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# THE BLIND SPOT IN WATER GOVERNANCE: CONJUNCTIVE GROUNDWATER USE IN THE MENA COUNTRIES

## I. INTRODUCTION

In many areas of the Middle East and North Africa[3] intensive aquifer use has been the single major factor that transformed the rural economy in the last 25 years. It has boosted crop production and improved access to relatively clean drinking water. The use of wells has a long history in the region and so has groundwater governance. In early Muslim jurisprudence, there was reference to groundwater regulation under the so-called minimum distance rule[4], which specified a minimum distance between two wells, depending on soil conditions. Yet the scale of groundwater use in the last thirty years is unprecedented. Some authors have observed that whereas almost all surface irrigation infrastructure in the Mediterranean can be traced back to origins many centuries ago, the only thing that is new is what is being pumped – and this is quite substantial.

The miracle created by intensive aquifer use in many parts of the MENA region is under severe strain. Overuse of groundwater is by now documented in several rural economies in MENA countries and can lead to alarming consequences varying between places – declining, sometimes vanishing water tables, entire rural economies in peril, saline water intrusion, and destabilized coastal regions. In some countries even national stability may be at stake. The President of Yemen has stated that water security is the second priority next to national security. This paper tries to document the importance of groundwater. It focuses specifically on conjunctive use of groundwater and surface water in Morocco, but uses examples from Yemen and Egypt as well. The paper makes the point that

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amazingly with all attention regarding governance and regulation in the MENA countries, the emphasis has been on procedures, processes, laws and institutions, whereas large part of the agenda is left blank. This is not just a theoretical oversight but an area of missed opportunities and induced disasters.

## II. CONJUNCTIVE WATER MANAGEMENT IN MOROCCO

### 1. Groundwater in Morocco

The groundwater in Morocco was for a long time a blind spot – but with catastrophes such as the collapse of the Guerdane Aquifer, groundwater management could no longer be ignored.

In May 2008, the King Mohammed V declared groundwater protection as a national priority and instructed the government to prepare a National Water Strategy. After intensive consultation with relevant government units, the Water Resources Department[5], as part of this strategy, produced a national Groundwater Action Plan[6] consisting of 30 actions (including demand management and supply-side actions, stakeholder participation and institutional strengthening).

Water has been a constraining factor for economic development throughout the history of Morocco. For the last three decades the emphasis in Moroccan development policy had been to maximize the capture of the country's surface water and to provide infrastructure for its use in agriculture (86%), potable water supplies (8.5%) and industry and energy production (5.5 %). Even in normal years, rainfall is distributed unevenly across the landscape and it varies from more than 1,800 millimetres per year (mm/yr) in the northern part of the country to less than 200mm/yr in the southern part. Besides its uneven spatial distribution, the rainfall in Morocco also exhibits an uneven and erratic temporal pattern owing to its large year-to-year variations. Insufficient rain and droughts are fairly frequent. Seven of the last ten years had hydrological deficits of varying intensities. In 1982, Morocco received less than 60% of the long-term mean rainfall. In 1994, on the other hand, six of eleven hydrological basins in Morocco had more than a 50% deficit in their water balance.

The uneven rainfall pattern naturally creates highly variable flows over time and space causing severe uncertainty in water availability to both domestic users and

5 DRPE.

6 GWAP.

farmers alike. It is to minimize these risks and uncertainties associated with water availability that Morocco, like most countries, relies heavily on water storage. Of the average annual precipitation of 150 billion cubic meters (bcm) received by Morocco only 30bcm are stored. Unfortunately, not all water captured by these sources is readily available for use. For instance, the water resources actually available for use are estimated to be 16bcm from surface sources and 3–4.5bcm from groundwater sources.

Over the years, the country has established a diversified body of both formal and informal regulations to govern water resources allocation, utilization and management in response to increased pressure on limited water resources. Reflecting what had historically emerged, in 1995 by law, top priority was assigned to ensuring the security of the potable water supply. By 1990, most urban households had been provided secure access to a water supply whereas only 14% of rural households had secure water supplies, even by 1995. As the demand for potable water is concentrated in water-scarce basins, the issue of meeting a rapidly rising demand for potable and industrial water poses a major challenge. In many locations, efforts to satisfy urban and industrial demand imply inter-basin water transfers or inter-sectoral water transfers from agriculture.

