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WATER AVAILABILITY AND FOOD SECURITY CHALLENGES IN EGYPT

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SUMMARY – The availability of surface freshwater resources in Egypt, as in other middle-east developing countries, is a major challenge – not least of all because the average population density doubled during the last 30 years. The major challenge faced by the Egyptian government is the limited annual freshwater quota from the Nile of 55.5 km^3 $year^{-1}$ (809 $m^3.capita^{-1}.year^{-1}$). In order to meet the increased food needs, two basic strategies are possible: importing food or growing more food. Egypt imports about 236 m^3 water per capita per year in the form of food. Different agriculture projects were established with the aim to enlarge the cultivated area and to guarantee sufficient production of the main crops - issues considered as top priorities within the government economic agenda. Based on the concept of re-use and efficiency increase, it is expected that the use of scientific knowledge, international experience and cooperation as well as advanced management tools should help in the sustainable planning of the future economy. Thus on the national level, re-use and efficient water utilization have the highest priority. According to Egyptian estimates, an additional 20.9 $km^3 year^{-1}$ could be made available through recycling water, by changing irrigation techniques and adopting water efficient crops and cropping patterns. This is equal to 30% of the water that is used at present. Based on the measures taken by the government, the water balance of Egypt shows that the available water supply is sufficient for the future, at least until the year 2017.

Keywords: freshwater in Egypt, population increase, crop selection, sustainable planning, Future economy

1. INTRODUCTION

One of the greatest challenges facing humanity is how to use scarce resources in an equitable and sustainable way. According to Seckler (1999) water scarcity is now the single greatest threat to human health, the environment and the global food supply. Besides the qualitative aspect of water, (e.g. polluted water affecting human health), the available quantity of water has a direct impact on a region's potential to produce food. World wide, agriculture is the main consumer of water. In Egypt more than 85% of the water withdrawal from the Nile is used for irrigated agriculture. Water availability therefore has a direct influence on national food security. According to the FAO, all the countries of the Nile Basin, except Egypt, suffer from malnutrition. All countries of the Nile Basin, except Uganda (during some years), are net importers of cereals. Resources such as land and water, as well as the general political and economic situation play crucial roles. For countries that share the same river, such as the Nile riparian countries, competitive usage can accentuate the threat of running dry.

The Nile River is shared by ten countries (Egypt, Sudan, Ethiopia, Eritrea, Tanzania, Uganda, Burundi, Rwanda, D.R. Congo, and Kenya) .It is the home to more than 160 million people. The population is growing by 2-3% per year. The Nile Basin covers an area of 3.1 million km^2, of which 1% is urban, 2% are covered by forest, 3% by wetlands, 3% by open water, 4% by shrub, 5% by irrigated cropland, 10% by cropland, 30% by desert/semi-desert and 42% by grassland (NBI 2001). Many countries in the Nile Basin are highly dependent on the Nile’s water, as they are situated in arid or semi-arid regions. More than 95% of Egypt's water comes from the Nile, this means that it depends on rainfall outside of its territory. There are four main development needs concerning water use in the Nile Basin: 1) water for irrigation and hydroelectric power production; 2) prevention of floods; 3) minimization of erosion and siltation of reservoirs; and 4) prevention of water pollution. The national economic capacity to address these issues is limited (Mason 2004).

Egypt is now fully utilizing its share of the Nile river flow according to the Agreement of 1959 with Sudan and is effectively reusing drainage water, treated waste water and shallow groundwater. Challenging new development projects are being implemented by the government such as the El-Salam and Toshka agriculture projects. These projects will have a large impact on the distribution and use of presently available water resources. Continued population and economic growth will exert further pressure on the existing water resources. Major water quality problems are still limited to a number of hot spots, but proper attention will have to be given to the effects of expected socio-economic developments on water quality. The threats of the available water resources being insufficient to meet the demands from all socio-economic sectors requires an adequate and integrated water resources management (NWRP 2001).

Planning is central in water resources management, as it is needed to develop strategies to reduce water use and use it more efficiently (demand management), to optimize the supply (supply management) and to maintain or improve water quality (pollution control). Various planning studies were implemented in Egypt in the past, such as the Water Master Plan (1982) and Water Security Projects. The present situation, with limited possibilities for extension of water supply and growing demands, provides new challenges for planning. The Egyptian government, with support of international planning experience and in cooperation with national scientific and consultant institutions, has agreed to support the implementation of the National Water Resources Plan (NWRP 2001), that targets the year 2017 as a reference for measuring the success of the plan objectives.

