable groundwater resources:** 10 (10^9 m^3/year)
- **Yearly total water withdrawals on total actual resources:** 10,43 km^3/year
- **Water demand by sectors** Absolute (in 10^9 m^3/year) // in %
  - **Households:** 1.063 // 10.12%
  - **Agriculture:** 9.156 // 87.77%
  - **Industrial:** 0.212 // 2.03%
  - **Cooling water:** 0 // 0%
- **Water exploitation index:** 36%
- **Other sources of water supply** (in 10^9 m^3/year)
  - **Agricultural drainage:** 0
  - **Treated waste water:** 0.07
  - **Desalination:** 0.01
  - **Importation:** 0

Source: Burak and Margat (2016). FAO-Aquastat (2016).

Box 3. Brief summary of the state of water resources in Tunisia: Key facts.

State of water resources: Key facts (Tunisia)

- **Total population:** 11,254,000 inhabitants
- **Freshwater availability per capita:** 411 m^3/inhab/year
- **Total renewable surface water resources:** 3.42 (10^9 m^3/year)
- **Total renewable groundwater resources:** 1.6 (10^9 m^3/year)
- **Yearly total water withdrawals on total actual resources:** 3.3km^3/year
- **Water demand by sectors** Absolute (in 10^9 m^3/year) // in %
    - **Agriculture**: 0.4961 // 15%
    - **Industrial:** 2.644 // 80%
    - **Households:** 0.165 // 5%
    - **Cooling water:** 0 // 0%
- **Water exploitation index:** 72%
- **Other sources of water supply** (in 10^9 m^3/year)
    - **Agricultural drainage**: 0
    - **Treated waste water:** 0.07
    - **Desalination:** 0.02
    - **Importation:** 0

Source: Burak and Margat (2016). FAO-Aquastat (2016).

2.2 Challenges and future scenarios.

MAIN PROSPECTS AND CHALLENGES IN THE MEDITERRANEAN:

In the last decades, the Mediterranean is undergoing intensive demographic, social, economic and environmental changes that will predictably affect water availability in the future. In broad terms, the major challenges faced by water resources management in the Mediterranean region are the following:

Climate change:

The Mediterranean is one of the areas that are expected to be more vulnerable to climate change (Giorgi, 2016), given the high level of water stress, the concentration of population and economic activities in coastal areas, a climate-sensitive agriculture and the frequent occurrence of extreme weather events (e.g. droughts and floods) (UNEP/MAP, 2016).

By 2100, temperature is expected to rise from 3 to 5ºC, while precipitation will predictably decrease by 35% in the Southern countries and by 25% in the Northern (Intergovernmental Panel on Climate Change – IPCC –, 2013). Sea level is also expected to rise from around 0.1 m to 0.3 by 2050 and up to from 0.1 to 0.9 by 2100 (Intergovernmental Panel on Climate Change, 2013), which may possibly generate risks for coastal areas and potential saline intrusion in nearby aquifers. Jointly, these trends are expected to generate a higher pressure on water resources in the region, with risks expected to be particularly acute for the case of the Southern countries (UNEP/MAP, 2016).

Socioeconomic trends:

Population in the Mediterranean area has grown steadily in the last decades, doubling from the 240 million people in 1960 to 480 in 2010. Furthermore, it is expected to increase in the following years, predictably reaching 600 by 2050 (EEA/UNEP-MAP, 2014).

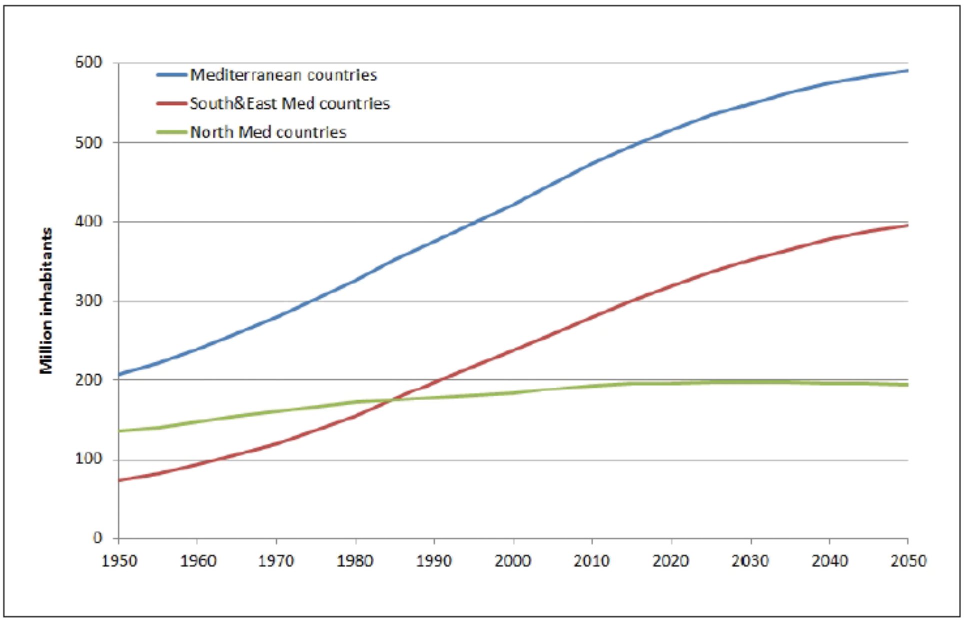


Figure 7. Mediterranean demographic trends until 2050.

Source: Plan Bleu, 2012. Based on United Nations Population Prospects (2008)

Since population growth rates are significantly higher in the Southern and Eastern regions of the Mediterranean as opposed to the EU Mediterranean countries, the distribution of population has significantly changed in the last decades. While Southern and Eastern countries represented a 41% of the population in 1960, by 2050 they are expected to represent around two-thirds of the total population in the region, posing an additional pressure on the countries displaying a higher level of water stress. Moreover, the trends in population growth have run in parallel to an increase in urban population, passing from the 48% of urban dwellers in 1960 to around 67% in 2010. Most of these urbanization trends have also focused in coastal areas, with particular intensity in the coastal towns of the southern countries (EEA-UNEP/MAP, 2014; UNEP/MAP, 2016).

In economic terms, the region is also considerably diverse. Although in the last years, economic growth rates have been higher in the Southern than in the European Mediterranean countries, the gap between them is still considerable (EEA-UNEP/MAP, 2014). Economic development is predicted to continue being dominated by activities that are intensive in natural resources, either in the primary (e.g. fisheries and agriculture), secondary (e.g. food processing and construction) or service sectors (e.g. shipping and tourism) (UNEP/MAP; 2016). Particularly, tourism is expected to be of special importance in the region, since by 2025 around 300 million tourists per year are predicted (Plan Bleu, 2012). In addition, high poverty and unemployment rates coexist in the region, especially in the Southern countries, generating economic insecurity and triggering the emergence of social unrest (UNEP/MAP, 2016). Moreover, problems derived from water scarcity will pose a serious risk on food security, particularly in the MENA region (Middle East and Nort Africa) (FAO, 2016). This, along with an increased competition among different water uses and countries for the allocation of an increasingly scarce resource, may further represent an additional source of conflicts and political instability in the Mediterranean (World Bank, 2009).

Institutional issues:

Some institutional aspects may also pose considerable constraints to the pursuit of sustainable development. In this respect, the lack of accountability of the water sector in most countries (both in relation to external users and internally among the different financial agents, policy makers and service suppliers), as well as an insufficient implementation of mechanisms of allocation (e.g. economic tools, rights over water and regulatory frameworks) have been found as majors factors hindering the application of satisfactory water management solutions in the region (World Bank, 2009). An additional complexity would derive from the existence of a large percentage of water resources in the Mediterranean being transboundary (FAO, 2015), which, exacerbated by an increased scarcity, may also result in social tensions and conflicts (World Bank, 2018). In this context, a strong cooperation among countries in the region and a more ambitious implementation of the principles of IWRM would prove as very effective institutional tools to improve water resources management in the Mediterranean.

FUTURE SCENARIOS:

The abovementioned trends and challenges are expected to continue and intensify in the years to come, leading to some scenarios that are described below. Since main climate change prospects based on the projections of the IPCC have been already commented, this section will be devoted to socioeconomic and institutional issues, paying special attention to their implications in terms of the evolution of water resources in the region. Particularly, we are going to focus on the scenarios developed by Plan Bleu (based on climate change and changes on population, consumption, production and distribution patterns) and the MedPro H2020 project of the European Commission (with more emphasis on institutional aspects; i.e. level of cooperation between the European Union and Southern and Eastern Mediterranean countries (SEMCs), and the change in total wealth).

Plan Bleu

In Plan Bleu (2012), two scenarios for the Mediterranean are proposed, taking 2025 as the horizon of reference. The **first scenario,** denominated ***"business as usual",*** is based on projections of the observed economic and environmental trends of the previous three decades. This scenario is thus characterized by increasing demands for water (particularly in the Southern and Eastern Countries), an increasing pressure on water resources (mainly due to an unsustainable exploitation and decreased quality), and the assumption that water policies will continue to be centered in supply solutions such as constructing new infrastructures, developing transfers between regions or using non-conventional water resources. Conversely, in the **second scenario** (known as ***"better integration of environment and development but on a voluntary basis"),*** some improvements in the management of water resources and water demand would be implemented. Particularly, Plan Bleu list a number of policy issues that should be addressed (Plan Bleu, 2012):

– "*Improve water resource management, storage and protection through pollution prevention, increasing the exploitable potential, improving soil and water conservation practices, and increasing the use of artificial replenishment of groundwater in arid areas;*

– *Ensure economical and effective use of water by setting up Water Demand Management (WDM) strategies and policies backed by the necessary technical, economic, and regulatory tools; and developing the appropriate institutional capacity through awareness-raising and training."*

As opposed to the first scenario in which no policy reform is applied, in the alternative situation substantial savings (up to a quarter of the total demand in the base year) are achieved by 2025 in terms of demand from the different sectors (65% in irrigated agriculture, 22% in industry and 13% in domestic water supply), indicating the need for the implementation of the abovementioned policies.

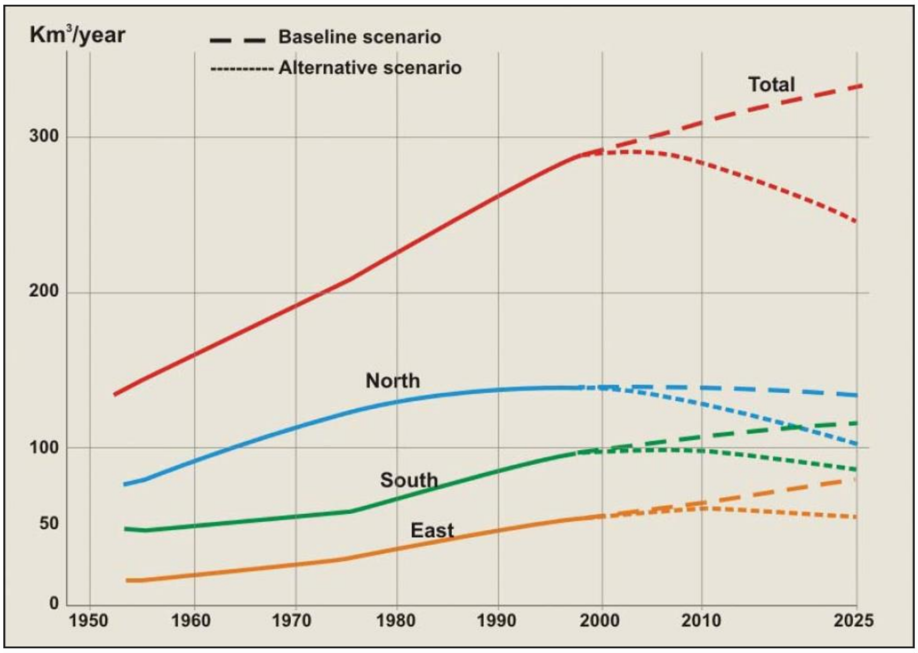


Figure 8. Total demand for water by subregion for Plan Bleu's baseline and alternative scenarios (2000 and 2025).

Source: Plan Bleu (2012)

<u>MedPro H2020 Project</u>

The MedPro H2020 Project of the European Commission also presents some scenarios and potential outcomes, particularly in relation to the countries in the MENA region, found among the most vulnerable to water scarcity within the Mediterranean. The results of the MedPro scenarios are of special interest for the task at hand in this report, as they deliver projections for the MACs countries object of study in MADFORWATER (i.e. Egypt, Morocco and Tunisia).

In the MedPro project (Varela-Ortega et al. 2013), four situations are distinguished according to the evolution of two main issues: 1) The level of cooperation between the European Union and Southern and Eastern Mediterranean countries (SEMCs), and 2) The change in total wealth and natural resources endowment.

The four likely scenarios identified by MedPro - ***Reference scenario, Sustainable Euro-Med growth, Decline and conflicts, and Fragmented regional developments*** - are afterwards combined with the ones developed by the SCENES project[7] specifically for the evolution of water resources in Europe and neighbouring **countries** - ***Economy first, Sustainability eventually, Fortress Europe and Policy rules*** - resulting in the set of scenarios represented in following axis:

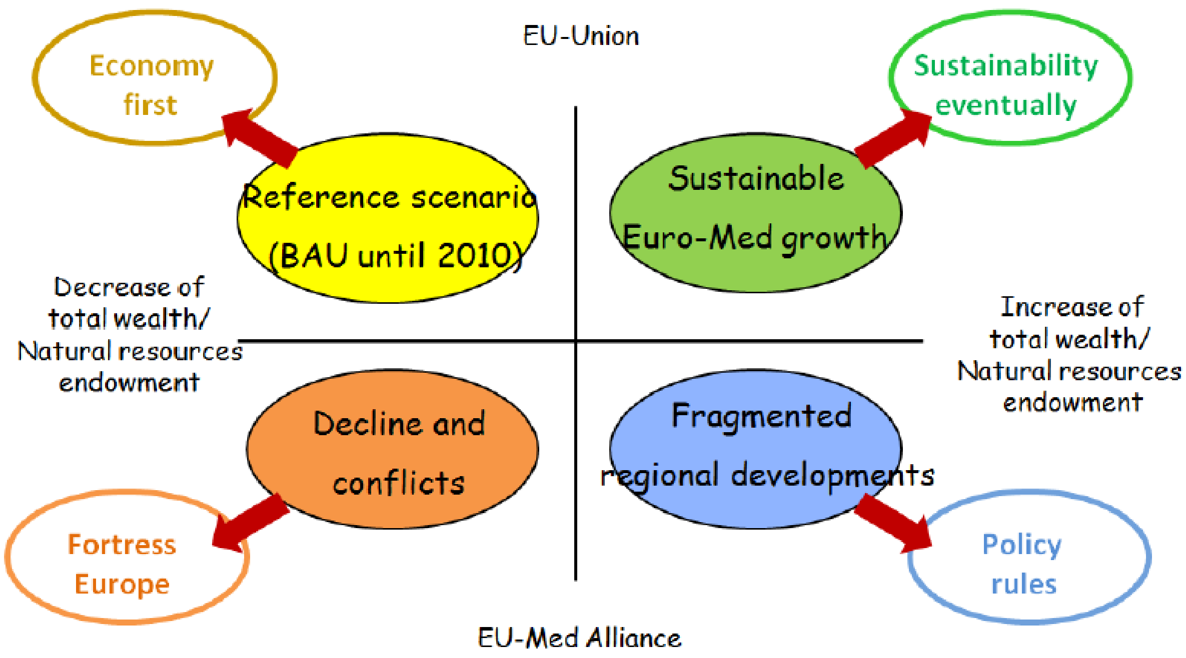


Figure 9. Combination of MedPro and Scenes scenarios.

Source: Varela-Ortega et al. 2013

In broad terms, the characteristics of the four situations are delimited in Table 2 below.

[7] "Water Scenarios for Europe and for Neighbouring States" (SCENES), European Commission. These scenarios depart from the ones of the Global Environmental Outlook (GEO-4) of the United Nations Environment Programme (UNEP, 2007).

Table 2. Summary of the main features of the MEDPRO socio-economic scenarios.

1) Reference Scenario (BAU until year 2010)	2) Sustainable Euro–Mediterranean Growth
• Partial EU–Mediterranean cooperation and limited cooperation among Mediterranean countries. • Unsustainable growth → towards depletion of natural, human and social capital.	• Decrease of conflicts; EU–Mediterranean integration, with a common market, strategies and institutions • Cooperation, research, innovation → sustainable development. •
4) Decline and Conflicts	**3) Fragmented Regional Developments**
• Increase of conflicts in the region; the Mediterranean sea becomes a border between Christian and Islamic worlds. • Failure to achieve sustainable development leads to unmanageable resource scarcity	• Alliance of EU with Mediterranean countries: two blocs in cooperation • Peace and stability • Important role of institutions and laws

Sources: (Varela-Ortega et al. 2013) Based on Sessa (2011) and Ayadi and Sessa (2011).

Main results are the following. As showed in Figure 10, in the first scenario **- "business as usual"-**, in which no policy change is produced, most countries in the region are expected to suffer from substantial increases in water withdrawals.

Figure 10. Percent variation in water withdrawals in MENA countries by 2030 with respect to the baseline year 2004. Projection for Business as usual scenario.

Source: Varela-Ortega et al. 2013

The second scenario **- Sustainability + Integration-** is characterized by the creation of a unified region integrated by EU and SEMCs that promotes sustainable use of natural resources. As depicted in Figure 11, the creation of such entity would be expected to generate a decrease in water withdrawals in all countries, with the exception of Egypt, Turkey and Jordan.

Figure 11. Percent variation in water withdrawals in MENA countries by 2030 with respect to the baseline year 2004. Projection for Sustainability + Integration scenario (Varela-Ortega et al. 2013).

Source: Varela-Ortega et al. 2013

When the countries in the region are involved in cooperation and development regarding climate change and sustainability, but fragmented into two separate groups (Northern European countries and the SEMCs), the predictions of scenario 3 – **Sustainability + Fragmented Cooperation -** indicate that some countries would experience decreases in withdrawals, although the results are not as good as in the previous scenario.

Figure 12. Percent variation in water withdrawals in MENA countries by 2030 with respect to the baseline year 2004. Projection for Sustainability + Fragmented cooperation scenario (Varela-Ortega et al. 2013).