At the same time, like in most developing countries, irrigated agriculture is fundamental to the economic and social development in Morocco. In order to achieve its irrigation and agricultural objectives, the government has built modern and relatively efficient infrastructure for water development, conveyance and distribution. It has also supported farmers through a comprehensive administration of irrigation perimeters and a strong system of legal and economic incentives. Irrigation has the dominant share of 85% of the total water resources developed in the country. There is considerable scope for improvement in water use efficiency and conservation. The 2020 Rural Strategy of Morocco underlines the need for more efficient use of irrigation water and the conservation and protection of water resources.

As a major response to the changing water conditions and future economic requirements, the government passed the Water Law of 1995[7]. The overarching goal of this law was to integrate and coordinate the allocation and management of all water sources and users under a single but decentralized institutional arrangement centred on river basin agencies[8]. The RBAs have authority to manage surface water storage and allocation, groundwater pumping and water pollution

7 Law No. 10/95.

8 RBAs.

and quality. The RBAs work with water sector "partners" or stakeholders in the basin area such as Regional Offices of the Agricultural Development[9], the National Authority of Potable Water[10], the representatives from environment, health and provincial officials and, more importantly, the water users associations[11]. In a sense, the RBAs act as wholesalers of bulk water to ONEP and ORMVAs which, in turn, retail water supplies to urban and rural water users. RBAs now have authority to control and monitor water from all sources. For example, the wells owned by ONEP for potable water supplies, which were autonomous earlier, are now under the yet to be defined RBA authority. This is also true for water in public irrigation perimeters, which were once under the sole responsibility of ORMVAs.

From an overall planning and managerial perspective, the main responsibility of the RBAs is to prepare, with significant input from the national government, river basin management plans based on the principles of integrated water resources management[12]. The Water Master Plan[13], as specified in Chapter 4, Article 16 of the Water Law, is a constituent part of the National Water Master Plan[14]. It must be formally approved by decree. The twenty-year Master Plan summarizes available water supplies in a river basin and proposes allocations to municipal, industrial and agricultural users. The plan also provides for groundwater exploitation through granting of permits to water users. As per the new Water Law, the Master Plan can be reviewed and amended every five years if changing conditions warrant amendments. The RBAs have considerable managerial and regulatory responsibilities besides their role in developing and supplying water. They can monitor and regulate water use and water quality as well as plan and organize flood control and water-related emergencies within their respective basins.

As mentioned, groundwater falls within the mandate of the RBAs. This is a major change, as in the past the ORMVAs were the only "kids on the block" in water management, but their preoccupation was and still is only with surface irrigation. The RBAs still have a way to progress – one unresolved issue is that they charge the ORMVAs for bulk water supply, but that ORMVAs are unable to pass the same on to the WUAs. From 2007 onwards three of the RBAs have

9 ORMVAs [agencies responsible for irrigation- ed.].

10 *Office National de l'Eau Potable* (ONEP).

11 WUAs.

12 IWRM.

13 Known as the *Plan Directeur d'aménagement intégré des ressources en eau.*

14 Chapter 4, Article 19.

started to work on preparing a first draft Groundwater Management Action Plan[15] for three pilot aquifers, respectively Bahira, Souss-Chtouka and Haouz. The development, let alone the implementation, of the GWMAPs is hampered; however, by the meagre capacity in the RBAs and their sometimes conflicting relations with the principal water users in the basins, e.g. the ORMVAs.

Table 1 provides information both on the sources of water supply and sector allocation of water resources across the important hydrological basins of Morocco. As can be seen from Table 1, although surface sources are dominant in the total supply of most basins, groundwater sources are very important because of their spread and ability to support both agriculture and domestic water needs in areas lacking sufficient supply from surface sources, as well as overcoming shortfalls within irrigation perimeters. Water for municipal and industrial[16] purposes is more important in some regions than in others and tourism is increasingly becoming an important sector in certain areas, particularly in the south[17].