This contribution is an overview of the Egyptian experience in implementing its National Water Resources Plan, to optimally meet food security as well as water scarcity challenges from a socio-economic and environmental point of view. The article is structured as follows: concepts of food security are introduced, followed by an overview of water availability and quality. Based on these environmental aspects, the socio-economic water demand and water development projects are presented. The increased focus on demand-side management and efficiency increase of the National policy is then highlighted. The article ends by putting the concepts of food security first introduced in relation with Egypt's food security strategy. One key conclusion is that Egypt's food security strategy is influenced by both national and international factors.

2. DIFFERENT CONCEPTS OF "FOOD SECURITY"

An important factor influencing the management of water in arid regions is the predominant understanding of food security in these countries. The World Bank defines food security as "Access by all people at all times to enough food for an active healthy life" (USAID 1992). While the aim is clear, there are different understandings as how to reach this goal. A widely held interpretation of food security concentrates on self-sufficiency, i.e. to be independent of the international market. Self-sufficiency does not necessarily have to be understood in the context of one country; it can also be applied to a region in order to use the comparative advantages of the various countries. Examples of this are efforts in the Arab world (Abdel-Moneim 2000). Food security can also be understood differently, in that a country does not have a negative food or trade balance. It is easier to import water in the form of cereals than it is to transport water. The so called "virtual water" is calculated by the following rule of thumb: 1 kg of bread needs about 1'000 litres of water for its production. International water experts therefore often stress the importance of industrialization in water scarce countries to allow them to develop the economic capacity to import food from water abundant regions (Zehnder, 1999):

A further understanding of food security goes even further and also includes the socio-economic and political stability of a country or region. According to this understanding, it is only meaningful to speak of food security when equity and stability are given. Hunger is often not a question of quantity, but of infrastructure and the institutional capacity of a country or region to distribute food. On a global scale, this definition of food security should also include a stable world market price and a free access to cereals independent of political interests. Various ideas have been proposed to do this, to make food importers less dependent on the main food exporters (e.g. USA, Canada, Argentina, Australia, Denmark and France). Such ideas are to create an institution that acts as a "go between" the exporters and importers, or a UN controlled private company that buys the food and then sells it independently of political preferences. Without such a stabilizing agency, it is likely that a country with little water resources will continue to produce food in their own country due to national security considerations, even if this does not make sense from an economic point of view. It is expected that the world food market in 25 years will be of a similar scale as the oil market today, i.e. 450 billion USD per year – demonstrating the global significance of the water challenge (Ohlsson 1999, Yang & Zehnder 2002).

3. WATER AVAILABILITY

Water scarcity can be measured by the physical availability of water in a country or by the amount of water that is withdrawn compared to the available amount of internal renewable and inflowing water from other countries. According to the UN (1997), countries that withdraw less than 10% of their available freshwater are considered as low water stress countries, countries with 10-20% withdrawal of their available resources as moderately water stressed, 20-40% as medium-high water stressed and more than 40% withdrawal is considered as highly water stressed. Egypt falls in the category of high water stress, where the Nile is the only surface source of renewable freshwater in Egypt, other than small amounts of rainwater on the coast and flashfloods in valleys. The mean annual rainfall of 18 mm ranges from 0 mm year^{-1} in the desert to 200 mm year^{-1} in the northern coastal region (Aquastat, 1995). According to the agreement of 1959 with Sudan, Egypt has the right to use 55.5 km^3 year^{-1} from the main Nile measured at Aswan. This amount and even more is withdrawn. Furthermore, the upstream countries besides Sudan contest the validity of the 1959 agreement. Negotiations on this matter are proceeding, taken care of by the Nile Basin Initiative Negotiating Team (Amer *et al*. 2005).