Source: Varela-Ortega et al. 2013

In the last scenario **– Decline and conflicts –**, the lack of cooperation among the countries in the region, that could even derive in wars and conflicts, results in a weak promotion of sustainability in the management of water resources. As a consequence, most of the countries in the MENA region would experience increases in the level of water withdrawals.

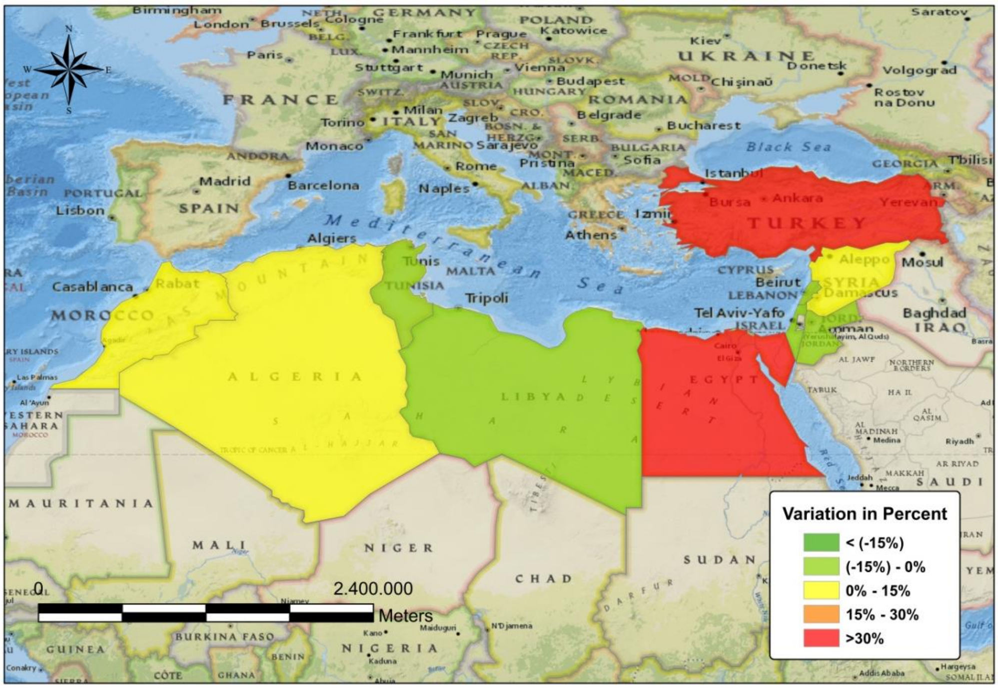


Figure 13. Percent variation in water withdrawals in MENA countries by 2030 with respect to the baseline year 2004. Projection for Decline and Conflicts scenario (Varela-Ortega et al. 2013).

Source: Varela-Ortega et al. 2013

Together, the results of the application of these scenarios and the description of the future challenges are able to convey an important lesson: The paramount importance of public policy in dealing with future problems derived from water scarcity in the Mediterranean.

3 Main instruments to deal with water scarcity in the Mediterranean and potential impact.

3.1 General overview on management tools and institutional framework.

In the above mentioned context, water management has become a paramount issue in the agenda of global leaders and international organizations in the last decades. The Mediterranean has been no exception. In the region, substantial efforts have been made towards the implementation of public policies addressing the likely problems derived from water scarcity.

Water management policies often involve both supply and demand interventions. In what follows, we are going to outline a brief overview of the management tools at disposal and the current situation or application of those tools in the Mediterranean region.

Supply-side policies

Supply side policies have traditionally been the most common way of intervention in water management. On the supply-side, public policies may include a wide range of solutions from very different nature. Following FAO (2012), supply interventions can be broadly classified/categorized as:

1) Reducing inter-annual variability of river flow, by promoting increased store in multi-purpose dams or on-farm water conservation.
2) Enhancing groundwater supply capacity: This would include all activities related to the development of groundwater, such as management strategies and artificial recharge.
3) Water recycling and re-use: Promoting the re-use of wastewater for crop production.
4) Pollution control: By means of point source controls of pollution generated by industries, cities or agriculture.
5) Importing water: This would involve actions such as inter-basin transfer or desalination.

The mix of sources currently employed within the countries in the Mediterranean region is depicted in Figure 14.

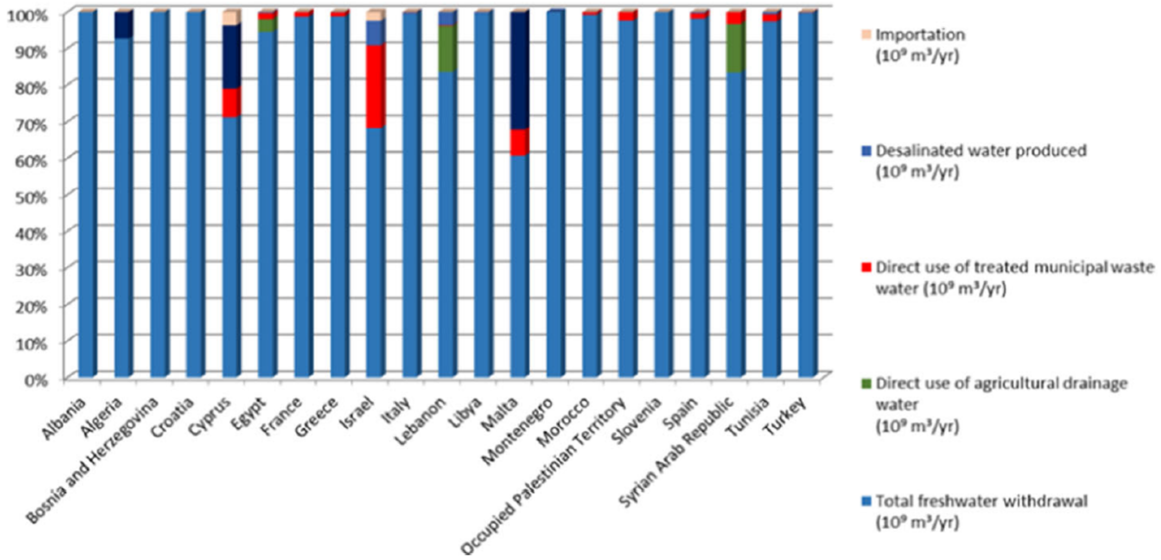


Figure 14. Sources of water supply in Mediterranean countries.

Source: Burak and Margat (2016).

Although supply sources in the Mediterranean are too diverse as to characterize a common profile, it can be drawn that conventional water resources (freshwater withdrawals) are the major source in the region. However, in some countries such as Cyprus, Malta or Algeria, desalination implies a significant share of total supply. In some others, such as Israel, treated municipal wastewater is also a main source for meeting demand. Use of agricultural drainage water also involves a substantial proportion of supply for some of the countries in the region (e.g. Syria and Lebanon).

Despite the fact that conventional water resources are still the most important source in the region, most Mediterranean countries are currently developing non-conventional sources of water supply. Therefore, an increasing share of water resources are now-a-days obtained from non-conventional. Table 3 offers the percentage of non-conventional resources employed in some of the countries of the Mediterranean.

Table 3. Proportion of supply from non-conventional sources in some Mediterranean countries.

Country	Percentage of non-conventional sources.	Year
Algeria	27	2000
Cyprus	25	2000
Egypt	4.5	2000

Israel	23	2004
Lebanon	0.04	2000
Libia	83	2000
Malta	45	2006
Morocco	6	2004
Occupied Palestinian Territories	-	-
West Bank	35	2002
Gaza	75	2002
Syria Arab Republic	28	2004
Tunisia	38	2003

Source: Burak and Margat (2006).

From the range of supply policy options, two deserve a closer attention due to its current or potential importance in the region: the reuse of treated wastewater and desalination.

Wastewater reuse:

The management of wastewater is key for several reasons (Plan Bleu-GWP, 2012; FAO, 2012). First, it can reduce the level of withdrawals. Moreover, since wastewater usually contains plant nutrients, it can be of particular benefit for irrigation purposes. Secondly, by using treated wastewater, policy makers are serving the additional target of reducing the amount of water discharged to the environment without previous treatment, thus contributing to the achievement of the goals related to sanitation and management of water pollution. Finally, the reuse of treated wastewater is currently cheaper that other non-conventional sources (such as desalination) in economic terms, mainly due to the lower energy needs (Plan Bleu-GWP, 2012).

In the Mediterranean, by 2025 the reuse of wastewater could potentially reach 6km^3 by 2025 (Plan Bleu-GWP, 2012), thus implying an important source of water resources that currently remains insufficiently exploited. The main barriers affecting the implementation of treated wastewater are usually institutional and regulatory constraints, driven in part by the lack of cultural acceptance. Economic and technical feasibility could also be a limiting factor in some of the countries.

Desalination:

Desalination is another non-conventional source that displays great potential in the Mediterranean countries. It is currently employed in many countries in the region, implying a substantial proportion of supply in some of those countries (See Table 3 above). In 2010, it already accounted for around a fifth of the total world desalination capacity), and it is expected to triple or even quadruple by 2030 (Plan Bleu-GWP, 2012). Figure 15 shows the proportion of the total desalination capacity in the Mediterranean region that corresponds to each of the countries.

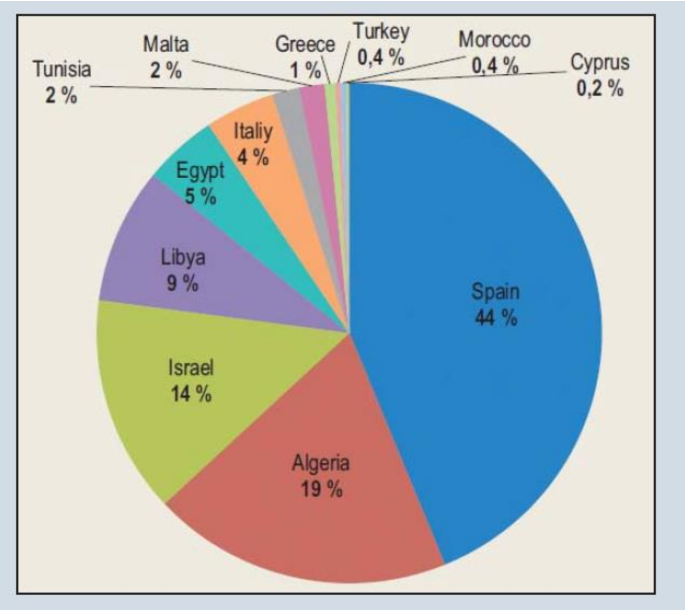


Figure 15. Percentage of total desalination capacity (percentages) corresponding to each Mediterranean country.

Source: Plan Bleu-GWP, 2012. Based on information from Boyé, Plan Bleu (2008).

Although desalination is still more expensive that other sources (e.g. treatment of freshwater, reuse of treated wastewater), its costs have significantly decreased in the last decades due to technological improvements, and it could even approach the cost for the treatment of conventional sources in the future.

Demand-side policies

Traditionally, Mediterranean water strategies and policies have been focused towards the improvement of the water supply in response to an increasing water demand. Such policies have permitted the development of water infrastructure, water transfers, the use of groundwater reserves or the use of desalinated sea water. The most recent strategies also include innovative elements about the development of non-conventional water resources, the reuse of wastewater (e.g. Egypt and Tunisia) or the reuse of agricultural drainage water (e.g. Egypt).

However, when not implemented with other complementary measures, traditional supply interventions have usually proved costly both in economic and ecological terms. Moreover, they have sometimes been found to generate a higher level of dependence in arid regions, as demand usually adapts to the increase in availability (World Bank Group, 2016). Particularly in the Mediterranean, supply-oriented policies are no longer enough to meet the needs of a water sector facing great and increasing pressures. Such diverse constraints (social, economic, environmental, physical…) expose Mediterranean countries to medium and long-term risks threatening not only their available water resources (overexploitation, sea water intrusion, water quality…) but also their economic, political and social stability.

Consequently, demand policies have taken an increasingly prominent role in the last decades. In this context, IWRM (Integrated Water resources management) has emerged as a new paradigm to provide long-lasting solutions to problems derived from water scarcity. IWRM was defined by the Global Water Partnership (2000) as "a process which promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems". As such, it seeks to develop holistic approaches to water-related issues, thus considering simultaneously social, environmental and economic factors involved in effective water management. The main principles in which IWRM is grounded, as well as the three pillars for the implementation of such principles can be found in Box 4.

Box 4. The four principles and three pillars of IWRM.

Four principles of IWRM – Dublin Principles- (CITA WEB).

Principle 1: Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.

Principle 2: Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels.

Principle 3: Women play a central part in the provision, management and safeguarding of water.

Principle 4: Water has an economic value in all its competing uses and should be recognised as an economic good.

The three pillars of IWRM.

The implementation of the principles of IWRM of the three principles relies on three main pillars (**The three E's**):

-**Economic efficiency in water use**: Water should be allocated to its highest value economic use.

- **Social Equity**: The basic right of human being to have access to clean water and sanitation must be considered. Water must be allocated in an equitable way across different social and economic groups.

- Environmental sustainability: Water resources should be managed in a way that do not compromise their use by future generations.

Source: FAO, 2015. GWP, 2004.

In the Mediterranean, the implementation of the principles of IWRM has led to the emergence of an approach known as Water Demand Management (WDM), a concept that was coined in the region with the objective of improving the use of available water resources by means of the implementation of economic and efficiency principles along with organizational and enabling systems (Plan Bleu-GWP, 2012).

Particularly concerning efficiency, the WDM seeks to increase its many dimensions and in the different water uses: technical, social, economic, environmental and institutional efficiency (Plan Bleu-GWP, 2012. In the context of WDM, efficiency can be understood in two different ways (Plan Bleu-GWP, 2012; World Bank, 2018):

- Efficiency in water provision and distribution:

In the Mediterranean, water losses produced due to leakages in the distribution networks are an important source of inefficiency, with the volume of water saved by avoiding those networks potentially reaching 30% of withdrawals (Plan Bleu-GWP, 2012).

- Efficiency in water use:

Agriculture is the main water consumer in the region. Therefore, although there is some potential for an increase in water productivity and efficiency in the industrial and domestics sectors, the main saving can be expected to come from increases in agricultural productivity.

In general terms, some of the actions that could be implemented in order to achieve the necessary improvements in efficiency would include reductions of wastage and misuse of water in the different sectors, the optimization of water allocation, the rationalization of the water use, and improvements in the water-saving infrastructure paired with the necessary financial support to these actions.

3.2. Main instruments for water management in the Mediterranean

The integrated and practical approach involved in the Integrated Water Resources Management (IWRM) and Water Demand Management paradigms rely in the implementation of several tools. Broadly speaking, those tools can be clustered into three main groups: economic tools, technical tools and command-and-control (or regulatory) tools. Such tools should be combined and tailored to the particular situation of a given water sector, use and country. Strategies and regulations should be combined with technical and economic tools for the effective and successful implementation of an integrated water resources management.

Agriculture, as the main water user in most countries, and very especially in Mediterranean countries, is a sector that highly impacts a country's water resources, and in turn is crucially affected by water management strategies.

The main tools for the agricultural water management in the Mediterranean that will be more thoroughly discussed below can be described as follows (Plan Bleu-GWP, 2012. Page 24, figure 9):

- **Technical tools:** E.g. improvements in canal streamflow processes or in the efficiency of irrigation systems, reduction of vulnerability of agronomical models and land use systems, or irrigation planning and management.

- **Economic tools:** Water pricing, Quotas, Financial assistance (subsidies, loans), fees…

- **Command and control/regulatory tools:** Those involve for example systems for offtake declaration and authorization, restrictions linked to hydro-climatic conditions, water monitoring systems and penalties or obligatory metering.

The functioning of economic, technical and command-and-control instruments is affected by other relevant tools and frameworks that cannot be included under a single category. Economic, technical and command-and-control tools demand for other horizontal elements providing coordination and support (Plan Bleu-GWP, 2012. Page 24, figure 9). The design of effective and successful strategies must necessarily build upon coordinated and sequential plans for the implementation of the selected tools. Furthermore, strategies and plans to generate the qualified and trained staff in the concerned institutions must be developed, thus enabling the proper consecution of the set targets. These strategies must be complemented with awareness raising actions in order to reach end users that, in line with participatory approaches, should take responsibilities in the water use.

- **Planning and coordination bodies and strategies.** Among them, we can find the establishment of improved management units (basin agencies) and associations of users and irrigators, as well as some support software.

- **Training and awareness raising actions,** such awareness campaigns for farmers and general public, the implementation of agricultural advisory services and training initiatives for agricultural professionals.

As shown Figure 16, the whole set of tools and support horizontal bodies and actions needs to be surrounded by an enabling and coherent institutional framework, boosting the success and impact of the implemented tools in the long term and reflecting the firm governmental commitment with the agricultural water sector.

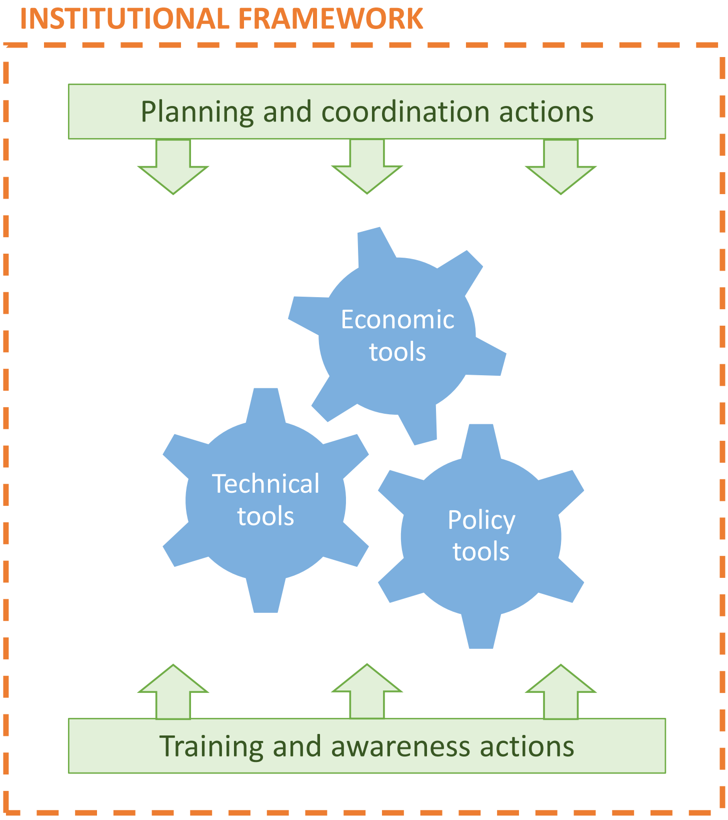


Figure 16. Main instruments for agricultural water management.