Table 1
Supply of and Usage for Water in Eight Basins in Morocco in 1990
(million m$^3$)

| | Supply of water | | | Demand for water | | | | |
|---|---|---|---|---|---|---|---|---|
| Basins | Surface | Ground Water | Total | M&I | Irrigation | Other | Total | Balance |
| Loukkos | 630 | 90 | 72 | 1 | 380 | 230 | 7 | 0 |
| Moulouya | 930 | 230 | 1,1 | 7 | 1,090 | 0 | 1, | 0 |
| Sebou | 1,690 | 350 | 2,0 | 2 | 1,560 | 60 | 1, | 160 |
| Bou Regreg | 310 | 250 | 56 | 3 | 160 | 30 | 5 | 30 |
| Om-er-Rbia | 3,010 | 280 | 3,2 | 1 | 2,490 | 80 | 2, | 360 |
| Tensift | 880 | 850 | 1,3 | 1 | 1,300 | 150 | 1, | -80 |
| Souss-Massa | 300 | 590 | 89 | 6 | 890 | 0 | 9 | -60 |
| South of Atlas | 710 | 290 | 1,0 | 2 | 1,330 | 0 | 1, | -350 |
| Total | 8,260 | 2,73<br>0 | 10,<br>99 | 1,<br>2 | 9,190<br>53 | 10,9<br>30 | 6<br>0 | |

While current water supply and demand are in balance in two of the eight basins, for the remaining basins, there is either a water deficit (3) or surplus (3). As the total of the surpluses in three basins exceeds the total deficits of the other basins, there is scope for inter basin transfers and this is happening in some instances.

The major response to droughts and water shortages has been the development of groundwater irrigation. Following the droughts during 1980–1985 the

15 GWMAP.

16 M&I.

17 Included in the column "Others".- [Eds.]

government reacted with a number of policy changes. Foremost was the government encouragement provided to individual initiatives and groundwater expansion. This encouragement took the forms of both a waiver on well authorization from the Ministry of Public Work, as well as subsidies for private investment in irrigation. The policy change had a remarkable impact on private-oriented and groundwater-based irrigation expansion. The extent of private irrigation has, in fact, surpassed all previous official estimates. For instance, the Rehabilitation Project of Large-Scale Irrigation funded by the World Bank has estimated the area under private irrigation to be about 60,000ha by 1991. However, according to the High Council of Water and Climate, this area was estimated to be about 170,000ha. But according to the information from the 1996 agricultural census and a recent survey conducted by the Ministry of Agriculture, the area under private irrigation reached 583,039ha in 2003. Of this total, 481,322ha were irrigated by groundwater either fully[18] or partially for supplemental irrigation[19].

The expansion of private and groundwater-based irrigation did minimize the impact of droughts as well as expand and stabilize farm production. But it is not without its negative effects. The rapid increase in private irrigation, especially in the absence of effective regulatory arrangements, has resulted not only in aquifer depletion, but also in serious decline in the flow of several springs and watercourses that support medium- and small-scale irrigation perimeters. Regarding the magnitude of the latter effect, it is estimated that the expansion of private and groundwater-based irrigation has reduced the irrigated area in the small- and medium-scale irrigation perimeters to the tune of 150,000–200,000ha. As a consequence of aquifer overdraft, well depth is increasing at an alarming rate causing the abandonment of agricultural activities. For instance, in the Guerdane perimeter of the Souss region, the water table is declining at a rate of 1.7 meters per year (m/yr) leading to an average well depth of 100m. In view of groundwater overdraft, the water deficit of this region has increased from 185 million cubic meters (mcb) to 358mcb between 1976 and 1998. The result was the abandonment of plantations which is common, particularly in the traditional citrus exporting region of the Souss.

18 As in the case of 376,662ha located outside the large scale irrigation perimeters.

19 As in the case of 104,700 ha located within these perimeters.

## 2. Conjunctive water management in Tadla[20]

Whereas overuse of groundwater outside irrigation areas has led to problems as flagged above, the development of conjunctive use of groundwater within the irrigation systems has had a different and more balanced route. The liberalization of crop patterns in large-scale irrigation perimeters after 1980 Structural Adjustment Plan, though desirable for efficient water and land use, was severely constrained by the rigidities of existing water distribution networks and allocation procedures. As the production in these perimeters was oriented towards import-substituting crops and heavily dependent on state intervention for cropping decisions as well as input and output marketing, it was ill-prepared to benefit immediately from the relaxations. The issue became complicated by the lack of input supplies, marketing channels and extension services needed for alternative crop options. Moreover, the irrigation infrastructure and the water billing system were more suitable to a homogeneous crop pattern and rotation than to a liberalized system with a diversified cropping pattern. Thus, the fundamental issue that was yet to be resolved was how to move from a supply-centred arrangement to a demand-oriented system of water resource allocation and use. Conjunctive use of groundwater has largely addressed this, and has made it possible to continue old-style surface irrigation management, while increasing productivity and growth.