The quantity of fossil groundwater in the western desert is vast at depths up to 1'500 m. The water quality and economic costs of pumping, however, make it difficult to use in great quantities. Fossil groundwater storage in the Western Desert is estimated at 40'000 km^3 (salinity 400-700 ppm) (Abu Zaid 1991). One has to differentiate between fossil groundwater and the groundwater from the Nile aquifer. The latter is renewed by the Nile River and irrigation water, and it therefore cannot be considered as separate from the Nile water flowing into Egypt. The groundwater storage capacity in the Nile Valley and Delta system is estimated at 200 km^3 (salinity: 800 ppm) and 300 km^3 respectively (Abu Zeid 1991). The wells in Egypt are concentrated along the North coast, the Red Sea coast, Sinai and in the South Western Desert.

At present, desalination of sea water produces about 0.03 km^3 year^{-1}. At a cost of 0.5-2 \$US/m^3 it is too expensive for agricultural use (Egypt 1999). Only a minimal increase is possible on the supply side by increasing desalinated water, withdrawing more fossil water and minimizing losses to the sea.

The main increase in availability can be gained by re-use and increase efficiency –demand management. Thus on the national level, re-use and efficient water utilization have the highest priority. According to Egyptian estimates, an additional 20.9 km^3 year^{-1} could be made available through recycling water, by changing irrigation techniques and adopting water efficient crops and cropping patterns (El-Quosy *et al*. 1999). This is equal to 30% of the water that is used at present. The water balance of Egypt shows that the available water supply is sufficient for the future, at least until the year 2017 (Table 1).

Table 1: Egypt's water availability and demand (*c.f.* Mason, 2004)

	1999 $km^3\ year^{-1}$	planned by 2017 $km^3\ year^{-1}$
Nile water, according to the 1959 agreement between Sudan and Egypt	55.5	55.5
Fossil groundwater	0.5 - 0.9	1.2 - 3.3
Rain	1.4	1.4
Desalinated water	0.03	0.5
Water lost to the sea	- 4 to - 1	- 0.3 to 0
Total available	53.4 - 58.3	58.3 - 60.7
Re-use / increase in efficiency:		
Recycling of drainage water	4.3	9
Recycling of sewage water	0.4	2.5
Nile-groundwater (reused Nile-water)	2.6 - 4.8	4.9 - 7.5
Improved irrigation system	0.5	3
Changed crop sorts and patterns		3.5 - 4.2
Total amount of water that can be used (=Total available + recycling / efficiency increase)	61.2 - 66.6	81.2 - 86.9
Use:		
Agriculture	56	66.6
Municipal	3	6.8
Industry	6	12.4
Total use	65	85.8

4. WATER QUALITY

4.1. Nile surface water

Water quality is a problem around urban centres and in the Egyptian delta. Pollution increases downstream, especially downstream of Cairo. Main pollutants are nutrients, salts, pesticides and microbes. In general, the river water quality is better than that of many other water bodies (close to surface groundwater and lakes), especially in high flood years, because the river is flushed periodically. High concentrations of fertilizers and salts in irrigation drainage water are likely to be the main challenges in the future.

4.2. Groundwater quality

The water quality of the River Nile upstream of Cairo is fairly good. The pollution of groundwater is, however, a national problem.

Six aquifer systems can be identified in Egypt, according to their geological structure:

1. The Nile aquifer system, occupies the Nile flood plain region (including Cairo) and the desert fringes.
2. The Nubian Sandstone aquifer system, occupies mainly the Western Desert.
3. The Moghra aquifer system, occupies mainly the western edge of the Delta.
4. The Coastal aquifer systems, occupy the northern and western coasts.
5. The carstified Carbonate aquifer system, outcrops in the northern part of the Western Desert and along the Nile system.
6. The fissured and weathered hard rock aquifer system, outcrops in the Eastern Desert and the Sinai Peninsula (Attia 1999).

Of these aquifers, the Nile aquifer system is the most threatened by pollution, because the population of Egypt is concentrated in the Nile Valley. The Nile aquifer system is a renewable water source as it is recharged by the Nile River. Groundwater quality depends on the quality of the recharge source and the cleaning ability of the aquifer. The water quality of the Nile aquifer reflects the surface water quality of the Nile River.

5. POLLUTION SOURCES AND TREATMENT FACILITIES

Water pollution in Egypt originates from domestic, agricultural and industrial sources and it is widespread over the country. The Egyptian government has adopted an Environmental Action Plan, which distinguished the following priorities:

- Protect the Nile river and its branches,
- Improve the water quality in the irrigation canals and drains.

