WATER POLICY AND POVERTY REDUCTION IN RURAL AREA: A COMPARATIVE ECONOMYWIDE ANALYSIS FOR MOROCCO AND TUNISIA

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Abstract

The main objective of this study is to compare the impacts of alternative water policy management scenarios on Tunisia and Morocco. A dynamic water CGE-model has been implemented and used to explore the likely effects of water economic instruments.
Results show that the low cost of water has encouraged farmers to adopt more water-intensive activities. Reducing public subsidies on water will affect directly farm income which is expected to drop by about 20 per cent in the short and medium terms. However, the reduction of farmers' incomes will be largely compensated by the saving in public expenditures but also in a better and more efficient use of water resources.

Key words: agriculture, water pricing, CGE model, Tunisia and Morocco

1. Introduction and objectives

Water constitutes the main constraining factor of agricultural development in Southern and Eastern Mediterranean and particularly in Tunisia and Morocco. According to the Blue Plan (2013) on the future of the Mediterranean basin, Morocco and Tunisia are among the countries where the pressure on water resources is strong with an index of exploitation of renewable natural resources between 50 and 75% indicating significant medium-term risks of structural stress. For both countries, the scarcity of water resources may cause a serious constraint to the development of their economies. This relevance has led Governments to design and implement ambitious policies aimed at water resources improvement. The opportunity cost of water has risen and economic concerns have become increasingly important in water resources management. Public interventions also aim to improve the efficiency of water utilisation in agriculture, i.e. to intervene on the demand side.

An economy wide analysis of water policies in Tunisia and Morocco will permit addressing the allocation and distribution issues of water resource management facing policy makers. Those issues have high policy relevance as part of the effort of policy makers to manage water resources in the long term and to reduce poverty in rural areas. More precisely, the objective of the study is to explore the impacts of alternative domestic water policies in the form of a cut on irrigation water subsidies and/or increases in public expenditures on water mobilization needed to fulfill the expected water needs escalation by the different users.

Although strategy for the agricultural sector is not as growth oriented as those for the industry and service sectors, agriculture is still considered the basis of both national economies and is targeted to grow considerably over the next ten years. This growth will permit achieving policy goals such as food security; production flexibility to meet changing world market conditions, and stabilization of rural incomes, which will also help to slow rural to urban migration. Agricultural sustainable growth in this context will probably entail the extension of the irrigated area. Agricultural growth as well as crop mix are likely to be affected by several policy reforms notwithstanding investment subsidies and water pricing policies. The ranking of crops according to economic profitability should depend on the shadow price of water and relative irrigation intensities.

This paper is organized in four sections. The first one describes the background relative to the importance of agriculture and water resources balances in Morocco and Tunisia. The focus will be also on water policies and the main remaining issues of water management in both countries. The second section presents a literature review on the main water-CGE models used in MENA countries followed by the most important characteristics of the proposed CGE model and the structure of the two SAMs. The third section is devoted to

explore and discuss the likely effects of alternative scenarios of water policies in Tunisia and Morocco. The last section summarizes the policy implications and concludes.

2. Main features and challenges of water management in Morocco and Tunisia

Over the last two decades, Morocco and Tunisia experienced a relatively steady economic growth based on a development strategy focused on economic diversification and export promotion. The growth of the agricultural sector has increased the pressure on natural resources in general and more particularly water. Furthermore, the increase in the share of GDP accounted for by the nonfarm sector implies an increase in residential water demand as well as manufacturing and service sectors. If production growth in the non-farm sectors requires a proportional increase of water demand factor, then water can be a major constraint to economic growth in these countries.

2.1. Importance of agriculture and recent features of water balance

Agriculture is considered one of the main pillars of the **Moroccan** economy. Its contribution to the GDP lies between 12 and 17% (15% in 2012). Agriculture has an important and growing multiplying effect on the rest of the economy (Global Forum on Agricultural Research, 2012). Regarding the employment rate, agriculture constitutes the main force for absorbing considerable amounts of workforce in Morocco. Indeed, almost half (46 percent) of the active population works in the agricultural sector.

The total agricultural area is about 9 million hectares of which nearly 83% are cultivated in rainfed production system. The remaining area is irrigated and contributes in average to 45% of the value added of the agricultural sector.