An example of the importance of conjunctive use of surface and groundwater in the Tadla Irrigation Scheme is provided below. In the Tadla irrigation scheme, irrigation is an essential element of farmers' livelihoods and an important aspect of the social life of water users. Issues of equity of distribution and water productivity are very important matters that are widely discussed between water users, especially during dry years. Water allocation during dry years has two problems:

- The supply is unsecured due to insufficient dam reserves; and
- The water allocation is unfair because there are crops that have priority due to political-economic reasons like sugar beet, alfalfa, trees and cereal crops and thus receive more water than others (beans, maize and vegetables).

Before the crop year 1980, water available for the irrigation system of Tadla exceeded requirements and the distribution of irrigation water was based on farmer demand independently of crop rotation practiced. On-demand water

20 The Tadla Plains are a large and important agricultural area of Morocco. They are located in the Oum Er-Rabia river basin. The area of Tadla is one of the 16 economic regions of Morocco located in the central-eastern part of the country. – [Eds.]

distribution however intensified a certain number of problems such as the rise of the water table and salinization. Since the beginning of the 1980s, the surface water resources in Tadla have shown a clear decline in water availability, a trend that continues until now. Certain factors are the cause of this severe scarcity of surface water:

- Decrease of rainfall by about 30% and more frequent drought periods;
- Population growth (urban and rural) has induced a competition on water between different sectors: (irrigation, industry and hydropower);
- The irrigation networks are getting old and inefficient irrigation techniques lead to important loss of water resources;
- Non rational water use caused by some policies like under-pricing;
- Reduced capacity of surface reservoirs as a result of siltation, due to deforestation in the mountains causing erosion and snow losses.

Consequently the ORMVA of Tadla shifted its policy from the allocation of water according to the farmer's demand to a distribution according to water availability and estimated crop requirements. After the drought in the beginning of 1980, farmers started to use groundwater to fulfil their need for irrigation. Due to the falling groundwater table, shallow wells in the unconfined aquifer were used for drilling holes into the deeper layers to satisfy the irrigation requirements and thus maintain the same crops.

Irrigated agriculture in the Tadla plains is now characterized by a conjunctive use of environment. Farmers are increasingly using groundwater resources in addition to available surface water resources. Recent research suggests that today, an annual volume of 500 – 600mcm comes from groundwater, which is more than the surface supplies, and about 50 % of the farmers have access to this resource. Two main questions related to the evolution of irrigated agriculture should be addressed:

- Firstly, the sustainability of the exploitation of groundwater resources is questionable. The groundwater quality is heterogeneous, and some farmers irrigate with saline water. There is concern on its adverse impact on soils and groundwater. Groundwater levels are falling, prompting farmers to exploit the captive aquifer with questions on its sustainability. Also, the viability of farms not having access to groundwater is threatened due to severe restrictions in surface water supplies;
- Secondly, Tadla is a leading innovator in Morocco in experimenting with a wide range of technical innovations, economic incentives and institutional arrangements to reduce water stress. However, despite certain

> advances, farmers use more water than they did 10 years ago and technical innovations are not adopted by a majority of them. Water users associations do not assume much responsibility in water management. Questions related to farmers participation in the formulation and application of water saving policies, and the scope for collective action in water saving at the grass roots level need to be addressed, to ensure a more sustainable water use for a viable irrigated agriculture.

Farmers with financial capital cope with the Tadla's increasing water scarcity by using alternative water sources (digging wells to access groundwater). The principal strategy of farmers is to free themselves from the constraints of water turns and "priority" crops, to manage their rotations freely. This practice is common among large farmers even if the cost of groundwater is higher than that of the water from the dam (between 0.35 and 0.60 Dirham/cm for groundwater compared with 0.22 Dirham/cm for canal water). As one can see on the ground, a great number of farmers with farm sizes higher than 2.5ha were freed from the constraints and the rigidity of the water turns by taking recourse to pumping, and able to cultivate other crops (sesame, niora, mint, etc).

The exact quantity of water withdrawn from the aquifers is not really known, but over the year, rising and falling water tables can be monitored in an irrigation perimeter. Some surveys in the irrigated perimeter of Tadla showed that there are more than 8,300 locations where water is pumped from the aquifers. Also in the zone outside the irrigated perimeter there are more than 4,500 pumping locations, of which more than 1,300 wells pump from the Eocene aquifer[21]. Besides, the sustainability of the groundwater use can only be assessed by a thorough geo-hydrological survey of the aquifers. Such an assessment is recommended to quantify the available resources in the aquifer in combination with measurement of the abstractions by the thousands of wells. It is also recommended to improve the measurements of the pumped groundwater by installation of water meters on the wells.