5.1. Domestic sources

In a number of cases, municipal and rural domestic wastewater is discharged directly into waterways, often without treatment. The discharge increases, year after year, due to the existing water supply networks set-up in many villages. Also, the present expansion of water networks in several towns without parallel construction of new sewerage systems leads to aggravated pollution. The constituents of domestic and urban input to water resources are pathogens, nutrients, suspended solids, salts and oxygen demanding materials.

5.2. Agricultural sources

Apart from being the largest consumer of water, agriculture is also a major source of water pollution. Saline irrigation return-flows or drainage containing agrochemical residues are serious contaminants for downstream water users. Agriculture nitrate is contaminating groundwater. The disposal of liquid animal waste pollutes surface and groundwater, etc. The major impact of agricultural activities on water quality can be identified as follows:

- Increase of salinity.
- Deterioration due to chemical fertilizers and pesticides.
- Eutrophication of water bodies due to increase in nutrients from fertilization.

5.3. Industrial sources

Food processing, textile manufacturing, cement and fertilizer production are the main industries. An important feature of Egypt's industrialization is the concentration of new industries in the metropolitan areas along the Nile Delta, north and south of Cairo, and in the Alexandria metropolitan area. Industrial pollutants seemed to have been reduced during the last 10 years as a result of adopted environmental laws.

5.4. Treatment facilities

The Egyptian government has made a significant effort toward providing wastewater services for its people. However, according to official figures, the coverage rates for wastewater services are much less than those for water supply. Just over 50% of the urban population has access to sewerage services, while the corresponding value for rural areas is less than 10% (NWRP 2001).

6. AGRICULTURE AND WATER DEMANDS

Water withdrawal is directly influenced by the area, yield, production and water demand of the main crops.

Cotton, wheat, rice, maize and winter-berseem account for 80% of the area in crops (Aboul-Enien *et al*., 2000) and about 60% of the water consumption of the agricultural sector in Egypt (EAAE, 2000). Since 1960 the area covered by wheat and maize has increased in Egypt (Fig. 1). In the same time period, the yields of the main crops have increased, except that of cotton seed that has remained the same. Production trends follow a similar pattern: the production of the main crops increased steadily, except for sorghum and cotton seed. Production increases in wheat covered the increased demand; the total amount of imported wheat has therefore remained constant over the last two decades. Rice is the greatest water consuming crop and consumes about 15% of the total agricultural water consumption in Egypt. Applied water takes into account the consumptive use as well as all sorts of water losses at field level. Sugarcane and rice have the greatest water requirement for applied water. Rice and sugarcane are the two main crops from a water efficiency point of view.

Besides political and economic factors, reasons for changes in harvested area, yield and production in the agriculture of Egypt are a result of technological developments. The Aswan High Dam allowed for perennial irrigation, up to three crops a year, and a secure water resource from 1970 onwards. At the same time, fertilization from the natural flooding of the Nile River was replaced by the application of artificial fertilization. The rate of application of basic nutrients such as nitrogenous (N) and phosphorus (P) and potassium (K) fertilizers in Egypt is 372 kg ha^{-1} year^{-1} (Aboul-Enien *et al* 2000).