Agriculture can be divided in three major sectors: 1) Modern, private, irrigated, highly capitalized, and export oriented farms producing mostly fruits and vegetables 2) Agriculture within reorganized large scale dams irrigated perimeters producing mostly dairy, sugar crops, seeds, fruits and vegetables mostly for the local market 3) Rain-fed agriculture with more favorable land in the Northwest (growing mostly grains, olives, pulses, red meat and dairy) and less favorable land in the South and East (growing mostly grains and non-intensive sheep production).
Given the high rate of rural population in Morocco which is around 43%, agriculture is a significant contributor also to social cohesion. How agriculture evolves will determine the stability and well-being of rural society and of the country as a whole.

Since its independence, Morocco has made considerable efforts in water supply consolidation, particularly through the construction of 130 major dams and hydro-agricultural extension networks by 2011 with a capacity of more than 17.5 billion of cubic meters. Significant results have been realized with the completion of 13 water transfer structures with a total length of nearly 785 km. These achievements allowed the country to have an irrigated area of 1.5 million hectares, of which two third are equipped by the Moroccan government. In contrast, potable water demand has begun to receive the prominence it deserves at the mid-1990s with the promulgation of the Water Act 1995 (Act 10-95). Among other major achievements, the increase in the rate of coverage of population by the safe drinking water, particularly in rural areas. Indeed, the access to potable water in urban areas has been generalized and secures (100%) and in rural areas it is currently estimated to 92%.

In **Tunisia**, while declining through time, the agriculture and forestry sectors continue to play significant roles in the economy, both at the macro and micro levels. At the macroeconomic level, the contribution of the agriculture sector has been around 12% over the

past decade (9% in 2012). Despite the relative downsizing of agricultural activities and the variability of their outputs, agriculture continues to play a significant positive role in the overall socioeconomic activities of the country. Moreover, agriculture and rural areas continue to provide a livelihood for about 35 to 40% of the population. Agriculture provides also employment for around 16% of the labor force. Agriculture is also contributing by around 10% of the country total exports of commodities. It is absorbing about 10% of total investment and is increasingly feeding an agro-food industry with the required primary commodities, a sector that is rapidly growing and providing increasing value added and hence contributing to economic growth. That sector represents today about 25 to 30% of Agricultural GDP.

In Tunisia, most of the public investment in agricultural sector (over 50%) has been in the hydraulic infrastructure so as to mobilize as much of the available and potential water resources as possible (table 1).

Table 1. Recent evolution of agricultural sector investment at current prices (MTD)

	2009	2010	2011	2012
Public	420.4 (43%)	410.2 (40%)	484.2 (46%)	627.9 (48%)
Private	556.8 (57%)	624.4 (60%)	574.7 (54%)	669.4 (52%)
Total	977.2	1034.6	1058.9	1297.3

Authors calculations based on statistics of Ministry of Agriculture (2013)

In 2012, 308 Million Tunisian Dinars (MTD) has been invested by the government on irrigation projects followed by forestry and water conservation (84 MTD) and soil conservation (79 MTD). These investments have been financed by the public budget (76%), foreign investments (22.5%) and the rest (1.5%) by bank credits. In that spirit, 27 large dams, more than 182 hill dams and around 700 artificial lakes were constructed in the country over the 5 past decades. The general balance in terms of water mobilization, confronted to the estimated potential, is shown in table 2.

Table 2. Mobilized versus Potential water resources in Tunisia (values in Mm^3)

	Potential (10^6 m^3)	Mobilized resources (10^6 m^3)				
		1990	2000	2005	2010	2015 (Projection)
Surface water (56%)	2700	1179	1876	2200	2400	2500
Large dams		1170	1688	1927	2080	2170
Hill dams		5	125	160	190	195
Artificial lakes		4	63	113	130	135
Groundwater (44%)	2140	1576	1818	1860	1900	1940
Shallow aquifers		740	740	740	740	740
Deep aquifers		836	1078	1120	1160	1200
Total resources	4840	2755	3694	4060	4300	4440
Mobilization ratio (%)	**-**	**59**	**80**	**88**	**93**	**96**

Source: Al Atiri (2007).