Source: Own elaboration based on Plan Bleu – GWP (2012).

Based on a review of several documents related to water management tools in the Mediterranean (Plan Bleu, 2012; Plan Bleu, 2014), a total of 15 technical tools, 8 command-and-control instruments, 13 economic tools, 8 planning and coordination bodies initiatives, and 3 training and awareness actions were found for the agricultural sector.

The following subsections will be devoted to outlining the main instruments identified and defining its most important characteristics. We will devote special attention to economic tools, that will be discussed more thoroughly, as they are the focus of this deliverable.

3.1.1 Technical instruments.

Technical instruments include all those tools based on technology solutions. These tools must be implemented with a few ultimate objectives (Plan Bleu-GWP, 2012):

- **Improvement of streamflows in canals**, by means of large-scale impounding and distribution systems that increase the level automation and dynamic regulation.

- **Improving water productivity in agriculture,** by selecting appropriate irrigation measures that allow to avoiding losses and increasing efficiency in water use.
  Mainly that would involve replace the predominant gravity irrigation systems, for other methods such as localised irrigation and sprinkling. However, caution should be taken, as

without the appropriate management (adaptation to the type of soil and crop), methods that should be expected to be superior in terms of performance could fail to achieve their objectives.

- **Reducing vulnerability of current agronomic models and land use systems:**
  In foresight of the increasing water scarcity and change in temperature and precipitation patterns, some measures should be taken to adapt to the new conditions. That would include using crops that can be resilient to climate change, as well as designing adapted cropping plans for rotation, planting and harvesting that are able to save water.

  Since some of these objectives are competing, the best option lies in the diversification of crops and cropping patterns.

- **Using supplemental irrigation:** Supplemental irrigation, based by supplementing small amounts of water to rainfed crops when the levels of rainfall are insufficient, has proven very successful in increasing yields and stabilizing crop production (Geert and Raes, 2009).

- **Using irrigation scheduling and planning tools:** Planning based on computer tools can be employed to optimize several objectives (e.g. maximizing agricultural production or minimizing water use) based on existing constraints on water, land availability, new technologies, etc.

The main technical tools identified for the agricultural sector in the Mediterranean can be grouped in four categories (Monitoring, repair and maintenance, modernization and new equipment, and the use of recycling, reuse and non-conventional sources of water), according to their final area of application (Plan Bleu, 2014):

Table 4. Main technical tools found in the Mediterranean.

Area of application	Measures
Monitoring	- Monitoring of the volumes produced and distributed by analysing data collected from macro-metering. - Monitoring of driller activity. - Monitoring of volumes abstracted from individual boreholes, particularly for electricity consumption.
Repair and maintenance	

	- Concreting, gates, cleaning canals and other improvements of hydraulic operations in irrigation canals. -Optimisation of pressure systems (by installation of replacement of lining and concrete, filling of cracks, cleaning…). - Modernization of gravity-fed irrigation networks by connecting them to a pressure network. - Modernisation of gravity-fed irrigation by switching to low pressure ones. - Removal of unused branches. - Instalation of meters. - Reparation of leaks.
Modernisation and new equipment	- Use of water management support software to control the irrigation areas. -Sprinkler systems and shift to drip irrigation to achieve increased efficiency. -Optimised crop rotation, revised crop management and intercropping.
Recycling, reuse and alternative water uses	-Collection basins and tanks for green spaces. - Policy encouraging the use of desalination and reclaimed water for agriculture.

Source: Adaptation from Plan Bleu, 2014.

3.1.2 Economic instruments.

Among other issues, the concepts of IWRM and WDM aim to recognize that water has an economic value in all its competing uses and that should be recognized as an economic good (GWP, 2004). That justifies the need for the rational allocation of water as a scarce resource by means of the use of different tools. In that respect, economic instruments play an important role in designing an adequate scheme of incentives among water uses and contributing to allocate water to its highest value economic use (economic efficiency) without hindering equity, environmental goals and financial sustainability (cost recovery).

There exist an extraordinary variety of economic instruments to be implemented in water management. In this section, we are going to discuss the ones that are most usually applied in water management in the agricultural sector: Pricing, subsidies, other financial assistance (e.g. assisted loans), quotas, taxes, water trading, royalties, and other complementary non-pricing policies (e.g. installation of metering and efficient technologies, raising awareness,…).

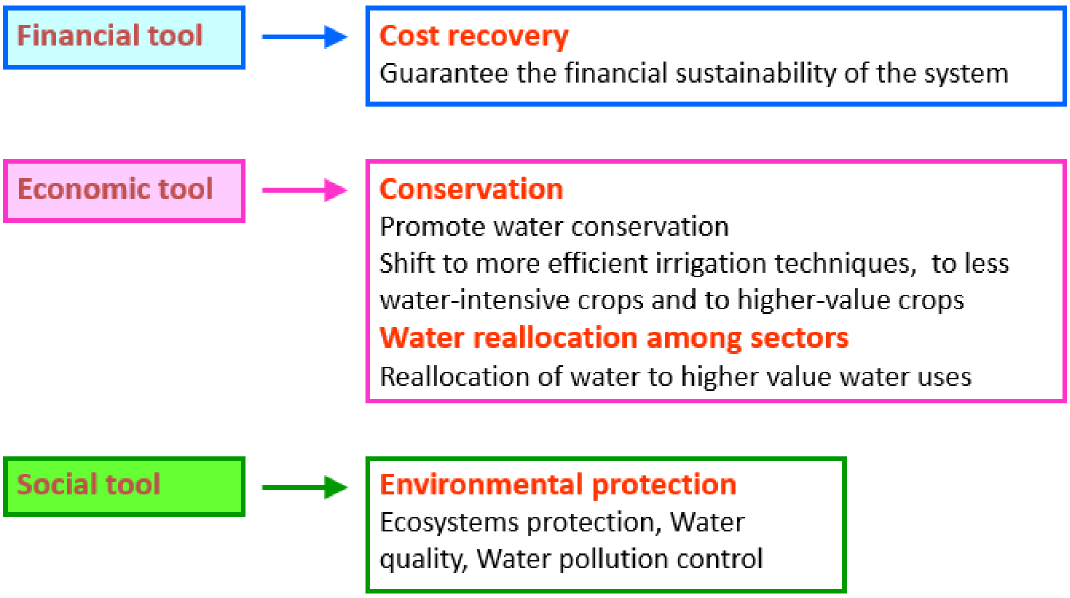
Pricing:

Pricing is currently one of the most important economic tools in water management. In fact, in the last decades pricing policies have been attributed an increasing importance and they are expected to take a paramount role in dealing with the problems related to water scarcity in the forthcoming future.

In accordance with economic theory, prices should result from the interaction between offer and demand in the relevant market. However, water as an economic good displays several characteristics that make it a good of particular interest for economists. First, it is considered a basic need, so universal access to a certain level of consumption should be guaranteed (Bovis 2005). On the other hand, it is a merit good that contributes to social, economic and environmental goals (OECD, 2003) and displays substantial positive externalities. As a consequence of these issues, water prices are not usually set in market environments but they are usually subject to public intervention by means of the implementation of regulation and control from government and public administrators.

Following the principles of IWRM, pricing schemes must be formulated in a way that they simultaneously accommodate the several objectives to which water management should respond: Efficiency, equity and environmental sustainability (GWP, 2000), as well financial self-sufficiency or cost recovery (Rogers et al. 2002). Figure 17 summarizes the main functions expected from water tariffs as an economic tool in the agricultural sector.

Figure 17. Water as an economic tool for water management.



Source: Own elaboration based on Molle and Berkoff, 2004.

Prices are also important for their role as powerful signals, as they are able to place a value on water and convey its relevance and scarcity, thus promoting conservation of the resource and public awareness (World Bank, 2018). In that respect, cost recovery has been given an increasing importance in the last decades, as its allow prices to signal the actual value of water while promoting efficiency and providing enough resources both to provide the service in adequate conditions and to promote actions to protect water resources (World Bank, 2018).

Reconciling multiple objectives from a single instrument is complex. Therefore, water tariffs have tended to take different shapes and structures according to the goals they pursue. Pricing schemes can be generically divided into two main categories: Non-volumetric (do not depend on the actual amount consumed) and volumetric (a variable amount is charged according to the volume of water consumed). Non-volumetric pricing displays the advantage of being easy to implement, as only data about farm size, input, output, type of crop or time of use is needed. However, they do not usually provide much incentives for saving water and installing efficient equipment, as the charge does not vary with consumption. On the other hand, volumetric pricing is able to promote a better allocation of the resource, but it is more complex to manage and it requires the installation of meters able to measure actual consumption (World Bank, 2008).

Table 5 and Table 6 below summarize main types of non-volumetric and volumetric structures used in agricultural water pricing, respectively.

Table 5. Non-volumetric irrigation pricing schemes.

Pricing system	Main characteristics
Area-based	**-Fixed** amount based on the irrigated area (usually per ha).
Crop-based	-Users are charged a **fixed** amount according to the irrigated area of each crop. -Type of crop and area serves as **proxies for the amount** of water needed.
Time-based	-A **fixed** charge is set in accordance with the amount of time that the farmer makes use of the service.
Input/Output based	-A variable amount is charged according to the input applied or output attained.

Source: World Bank, 2008; World Bank, 2016.

Table 6. Volumetric irrigation pricing schemes.

Pricing system	Main characteristics
Uniform rates	-The price per cubic meter is **constant**. -Provides some incentive for an efficient use, as every unit is charged.
Decreasing Block Rates	- The price per cubic meters **decreases** with consumption **in blocks** (e.g. Block 1 (3-5 m^3): 0.5€; Block 2 (5-10 m^3): 0.3€/ m^3, etc…). -They **reflect the decreasing cost of producing water**. -**Less incentive** to reduce consumption than uniform rates.
Increasing Block rates	- The price per cubic meters **increases** with consumption **in blocks** (e.g. Block 1 (3-5 m^3): 0.3€; Block 2 (5-10 m^3): 1€/ m^3, etc…). -Provides **more incentive** to reduce consumption than volumetric rates -Sometimes tariffs **may be complex and not understood by consumers**.
Seasonal rates	-A higher price is charged during peak seasons (e.g. summer, peak hours in demand...).
Two-part tariffs.	-Combination of a fixed part according to chosen criteria (Area, crop, time) and a variable volumetric part.

Source: Government of Canada, 2005.

<u>Subsidies and other forms of financial assistance:</u>

Subsidies are a form of financial aid or support usually with the aim of promoting economic, environmental or social goals. Financial assistance and subsidies usually come in various ways, including: direct forms (cash grants, interest-free or low-interest loans,…) and indirect (reduced regulation, tax breaks, rent rebates…).

In the agricultural sectors, financial assistance may have different objectives, such as providing a stable income to farmers -e.g. cash transfers- (Rey et al. 2018) or promoting incentives to install efficient modern irrigation systems -e.g. subsidized loans, rebate programs- (Plan Bleu-GWP, 2012). However, in practice, their contribution to achieving the objectives expected from water policy is not clear and they have been found to usually harm cost recovery (Rey et al. 2018). Therefore, subsidies should be applied with caution and tailoring them to the particular needs of countries and regions.

<u>Taxes:</u>

Water taxes are levies or charges on water use directed at achieving a specific target (environmental, economic or social goals). They are useful in the sense that they can help to address market failures by internalizing the true cost of depleting the resource, with their functioning being very similar to other charges such as prices. Some examples of taxes related to agricultural water management are groundwater abstraction charges (in which a tax is imposed on each cubic meter reflecting the cost of depleting aquifers) or effluent taxes (used to reduce point source pollution).

Quotas or rationing:

Quotas are based on providing farmers with the entitlement to a certain limited amount of water, which may be defined in absolute terms or according to several criteria (World Bank, 2016). They might be useful to control the maximum demand that will be available and they are equitable in the sense that water is allocated according to objective criteria, although they are less flexible than other methods such as water markets (Government of Canada, 2005). It could be also considered as a command and control measures, but it is usually included as an economic instrument insofar as a better allocation is fostered by means of the use of this instrument (Se for example some documents cited in this report such as Plan Bleu-GWP, 2012; Rey et al. 2018, Government of Canada, 2005).

Water markets:

They can be defined as an institutional framework to trade water rights in a temporary or permanent way in exchange for pecuniary compensation (Rey et al. 2018). As with quotas, they offer the advantage to allow regulators to control the total amount of water that is abstracted. Moreover, in a competitive setting, markets would allow to reallocate water to its highest value use, thus promoting efficiency (Government of Canada, 2005). Therefore, they are considered by some authors as a cost-efficient mechanism (Escriva-Bou et al. 2017). However, in practice water markets may end up operating in monopoly conditions (Government of Canada, 2005) and sometimes local economies may be harmed (Doherty and Smith, 2012). Therefore, a proper regulatory framework that stablishes clear guidelines for the design and implementation of water market has been found key for a correct functioning (Wheeler, Loch, Crase, Young and Grafton, 2017) and for the success of water markets

Insurance:

Insurance is an economic instrument in which a person or entity (insurer) covers a potential loss of other agent (the insured) in exchange for guaranteed and relatively small payments.
It is therefore a form of protection from financial and risk-contingent losses. In the case of agricultural water management, crop insurance protect for the effects of droughts, offering farmers a compensation for the loss in production. Since it has been found that water deficits during droughts usually lead to illegal abstractions (Pérez-Blanco and Gómez, 2014), crop insurance could prove a useful instrument to avoid aquifer overdraft. Traditionally, insurance have been contracted by farmers on a private basis. However, there is an increasing presence of public sector in crop insurance by means of mutual funds that compensate drought related losses (Rey et al. 2018).

Payment for ecosystem services:

They can be defined as pecuniary compensations offered for the provision of ecological services. By paying water users, these economic tools provide a signal for the value of ecosystems as well as compensating the providers and promoting the involvement of water users in the provision of the services (Rey et al. 2018). Ecosystem services in the context of water resources involve very diverse benefits that can be broadly classified in three groups (Reynaud and Lanzanova, 2017): provisioning –e.g.in-drought protection-, regulation and maintenance –e.g. maintenance of aquatic habits- and cultural- e.g. recreation activities-

3.1.2.1. Economic instruments in the Mediterranean.

The use of economic tools remains limited in the Mediterranean basin, although such instruments can greatly help to reduce losses and bad water use. Economic tools can also help to increase the efficiency of water resources allocation among sectors, and may change the behavior of water users, helping to cope with water-related environmental issues. In addition, economic instruments become a valuable financial tool to ensure the sustainability of water management systems, as it permits to at least partially recover the costs associated to the operation and maintenance and also the investment costs of water infrastructures and management systems.

According to Plan Bleu-GWP (2012), the use of such economic tools is increasing, particularly in the agricultural sector for irrigation, but the current level of implementation remains low. Water pricing (both for drinking and irrigation purposes) is the most used tool in the Mediterranean countries, while other tools such as subsidies or quotas are less developed. Table 7 lists the main economic tools used in Mediterranean countries.

Table 7. Economic instruments and water saving incentives for irrigation in the Mediterranean.

Type of instrument	Countries using tool	Degree of incentive to save water
Pricing	Nearly all Mediterranean countries	The priority is to **recover water O&M costs**, incentives to **water saving** according to tariff structure and price level.
Quotas	Cyprus, France, Israel	Limit consumption, does not encourage water saving within the quota limit
Financial support (subsidies, easy-terms loans)	Cyprus, Spain, France, Israel, **Morocco**, Syria, **Tunisia**	Contribute to implement technologies and practices that contribute to save **water and prevent wastage**, (e.g. water-saving irrigation technologies, new crop varieties, etc.)
Royalties for withdrawals	EU MSs, Israel, **Morocco, Tunisia**	Little incentive to save water, as **taxation levels remain low**.

(pollution and resource)		

Source: Adapted from Plan Bleu - GWP (2012).

With respect to pricing systems, some countries rely on the different structures of the pricing system in order to include economic incentives that promote specific actions such as reducing pollution, saving water, increasing the use of unconventional sources, etc. However, changes in water demand for irrigation as a consequence of a change in the price paid is complex and depend on a number of factors as follows. (Plan Bleu-GWP, 2012)

- The response of farmers to price changes is limited by the existence of alternative water resources and alternative cropping systems.
- The more modern the irrigation technology, the less flexible water demand (less room for technical efficiency improvement).
- The more value irrigation adds to crops, the more stable remains water demand when price changes.
- The impact of a price increase in irrigation water consumption depends on the initial price, the extent of the increase and implementation over time.

Table 8 includes information of the pricing schemes in place for some of the Mediterranean countries, their configuration, and the degree in which they are expected to offer incentives for an efficient allocation of water resources.

Table 8. Irrigation water pricing systems and water-saving incentives in the Mediterranean.

Tariff structure	Countries using tool	Degree of incentive to save water
None	Albania, Egypt, Palestinian Territories	None.
Standing charge / ha	Spain, France, Greece, Italy, Lebanon, Syria	Combined with very low prices and subsidies for irrigated output. This has led to increases in irrigated areas and demand for agricultural water.
Incremental standing charge (by crop or irrigation tech.)	Italy, Turkey	• Not encouraging water saving for a given cropping system or irrigation technique • Discourages irrigation of certain crops (big water consumers).
Two-part charge	Lebanon (new areas), **Tunisia** (areas of controlled irrigation)	• Fixed part: based on **irrigable area** (incentive to irrigate land with facilities). • Proportional part: based on **volumes of water** actually consumed (encourages rational water use).
Uniform volumetric pricing	Cyprus, Spain, France**, Morocco, Tunisia**	Encourages **water saving according to price level**.

Source: Adapted from Plan Bleu - GWP (2012).

Likewise, in the Mediterranean financial support – e.g. subsidies- can be considered as a key tool to support pricing policies and promote environmental and social goals. In the region, subsidies are very often employed to implement changes in agricultural practices –e.g. modernisation of equipment and irrigation systems- without the subsequent loss of income for farmers. For instance, in the context of the National Irrigation Water Saving Strategy in Tunisia (which includes water pricing as a tool to promote savings) the Government offered 40, 50 and 60% subsidies for large, medium-sized and small farms respectively, for the modernization of the irrigation equipment. As a result of such strategy, the extent of modern irrigation technologies rose from 20% to 80% of total irrigated area between 1990 and 2007 (Plan Bleu-GWP, 2012).