Tube well water is currently not charged for by the government yet, but well-owners pay the full cost of development and operation and maintenance – often preferring diesel because of the high cost of electricity. Most pumps have a discharge of 15l/s (54 cubic meters per hour; cm/h) and consume 2.0l/h of oil for a well depth of 20m (that is 1,3$/h). The cost of groundwater is more expensive than canal water. Nevertheless pumping still increases, but is restricted because of the high salinity of water.

21 In the Oum Er-Rabia Basin.- [Eds.]

Pumping groundwater is officially prohibited without an authorization and restricted – as farmers are not allowed to pump below 40m but this is actually subject to very weak control and the "ostrich" approach appears in place here. The majority of farmers install their wells without obtaining the required authorisation – and this is a good thing probably, given the boost it is giving to food security. Pumping varies widely between the years due to large variations in rainfall – signifying the importance of groundwater as a drought mitigation measure. The current policy of unenforced regulation shows that conjunctive groundwater management is still a blind spot. Unfortunately it should not be put in the domain of restrictions and controls, but be approached pro-actively to maximize the impact and equity effect of this type of water use.

To ensure sustainable groundwater extraction, supply and demand of groundwater should be balanced. Existing policies (restriction to pump below 40m and authorisation to install wells) are not very effective due to insufficient controls. The administrative costs to be charged for extraction on the basis of the number of pumping hours, as currently proposed, seems to be rather high, and will not guarantee a reduction in usage. What is required is not a negative, sacrificial attitude to resource management, but a pro-active, positive approach. There is large scope to improve recharge by adjusting surface irrigation deliveries – how much, where and when. Surface supplies are the main source of recharge and should be adjusted to areas where recharge is most needed. So far irrigation management is in an extremely narrow domain – not looking at even the most immediate other uses, such as groundwater management. Clearly as pressure on water resources multiplies this limited agenda is a luxury one can ill-afford.

## III. CONJUNCTIVE WATER MANAGEMENT ELSEWHERE IN MENA

### 1. Yemen

The water problems in Yemen are well known. Over the last twenty years the use of groundwater has intensified tremendously, often feeding high value agriculture (qat, bananas, and mangoes). Groundwater is being pumped at a rate approximately four times that of natural recharge. This has brought prosperity to rural areas, but it is not sustainable. Water tables have fallen worryingly in many of the highland areas, but also coastal plains suffer from overuse of groundwater. The problems in the lowlands are also aggravated by a reduced inflow from the highlands. Studies suggest that the reduced surface flows in Wadi[22] Zabid and Wadi Tuban may be in the order of 20-30% and may be related to the development of upstream micro-dams.

There has been considerable work in water policy formulation and legislation in Yemen in recent years. Highlights are the National Water Strategy, the Water Law and the Irrigation Policy Statements. Similarly the National Water Resources Agency has been established with branch offices in several governorates. Given the large problems in the water sector this attention for new institutional arrangements is very timely. There is no lack of governance initiatives. The main challenge now is to translate these policies into effective institutions and programmes on the ground and here expediency is sometimes lacking.

Given the water scarcity in Yemen, one would expect that most investments in Yemen would be directed to improved water efficiency and regulating water use. Farmer interviews also highlighted the importance of such interventions[23]. Instead the larger share of investments is directed at the development of structures. The two main sources of investment are the regular budget of the Ministry of Agriculture and the Agriculture and Fisheries Development Promotion Fund. The amounts spent annually are substantial. From the budget of the Ministry of Agriculture YER 600 million[24] was approved for 2004 to be spent mainly for dam structures. From the Agricultural Promotion and Fisheries Fund YER 2,278 million was spent on average annually in the period 1996-2002). Over this period 801 water management structures (mainly small dams and water harvesting structures) have been built by the Fund. Other sources for the funding of water structures are the Social Development Fund and some bilateral donor funds. There is some small funding for irrigation networks in the latter programmes, but overall investment in surface irrigation systems is very small. Even worse – on several of the rivers (Wadi Surdud, Wadi Tuban), investment in large dams has been considered – fortunately in some cases these plans were later withdrawn. What these investments would have done would be replacing of highly productive conjunctive resource systems with using spate (temporary floods) irrigation and groundwater.