Such water mobilization policy has enabled the development of near 450000 Ha of irrigable land, corresponding to about 7 to 8% of Tunisia's total arable land. It accounts for 35% of the value of agricultural production, 20% of agricultural exports and 27% of the labor force in agriculture. The overall ratio of water resources to water demand appears worrying and is further compounded by high salinity of groundwater resources, erratic nature of rainfall, and uneven geographical distribution of resources. Chronic water shortages affect the supply-demand balance and forecasting models show that Tunisia's fragile hydrological situation is likely to deteriorate with increasing demand.

2.2. The challenges of water management

The established fact is that water resources in Morocco and Tunisia are scarce and their quality is degrading. Consequently, several interventions have been made by the authorities of both countries at different levels. The first level which still absorbs important resources is the investment in hydraulic infrastructure and the construction of dams in order to catch up a rising demand by increasing water supply. The second level of intervention is the implementation of rationalization measures aiming at controlling a steadily increasing demand using water pricing instruments. The third level concerns the institutional organization reform towards more decentralized water management.

An example which reflects the difficulties encountered by the Tunisian public authorities in the management of water resources is water pricing. Indeed, conscious of the importance of economic instruments in reducing water consumption, several increases in water prices have been implemented since the beginning of the Structural Adjustment Program in 1986. The aim of this water tariff hike was also to make farmers paying the total cost of producing and delivering water to their farms. However, a study conducted by the Tunisian Ministry of Agriculture (2006) concluded that farmer's response to water prices increase was very weak and that farmer's behavior is mostly influenced by climatic conditions and results from a combination of other variables.

In their study of water pricing in Tunisia, Thabet and Chebil (2006) expressed doubts about the accuracy of the amount of subsidies to irrigation water. By examining the cost structure of delivered irrigation water published by the Ministry of Agriculture and crosschecking it with the declared invoiced volume of irrigation water, some inconsistencies have been raised. These inconsistencies were considered problematic since that the rate of subsidy on irrigation water depends on the water volume consumed by the agricultural sector. The authors concluded that, for a successful reform of the irrigation water pricing policy, some conditions have to precede: i) a reform of the public accounts integrating the capital depreciation and an analytical approach behind invoicing; ii) assess the farmers' ability and willingness to pay for irrigation water; iii) a definition of the priority goals assigned with the irrigation water pricing policy.

3. Methodology

The main objective of this study is to evaluate the implications of alternative water policy management scenarios with a focus on inter-sectoral water allocation and their distributional impact. The evaluation of alternative policies will be conducted on a comparison basis between Tunisia and Morocco. The fact that even a same policy instrument applied to two different countries can have different impacts; represent the main motivation behind the adoption of a comparative analysis. In fact, heterogeneous socioeconomic structures, different market features and economic policies, various levels of endowment in natural resources and access to factors of production, are among the reasons that explain different impacts of same policies across countries.

3.1. The water- CGE model. The literature includes many examples of CGE models that have been used to examine the economic consequences of alternative water projects, allocations, or prices, as well as the effects of increasing scarcity.

Several water-CGE models have been built for Morocco and Tunisia and used in the analysis of water policy reforms. We find seven published studies, based on CGE models that assess changes in water policy for Morocco and Tunisia (Goldin and Roland-Holst (1994), Löfgren et al. (1996), Decaluwé et al. (1999), Diao et al. (2005), Tsur et al. (2004) and Roe et al. (2005), Hassan et al. (2008) and Thabet et al. (1999) and(2005)). These models differ in several aspects in terms of agriculture technology and the relation of water with other production factors, the source of water, whether water faces competition with non agricultural users or not etc..

The model used here is based directly on the prototype developed by the OECD Development Centre (Beghin, Dessus, Roland-Holst and van der Mensbrugghe, 1996) which has been applied to many developing countries, including Tunisia (Chemingui and Dessus, 1999; Chemingui and Thabet, 2001).

Additional features have been incorporated in the original model for the purpose of this specific study. In what follows, the main features of the present water-CGE model are described. The backbone of any water-CGE specification is usually the production function. A particular feature of water-CGE models is that land or water or both are usually included as a factor of production in the specification. In the present model, water is entered as a factor of production (like physical capital or labor or land). The production block in the water-CGE model follows the typical specification observed in many other types of CGE models. One of the important features of CGE production function is that functional forms are generally chosen that allow for substitution between various factors of production such as labor, capital, land and water. The model focuses more on production than on private demand, given the predominance of agricultural water uses.