Although economic instruments have proven to be very useful for water demand management (WDM), it is noteworthy to mention that they are not a solution on their own (Rey et al. 2017). To be effective, economic instruments should be implemented according to national objectives and aligned with national policies and strategies (regulation instruments). Thus, the implemented economic instruments should be consistent with users' income level and should present particular structures tailored to the different sectors (agricultural, domestic, etc.) addressed in order to serve the principles of equity and sustainability while promoting efficiency.

3.1.3 Command-and-control or regulatory instruments.

This category of instruments involve all those water management tools that rely on regulation and control (including abstraction control) from public authorities.

Regulatory instruments may include a wide range of policy interventions. Some of them are related to the establishment of special regulations in certain areas (i.e. protection areas) that are found to be key in water demand management for different reasons (e.g. more fragility of ecosystems and water resources, key importance for securing future supply…).

Other group of policies within this category involve the ones affecting abstraction control. Some of the most usual ones within this group may include the establishment of water rights, systems of offtake declaration and authorization, linking restrictions and water rights to hydro-climatic conditions or the obligatory metering of offtake volumes. Moreover, although sometimes categorized as an economic instrument, quotas could also be considered a regulatory tool aimed at controlling the level of freshwater withdrawals. In the same vein, penalties, rewards and other regulated obligations could be considered a powerful tool to avoid over-exploitation of freshwater resources.

Finally, any kind of reform to legislative and regulatory frameworks aimed at introducing, promoting and enforcing the principles of IWRM are considered within this group of policies. Also, an adequate management of transboundary waters by means of transboundary agreements can be found among the instruments for water management that depend on a sound regulatory framework in order to ensure an efficient allocation and avoid potential conflicts (World Bank, 2018). The establishment of transboundary agreements on water necessarily rely on the creation of international conventions and laws that must be afterwards incorporated into their respective national regulations (World Bank, 2009).

Table 9 gathers some of the regulatory and command-and-control instruments found in place in the Mediterranean (Plan Bleu, 2014).

Table 9. Main command-and-control and regulatory tools found in the Mediterranean agricultural sector.

Area of application	Measures
Protection area	- Qualitative protection areas: Declarations and authorisations. -Protection zones for storages areas: Reservoir monitoring, antipollution missions.
Abstraction control	- Seasonal, climate-based restrictions and bans on swimming pools, golf courses and irrigation water.

	- Regimes of declaration and groundwater uses authorizations.
Reforms of legislative and regulatory frameworks.	- Implementation of regulatory policies for agricultural productions - Water laws including groundwater - Design of adequate water rights.

Source: Adaptation from Plan Bleu, 2014.

3.1.4 Institutional framework, coordination, training and awareness.

Technical, economic and regulatory instruments are essential to achieve an integrated and effective water resources management. However, the implementation of such tools without a consistent institutional framework supporting the development and adoption of the proposed solutions may inhibit the achievement of the established objectives.

In this context, planning, coordination and monitoring elements show up as key units for water management providing, for instance, support for decentralization at local level and a sustainable scheme in the long term. The involvement of local communities and end users in the management of common resources is beneficial from many points of view. This way of management enhances the awareness of users about the situation of available water resources and thus, users show more commitment to the rational use of water. In addition, management at local level benefits from the experience and knowledge of local communities on the resources managed, developing tailored solutions and strategies. Local participation should be performed through user associations, basin agencies, etc.

Further, awareness of farmers and local communities needs to be complemented with the training of agricultural professionals and technicians, for the progressive development of qualified institutions in charge of the water resources management (support software, IWRM approach, etc.) and farmers trained in the use of innovative technologies and cropping systems.

The different management initiatives and schemes must be coordinated for an effective implementation and for the consecution of national goals. This can only be possible with the strong commitment of national governments through improved legal and financial frameworks supporting the decentralization of the management, the monitoring of the implementation and the capacity building.

Table 10 and Table 11 show main measures adopted in the Mediterranean with respect to the institutional framework/coordination actions and training/awareness raising programs respectively (Plan Bleu, 2014).

Table 10. Main actions identified in the Mediterranean agricultural sector with respect to the creation and improvement of planning and coordination bodies and strategies.

Area of application	Measures
Management systems	- Management contracts -Ratification of agreements and multi-user conventions. -Policies for shifting farming to crop types requiring little water
Creation of institutions	-Creation of decentralized institutions. -Creation of irrigator associations. -Creation of participatory institutions (e.g. local water commissions). _Creation of water use mediation and conflict management bodies -Creation of a water police / antipollution mission.

Source: Adaptation from Plan Bleu, 2014.

Table 11. : Main actions related to training/awareness raising identified in the Mediterranean agricultural sector.

Area of application	Measures
Awareness-raising	- Studies of virtual water: monitoring and measuring scales, raising awareness among farmers and retailers.
Training	- Training stakeholders from the water-saving sector -Training and informing apprentice plumbers on leak detection. -Training farming professionals, technicians and engineers. - Educating farmers.

Source: Adaptation from Plan Bleu, 2014.

4 Water management: main policies and economic instruments in place

After performing a brief revision of the main instruments that are currently available in water management and the state of development of those instruments in the Mediterranean, the present section of this document aims to analyse the main water-related strategies and economic instruments in place in the MADFORWATER target countries (Egypt, Morocco and Tunisia).

For that purpose, first we are going to conduct a general review of the state of the policy measures that were explained in the previous section for the MADFORWATER target countries. Afterwards, the main elements of national water resources management will be explored for each country separately, paying special attention to the regulatory and institutional framework, and to the economic instruments in place.

4.1 General overview of water management strategies in the MACs (Mediterranean African Countries) included in MADFORWATER: Egypt, Morocco and Tunisia.

Water supply policies in Egypt, Morocco and Tunisia:

With water exploitation indices of 134%, 72% and 36% respectively (See Box 1, Box 2 and Box 3), Egypt, Tunisia and Morocco are among the Mediterranean countries with the highest level of exploitation of their water resources (See Plan Bleu - UNEP/MAP , 2013). Particularly, according to the Falkenmark indicator, that takes into account natural resources availability per capita, Tunisia could be considered as experiencing water shortage (annual water resources under 500m3/capita/year), while Egypt and Morocco could be ranked among the water poor countries (between 500 and 1000me/capita/year) (Plan Bleu - UNEP/MAP, 2013).

As shown in Figure 18, freshwater abstractions are the main source of supply in the Tunisia. On the other hand, Morocco and Egypt rely mainly on surface water. As for the role of non-conventional water resources such as desalination and treated wastewater, their use is still marginal in the three countries, entailing less than 5% of the total withdrawals. Moreover, most of the conventional resources are being exploited in an unsustainable way (World Bank, 2018; Plan Bleu-GWP, 2012). Therefore, the potential to exploit other non-conventional sources (i.e. desalination and wastewater reuse) is still substantial in these countries (World Bank, 2018; Plan Bleu-GWP, 2012).

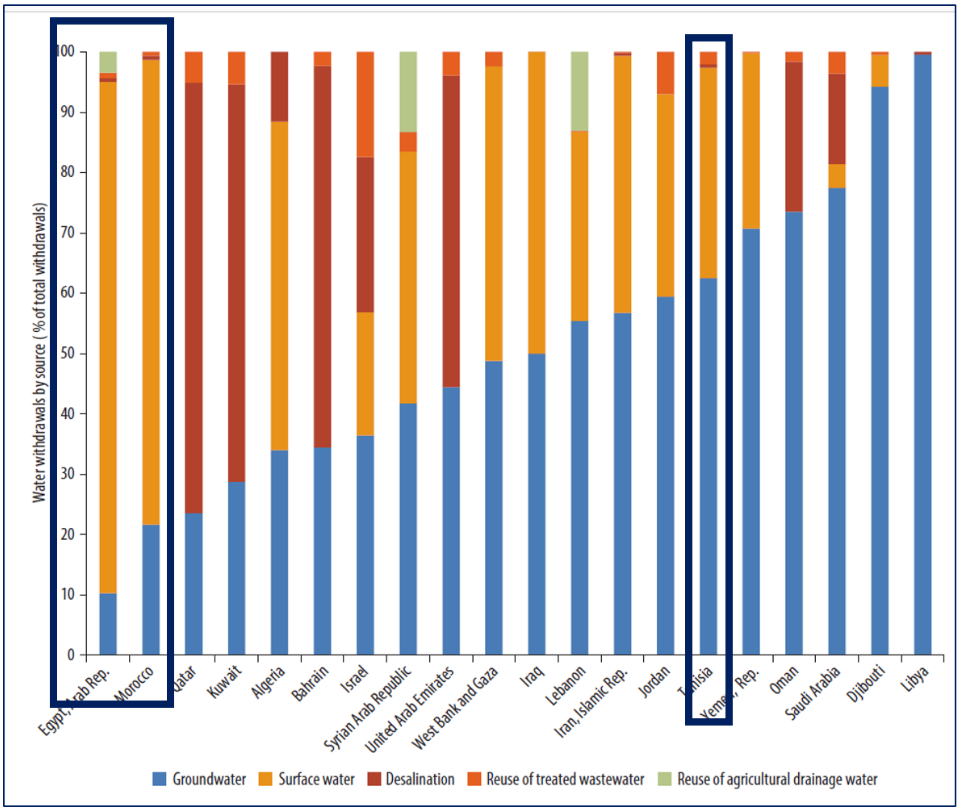


Figure 18. Total water withdrawals by sources in the MACs countries in MADFORWATER.

Source: World Bank, 2018.

In this context, MADFORWATER plays an essential role as it would allow to increase the percentage of water originated from treated wastewater in the MACs countries, thus contributing to mitigate the effects of climate change and the expected socioeconomic trends in the region.

Local perceptions on wastewater reuse for irrigation derived from the Stakeholders Consultation Workshop (SCW)

During the 1st SCW, main drivers and barriers for the implementation of wastewater reuse were discussed by the members of the Stakeholders Advisory Board (SAB) of MADFORWATER (Ker Rault et al. 2017). Regarding economic issues, several barriers were detected. The high cost of the involved technologies, combined with a lack of funding was found as a major constraint for the implementation of these technologies, as well as the existence of cultural factors hindering its adoption. Other barriers of less importance pointed out in the workshop were the lack of financial incentives (e.g. free health controls for farmers) and a usual weak economic orientation in irrigation.

As for drivers, the main driver for a successful implementation would be related to the cost of the distribution networks and canalizations. A lower cost for wastewater reuse would also be a desirable factor to ensure acceptance by farmers and penetration in the market. The existence of public funding for pilots is found an important driver as well. Finally, although of less importance for the members of the SAB, promotion of the utilization of wastewater reuse, the existence of subsidies to this type of technologies and the establishment of guidelines for the design of tariffs regarding treated wastewater by the Ministries of Agriculture, are pointed out as issues that would significantly contribute to an effective implementation of the technologies of MADFORWATER.

Water demand policies in Egypt, Morocco and Tunisia:

In the last decades, substantial efforts have been made in the three countries in order to implement the principles of IWRM. However, the level of achievement is still relatively low. Following World Bank (2009), countries can be classified according to their attainment in two particular goals that are at the core of the application of the principles of IWRM: Financial sustainability and environmental sustainability (Sustainable use of water resources).

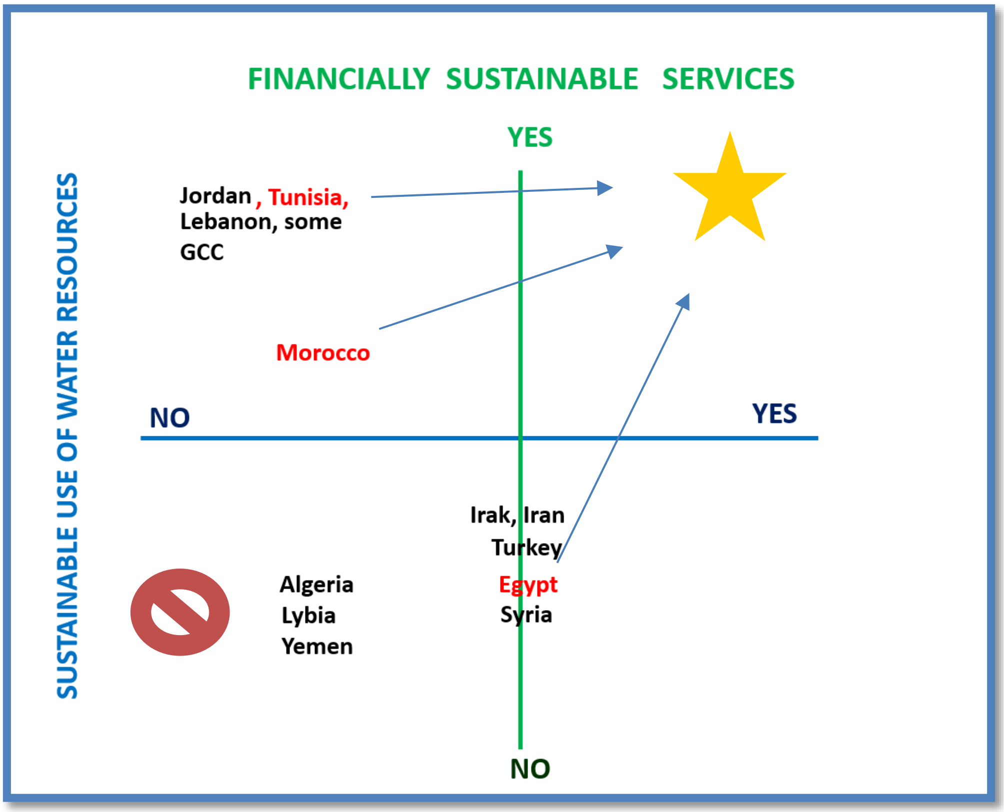


Figure 19. Level of application of two facets of IWRM in the three MACs in MadforWater.

Source: Own elaboration. Adapted from World Bank (2009).

Figure 19 shows the position of the three MACs in MADFORWATER and other countries within the MENA region with respect to the two criteria. Financial sustainability is considered to be achieved (the "YES" part of the axis) when countries recover at least Operation and Maintenance (O&M) costs. The opposite ("NO" portion) would imply insufficient cost recovery. On the other hand, sustainability in the use of water resources is referred to other criteria more related to environmental sustainability. Countries are expected to be sustainable if water is currently being used in a way that the needs for future generations are also accounted for. Among other things, that would imply not only extracting it in a sustainable rate, but also apply actions and policies to optimize those extractions in terms of their recovery after use (e.g. wastewater reuse), increased productivity or the minimization of the non-beneficial consumption such as waterlogged land, evapotranspiration (World Bank, 2009).

Although countries are already rather far away from the least desirable situation represented by the red sign (See Figure 19), there is still substantial room for improvement until achieving an ideal situation characterized by an optimal application of the principles of IWRM (represented by the yellow star).

Financial and environmental sustainability are not conflicting objectives, but on the contrary an improvement in one of them could contribute to the overall improvement of IWRM. Particularly, the achievement of adequate levels of cost recovery would allow to place the right value on water and to increase efficiency in their use by generating the right incentives. However, lack of cost recovery is a common issue to be dealt with in the Mediterranean and more specifically in the Arab countries. According to World Bank (2018), for the countries in the MENA (Middle East and North Africa) region, water charges only cover, on average, a 35% of the total costs for conventional sources and 10% in the case of others such as desalination.

Efficiency is another important facet of WDM and IWRM. As explained with more detail in the previous section, WDM should aim at improving efficiency in the use of water resources both in terms of its provision (e.g. water losses), and its use (e.g. water productivity). With respect to efficiency in use of water resources, agricultural water productivity in the MACS countries is generally low (World Bank, 2018).

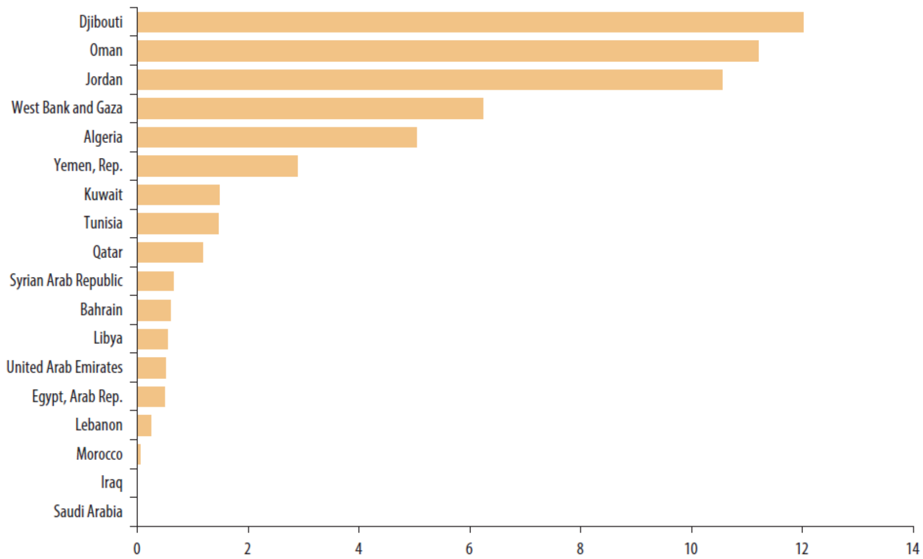


Figure 20. Agricultural water productivity* for selected countries in the MENA region, by country in 2012.

Source: World Bank (2018).

*Agricultural water productivity is understood as agricultural GDP divided by freshwater withdrawals for agriculture.

Since agriculture is the main water consumer, entailing a 81.8% of total water consumption in Egypt, a 80% in Morocco and a 87.7% in Tunisia (See Boxes 1, 2 and 3 of this report), overall water productivity in the three countries is also low as a result. This is also true for the MENA considered as a region, with average water productivity being around a half of the world's average (World Bank, 2018).

4.2 Egypt case study: policies, institutional framework and economic instruments.

Main water strategies and policies

Water management policies in Egypt have a long tradition over time, and were initially aimed to increase the water resources utilization for the country through the development of related infrastructure. In 1928, the first water policy was developed to meet the needed supplies required to seek the food security through the horizontal expansion of 3.4 million fed (1.4 ha) (this figure was not reached until 2017).