22 Arabic wādi: (1) the bed or walley of a stream in regions of southwestern Asia and northern Africa that is usually dry except during the rainy season and that often forms an oasis; (2) a shallow usually sharply defined depression in a desert region.- Miriam Webster Dictionary, http://www.merriam-webster.com/dictionary/wadi [Eds.].

23 *See* Table 2.

24 Over 200 MEUR (on 30.10.2010) .- [Eds.]

Even though after national security, water security is the primary concern in Yemen, very little is happening in terms of actual water resource management in the country at a national level. There has been no lack of studies, research, and drafting of legislation, but real regulatory initiatives are lagging behind. The same applies to water management at a local level[25]. In fact in some of the most overstretched areas farmers now demand the government, in this case the National Water Resources Authority, to take more effective action against illegal drilling. It was observed in the late 1990s that in contrast to land disputes conflicts over water were scarce – even though the writing was very much on the wall even at that time. These days the situation is completely reversed and violent conflicts with drilling companies are frequent.

Table 2
Main Water Management Issues
identified in Wadi Tuban and Wadi Zabid in Farmer Focus Groups

| Wadi Tuban | Wadi Zabid |
| --- | --- |
| • Increasing inequity in water distribution;<br>• Random drilling of wells;<br>• Increasing misuse of water (drinking water for irrigation);<br>• Increasing pollution and salinity;<br>• Weakness of extension;<br>• Continued expansion of agriculture while there is no water. | • Decreasing inflow into the system – probably related to the increase of dams upstream;<br>• Sedimentation of the spate system resulting in land going out of control, sand deposition in fields and heavy sedimentation in canals;<br>• Increasing inequity in water distribution – related to the increase in banana and mango cultivation;<br>• Decreasing groundwater table. |

Two major opportunities to promote water management at the local level are decentralisation, which started with the announcement of Law 4/2000 concerning Local Authorities, and the new institutional arrangements for local water management introduced by the Water Law 2002. According to the Law on Local Authorities, local councils have a role in supervising the implementation of water policies and protecting water resources from overuse or pollution. They are, moreover, to generally have a role in "controlling the applications of the laws in force". Another new development is the Water Law 2002 creating the possibility of establishing Water Basin Committees and Water Zone Committees. The composition and task of these committees is still under debate, but the Law makes an explicit reference to the need of dovetailing the Committees with the

25 *See* Table 2.

work of the Local Councils. A first few activities in setting up such committees have been undertaken in Sa'adah and Taiz.

Conjunctive use of spate irrigation and groundwater is also common in coastal Yemen where cropping patterns in many coastal spate systems in the Wadis, *e.g.* Tuban and Zabid, have changed dramatically since the 1980s due to a remarkable increase in shallow wells. As a result, the area under banana cultivation has increased from 20ha in 1980 to more than 3,500ha in 2000 in Wadi Zabid, while about 2,300ha are used for high value vegetables in Wadi Tuban. Many spate irrigation areas have been transformed into areas of high value agriculture, with bananas and mangoes as the main crops, dependent on the combined use of spate flows and groundwater.

Groundwater quality in coastal Yemen is generally good enough for irrigation. Two types of aquifers are important in the spate irrigated area. In valley bottoms one finds strip aquifers. The alluvial sediment deposits consist of generally unsorted, but coarse and un-cemented material with high permeability. The deposits are found in a strip along the river bed that may vary in width from a few meters to a few hundred meters. Strip aquifers have very favourable recharge conditions and are recharged from infiltration of spate flows and from springs and seepage zones along the Wadi bed. Because of their small volume and high permeability, the strip aquifers are quickly depleted. Another type of aquifer is found in the lowland systems at the alluvial fans and on the plains. They are actively recharged by the Wadis and may be several thousand feet thick. They may not be homogeneous and instead consist of a number of independent groundwater flow domains, with their own recharge and discharge zones and with varying water quality. In recent years in Yemen these coastal aquifers have been intensively developed.