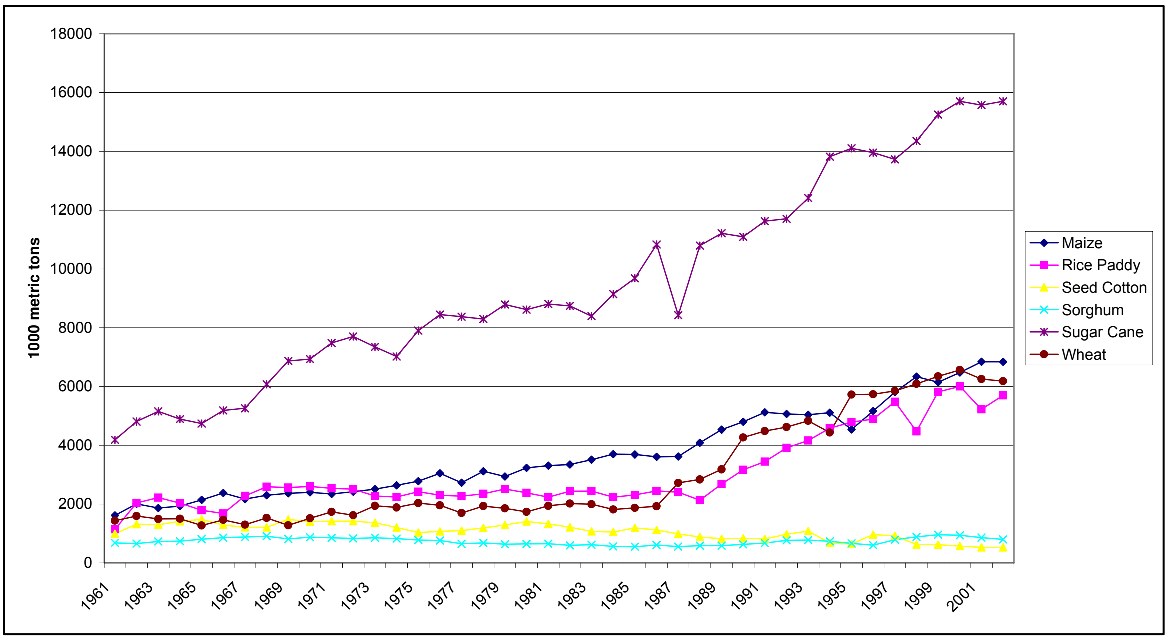

Figure 1. Trend of main crops production in Egypt during 1961-2001 (FAOSTAT 2002)

7. OLD AND NEW LANDS DEVELOPMENT

Egypt‘s agriculture can be divided into old and new lands. The old lands are along the Nile River and the delta, whereas the new lands are the newly reclaimed lands that used to be desert. All new lands use modern technology, e.g. sprinkler or drip irrigation, an average of 14'000 m^3 of water ha^{-1} year^{-1} are used. The new lands mainly grow cash crops, e.g. fruit and vegetables both for the local and international market. It is believed by most of farmers that, the most suitable irrigation system on the old lands is flood irrigation because of the clay soils, even if it is less water efficient than the technology used on the new lands. The old and new agricultural land together, amounts to about 3.2 million ha. Of this, the old land comprises 2.5 million ha. There are 750’000 ha already existing new lands on the northwest coast. Furthermore, there is the potential of an additional 1.4 million ha in Toshka, the desert oases, along the East and North Coast, and in North Sinai. Groundwater is being used - inefficiently at times - in the north-western reclaimed areas, near the desert road Alexandria-Cairo.

Agricultural cultivation on the new lands takes a different approach than traditional farming, and the farmers are mainly graduated from universities. The high level of technology is only used for the water saving procedures. For the rest of the farming activities, normal labour-intensive practices are the norm. As a consequence skilled as well as un-skilled labourers are to be employed. Products from the new lands include vegetables, fruit, aromatic plants and flowers, both for local consumption and for export. Agriculture in these areas is expensive, so the economic return has to be high. Nevertheless, in north Sinai some wheat and barley is grown. In the new lands the holdings are a minimum of 8.4 ha (20 feddans). In the old lands more than 80% are small holdings of 0.4 - 0.8 ha (1-2 feddan). Making the desert useable for agriculture is called desert reclamation. The estimates of the costs to reclaim 1 hectare are between 11000 and 22000 USD.

8. EGYPTIAN WATER MANAGEMENT TOWARD FOOD SECURITY

Changes in agricultural and water policy are linked to social consequences, in an environment where the enormous pressure of population growth and other related problems such as unemployment are a pertinent disturbing factor. Parallel to the search for more living space outside the Nile valley and Delta are considerations of social stability. The Egyptian government has accepted to initiate challenging agriculture projects, which may influence its economy in the present time, but it will guarantee food security for its population at least for the forthcoming decades.

8.1. Water development projects

Water development and land reclamation projects aim to 1) increase food security and exports from cash crops, 2) create living space, 3) create jobs, 4) compensate for land lost to urbanization, and 5) stabilize regions. Since living space is very limited, the government sees itself as being responsible to seek new living areas, so that Egypt can free itself from the Nile valley corset. The population of Egypt is increasing at present by 1.2 million individuals per year (UNFPA 2000). At the moment less than 5.5% of Egypt's territory is populated, that means that about 70 million people live in an area that is about the size of Switzerland. About 70'000 ha year^{-1} is lost to urbanization (El-Arabawy 2002). With the help of mega development projects, the populated area should increase to 25%. In the next 20 years (Fig. 2). Egypt plans to expand its agricultural area by 1.43 million ha. These large projects will reclaim land from the desert in Sinai, the west and southwest of Egypt (Toshka Project). They are integrated projects that include the development of industry, cities and tourism.