In 1933, a new water policy was adopted to regulate the water storage expansion of the Nile, including international-concerning and infrastructure elements such as (FAO-Aquastat, 2016):

- 2nd expansion of the Aswan Dam storage capacity (up to 2500 million m^3)
- Construction of the Jebel Aulia Dam in the White Nile (Sudan). The construction of this dam would represent an increase of the water available for Egypt (about 2000 million m^3 a year)
- Design of several water infrastructure projects to be performed: the Sennar Dam in the Blue Nile, the Junglei Canal in Sudan, and the Lake Tana (storage) in Ethiopia.

Alligned with such water development policies in force, in 1959 Egypt signed the Nile Water Agreement with Sudan aimed to regulate the construction of the High Aswan Dam and the subsequent share of additional water resources between both countries. After such agreement, policies and agreements in the following years would aim to find new water resources for Egypt to face the important challenges that led Egypt to be one of the water poverty countries due mainly to high population increase, with a particular focus on groundwater and the reuse of drainage water (FAO-Aquastat, 2016).

In the early 80's, the approach of new water policies included elements for water and environment management and protection towards the application of Integrated Water Resources Management. The Agricultural Development Strategy, together with the adoption of Law 48/1982 on the Nile River Protection and the Law 12/1984 on irrigation and drainage, included issues such as salinization or the modernization of irrigation methods in recently developed areas.

Law No. 12/1984 was the legal basis for the agricultural water sector, regulating the public and private ownership of water infrastructures (irrigation and drainage) while defining distribution and O&M costs. Ten years later, in 1994, a supplementary law (Law 213/1994) was launched to include an innovative element: farmers' participation through Water Users Associations (WUAs). In the late 90s, horizontal expansion was increased up to 4.62 million ha with a relevant budget investment to such action. This financial issue motivated in turn the improvement of other water-related elements and the approach of strategies and policies seeking for instance the improvement of irrigation efficiency, the reuse of drainage water, wastewater treatment, the development of water-saving technologies O&M and cost recovery, etc. All these innovative elements were recently supported and highlighted by the Sustainable Agricultural Development Strategy towards 2030, where the decentralization of water management through WUAs is also acknowledged as a key element for the sustainable development of the agricultural water-sector in Egypt, also enhancing economic and social stability.

In Table 12 the main water policies and legislations performed in Egypt are presented along with its key features. Likewise, Table 13 briefly summarizes the main policy plans and their scope of application in order to better understand the evolution of the approach over time.

Table 12. Key water-related policies and regulations in Egypt.

Year	Main regulations	Key facts
1928	-	• Limit of horizontal expansion (3million ha).
1933	-	• 2nd expansion of the Aswan Dam storage capacity. • Construction of the Jebel Aulia Dam in the White Nile (Sudan). • Future projects: the Sennar Dam in the Blue Nile, the Junglei Canal in Sudan, and the Lake Tana (storage) in Ethiopia.
1953	-	• Expansion of the Owen Dam storage capacity (Uganda).
1959	**Nile Water Agreement** (Sudan-Egypt)	• Construction of the High Aswan Dam. • Regulation of shared additional water resources.
1962	Law No. 93/1962	• Control of the waste water disposal in the water canals.
1966	Law No. 53/1966 and modifications of this law	• Control of the agricultural uses
1967	Law No. 38/1967 and its modifications	• Control of the hygiene
1978	Law No. 27/1978	• Control of drinking and human consumption uses

1982	Law No. 48/1982 Protection of the Nile River and waterways	• Protection of the Nile water from sewage pollution
1983	Law No. 123/1983	• Control of fishing and organization of the fish bonds.
1984	Law No. 12/1984 on **irrigation & drainage**	• Distinction between **public property of the irrigation and drainage infrastructures** from canals and private banks • Definition of **water distribution** and **O&M costs**
1994	Supplementary Law No. 213/1994	• Farmer participation through **WUAs** • includes benefits and costs of irrigation systems by the WUAs
2005	**National Water Resources Management Plan (NWRP)** – H2017	• Future strategies for the preservation of water quality & quantity • Best use of water resources from **socio-economic and environmental perspectives** • **IWRM approach** (all water users involved) • Promotion of **policy decentralization to governorate level** (3 pilots)
2009	Law No. 9/2009	• Control of Environmental Protection
2009	National Strategy for water & sanitation (NSWSS)	Rural & Urban WSS Regional Master Plans (Governorates)
2009	Sustainable Agriculture Strategy towards 2030	• Decentralization • Irrigation O&M and cost recovery • Decrease of rice & sugarcane areas
2010	**National Strategy for the development & management of water resources**	6 Pillars: • Development of conventional and non conventional water resources • Increase **water use efficiency** • Upgrade water resources **infrastructure** • Combat water resources **pollution** • Address CC impact (adaptation strategies) • Enhance **IWRM**

Source: CEDARE (2014a), FAO-Aquastat (2016).

Table 13. Key water-related policy plans and strategies in Egypt.

Policy	Scope of application
✖Water Policy for the year 1975	**Supply Management**
✖Water Master Plan 1981	
✖Water Policy for the Year 1982	
✖Water Policy for the year 1997	**Supply & Demand management**
✖National water resources Plan 2003-2017	**Integrate Water Resources Management**
✖National Water Strategy 2010	
✖National water resources Plan 2017-2037	

Source: Elaborated by Alaa Abdel-Motaleb from the National Water Research Center in Cairo (Egypt), partner in MadForWater.

Main water-related institutions and stakeholders

Agricultural water management has been complicated in Egypt, due to the high number of institutions and representatives at local level. Originally, there were 22 irrigation directorates and 22 drainage directorates, being each one also divided into 62 inspectorates and about 206 districts which included from 40,000 to 100,000 farmers. Therefore, the Egyptian government applied integration measures to simplify this complicated institutional setting through the application of IWRM policies.

Further, the irrigation management in Egypt is organized following a hierarchy with different levels and units. The lower level of irrigation management is the *mesqa* (tertiary level), where WUAs operate. Farmers within a *mesqa* elect what's called Mesqa Water User Association (WUA) including about seven representatives, the elected members of the WUA re-ellect a head for the WUA among themselves who works as a representative, who is in charge of dialogue and nexus with the irrigation engineers from the district. Mesqa WUA is responsible for the coordination between Farmers within the *mesqa* for the irrigation system maintenance as well as for the coordination and relationship among farmers. The following unit of management are the Branch Canals (secondary level), which bring together the representatives of the different *mesqas (i.e the heads of the mesqa WUAs along the branch canal) to form what so called branch canal Water Users association*. The following management units are the Main Canals (or feeder canals), scaling up to irrigation districts, then the general directorates and finally, the Governorates.

- **Ministry of Water Resources and Irrigation (MWRI)** is in charge of water management and allocation among different water uses as well as construction and O&M of the irrigation networks
- **Regional Management Committee (RMC)**, includes all the stakeholders at the governorate level and it is chaired by Water resources Undersecretary of the governorate of the MWRI.
- In parts of the country **Water Users Associations (WUAs)** perform irrigation management at mesqa (tertiary) level, upscaling to secondary level (**Branch Canal Water Boards**).

Figure 21. Institutional framework of water management in Egypt.

Source: CEDARE (2014a).

Main economic instruments used in the water management

Egypt is a country subject to substantial levels of water stress. With a water exploitation index of 134% (Burak and Margat, 2016) and less than 1000m3 available per capita, it is considered as a water poor country (Plan Bleu-UNEP/MAP, 2013). In fact, after the Fréjus Workshop, Plan Bleu (Plan Bleu-GWP, 2012) classified Egypt within the group of countries with structural shortage from 2000 (See Table 1). Total withdrawals in the country amount to 78 km3/year (Burak and Margat, 2016), from which around an 85% comes from surface water and 10% from groundwater. That implies that only a 4.5% (See Table 3) corresponds to non-conventional sources (Desalination, treated wastewater and reuse of agricultural drainage water). Thus, there still remains a lot of potential for their exploitation.

In Egypt, agriculture accounts for a 14% of the GDP and up to 30% of total employment. In terms of water consumption, agricultural activity entails an 81.8% of total water demand. However, although the level of implementation of IWRM has significantly improved in the last decades, water losses in the distribution networks amounted to 31% in 2011 (CEDARE, 2014a). Moreover, in the agricultural sector efficiency in the infrastructures for irrigation and drainage is currently at around 50% (World Bank, 2018). Agricultural water productivity is below the average for middle income countries, with around 5€/m^3 (World Bank, 2018)

With respect to economic policy, in the last decades substantial efforts have been made to increase investments in the infrastructure and build the human resources capacity needed to re-use drainage water. However, the combination of population growth, economic diversification, rapid urbanization and climate change demanded from a more integrated approach to water management, which was reflected at policy level since 2003.

From then, economic instruments have been given an increasingly important role in the implementation of the principles of IWRM. Among them, particular emphasis has been attributed to **cost recovery** as a tool for the recovery of the irrigation and drainage improvement works at the field and *mesqa* level, as it is effective to maintain the sustainability of such projects. However, some more efforts to increase the rates of recovery must be made to match the disbursed values. In Egypt, current levels of cost recovery in irrigation and drainage systems are estimated at a 40% (World Bank, 2018).

In order to improve this situation, some policies have been implemented in recent times. Main issues in the implementation of an economic policy to foster cost recovery in Egypt are summarized Box 5.

One important economic tool for cost recovery is **pricing**. As mentioned in the previous section, according to the principles of IWRM, pricing policies should aim at promoting efficiency and environmental sustainability, while ensuring social equity and cost recovery. In Egypt, some steps have been given towards the implementation of such pricing policies. According to Plan Bleu- GWP (2012), prices per irrigation are usually incremental or volumetric pricing. However, since initial prices are relatively low and the escalation in price is not very steep, the incentive for water saving is low. Moreover, in some old lands water for agriculture is still free, causing imbalance between sustainability and social goals (CEDARE, 2014a). That may be related to the fact that some studies in Egypt found that in certain regions volumetric pricing could harm farm income without generating additional incentives as opposed to a crop-based charge (Perry, 1996; Easter and Liu, 2005).

Likewise, an **excessive subsidization** also contributes to eliminating part of the incentives and the low cost recovery rates observed. In Egypt, Operation and Maintenance (O&M) costs, rehabilitation of infrastructures and irrigation improvement have been traditionally founded by MWRI or international donors like The World Bank, German Fund, Swiss Fund and others (CEDARE, 2014a), only the pumping costs from the *mesqa* to the field are paid by farmers (AQUASTAT-FAO, 2016).

Regarding **water rights**, in Egypt allocation of water is tied to land property. Water is allocated according to a procedure that involves landowners submitting in advance a scheduling with information of land area and type of crops grown in the farm (World Bank, 2009). In the last decades, some international organizations, such as the World Bank and other institutions have been advocating the establishment of **water markets** such as the benchmark one developed in Australia.

Box 5. Summary of a relevant economic policy in Egypt.

- Official name of the economic instrument/policy

  Cost recovery (according to the Law number 213 for the year 1994)

- Region/Basin concerned.

  Irrigation and drainage improvement areas in the Nile Delta governorates, especially in Behera and Kafr ElSheikh governorates

- Institution(s) in charge of coordination & monitoring.

  Irrigation Improvement Sector, Egyptian Public Authority for Drainage Projects, and Irrigation Sector within the Ministry of Water resources and Irrigation of Egypt

- General description and overview of the policy.

  The cost of irrigation and drainage improvements projects at the farm level are recovered from the beneficiaries according to the actual cost divided on 15-20 years without interest.

- Objective of the policy and main commitments of stakeholder involved.

  The objective of the cost recovery is to provide the beneficiaries with the sense of ownership of the project and also to cover the high cost of these projects as they are mostly financed through loans taken by the country from international financing agencies.

- Time frame (year of adoption of the policy or first negotiations, end year, major milestones, already performed and next foreseen revisions of the policy…)

  The cost recovery was applied after the issuance of the law in 1994

- Progress achieved and progress indicators (monitoring outcomes)

  So far, the cost recovery didn’t reach the targeted values, but in the meantime the collection rates are getting higher which indicate that the iterative process of the cost recovery policy is developing with time

- Main drivers and barriers found during the implementation of the agreement

  Increasing the awareness of the beneficiaries, the high cost of irrigation and drainage, and finding adequate financial resources needed to implement these projects on a wider range.

Source: Elaborated by Alaa Abdel-Motaleb from the National Water Research Center in Cairo (Egypt), partner in MadForWater.

Box 6. Key elements of Egyptian Water Demand Management.

Key elements of the Water Demand Management (Egypt)

Decentralization:

WUAs operating for the last 20 years: allocation, distribution & management of water.

Economic instruments:

Cost recovery

- Cost recovery rates at a 40% for irrigation and drainage systems.
- Efforts are being made to increase it.

Water Pricing:

- Main obstacle to water pricing is high land fragmentation (high costs).
- Prices are usually incremental or volumetric, but with low initial prices and low escalation.
- In some old lands, water is still free.

Subsidies:

- High level of subsidization.
- O&M costs, rehabilitation of infrastructures and irrigation improvement traditionally founded by MWRI or international organizations.

Water markets and rights:

- Water rights tied to land property. Water allocation based on water needs of land owners.
- Advocacy for constitution of water markets. Significant institutional constraints.

Source: Own elaboration.

4.3 Morocco case study: policies, institutional framework and economic instruments.

Main water strategies and policies

The Moroccan Water Law (Water Act No. 10-95) was firstly published in 1995. Its main objective was to classify Moroccan water resources within the public water domain, also addressing protection and preservation against pollution and depletion of resources. Further, this main Water Law established the principles of water management at basin level, the acknowledgement of the economic value of water, and the principles of national and regional solidarity.

However, Moroccan water-related regulations began previously, in the late 60's. Particularly concerning agriculture, the Code of Agricultural Investment (1969) established the main bases on the agricultural water infrastructure, users' rights and obligations and financial structures (Ait Kadi, M., 1998;-Aquastat, 2014).

In the decade of the 80's water regulations were oriented towards an integrated planning of water management at hydraulic unit level. In this context, since the adoption of Law No. 02-84 (1984) on Agricultural Water User Associations (AUEAs), more than 600 AUEAs have been established (Plan Bleu- GWP, 2012). In areas of medium-low water availability, with a long history of participatory management, the AUEAs are in charge of the management of irrigation systems. On the other hand, in those areas with more water resources available, the coordination role of the AUEAs has become of great importance. Agricultural water users are involved in the decision-making processes through the AUEAs, also benefiting from its advice on diverse issues such as irrigation technologies or O&M of irrigation systems. This in turn has a positive impact on the water demand management and its accuracy to better suit users' needs (Plan Bleu- GWP, 2012).

From the 90's, with the Water Act leading, many National Strategies were implemented in Morocco mainly aimed to improve the efficiency of water infrastructures, to establish the principles of IWRM in the water sector of the country and to foster the development of non-conventional water resources.

The National Water-Saving Programme (PNEEI) was established in 2007 on a voluntary basis. It was aimed to convert about 500,000 hectares to localized irrigation by 2022. The main expected impacts of the PNEEI were defined as follows (Plan Bleu – GWP, 2012):

- 20-50% water savings by reducing water losses by implementing technical solutions to improve water supply networks. Such improvements in the hydraulic infrastructure will also help to reduce wastage in private irrigation perimeters by about 500Mm^3 a year.
- This will result in a reduction of the overexploitation of available water tables.
- Increases in water productivity ranging from 10% to 100% improvements depending on crops and farm types.
- Significant positive impact in the income level of farmers.
- At national level: positive impact on the national agricultural output and jobs creation.

The Green Morocco Plan (PMV) was established in 2008 becoming one of the main agricultural strategies of the country. Once achieved the "post-independence" target of

"1million hectares irrigated", this new national plan established a new target of "1 million farms" (Plan Bleu – GWP, 2012). The main objective of the PMV was developing the Moroccan agriculture in a sustainable, diversified and market-oriented way. The PMV is organized around two complementary pillars and it is complemented by several cross-cutting initiatives on water and land-owning issues.

- Pillar I: High value added and market-oriented agriculture. This implies private investment allowance and small-farms association schemes in certain areas (Plan Bleu – GWP, 2012).
- Pillar II: Joint development of smallholdings in areas with geographic or climate constraints (Plan Bleu – GWP, 2012). Particular focus on rural development (income improvement, food security, social stability).
- Structural cross-cutting initiatives:
    - Modernization of irrigated agriculture and increase of irrigation efficiency (e.g. The National Programme for Saving Water in Irrigation (PNEEI) was adopted one year before (in 2007), but serves to this PMV objective).
    - Private-Public Partnerships (PPP) for the management of irrigated areas will improve irrigation performance (efficiency, water utility, sustainability).

In addition, in 2009 the National Water Strategy was adopted. Since its adoption, the following instruments have been fostered to support water management and the development of the water sector:

- Conversion to localized irrigation (Programme National d'Économie d'Eau en Irrigation (PNEEI) - National Programme for saving water in irrigation)
- Improvement of hydraulic efficiency of distribution networks
- Water pricing (cost recovery)
- Conventional water resources mobilization (new dams)
- Non-conventional water resources development (desalination).
- Water transfers
- Monitoring and protection measures for the preservation of water quality and to avoid overexploitation of water resources.

Regarding most recent Moroccan strategies, a strong political will towards developing non-conventional water resources is demonstrated. In 2014, the National Water Plan (2014) was established, focusing mainly in water demand management, water reuse and treatment. Furthermore, the National Plan on the reuse of treated water (PNREU) launched in 2015 also sought to reuse up to 325Mm^3 by 2030.

Further, it is worth to mention that Morocco has included the desalination of sea water as part of its sustainable development strategy to deal with water scarcity (Peuch et al, 2016). Such desalination processes will need for energy, which is intended to be developed as green energies (e.g. wind power). This commitment has been reflected in the recent revision of the Water Act: the New Water Act No. 36-15 (August 2016), which includes a specific chapter about sea water desalination (Peuch et al, 2016). This new regulation also foresees institutional reforms for a more coordinated and decentralized water management and the development of a complete regulatory framework. The Higher Council for Water and Climate (*Conseil Supérieur de l'Eau et du Climat*), at the lead of water policies, will be supported by the new Rivers and

Dams Council (*Conseil du Bassin Hydraulique*) along with 9 Rivers and Dams Agencies (*Agences des Bassins Hydrauliques*) favoring decentralization and participative water resources management.

Table 14 shows the main water-related policies and strategies performed over time in Morocco along with its main features.