Since the modernization of the Wadi Zabid system in Yemen, the area under cultivation has increased substantially. This seems to be strongly related to the increase in groundwater use, rather than any increase in the diversion efficiency provided by the new structures in the spate irrigated areas. In Wadi Zabid, wells are used conjunctively with surface supplies, as well as a single source of irrigation water. Since the 1970s there has been a rapid increase in well development, mainly shallow wells with some extension. 1,411 wells were recorded in Wadi Zabid in 1988 of which 1,221 were pumped. These were predominantly used for irrigation, but at the same time served as an important source of drinking water. Most well development had been along the axis of the Wadi, and most wells are located in the lower Wadi areas near the coast, where the water table is higher. Saline water intrusion was already a factor in Zabid, and a recent water resource study observed that it would be difficult to reverse. The consequences are in several cases quite dramatic. A large area of date groves in coastal Tihama for instance has been destroyed. This happened as the spate flows no longer reached the coastal areas with the modernization of diversion infrastructure upstream. Earlier an occasional runaway flood would replenish the coastal aquifer and would keep water tables high – so that the date palms were largely served from the high soil moisture. As these floods made their appearance less and less frequently in the coastal areas, farmers turned towards groundwater irrigation for the date palms. This lowered groundwater tables even more, and made it uneconomical to sustain the entire area with pumping, especially as soils are outright sandy. The neglect of part of the palm groves meant that the area gradually fell prey to the heavy wind erosion in this area, with two storm seasons lasting a combined five months. This turned the data palm areas into a desert landscape of moving sand dunes – accelerating the downfall of the area.

The large importance of spate flows for recharge rather than irrigation is also reflected in the recent debate on water distribution in Wadi Zabid. In Wadi Zabid, a time allocation system is in place. Under this regime, the downstream command area is entitled to floods in the off-season only. As the occasional spate flows are able to recharge wells for a long time, downstream land users are now requesting for a share of the floods in the peak season.

The intense use of groundwater and the higher "water productivity" of groundwater-based irrigation raises questions on the relation between spate irrigation and groundwater recharge. The issue is whether the best spate water management strategy would maximize recharge, or agricultural productivity of the spate irrigated areas. The relationship between spate diversion and recharge is not well studied, although some information is available from water balance studies carried out in spate irrigated areas in the Yemen.

It is generally accepted that recharge mostly occurs through infiltration in the Wadi beds rather than from channels and fields. Recharge may be enhanced by spate irrigation where diversions flatten the river slopes, and in the case of diversion bunds, produce ponding, and reduced flow velocities. Another important practice is to leave the stone armouring of Wadi beds intact, as the presence of large stones and boulders reduces the water velocity and encourages river bed recharge. For the same reason one may expect infiltration rates to be higher in the upper section of the ephemeral streams rather than at the lower ends where bed material is often clayey and silty.

The ephemeral river beds also carry a substantial subsurface flow which is often the main source of well recharge. Again, this is generally not understood and certainly not managed. Extreme caution is required not to interfere with these subsurface flows through cut-off weirs or impervious bed stabilizers, as downstream well water supplies depend on these hidden flows. An example of a spate irrigation project gone wrong in this respect is the Wadi Siham in Yemen. The weir was extremely ill-designed system interfering and cutting-across the traditional flood channels, blocking the subsurface flow in the river, and depriving a large number of downstream well-owners of their secure source of water.

Hence the overall conclusion of all these examples is similar to the case in Morocco: although conjunctive use is the backbone of the coastal farming systems it is not managed. It is in fact worse as many interventions are allowed that effectively jeopardize the highly productive conjunctive system of groundwater and surface water management in coastal Yemen.

## 2. Egypt

At present in Egypt the annual expenditure on water services absorbs up to 10% of the GOE's total public expenditures. A recent public expenditure review showed that about LE[26] 12 billion[27] per year of public finances were spent on national irrigation infrastructure and water resources related programs, while the annual public financing of operation and maintenance in the irrigation sector is approximately LE six billion. The National Water Resources Plan till 2017 envisages that the required investments in the sector are about LE 165 billion, of which 35% would be designated for irrigation and drainage projects.

Groundwater is not a major feature in water policies or management plans in Egypt at all – even though the entire Nile Basin systems depends on an intensive reuse of water – with the shallow water tables feeding the surface flows, and water being used many times before it reaches the Mediterranean.

In less than a decade, starting in the 1990s, the West Delta area – less than 50km from Cairo - was transformed from empty desert into a groundwater-based high value export agriculture area. In this case deep fossil groundwater was used. Groundwater permits were given to investors and the West Delta area was very much part and parcel of the fast growth and modernization that transformed a large part of the Egyptian economy in this period. The West Delta hosts numerous horticultural export firms, industries and also resorts and golf resources. By 2005 the various activities in the area supported an economy of $300 million annually, employing directly and indirectly 250,000 persons. Persistent depletion

26 EGP (Egyptian Pound).- [Eds.].

27 Approximately 1.5 billion EUR (on 30.10.2010) .- [Eds.].

of groundwater – the very resource froming the basis of the mirage – however, threatened the loss of this agricultural area and a premature end to the fast development. To counter this, the West Delta Canal Project was conceptualized – to be funded by international loans and private capital. The project concept is to substitute the groundwater supply with a surface water channel serving the entire West Delta area (100,000ha including the 47,000ha already developed). Both the investment costs and the operation and maintenance costs of the West Delta Project are to be recovered from connection and service charges as well as from land development near Sadat City. Private operators are expected to operate the main infrastructure.