Typically, government and investment demands are not a major focus of interest in CGE models. However, and given the importance of public investments in water mobilization and distribution (Horridge et al. 2005), government and investment spending shares are assumed to be exogenous to the model. This assumption is a key feature for this study mostly when simulations on alternative public investment plans will be performed.

Wages, rents and returns to factor supplies are determined endogenously. The interplay of the producing sectors' demands for factors such as water and land and the owner's (household's) supplies of these factors will determine price so that the market clears. Factor mobility decisions, often referred to as 'closures', are very influential in CGE simulation results. The mobility of factors is critical to determining the value of water in production. The degree of inter-sectoral mobility of labor and capital, as well as of water as a factor of production, is an important dimension of the model. In particular, when the issue involves water trading between urban and rural groups, assumptions regarding labor mobility may be quite important. A high degree of mobility may mean workers leave an agricultural area if agricultural water use decreases, while a lack of mobility may mitigate negative rural economic impacts from reduced agricultural activity when the worker remains and is employed in a non-agricultural sector (Seung et al. 1998). Inclusion of non-irrigated agricultural activities may also allow alternative employment of labor, land and capital as water prices rise, and factors are often modeled as perfectly or partially mobile between irrigated and non-irrigated agricultural sectors.

The mobility of land and water across activities is also typically an important issue. In the present model, water is perfectly mobile across agricultural activities. However, in modeling water trade between rural and urban activities, we assumed that water is not mobile between the agricultural sectors and the drinking water supply sector (see Goodman, 2000).

Accordingly, sectors which do not have mobility of water between them will be separate markets with separate equilibrium prices.
In Tunisia and Morocco, water is available to agricultural sectors at a lower level than market price. In a competitive market without any distortions, the shadow price will be equal to the market price, but this is not the typical case for water in most countries and particularly in the two cases selected here. The model developed here already specifies a market for water as a factor of production whether there is an existing market or not.

3.2. The data.

Water-CGE models require the same data as traditional CGE models, but need water data in addition to the standard social accounting matrix. Moreover, CGE models, including water-CGE models, are calibrated by using the baseline data to find parameters and by searching the literature for existing parameters that may fit the current model.

In addition to the water intensity factors previously discussed, an important consideration for the water-CGE model is the elasticity of substitution of water with other factors of production. For agricultural sectors, these are typically assumed to be low because water is a vital input for which there are limited substitutes. Three categories of data are required for the calibration of the two countries water-CGE model: the social accounting matrix (SAM), the different elasticities, and the trend in exogenous variables.
Both SAMs for Morocco and Tunisia have the same structure and reflects the economic situations that prevailed in both countries. The SAMs contain 15 productive sectors and their 15 corresponding commodities, 3 types of work (farmers, paid-skilled workers and paid-unskilled workers), 5 types of capital (physical capital, two types of lands and two types of water), 2 household categories (by areas) and one trade partner (the Rest of the World).

4. The water sector in the absence of economic reforms : the baseline

Tunisian case

Main assumptions

Taking real values of 2005, a baseline scenario has been generated for Tunisia once the model was fully calibrated and solved. The so-called baseline scenario assumes observed growth rates for both GDP and government consumption in 2006-12. It also projects a marked GDP growth deceleration in 2012 owing mostly to the political crisis and, subsequently, a recovery of GDP at a rate of 5.5% per annum by the end of the simulation period (2020). The baseline scenario also shows that economic growth was already on the decline since 2008 when the global economic crisis erupted but this crisis barely affected the sector of mobilization of water resources during 2008-9 because public spending grew on average by 4.6% and 7%. The scenario, then, includes the effects of the global economic and political crises.

Notice that both real GDP growth and real government consumption growth are being imposed in the baseline scenario. Real GDP growth is merely imposed through a calibration procedure, adjusting productivity, but GDP is fully endogenous in the model.[1] This means

[1] The aggregate growth trajectory is imposed through the production function. The model is first run assuming that the quantity of value added (that is, real GDP at factor cost) is exogenous while the exogenous component of the efficiency parameter temporarily becomes endogenous. In this run, the observed trajectory of real GDP is imposed on the quantity of value added and this is achieved by proportionally scaling the efficiency parameter for all production activities. This run becomes the starting point to solve the model again and generate the baseline scenario, assuming that the quantity of value added is endogenous and the exogenous component of the efficiency parameter remains exogenous, though this is exogenously set to vary yearly to enable reproduction of the observed trajectory of aggregate real GDP growth.

that for the baseline scenario, we are simply assuming that the effects of the political crisis take place through productivity losses, without exogenously updating any other parameter. Productivity losses affect the level of production and, as a result, factor employment and household income and consumption per capita. In the case of government spending, it is assumed that consumption and other components of recurrent spending grow at a given rate per annum, which is part of the closure rules of the model. Government investment spending depends on the demand for capital in the public services sector and this, in turn, depends on government consumption.