General assessment of water policies and regulation in Morocco.

In Morocco water security has always been a key component in economic and social development. The growing demand for good quality water stems from increased industrialization and a rapidly growing population, accentuated by a progressive shift from rural to urban living. Over the last four decades the emphasis was to maximize the sustainable development of the country's surface water resources and their optimal use for irrigated agriculture, potable water supply, industrialization, and energy generation. This meant significant capital investment in infrastructure to control rivers and to capture and use about two-third of the country's surface water. More major infrastructure projects are at advanced stages of planning and construction to capture most of the remaining surface water potential by 2020.

As Morocco approaches the end of the infrastructure development phase, emphasis is shifting to the more sophisticated and difficult task of ensuring socially, technically efficient, and sustainable allocation of existing water resources among competing consumer groups. Morocco's water economy is now characterized by sharply rising costs of supplying additional water and more direct and intense competition among different types of water users and uses. Better management of existing supplies is the most rational response to this growing water scarcity. As irrigation is the predominant water user, serious questions were directed towards reducing wastage in this sector by restructuring production and consumption patterns away from wasteful and low-value crops to more effective water use for high-value crops.

To meet these challenges, Morocco has adopted an IWRM approach through mutually reinforcing policy and institutional reforms as well as the development of a long-term investment program. The major policy reforms adopted include:

- Adopting a long-term strategy for integrated water resources management. The National Water Plan will be the vehicle for implementing the strategy and will serve as the framework for investment programs until 2020.

- Developing a new legal and institutional framework to promote decentralized management and increase stakeholder participation.

- Introducing economic incentives in water allocation decisions through rational tariff and cost recovery.

Although several management instruments (e.g. issuing of permits, licensing, and monitoring) have been developed and introduced, human capacity remains a major challenge. This results in limited compliance to permit conditions and inadequate pollution control, since only 50–60% of permit holders report their abstraction figures. Therefore, capacity enhancing measures would allow to meet institutional challenges for the management of water resources and establishing effective monitoring and control of water quality and reducing environmental degradation.

Since the new water law was promulgated in 1995, a comprehensive framework for integrated water management was provided. Investment efforts in the water sector continue to capture most of the remaining potential and develop the accompanying hydropower infrastructure to reduce energy imports, meet the government's objective for the potable water supply sub-sector –i.e. to supply virtually the entire rural and urban population by 2020-, and continue the on-going expansion of modern irrigation, which is expected to bring the total irrigated area to 1.35 million hectares by 2020. This is the country's full potential given the available water resources.

Morocco's water reform experience offers a range of useful features covering mainly the new institutional arrangements governing the water sector with the reinforced role of the High Water and Climate Council as an apex body on national water policies and programs and the creation of river basin agencies. At the sub-sectorial level, the Moroccan irrigation agencies are unique as they integrate the provision of production services to farmers with water supply – an approach that is crucial for enhancing water productivity and farm output. Although Morocco has developed a comprehensive water sector reform agenda, the pace of implementing the reforms remains slow. It is indeed complicated by the place water occupies within the set of interdependencies among the country's different physical, economic, and social systems. Thus, reforms cannot be seen in isolation from socioeconomic development policy, urban policy and urban design, land use, and agricultural policies etc. They should also be considered from the wider political and cultural changes occurring within the country mainly with regard to the progress of democracy and distributive governance.

The Government is continuing its efforts towards completing IWRM reforms mainly through improving sector governance, strengthening policy coordination bodies, and improving sector organization. It has completed the issuance of all the decrees needed to enact the 1995 Water Law. River Basin Agencies are being progressively empowered to enact decentralized and participatory resource planning, co-fund resource conservation and protection projects, enforce 'user pays/polluter pays' policies and aquifer management strategies.

A number of key lessons can be drawn from this experience. First, that completing and enforcing IWRM reform is key to restoring sustainability in Morocco's water management and promoting efficient use and allocation of water. Moreover, that achieving a successful, sustainable, cooperative river basin is found a clear challenge and that useful learning can be taken from other countries' experiences. However, 'one-size-fits-all' solutions to water resources planning and management should be avoided, thus incorporating an approach closer to political economy.

Moroccan Water Strategy include Water demand management and valorisation of water resources, the preservation and protection of water resources, natural habitats and fragile areas, a reduction of vulnerability to natural water risk and adaptation to climate change, the promotion of the management and development of water offer, and a continuation of the legislative and institutional reforms, while upgrading information systems, capacity building and skills. Main highlights can be summarized as follows:

1. Water demand management and valorisation of water resources

Water-saving in Irrigation.

- Massive conversion to local irrigation: potential to save 2 billion m3 per year (40 000 Ha per year).
- Improvement of the efficiency of water supply system networks in the irrigated areas: potential to save 400 million m3 per year.

Saving in drinking, Industrial & Tourism water.

- Improvement of the efficiency of urban water supply networks: potential to save 120 million m3 per year.
- Incentive to use technology to save water.
- Revision of the tariff system.

2. Management and development of water offer.

Mobilization of conventional water: 2.5 billion m3 / year.

- Construction of 3 larges dams per year (more than 1,7 additional Bn m^3 mobilized in the long term).
- Strengthening the small dams program for local development.
- North-south water transfer programs: 800 MCM/YEAR.

Mobilization of non-conventional water.

- Desalination and demineralization programs: 400 MCM/YEAR.
- Wastewater treatment and re-use programs: 300 MCM/YEAR.
- Collecting rainwater.

3. Preservation and protection of water resources, natural habitats and fragile areas

Safeguard and reconstitution of the groundwater

- Limiting pumping of groundwater, reinforcing the control system (water police), introduction of safeguard perimeters.

Protect water resources against pollution

- Implementation of the national program of sanitation and wastewater treatment and solid waste program: access rate to sanitation from 90% in 2030.
- National Program for Prevention and struggle against industrial pollution.

Safeguard watersheds side hill basins, humid zones and oases

- Protection of watersheds upstream of the dam against erosion.
- Program for the protection of sources.
- Program of humid zones and naturel lakes protection.
- Preservation of oasis and fight against desertification.

4. Reduce vulnerability to natural water risk and adaptation to climate change

Improve protection against flood

- Complete the actions set out in the National Plan for Protection against Floods: 20 sites to be protected by year.
- Integration of flood risk in urban planning and land management.
- Implement an alert system in case of flooding.
- Implement a proactive plans to mitigate drought.
- Implementation of structural measures and emergency plans and management of impacts.
- Establishment of financial mechanisms to support.

5. Continuation of the legislative and institutional reforms.

- Completing the legal framework necessary for the implementation of all provisions of water Law N°10-95.
- Proofreading of the Water Law and its implementing legislation in order to enrich and adapt them after 15 years of field application.

6. Upgrading information systems and capacity building and skills.

- Applied Scientific Research.
- Modernization of measures networks.
- Modernization of Administration and Development Skills.

Finally, it should also be noted that Morocco has adopted an integrated approach to water resources management through mutually reinforcing policy and institutional reforms.

The major policy reforms adopted are the following:

- The adoption of a long term strategy for IWRM. The National Water Plan is the vehicle for strategy implementation and will serve as the framework for investment programs until the year 2020;
- The development of a new legal and institutional frameworks to promote decentralized management and increase stakeholder participation;
- Introducing economic incentives in water allocation decisions through rational tariff and cost recovery;
- Taking capacity enhancing measures to meet institutional challenges for the management of water resources; and
- Establishing effective monitoring and control of water quality to reduce environmental degradation.

In addition, Morocco has adopted an "interventionist" type of irrigation policy for large scale irrigation (LSI) systems development to promote the rational use of water resources and to overcome the constraints related to the situation of its peasants. The framework of this policy is defined by a variety of laws grouped in the "Code of Agricultural Investment" (1969).

This Code is regarded as a contract between State and farmers to build the national economy through irrigation development. The state pays for the dams, the irrigation network and necessary on-farm development. It provides credit, selected seeds, fertilizer, farm equipment etc. Finally, it guaranties the prices of certain crops through contracts.

In turn the farmer is obligated to farm his irrigated land in the national interest, to follow the norms imposed for this hydraulic sector, and to repay the State 40% of the investment costs and 100% of operation & maintenances costs through a land improvement tax and volumetric water charges.

A volumetric charge is intended to cover 100% of operational and management costs, 10% of original investment cost and 40% of replacement cost. Thus, this variable cost is computed as follows (Ait Kadi no date)

$$VC = (OE + ME + 0.01\ I + 0.40\ R) / (V * PF) \quad (1)$$

Where: OE = present value of total operation expenditures;

ME = present value of total maintenance expenditures;

I = original investment cost; R = present replacement cost;

V = annual volume of water delivered; and PF = present value factor

OE and ME expenditures are fixed as a percentage of the initial investment cost

To conclude this assessment, a summary of a relevant water policy in included in Box 7.

Table 14. Key water-related policies and regulations in Morocco.

Year	Main regulations	Key facts
1969	Law No. 1-69-25. **Code on Agricultural Investment**	• **Hydro-agricultural installations** • Relationship State - agricultural **water users (rights and obligations)** • Financial structure of investment • **Bases of water pricing** for agricultural use & conditions of irrigation distribution
1984	Law No. 02-84. Water User Associations	Establishment of **Agricultural Water Users Associations** (AUEAs)
1995	Water Act No. 10-95 **Morocco's Water Law**	• Emphasis on **IWRM** • **Financial instruments** under the "user-pays" & "polluter-pays" principles • Economic value of water, linked to **national and regional solidarity** • Watershed management principles
2005	National Programme on Sanitation & Wastewater treatment (PNA)	Improve living conditions and protect the environment while achieving a 60% treatment rate for collected wastewater and an 80% rate for connections to the sanitation network in urban areas by 2020.
2007	**National Programme for saving water in irrigation (PNEEI)**	• Conversion of 550,000 ha to localized irrigation in the coming 15 years
2008	**Green Morocco Plan (PMV)**	• **Pillar I:** High added value agriculture • **Pillar II:** Joint developm. of smallholdings in diff. areas • **Crosscutting initiatives:** Modernization of irrigation and increased efficiency • PPP management of irrigation areas; massive conversion to localized irrigation
2009	**National Water Strategy**	• **Pillar I:** WDM (localized irrigation PNEEI, water efficiency, water tariffs…) • **Pillar II:** Developm. & management of water supply (mobilization of conventional & non-conv. water resources, water transfers…) • **Pillar III:** Water resources protection
2014	**National Water Plan (PNE)**	• Water demand management • Water reuse & treatment

2015	**Plan national de réutilisation des eaux usées (PNREU)**	Promotion of treated water reuse. Objective: 325mm3 reused by 2030
2016	**Water Act No. 36-15** (revision of Moroccan Water Law 10-95)	• Access to drinking water • **Desalination** of sea water • **Decentralization** (Conseil du Bassin Hydraulique - Rivers and Dams Council)

Source: FAO-Aquastat (2014), MEMEE (2012), Plan Bleu - GWP (2012), Peuch S. et al. (2016).

Box 7. Summary of a relevant economic policy in Morocco.

- Official name of the economic instrument/policy

  Water policy in Morocco (Ministry of Energy, Mining, Water & Environment, 2012)

- Region/Basin concerned.

  The 9 basins of Morocco: Loukouss, Tangerois and coastal mediterranean – Moulouya – Sebou – Bouregrag – Oum Er Rbia – Tensift and coastal of Essaouira – Souss Massa – Guir, ziz Rheriss and Draa - Sahara

- Institution(s) in charge of coordination & monitoring.

  Ministry of Health; High Commission for Water and Forests; **Ministry of Agriculture and Maritime Fisheries**: 9 Regional Offices for Agricultural Development (ORMVA), User Association, Private Users; **Ministry of Energy, Mines, Water and Environment**: 9 National Water and Electricity Offices (ONEE), 9 Water Basin Agencies (ABH); **Ministry of the Interior; Ministry of Finance**.

- General description and overview of the policy.

  The **water sector in Morocco has benefited from a particular interest by the public authorities** and has been at the focus of the economic policies because of its determining role in the country's water security and the derived economic development through the development of irrigated agriculture.

  In this context, Morocco has for a long time been engaged in a dynamic policy to provide the country with an important **hydraulic infrastructure,** to improve **access to drinking water,** to meet the needs of industries and tourism and the **development of irrigation in large scale.**

- Objective of the policy and main commitments of stakeholder involved.

  - **Mobilization of water resources** through the construction of large dams and water transfer structures.
  - Anticipation of water scarcity by giving public authorities long-term **visibility** (20 to 30 years).
  - **Development of irrigation** (convert gravity irrigation into localized irrigation)
  - **Energy recovery** of structures (hydroelectric production)
  - **Flood protection**
  - Supply of **drinking water** to population.
  - **Minimization of losses** in the hydraulic network

- Time frame (year of adoption of the policy or first negotiations, end year, major milestones, already performed and next foreseen revisions of the policy…)

  The policy was launched in the **early 1980s**

- Progress achieved and progress indicators (monitoring outcomes)

  - **Mobilization of Water Resources:**
    - 130 large dams: Total capacity of 17.5 billion m3
    - Thousands of wells
    - More than a dozen water transfer systems.
  - **Potable water :**
    - Urban: total service (rate: 94%)
    - Rural: Service rate (rate: 92%)
  - **Sanitation:**
    - Overall connection (rate: 72%)
    - Treatment (rate: 24%)
  - **Development of irrigation:**
    - Irrigation of 1.5 million hectares of which 2/3 are equipped by the public authorities.
  - **Energy valorization of hydraulic structures**: 10% of national energy production.
  - Protection against **flooding** in large cities and plains and fight against the effects of drought.
  - **Modern legislative framework:**
    - Law 10-95 on water: Institutionalization of the IWRM (Integrated Water Resources Management).
    - Creation of the Hydraulic basin agency and introduction of the financial instruments in application of the principles sampler-payers and polluters-payers.

- Main drivers and barriers found during the implementation of the policy:

  - Scarce water resources accentuated by climate change
  - Increased pressure on water resources
  - Degradation of water quality (Pollution and marine intrusion)
  - Farmers complain about rising agricultural water tariff

Source: Elaborated by Professor Redouane Choukr-Allah from the Insitut Agronomique et Veterinaire Hassan II (IAV), partner in MadForWater.

Main water-related institutions and stakeholders

In Morocco, a few ministries are involved in water management. The Ministry of Energy, Mining, Water and the Environment (*Ministère de l'énergie, des mines, de l'eau et de l'environnement, MEMEE*) is responsible for water management, while other Ministries such as the Ministry of Agriculture and Fishing (*Ministère de l'agriculture et de la pèche maritime, MAPM*) or the Ministry of Internal Affairs (*Ministère de l'intérieur*) also intervene in a direct way in its management (FAO-Aquastat, 2014; SWIM-SM, 2013a).

The Department of Water (*Departament de l'eau, DE*), under the umbrella of the Ministry of Energy, Mining, Water and the Environment, is the one created specifically for water management. The 9 River Agencies are also reliant on this Ministry (FAO- Aquastat, 2014). On the other hand, the Ministry of Agriculture and Fishing, with 9 Regional Offices for Agricultural Development (*Offices régionaux de mise en valeur agricole, ORMVA*), is in charge for irrigation. The Ministry of Interior, with a Direction for Water and Wastewater (*Direction de l'eau et de l'assainissement*), has an additional role, being in charge of local communities and supervising the application of the NAP (National Water Sanitation and Cleansing Plan) (SWIM-SM, 2013b).

Other agencies, such as the National Agency for Energy and the Water (*L'Office national de l'électricité et de l'eau potable, ONEE*), the Water Interministerial Commission (*Commission interministérielle de l'eau, CIE*) or Superior Council for Water and Climate (*Conseil supérieur de l'eau et du climat, CSEC*) constitute also important agents in the water management landscape, as they serve as advisors and coordinators of the activities of different Ministries and organizations.

Although the institutional structure and decision making process have tended to be substantially centralized in Morocco, some power and attributions are given to local and regional institutions, such as:

- **MAPM - Regional Offices for Agriculture Development (ORMVAs**): manage large irrigation perimeters
- **MEMEE - River Basin Agencies (ABH)**
- **Agricultural Water User's Associations (AUEAs)** Irrigation network development & maintenance in small-medium perimeters.

Moreover, after the implementation of the Water Act No. 36-15, more decentralization towards the Rivers and Dams Council (Conseil du Bassin Hydraulique) has been intended (Peuch et al, 2016).

Figure 22 summarizes the institutional framework in water policy making in Morocco.

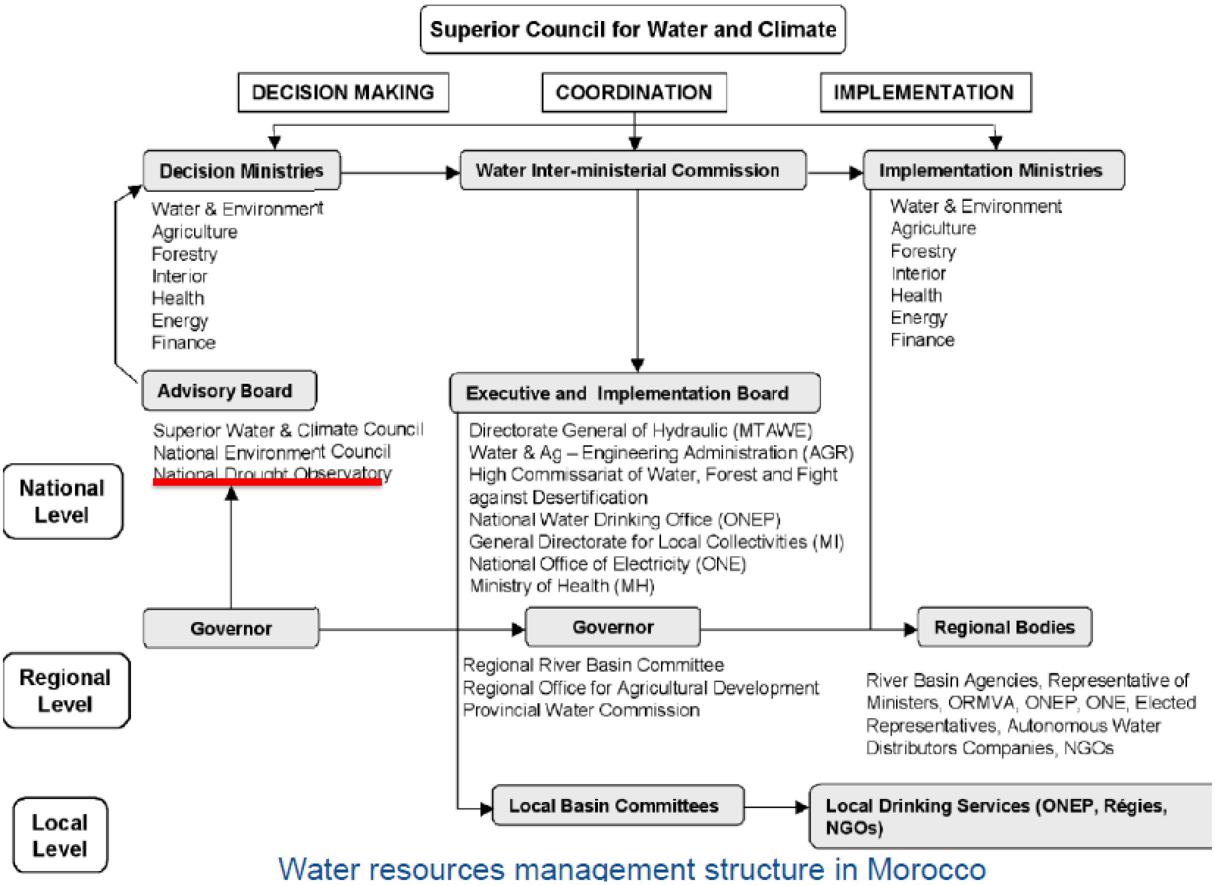


Figure 22. Institutional framework of water management in Morocco.