The water from the West Delta Canal will come from the Nile Valley. The allocation for the West Delta is justified on the basis of the assumed savings caused by the so-called Irrigation Improvement Project, which introduced, among other things, shared farmer-operator pumping units and improved field level canals in the lower Nile Basin.

Whatever these savings, the concept overlooks the current conjunctive water management practice in the Nile system – where water is reused many times before it reaches the Mediterranean. By channelling water out of the Nile Basin to the West Delta the scope for the reuse of this water in the Nile system is foregone, whereas the scope for reuse in the West Delta with its deep aquifers is small or practically non-existent.

## IV. CONCLUSIONS

The three examples show that groundwater management in the MENA area is only recently gaining attention at a policy level – but that operational management of groundwater is still some time off. This is in spite of the importance of groundwater in bringing about a turn-around in agriculture – sustaining not only an expansion of cultivated areas but also a move to high value crops. Whereas groundwater is still largely unmanaged in the MENA region, the conjunctive management of shallow groundwater is completely *terra incognita*. Shallow groundwater – which is the main water resource in agriculture - falls entirely between the cracks institutionally and technically. In Morocco groundwater is off the radar screen for the ORMVAs. It is in the domain of the River Basin Agencies, who are the main institutional embodiment of the move towards integrated water resource management, but these agencies, like elsewhere, are still in the early stages and relatively weak because of a focus on coordination and regulation, rather than on implementation and service delivery.

The picture in Yemen is somewhat similar. Here groundwater is high on the political agenda – and the President has even stated that water security is the next important thing to national security. A Water Law is in place but the implementation and operation is time consuming. For groundwater the focus is on regulating deep wells. This is difficult enough – and requires the development of a whole new interface among users and between users and government. The management of shallow groundwater again is not in the picture, in spite of its importance in the current farming system in the Tihama coastal plains, which comprise 35-40% of national food production. The National Water Law does not require licensing for wells with a depth of less than 60 meters. In some of the coastal plain areas local governments have made restrictions on shallow well development but this is piecemeal and *ad-hoc*. More importantly, no operational water management strategies have been put in force – that would acknowledge and maximize the value of shallow groundwater in coastal Yemen, particularly to safeguard the recharge at the tail end areas of the wadis.

Finally, in Egypt the groundwater management is not an issue as all attention is on surface water supply and irrigation. This overlooks the intricacy of the Nile Basin where no water is lost as also seepage is reused. Taking part of this flow out of the Nile Basin to the desert West Delta area, means foregoing opportunities for reuse.

In all countries there has been a frenzy of restructuring water management organizations and putting in place new laws and policies – the overriding theme being integrated water resource management. There has been much attention to new laws and policies as well as moving towards multistakeholder processes.

But, is this governance? How come blind spots continue to exist – something that cannot be explained by the lack of importance of the blind spots? Reuse of groundwater has been a driver for agricultural development, but opportunities to manage it better (for instance readjusting irrigation schedules in Tadla) are not forthcoming. Elsewhere, things are made worse (West Delta in Egypt, Wadi Surdud Dam in Yemen) because of ignorance. What is governance then all about?

Though important, there is a risk of groundwater being cast in special new institutional arrangements – new laws, bylaws or agencies. The consequences of this are time lost and a sense of urgency thwarted, as in the meantime nothing happens on the ground. There seems in general to be a large pre-occupation with institutions, coordination and laws – process outputs, that though tangible are not necessarily effective in addressing the immediate challenges, if the agenda is not right. What is still missing from the picture is the mainstreaming of water management strategies that give due cognizance to the strategic value of groundwater and the contribution it can make – particularly the effective recharge, retention and reuse of shallow groundwater. So the question is what is governance? Is it the positioning of players in an arrangement of accountability or regulation, or is it creating short-links between responsibilities and results? We think the latter – more dynamic and messy. It seems the issue is not good or bad governance but the effective presence or complete absence of it.

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