Other macroeconomic closure rules used to generate the baseline scenario are as follows. Government investment spending is covered through current savings and fixed levels of borrowing (domestic and external) and tax rates. Any remaining imbalances are covered by foreign transfers from abroad (i.e., foreign aid) which basically assume their true value as the calibration of the model entailed imposing observed trends for the levels of borrowing and tax revenues. The real exchange rate adjusts to clear the current account of the balance of payments. Private savings rates adjust such that private investment equals total savings given a fixed ratio of private investment to GDP.

The baseline scenarios reflect the actual aggregate functioning of the Tunisian economy and the government accounts remain in realistic territory—based on existing data available for the preparation of this paper. The real exchange rate appreciates on average by 0.6% per annum in the baseline, in consistency with more spending on non-tradables (clearly, government consumption), though it is worth mentioning that the actual trend of the real exchange rate is not being reproduced as world prices are not updated due to lack of information. As a result of this the real exchange rate appreciates, exports fall as a percentage of GDP whereas imports remain on the increase—such that foreign savings turned larger relative to GDP. In consistency with past trends, government debts decline over time.

Table 3. Tunisia and Morocco: Selected macroeconomic and government indicators for the baseline scenario, 2005-2020 (% of GDP)

	2005		**2010**		**2020**	
	Tunisia	*Morocco*	*Tunisia*	*Morocco*	*Tunisia*	*Morocco*
National accounts						
Consumption- private	63.4	56.4	69.3	55.8	72.6	55.6
Consumption-Government	15.7	19.9	16.6	21.5	17.3	22.1
Investment-Private	12.9	23.9	12.9	26.8	13.9	28.2
Investment-Government	9.6	4.5	10.0	4.3	10.2	4.1
Exports	50.0	32.2	39.8	29.8	38.6	23.3
Imports	47.6	38.3	48.2	36.8	49.2	35.7
Government						
Foreign debt	53.9	13.4	39.0	15.3	47.8	15.7
Domestic debt	2.8	51.5	1.7	50.6	2.4	49.4

Source: authors' estimates based on application of Water-CGE model for Tunisia and Morocco

The table below reflects the additional public spending required to keep the price of water constant over the period 2005-2020. In Tunisia, maintaining the current level of water price requires 0.8 percentage point of GDP additional public spending by 2020 compared with 1.1 percentage point of GDP in Morocco.

Table 4. Tunisia and Morocco: Additional annual public spending required to keep the domestic price of water at its level in 2005 (deviation from baseline scenario, % of GDP)

Closure: additional public spending will be financed through an increase in taxes

	Tunisia	**Morocco**
	0.8	1.1
Current	0.2	0.4
Capital	0.6	0.7

Source: authors' estimations based on application of the Water-CGE model for Tunisia and Morocco

5. Alternative scenarios of water management

Three alternative scenarios have been tested:

- Cutting subsidies on water price by 50%
- Doubling public spending on water mobilization progressively over the period 2014-2020
- Both above scenarios implemented simultaneously

In both baseline and alternative scenarios one financing variable clears the government budget, while three other remain fixed and are updated depending on a rule (for example, a percentage of GDP can be imposed exogenously on a year-on-year basis). Foreign transfers from abroad (the equivalent to grant aid) clear the government budget in the baseline scenario. This rule changed under the alternative scenarios when the financing mechanism alternatively is domestic borrowing, domestic taxation or foreign borrowing in which case one of these three becomes the clearing variable of the budget.