Source: UN-DESA (2014).

Main economic instruments used in the water management

Morocco, with a water exploitation index of more than 40%, was already considered as a country at localized risk of cyclical shortage in the Fréjus Workshop in 1997. Total water abstractions amount to 22 km^3 per year and freshwater availability per capita is estimated at 844 m^3/year/inhabitant (Burak and Margat, 2016), more than in Morocco and Tunisia (See Boxes 1, 2 and 3). According to the Falkermark Indicator (Falkenmark, 1989), it could be therefore considered as a water poor country. With respect to the main sources of abstraction, in the case of Morocco, surface water is the main source of supply (World Bank, 2018). Groundwater, implying around a 20% of abstractions, constitutes the second source in terms of volume (World Bank, 2018). On the other hand, non-conventional sources still represent a minor proportion of total supply (World Bank, 2018; Burak and Margat, 2016).

In Morocco, agriculture displays the highest importance in terms of water consumption among the three MACs countries in MADFORWATER, with an 87.77% of total water demand being for this sector (See Box 3). In economic terms, irrigated agriculture is substantially important in Morocco. On average, it represents around a 14% of PIB, 25% of employment and up to 75% of exportations (CES, 2014).

The implementation of the principles of IWRM is ongoing, with substantial efforts still to be made (See Figure 19). Losses in the distribution networks in irrigation are estimated as exceeding 50% of the total water abstracted (AfDB, 2009) and agricultural water productivity is on average low (around 15$/m3), although slightly higher than the average in middle-income countries(World Bank, 2018). However, some initiatives have been taken. For instance, in Fez, a reduction of network losses of a 10% and full recovery of the initial installation costs was achieved after the installation of valves that allowed to reduce pressure (SWIM-SM 2013b, World Bank, 2018).

Water management in Morocco has been characterized over time by the centralized supply management through the hydraulic infrastructures of the country. However, since the 90's decentralization has become more prevalent with the creation of a number of user associations involving users in the decision-making and maintenance responsibilities of the irrigation networks.

Further, since the adoption of the National Water Strategy in 2009, water management has focused in the development of the water sector. For that purpose, some instruments such as water pricing (cost recovery) and water transfers, as well as the conversion to localized irrigation or the development of non-conventional sources have been fostered and emphasized as a way to give an economic value to water and increase its productivity and efficiency.

Regarding economic instruments, the decentralization of O&M costs to the WUA (water users associations) has incentivized the definition of water prices, charges and instruments for a better water allocation tailored to the specific needs of each users and regions (UNDP, 2013). According FAO-Aquastat (2014), national average **cost recovery** rate is about 75%, reaching 90% in specific irrigation perimeters, while agricultural water sale cost ranges from 0.035 and 0.07 dollar EU/m^3. In fact, Morocco is one of the countries that has aimed at achieving full cost recovery in pricing schemes. In the same vein, in irrigation "sustainable cost" is fostered (*Chohin-Kuper and Strosser, 2008)*

Particularly concerning **water pricing**, tariffs have been based in progressive volumetric charging and the solidarity principle among social strata of the different water users (Plan Bleu – GWP, 2012; FAO-Aquastat, 2014). Agricultural water prices were risen in a progressive way as not to inhibit technical progress (Plan Bleu – GWP, 2012).

With respect to **subsidies**, Morocco relies on several kind of financial aids for irrigation, such as on subsidies to water-saving technologies for irrigation (Chohin-Kuper and Strosser, 2008). Moreover, the usual deficit in terms of cost recovery is covered by transfers from the electricity sector by means of cross-subsidies. For instance, in the water saving program (PNEI), a financial incentive was established for the installation of irrigation water saving techniques. The main objective was to cover up to 550,000 ha with localized irrigation (Chohin-Kuper and Strosser, 2008).

Finally, according to World Bank (2009), in what **water rights** are concerned, Morocco's Water Law (Water Act No. 10-95) established that water is a public asset, although some rights can be retain from the public domain provided that they fulfill several requirements. Moreover, landowners have rights over the rainfall in their land. However, artificial techniques to collect rainfall or contruction of wells are regulated.

Box 8. Key elements of Moroccan Water Demand Management.

Key elements of the Water Demand Management (Morocco)

Decentralization:

From 1992 increase of users participation through **AUEAs**.

Modernization:

- Surface irrigation is gradually being replaced by drip irrigation (Green Morocco Plan): e.g. **Souss-Massa basin: 54% grav. 15% sprink. 31% drip** (Oates et al, 2015)

Economic instruments:

Cost recovery

- Cost recovery rates about 75%, reaching 90% in specific irrigation perimeters
- Agricultural water sale cost ranges from 0.035 and 0.07 dollar EU/m^3.

Water Pricing:

- Volumetric and progressive volumetric charging.

Subsidies:

- Subsidies to water-saving technologies for irrigation
- Cross-subsidies from energy.

Water markets and rights:

- Water is a public asset.
- Water rights tied to land.

Source: Own elaboration.

4.4 Tunisia case study: policies, institutional framework and economic instruments.

Main water strategies and policies

In Tunisia, water legislation is elaborated by the colonial administration, with the main objectives of supporting the various hydraulic projects developed and modernizing the traditional legal framework of water management.

For that purpose, already in the 19th century several water laws were established. In 1885, the beylical decree of 24 of September was released, aiming at the integration of water bodies to the hydraulic public domain. From then, streams, aqueducts, wells, irrigation canals and canals started to be managed by the State in order to pursue and preserve public interests. Two years later, in 1897, a decree recognized the “watering syndicates”, a paramount structure in the Tunisian water sector.

Since the beginning of the 20th century, several other laws were developed. In 1920, a decree regulating the conservation and use of public water was created. This decree was of special relevance, as it was the first water code that included the Special Associations of Hydraulic Interest, that is, associations that can be created at the initiative of users and placed under the authority of the administration. Some years later, in 1933, a beylical decree came into force, integrating groundwater into the public hydraulic domain. As a consequence, property rights were transformed into non-transferable rights of use.

Tunisian Water Code (Law 75-61) (Water Act No. 10-95) was firstly established in 1975, and was successively revised and completed in 1987 and 1988, being the last modification performed in the year 2001 (Law 2001-116). This is the main water-related regulation in Tunisia, and it was developed mainly focusing in the use of water in the agricultural sector. In its original version (1975) the Water Law covers agricultural water usage rights, water saving, water wastage and water pricing, but it also includes innovative elements such as the reuse of treated water for irrigation (FAO – Aquastat, 2015). Moreover, the water code introduced the notion of rational management of water and environmental protection based on three main principles: the centralization of the water administration, the priority to drinking water and maximization of the value of the resource. The last revision of the Water Code (2001) emphasizes the need for developing non-conventional water resources (e.g. desalination) in order to increase the availability of water in the country. The most important contribution of the law 2001-116 was that of the integration of certain basic principles in the legal qualification of water resources: water was qualified as "national wealth" and the concept of sustainable development in what water management is concerned was clarified. This amendment also aimed at strengthening the proposed measures for the conservation and protection of the resource, implying that water consumption, when exceeding a certain threshold, is subject to a periodic and compulsory technical diagnosis (Decree 2002-335 of 14 February 2002). Furthermore, it introduced schemes of incentives for water saving, particularly in the agricultural and drinking water sectors. Currently, the Tunisian Water Code is under revision and discussion with the Prime Minister, and a new version is expected to be launched in the short-term.

In addition, before the 90's many water-sector plans and policies were performed, among which the Northern Water Use Master Plan (1975), the Central Water Use Master Plan (1977) and the Southern Water Use Master Plan (1984) and National Water Saving Strategy (1993) can be found. One of the most important plans was the National Water Saving Strategy (1993), which aimed to reduce waterwaste at the level of the exploitations for all irrigated areas. This program has seen considerable momentum since 1995, favored by the increase in investment premiums granted to high-performance irrigation equipment: from 30%, these premiums have risen to 40%, 50% and 60% respectively for large, medium and small farms. Field equipment has also been very important over the 1995-2005 period when the equipped area increased from 127,255 ha in 1995 to 310,049 ha in 2005 and continued to reach 78.38% in 2015. From 1995 to the end of 2014, the total subsidy granted for the water economy reached about 553 million dinars. Other elements of the 1993 National Water Saving Strategy are summarized in Table 15.

Further, and following the decentralization approach for water management established in the 1993 National Strategy, a series of texts were created as to govern the field of **collective organization of water users.** The decree n ° 87-1261 of October 27, 1987 organized the constitution and operation of the Groups of Collective Interest (GIC) which took up the same missions as the old Associations of Collective interest (AIC). Some years later, in 1999, the Law n° 99-43 of May 10, 1999 allowed the extension of the GIC activities to other agricultural development activities and the GICs gradually evolved into Agricultural Development Group (GDA). The water interest group responsible for the regulation of GICs at the level of each governorate was also replaced by a regional council of much broader competences (Decree 2005-2647 and 2009-2254). At the end of 2015, there were 2743 GDAs, of which 1364 were for drinking water supply, 1243 for irrigated public areas and 136 mixed GDAs -Irrigation and drinking water supply-. (Ministry of agriculture, 2016)

Supply management **by the mobilization of water resources** have been another focus of attention from the 70's, passing from 55% in 1987 up to 90% in 2011. Since then, many master plans and national strategies have been implemented for such purpose (FAO-Aquastat, 2015):

- Several Master Plans for Northern waters, Southern waters and Central Tunisia (1970-1990)
- The ten-year National Strategy (1990-2000), whose ambitious objective was the mobilization of the 85% national water resources.
- The complementary Mobilization Strategy (2000-2011), supported by the Water Sector Investment Projects PISEAU (2001-2006) and PISEAU II (2009-2014), which wanted the mobilization of the 90% of national water resources.

While continuing the mobilization of new water resources in the framework of the Master plans or ten-year strategies, water sector reforms were initiated and specific programs aimed at stimulating demand management policies were introduced. Initiatives in this respect have had continuity over time, leading to the following laws and strategies: (i) the political and institutional orientations related to the implementation of the agricultural structural adjustment plan (1986-1994), which was devoted to the gradual disengagement of the State (liberalization of agriculture, reduction of subsidies granted by the State, readjustment of water prices, loss of monopolies of marketing boards), (ii) the major programs of a hydraulic nature initiated during the last decades: the Investment Project in the Agricultural Sector PISA and PISA- Relays 1991-2000) and the Investment Project in the Water Sector PISEAU I (2001-2007) and PISEAU II (2009-2014).

In addition, several sectorial policies implemented in Tunisia have also contributed to the development of the irrigated agriculture management and water resources management (FAO-Aquastat, 2015):

- Presidential Programmes (2004-2009; 2009-2014) aimed at restructuring agricultural production around irrigated perimeters (water savings).
- The ten-year Water and Soil Conservation Strategies (1991-2000; 2002-2011).
- The Agricultural Sector and Ecosystems' Adaptation to CC Strategy

The objective of these policies was to promote several changes in the irrigation sector, among which we can find:

- The introduction of pricing systems adapted to the drinking water and irrigation sectors with a view to improving cost recovery, guiding the policy of irrigated production and encouraging economic available resource.
- Development of water economy programs in different sectors for a better preservation of the resource.
- Encouragement of active participation of users from rural areas in irrigation and drinking water through the Agricultural Development Groups (GDA).
- The development of non-conventional water resources through the reuse of treated water for agricultural and recreation purposes, and the desalination of brackish water for the needs of drinking water.
- Protection against water pollution, by means of urban sanitation programs.

From the beginning of the 21st century, the focus of the water-related policies changed and the IWRM became strategically important. This political will to rationalize the water use and to develop new technologies to avoid wastage is reflected in the revision of the Tunisian Water Code (2001). In addition, the development of non-conventional water resources was considered as a key element for the future of the Tunisian water sector. In such context, the 12th National Development Plan (2010-2014) acknowledged IWRM along with sanitation and wastewater treatment and reuse as priority issues for the sustainability of the Tunisian water resources.

Table 15. Key water-related policies and regulations in Tunisia. shows the summary of the main water-related policies and strategies performed over time in Tunisia along with its main descriptive features.

Table 15. Key water-related policies and regulations in Tunisia.

Year	Main regulations	Key facts
1975 (modif.2001)	**Tunisia's Water Code** (Law No. 75-61)	• Establishment of **rights of use** • Economy of water • Reduction of wastewater • **Reuse of wastewater** for agricultural purposes • **Water pricing**
80's	National Standards	Regulating potable water characteristics, reuse of WW, etc.
1987	Revision of Tunisia's Water Code (Law No. 87-35)	• Creation of the Group of Hydraulic Interest (Advisory bodies at Governorate/regional level). • Functioning and creation of associations of Collective Interest are regulated.-
1988	Revision of Tunisia's Water Code (Law No. 88-94)	• **Terms and conditions for supply and pricing of irrigation policies** in irrigated public perimeters and irrigated perimeters equipped by the state, are **regulated** according to the specifications of a decree elaborated ad hoc for this purpose.
1990	Ten-year National Strategy	• **Mobilization** of 85% of the water resources
1993	**National Water Saving Strategy**	• Incentives to **rationalize the use** of agricultural water & **maximize economic profit** • **Integrated** approach • **Flexibility, adaptation to local** WM contexts • Decentralization • **Subsidies to water-saving technologies** • **Pricing system** based on transparency and flexibility
1999	Law 99-43 + Decree 99-1819	• Creation of **new entity:** Agricultural Development Groups **(GDAs)**
2000	Complementary Mobilization Strategy	• **Mobilization** of 90% of the water resources (H 2030)
2001	Water Sector Investment Project (PISEAU)	-

2001	**Revision of Tunisia's Water Code** (Law No. 2001-116)	• Development of **non-conventional water resources** (desalination) • "**Water Economy**" concept. • Proposal of the general **principles** of the **mobilization and the valorization** of the use of water resources. • Development of programs and plans for mobilizing water resources and optimize their use. • Proposal for the development of a national water saving policy through programs to rationalize water consumption, • Creating of a national water council to assist the Minister of Agriculture in carrying out the aforementioned missions.
2004	Law 2004-24	• **Conversion** of former Collective Interest Associations (AIC) and Collective Interest Groups (GIC) **to Agricultural Development Groups (GDAs)**
2009	2nd Water Sector Investment Project (PISEAU II)	• Improvement in the living conditions of rural populations through better integrated and sustainable management of water resources. • Technical assistance to the implementation of the national perennial strategy for Drinking water supply system managed by GDA.
2010	**12th National Development Plan (2010-2014)**	• Demand management & **Integrated water resources management (IWRM)** • **Sanitation & wastewater treatment** priority issues

Source: FAO-Aquastat (2015), Plan Bleu - GWP (2012)

Main water-related institutions and stakeholders

In the Tunisian water sector, the main ruling organizations can be summarized as follows:

- **At a national level, the Ministry of Agriculture, water resources and fishery (MARHP)** is in charge of public water management through 5 General Directorates. **DG/GREE** is in charge of irrigation water.
- **At the regional level, the Regional Commissariat for rural development (CRDA)** in every Governorate, dependent on the MARHP, which among other responsibilities, are in charge of water management, particularly for irrigated permiters.

- At local level, DG/GREE delegates network operation to **GDAs** (Groupement de développement agricole). Among the functions carried out Irrigation GDAs during its regular operation, it can be found the exploitation and review of irrigation infrastructures and cost sharing among farmers.

Figure 23 contains a detailed graphical representation of the structure and system of interrelations between different ministries, agencies and organizations involved in water in Tunisia at the national and regional levels.

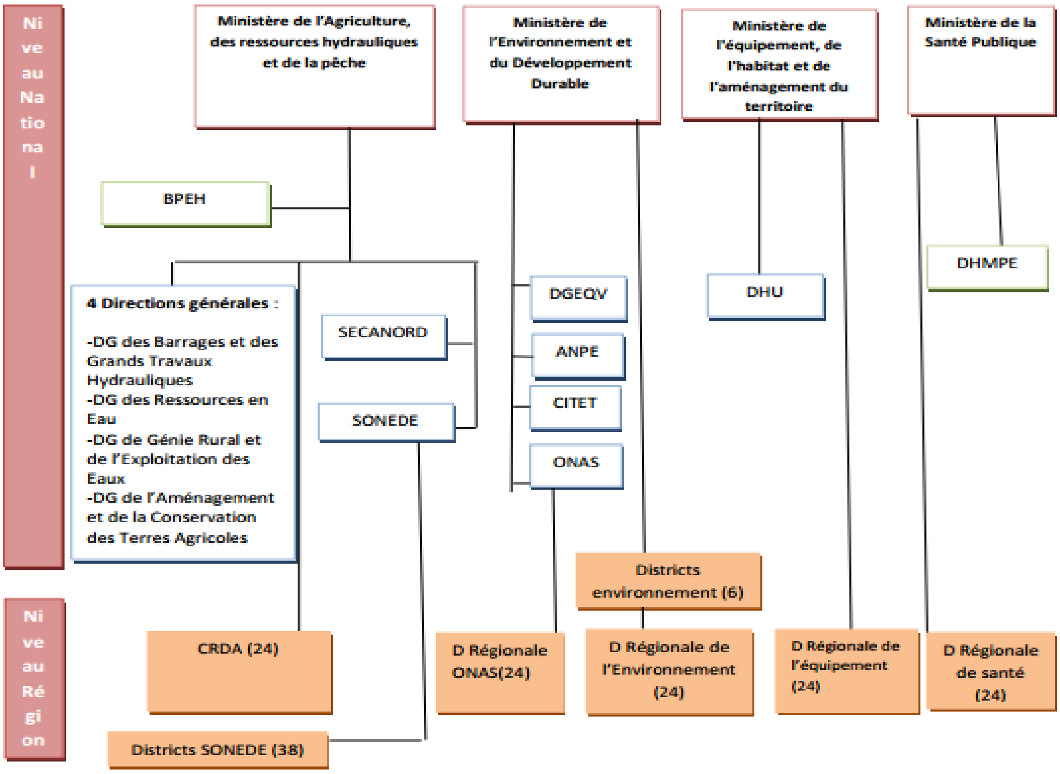


Figure 23. Institutional framework of water management in Tunisia.