The subsidized water price has an impact on the amount of water used for irrigation, as arguably a low price does not encourage efficient use. Moreover, subsidized water price has also affected the allocation of production factors first among agriculture activities and second between the agricultural sector and the rest of the economy. Accordingly, removing this type of subsidy is expected to affect the structure of water consumption in the economy in addition to a reduction in water consumption in both countries which is directly due to an increase in water price. In Tunisia, the water pricing policies followed since the 1960s increased the domestic demand of water given the high price elasticity of demand in all sectors, mainly in the upper blocks of consumption. Removing the half of subsidy on all types of water consumption will affect all segments of the economy. The two first direct effects are those linked to expected saving in public expenditures while the second reflect the deterioration of the households' welfare. In addition to these two contradictory effects (positive and negative), efficiency gains resulting from a better use of water resources among the various types of demands will be also important. The overall impact on the Tunisian economy is expected to be positive (growth in GDP under all financing alternatives). Increasing public investments in the mobilization and distribution of water is also expected to enhance economic activities through higher production and exports. Finally, and as expected, the cumulative impact of the implementation of the two previous scenarios is also positive.

In Morocco, the cost recovery policy through the reduction of 50% of subsidies will affect negatively the overall economic activity through a reduction in the level of GDP. Three major factors explain this result. First, in Morocco the level of water subsidy is higher than Tunisia (around 45%). Second the contribution of the agriculture sector to the Moroccan economy is much higher than Tunisia (15 against 9% in 2012). Third, irrigated agricultural sector contributed much largely than Tunisia in the overall economic activity given its higher

multiplier effects on the rest of the economy. For these reasons, the efficiency and public saving gains are found to be smaller than the direct costs related to the decrease in households' welfare and agricultural production. The results of both models show clearly that the Tunisian agriculture sector has more flexibility to positively adjust to higher water prices compared with Morocco where the level of substitution among activities is lower.

Table 5. Cutting subsidies on water by 50% (SCENRIO 1), doubling public investment in water mobilization by 50% (scenario 2), 2+1 (scenario 3)

	Scenario 1			Scenario 2			Scenario 3		
	tax	Fb	Db	Tax	Fb	Db	Tax	Fb	Db
Absorption	0.1	0.3	0.3	0.4	0.5	0.3	0.2	0.4	0.2
Consumption – private	0.2	0.2	0.3	0.3	0.5	0.2	0.3	0.4	0.2
Consumption – government	0.1	0.1	0.1	1.2	1.2	1.2	0.7	0.7	0.7
Fixed investment – private	-0.4	-0.4	-0.2	0.2	0.4	-0.1	-0.1	0.1	-0.2
Fixed investment - government	0.6	0.6	0.6	0.9	0.9	0.9	0.7	0.8	0.8
Exports	-1.4	-1.4	-1.2	1.5	1.7	1.4	0.2	0.4	0.3
Imports	0.6	0.6	0.5	-0.3	-0.4	-0.3	-0.1	0.2	0.2
GDP at market prices	0.2	0.2	0.2	0.4	0.5	0.3	0.3	0.4	0.3

Source: authors' estimations based on application of Water-CGE model for Tunisia.

Table 6 Cutting subsidies on water by 50% (SCENRIO 1), doubling public investment in water mobilization by 50% (scenario 2), 2+1 (scenario 3)

	Scenario 1			Scenario 2			Scenario 3		
	Tax	Fb	Db	Tax	Fb	Db	tax	Fb	Db
Absorption	0.1	0.0	0.0	0.4	0.6	0.6	0.2	0.3	0.3
Consumption – private	0.2	-0.1	-0.2	0.4	0.6	0.6	0.3	0.3	0.2
Consumption – government	0.1	0.1	0.1	1.2	1.2	1.2	0.7	0.7	0.6
Fixed investment – private	-0.3	-0.6	-0.6	1.2	1.9	1.9	0.4	0.6	0.7
Fixed investment - government	0.1	0.1	0.1	0.9	0.9	0.9	0.5	0.5	0.6

Exports	-1.4	-3.4	-3.2	1.3	1.7	1.6	-0.1	-0.8	-0.7
Imports	1.6	1.7	1.5	0.6	0.7	0.6	1.0	1.3	1.1
GDP at market prices	-0.1	-0.4	-0.4	0.3	0.5	0.4	0.1	0.1	0.1

Source: authors' estimations based on application of Water-CGE model for Morocco.

Usually water-intensive products are encouraged in countries or regions where the price of water is very low and where incomes from these products are higher than previous activities in the same country or regions. In both cases of Tunisia and Morocco, water subsidies distorted the agricultural production as water intensive agricultural productions have been gradually introduced rather than more efficient activities that are much more appropriate to the effective costs of water. By reducing the subsidy, the production cost of water intensive crops will rise significantly in both countries, mostly in the most water scarce areas. This would potentially lead to a change in production patterns in both of them, likely affecting the import and export of agriculture products. However, caution is required since water in water scarce areas is typically used more efficiently and more productively. The value added of farming in these two types of areas is also high, the net margin between rain-fed agriculture and irrigated agriculture for many activities is also an important issue in the determination of the net effects of rising water prices. Until a very high water price is reached, the reduction of subsidies to water infrastructures and operations costs might not change the farmers' decisions on crops (and hence water use), since the price of the input (i.e. the water cost for the producer) is a very small proportion of the total costs (and benefits) of production. Also, there is no alternative best crop that will generate at least the same benefits.

6. Conclusions and policy recommendations

In both countries, pricing policies need to be accompanied by educational efforts to raise awareness on water consumption levels if they are to play a role in water conservation and public spending efficiency. Agriculture sectors in both countries enjoyed high public supports for water pricing which impacted the capacities of farmers to introduce other activities with lower consumption of water. Despite many previous attempts to remove water subsidies in both countries, progress has been mitigated given the key social role of agriculture sector in term of reducing social pressures in urban areas. Thus, water pricing has usually been below full cost recovery (especially when investments and externality costs are taken into account) despite the successive reforms of water pricing policies towards a more effective pricing. However, the increasing pressures on public resources in both countries requires the adoption of water pricing policy taking into account the principle of water services cost recovery. Given that irrigation water subsidies policies adopted since the 60th affected the choice of crops, leading to the farming of more profitable crops with higher irrigation needs which in turn leads to a higher consumption of water in both countries. Subsidies decrease production costs, but at the same time incentive an inconsiderate use of water, promoting the farming of more water intensive crops – which can be more profitable for farmers, but arguably lead to water over abstraction. Furthermore, the subsidies remove or decrease the price signal related to water consumption and therefore do not provide sufficient signal to stimulate water efficiency, such as the introduction of water efficient technologies or the renewal of old infrastructures, which currently are responsible of huge losses. Increase of water prices is expected to lead to irrigation practices with less water loss. However, the adoption of those practices may require significant investments from farmers. The reform of water subsidies can take several forms. It can either be through an outright elimination or a phased elimination of the subsidy. In case of *outright* elimination, the substitution of crops with less water intensive

ones can be used as a flanking measure, if financial support and technical advice aimed at such substitution is provided by the authorities to farmers simultaneously with the removal of the subsidies. Alternatively, if a *phased* elimination is chosen, authorities can direct crop selection towards less water intensive crops by providing financial support and technical advice without removing the subsidies immediately and wait for the impact on water consumption. This is due to involve slower progress in water efficiency than the scenario where substitution of cultures is accompanied by a removal of the subsidies, since imposed substitution of cultures might not be feasible. However, such approach involves a smaller threat to farmers' income. If water demand is relatively inelastic, prices of agricultural products, the competitiveness and the income of farmers. The removal of the subsidy can lead to significant impact on farmers' income. The results of this study show that farm income will decrease by about 20 per cent before water demand decreases significantly. A reduction in the number of crops available for farming can also lead to greater technical and economic vulnerability of the agricultural sector in both Tunisia and Morocco. Employment is likely to be affected also in both countries.

Both social and economic negative impacts are expected to follow the reduction of water subsidies, especially in terms of reduced farmers' income, reduced level of employment and, in extreme cases, land abandonment. Negative impacts can be addressed either through 1) flanking measures that support the removal of water subsidies, reducing the negative impact this removal might have on farmers' income, 2) compensatory measures that make up for the farmers' income loss following the removal of water subsidies in sustainable ways. Measures that address negative economic impacts through production changes (e.g., adoption of new technologies and production processes, introduction of new cultures with crop replacement and crop diversification) that improve farmers' competitiveness and consequently support farmers' income should be preferred to the ones that address primarily farmers' income. This is so since the former tend to be transitory, enabling the individuals to recover or improve their initial income without further support in the medium term, whilst the latter tend to delay the adaptation to the new conditions.

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