Source: BPEH-MARHP (2015).

Main economic instruments used in the water management

With water availability per capita of 411 m3/inhabitant/year, Tunisia is considered as a country experiencing water shortage according to the Falkenmark Indicator (Falkenmark, 1989; Plan Bleu-UNEP/Map, 2013). Accordingly, during the Fréjus workshop in the context of the Plan Bleu and Mediterranean Action Plan (MAP) of the United Nations Environment Programme (UNEP), it was classified within the group of countries suffering from cyclical and structural shortage.

Opposite to the other two MAC countries belonging to MADFORWATER, in Tunisia freshwater abstractions are the main source of supply, entailing around a 60% of total withdrawals. Surface water also displays great importance, with a 35% coming from this source.

The remaining less than 5% comes from non-conventional sources, mainly from reuse of treated wastewater (World Bank, 2018). Therefore, there is still substantial room for implementation of policies regarding non-conventional sources.

With respect to agriculture, in Tunisia it represents an 8.7% of the GDP and up to 19.6% of employment, with an 80% of total demand coming from this sector. However, water losses in irrigation are still high -from 40% to 60%- (Omrani and Ouessar, 2011) and agricultural productivity is also low (around 17%), although higher than the average productivity in middle-income countries and, particularly, in the other two MACs in MADFORWATER (World Bank, 2018).

Regarding water management policies for irrigation, before the 90's public irrigation perimeters in Tunisia were managed by the Agriculture Development Offices (OMIVAs). However, following the decentralization policies (in force since 1986), Regional Commissariats for Agricultural Development (CRDAs) were established in order to support the activities of the OMIVAs at local level and to enhance the participation of water users in the water management (FAO-Aquastat, 2015).

In the agricultural sector, Agricultural Development Groups (GDAs) currently manage about 70% of public irrigation perimeters. In this context, such associations are enabled to set the charges (FAO-Aquastat, 2015), to collect fees (cost recovery) from involved users and use them to defray running expenses of the collective management of irrigation facilities (Plan Bleu – GWP, 2012). Within big public perimeters the CRDAs still intervene in infrastructure-related works in the common networks, charging their services to the GDAs (FAO-Aquastat, 2015).

Concerning **water pricing**, Tunisia reformed the irrigation water pricing system in the 90's with the launching of the National Water Saving Strategy (1993) by the Ministry of Agriculture. The major objective of the Water Saving Strategy was to mitigate water scarcity and wastage in Tunisia by promoting the rational use of agricultural water as well as optimizing the economic profit (Plan Bleu – GWP, 2012). Among other measures, the Strategy sought an integrated approach including the coordination of technical tools, **subsidies** for the modernization of irrigation technologies, progressive adaptation to local contexts (decentralization), the inclusion of irrigator associations in the local water management and the support of farmers' incomes to grant social stability and the sustainability of investments. In addition, the Strategy also envisaged a "transparent and flexible" pricing system, aligned with national food security objectives (Plan Bleu – GWP, 2012).

Water charges were designed according to the regional needs and the objectives of irrigated production / areas (Plan Bleu – GWP, 2012). In the decade from 1990 to 2000, the Tunisian Government increased water price at a regular rate of 9% a year, paired together with a massive installation of metering systems. Such price rises were performed with the objective of recovering the costs of O&M of the water supply network. As a result, the **cost recovery** rate over the same period increased from 57% in the early 90's to nearly 90% in 2003 (Plan Bleu – GWP, 2012). In addition, and according to Plan Bleu – GWP (2012), price increases had relevant impacts on the volumes of water consumed (reduction of consumption).

In 1999, another reform was performed in the Tunisian water pricing system: the single-element pricing in force was gradually replaced by a two-part charging system starting in the large irrigation areas of the North of the country (Plan Bleu – GWP, 2012). This two-part water tariff would permit a faster cost recovery while encouraging irrigation in those areas already having irrigation facilities.

After such reforms in the agricultural water pricing system of Tunisia, according to recent information (FAO-Aquastat, 2015), currently there are in place several types of pricing:

- Volumetric charging is the most common in big PPIs.
- Two-Part charging (by irrigated area and water volume consumed)
- Flat-rate charging (by ha or by hour) is the most common in the Southern oasis of the country.

Accordingly, currently cost recovery rates are higher. Table 16 shows average water cost and cost recovery rates in Tunisia, by type of irrigated perimeter.

Table 16. Agricultural water cost and cost recovery rate in Tunisia (2003 data).

	Big perimeters managed by CRDAs	Big Perimeters	Mid-Small Perimeters	Oasis
Average water cost (DT/m3)	0.096	0.095	0.071	0.015
Cost recovery rate (%)	83	107	100	99

Source: FAO-Aquastat (2015)

Regarding price setting decisions, in Tunisia each GDA fixes its own price. The GDA Board of Directors usually sets the price at the beginning of each year based on operating expenses in the perimeter. This tariff varies from 50 millimes[8]/m3 to 200 millimes/m3, with the price depending on the type of water source (well or surface water). Likewise, with respect to the price of reuse of treated wastewater, of direct relevance for MADFORWATER, currently it is fixed to 20 millimes/m3. However, some GDAs that have installed a technical improvement of the quality sell water to the farmers at 200 millimes /m3.

Finally, in what water rights are concerned, according to World Bank (2009) water rights under the Tunisian Water Code have been private rights that existed before the come into force of the Code, and that have been linked to land ownership. Therefore, if a land is transferred, the water right is supposed to be transferred with it. In the same vein, if new land is recognized for irrigation purposes, a new water right must be approved.

[8] The dinar is the currency of **Tunisia**. It is subdivided into 1000 milim or **millimes**.

Box 9. Key elements of Tunisian Water Demand Management.

Key elements of the Water Demand Management (Tunisia)

Decentralization:

1986 **Decentralization & Users Participation Strategy**.

GDAs manage 87% of PPI: provide and manage facilities, recover costs, etc.

Modernization of irrigation:

- Financial support to irrigation modernization -> lower impact of tariffs
- Modern irrigation grew from 20% of land irrigated in 1990 to 80% in 2007

Economic instruments:

Cost recovery:

- Cost recovery rates increased from 57% in the early 90's to nearly 90% in 2003.
- By 2015, cost recovery rates vary from 87 to 107% depending on the size of the irrigated perimeter.

Water Pricing:

- Uniform **volumetric** pricing and **two-part tariffs** in modern areas
- Significant price increases from 90's -> remarkable increase of **cost recovery.**
- Transparent and flexible pricing envisaged.

Subsidies:

- **Subsidies** for the modernization of irrigation technologies

Water markets and rights:

- Water rights linked to land ownership.
- Water rights are transferred with property rights of the land.

Source: Own elaboration based on World Bank (2009), BPEH-MARHP (2015), CEDARE (2014a), FAO-Aquastat (2015), Plan Bleu - GWP (2012).

5 Concluding remarks

The Mediterranean is a region comprising very diverse cultures, climatic conditions and socio-economic backgrounds. Regarding water resources, the combination of high temperatures and low precipitation have led to high pressure on water resources in most countries of the region. Within the Mediterranean, the MENA region is particularly vulnerable, being the most arid region in the world (FAO, 2016). In Egypt, Morocco and Tunisia, the situation is not very different. As shown in Table 17, with high levels of exploitation of their water resources and freshwater resources availability below 1000 m3 per capita and year, they are considered as water poor countries (in the case of Egypt and Morocco) or even as suffering from water shortage (i.e. Tunisia).

As a consequence, the notions of Integrated Water Resources Management (IWRM) and Water Demand Management (WDM) have taken a prominent role in the last decades, as a way to promote efficiency and environmental sustainability in the management of water resources, while preserving equity and financial self-sufficiency (i.e. cost recovery). However, despite the substantial efforts made in the last decades, the **level of implementation of IWRM** in Egypt, Tunisia and Morocco **has not reached the expected targets yet** (World Bank, 2009).

In this report, several <u>needs and gaps</u> have been detected for an enhanced implementation of those policies. With respect to supply, in Egypt, Morocco and Tunisia, policies are mainly based on conventional sources –e.g surface water in Morocco and Egypt, and freshwater abstractions in Tunisia-, with non-conventional resources –e.g. desalination, wastewater treatment and reuse- only representing a small fraction of total supply. Therefore, substantial room for the **implementation of policies aimed at increasing non-conventional sources** still remains. Moreover, generating alternative sources of supply may in addition contribute to the necessary **control of withdrawals.**

However, supply interventions are not on their own enough to achieve sustainability. Regarding demand, agriculture in the main consumer in the region, with more than 80% of withdrawals coming from this sector. Nevertheless, in Egypt, Morocco and Tunisia agricultural productivity is low as compared to the world average and network losses in irrigation are high (ranging from 40% to 60%). Therefore, an increase in efficiency, both in terms of efficiency in provision –i.e. **reduction of network losses**- and efficiency in use –i.e **increase in agricultural water productivity**- could prove very successful in achieving a more sustainable management of the resource.

For the implementation of such principles and goals, a number of tools have been outlined in this Deliverable (D5.1.) –e.g. technical, command-and-control or economic.-. Particularly, **economic tools** – e.g cost recovery, pricing, financial aids, water markets, etc.- **have been highlighted as a means to place a right value on water** and allocating it to its highest value economic use, thus improving water demand management and contributing to the achievement of the principles of IWRM. Regarding the application of economic tools in the MACs in MADFORWATER, **tariffs** in Egypt, Morocco and Tunisia still **do not reflect the scarcity value of water or the full cost recovery of delivery**. Although price structures and levels are being adjusted, the current structures offer low incentive for water saving. Moreover, some additional constraints are found for an effective implementation of cost recovery. First, that the **level of subsidization is high**, mainly due to subsidization of water-saving investment programs, the existence of cross-subsidies from other sectors (e.g. electricity) and funding received from the government and international organizations. Therefore, careful attention should be paid to the use of subsidies as an economic instrument in the region, since besides reducing the level of cost recovery, they may eliminate part of the incentives generated by other economic tools, thus leading to overuse of water resources. The second limitation to cost recovery derives from the fact that **difficulties are found to apply the “user pays principle”**, as it could affect farmer’s income and increase the risk of social conflicts. Finally, with respect to management tools for the control of freshwater abstractions, **currently water use is mainly limited by authorizations (“quotas”)**. In this regard, a **better definition of water rights, combined with the development of water markets** would significantly contribute to the control withdrawals and an improvement in the allocation of the resource.

Lastly, some considerations must be made for a right implementation of economic instruments in Egypt, Morocco and Tunisia. First, it should be taken into account that **no instrument works alone**. Their functioning usually depends on a wide range of factors such as their combination with other regulatory and technical tools, as well as other horizontal elements providing coordination and support –i.e. planning and coordination bodies and strategies, awareness raising actions or adequate training of human resources -. Therefore, emphasis must be made on **designing a mix of mutually strengthening instruments**. Second, that trade-offs between efficiency and equity should be carefully considered by **tailoring economic instruments such as prices to the needs of the different users**. Finally, it is important to note that water management policies and **economic instruments must necessarily be embedded within sound sectorial and economic policies**. Particularly, **accountability from policy makers and the establishment of cooperation agreements between Mediterranean countries are found especially important** for the achievement of an adequate level of implementation of IWRM.

Table 17. Water management policy summary for the 3 MADFORWATER countries, with special emphasis on economic instruments (Egypt, Morocco, Tunisia).

Policy Strategies	Measures		
	Egypt	Morocco	Tunisia
State of water resources			
Water Exploitation Index	134%	36%	72%
Water availability per capita	**637** m^3/inhabitant/year	**844** m^3/inhabitant/year	**411** m^3/inhabitant/year
Classification according to Falkernmark indicator	**Water poor country** (less than 1000 m^3/inhabitant/year)	**Water poor country** (less than 1000 m^3/inhabitant/year)	**Experiencing water shortage** (annual water resources under 500m^3/capita/year)
% of total abstractions consumed in irrigation	82.8%	87.77%	80%
General economic indicators			
Agricultural share of the GDP (%)	14%	14%	8.7 %
% of employment	30%	25%	19.6%
% of exports	75%	-	-
Water losses in agricultural sector (%)	Around 50%	Exceed 50%	40%-60%

Agricultural water productivity	5-10€/ m^3	Around 15\$/m^3	20€/ m^3
Economic instruments			
Cost recovery	**40% O&M** for irrigation and drainage systems	**75% O&M** costs Up to 90% in some perimeters	Cost recovery rates vary from **87% to 107%** depending on size of irrigated perimeter
Water pricing	**Incremental or volumetric** Low initial prices and low escalation Free in some old agricultural exploitations	**Progressive volumetric** charging	**Two part-tariffs** Uniform **volumetric** pricing
Subsidies	**High level of subsidization** O&M and investment **financed by government or international organizations**	Subsidies to **water-saving technologies** for irrigation **Cross-subsidies** (electricity)	**Subsidies for the modernization** of irrigation (**Water-saving technologies**)
Water rights and markets	Water rights **tied to land property**	**Water is a public asset** although rights can be retained from the public domain. **Highly regulated rights** over water for landowners	Water rights **linked to land ownership**
Other	-	**Abstraction taxes**	**Abstraction taxes**

Source: Own elaboration based on previous review, *Easter and Liu (2005) and Chohin-Kuper and Strosser (2008).*

6 Abbreviations

ABHs	*Agences du Bassin Hydraulique* (Morocco) River Basin Agencies
AICs	*Associations d'Intérêt Collectif* (Tunisia) Collective Interest Associations
AUEAs	*Associations d'usagers des eaux agricoles* (Morocco) Agricultural Water User Associations
BPEH	*Bureau de Planification et des Equilibres Hydrauliques* (Tunisia) Office of Planning and Hydraulic Balance
CC	Climate Change
CEDARE	Centre for Environment and Development for the Arab Region and Europe
CRDAs	*Commissariats Régionaux au Développement Agricole* (Tunisia) Regional Commissariats for Agricultural Development
DT	Tunisian Dirham
EEA	European Environmental Agency
EU	European Union
FAORN	Food and Agriculture Organization of the UN – Regional Office for Near East and North Africa
GDAs	*Groupements de développement agricole* (Tunisia) Agricultural Development Groups
GIC	*Groupements d'Intérêt Collectif* (Tunisia) Collective Interest Groups
GWP	Global Water Partnership
IAV	Institute of Agronomy and Veterinary Hassan II (Morocco)
IWMD	Integrated Water Management Districts (Egypt)
IWRM	Integrated Water Resources Management
MACs	Mediterranean African Countries
MADFORWATER	DevelopMent AnD application of integrated technological and management solutions FOR wasteWATER treatment and efficient reuse in agriculture tailored to the needs of Mediterranean African Countries
MAP	Mediterranean Action Plan
MAPM	*Ministere de l'Agriculture et de la Pêche Maritime* (Morocco) Ministry of Agriculture and Fisheries

MARHP	*Ministere de l'Agriculture, des Ressources Hydrauliques et de la Pêche* (Tunisia)
	Ministry of Agriculture, Water Resources and Fisheries
MEMEE	*Ministere de l'Energie, des Mines, de l'Eau et de l'Environnement* (Morocco)
	Ministry of Energy , Mining , Water and the Environment
MEWINA	Monitoring and Evaluation for Water In North Africa
MWRI	Ministry of Water Resources and Irrigation (Egypt)
MWWU	Ministry of Water and Wastewater Utilities (Egypt)
NWRC	National Water Research Center (Egypt)
OMIVAs	*Offices de Mise en Valeur Agricole* (Tunisia)
	Offices for Agriculture Development
ONEE	*Office National de l'Electricité et de l'Eau Potable* (Morocco)
	National Agency for Energy and the Water
ONSSA	*Office National de Sécurité Sanitaire des produits Alimentaires* (Morocco)
	National Agency for Sanitary Safety of food products
ORMVAs	*Offices Régionaux de Mise en Valeur Agricole* (Morocco)
	Regional Offices for Agriculture Development
O&M	Operation and Maintenance
PISEAU	*Projet d'Investissement dans le Secteur de l'Eau* (Tunisia)
	Water Sector Investment Project
PMV	*Plan Maroc Vert* (Morocco)
	Green Morocco Plan
PNEE	*Programme National d'Économie d'Eau d'irrigation* (Tunisia)
	National Programme for Saving Water in Irrigation
PNEEI	*Programme National d'Économie d'Eau en Irrigation* (Morocco)
	National Programme for saving water in irrigation
PNREU	*Plan national de réutilisation des eaux usées* (Morocco)
	National Plan for Water Reuse
PPI	*Périmètres publics irrigués*
	Public Irrigation Perimeters
RMC	Regional Management Committee (Egypt)
UMA	University of Manouba, Higher Institute for Biotechnology, Laboratory of Biotechnology and Bio-Geo Resource Valorization LR11ES31
UN	United Nations
UN - DESA	United Nations – Department of Economic and Social Affairs

UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UPM	Universidad Politécnica de Madrid
UTM	University of Tunis El Manar, Faculty of Sciences of Tunis, Laboratory of Microorganisms and Active Biomolecules
WDM	Water Demand Management
WER	Wageningen Environmental & Research
WM	Water Management
WP	Work Package
WUAs	Water Users Associations (Egypt)

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