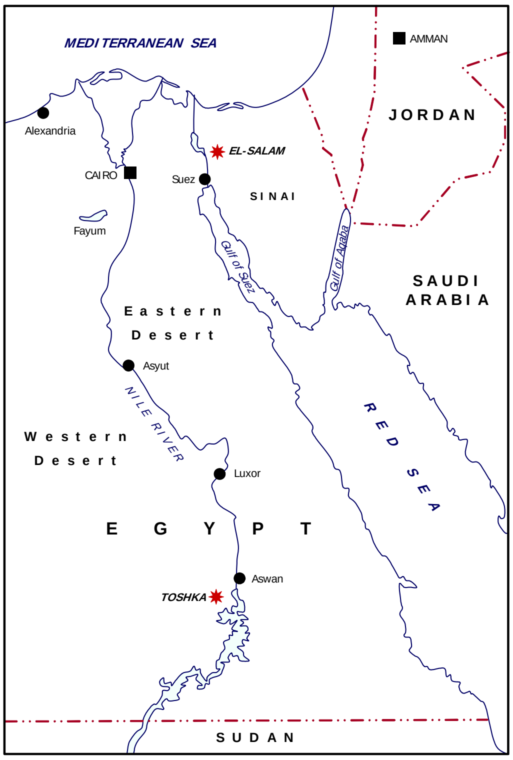

Figure 2. Locations of Mega projects in Egypt

8.2. South Western development project, Toshka

The South Western Development Project, imprecisely called Toshka project for short, is located in the southwest of Egypt. 0.97 Million ha of agricultural land are to be reclaimed in the "Southern Valley". The project aims to create 2.8 million job opportunities, industry area, towns and various tourist attraction e.g. safari and agro- tourism. About 3.0 to 6.3 million persons should find a home. The estimated total investment by 2017 is about 80 billion USD financed with up to 20-25% from the government and the rest from private and external investments. The first stage of Toshka was inaugurated in January, 2003. The project water demand is estimated as 5.5 km^3year^{-1} of the Nile water. The main source of water to compensate for the 55.5 km^3year^{-1} used in the project will come from efficiency increase. Besides, an additional 2 km^3year^{-1} of deep groundwater and desalination of 0.5 km^3year^{-1} of brackish groundwater will have to be utilized (El-Arabawy 2002). The project – according to plan – does not therefore mean that Egypt will use more than the 55.5 km^3year^{-1} quota of Nile water, and it is therefore generally viewed in Egypt as a project that does not have any international implications. In a first phase 227'000 ha are to be irrigated. Egypt and the United Arab Emirates are the main investors. The Egyptian government is building the infrastructure; private investments are taking care of drainage, levelling, and the preparing of the ground. A study of the World Bank confirms that the project will yield an output of about 8%; according to the Ministry of Irrigation and Water Resources, this output could be higher, in the range of 11-13%, depending on the crops (SIS 1999). Thus, the government argues that the project is economically viable, and that the population pressure is so great, that the Toshka project is necessary to create living areas, jobs and food security.

8.3. Sinai development project; El-Salam

The total inhabitant of Sinai is around 3.2 millions. The aim is to create job opportunities to 800'000 by year 2017. The total investment is 20 billion USD. The agriculture plane of the project is divided into several phases. In phase I, about 168'000 ha aim to be cultivated with the utilization of 3 km^3year^{-1} of freshwater. That water should be obtained from El-Salam canal, which formed as 50% of recycled water and 50% of Nile water (Mason 2004).

It has been mentioned in a specialized study that "under the pressing overpopulation problem entailing a progressive dependence upon imported food from abroad, Egypt has to continue a sustained horizontal expansion in the agricultural field exploiting to the maximum all the available water resources in order to satisfy all the food needs of the people, or at least minimize Egypt's foreign dependence in this respect (SIS 1999). Nevertheless, Egypt imports about 40% of its basic food requirements – due to economic considerations (Mason 2004).

Egyptian interests in social stability (employment and living space), self-sufficiency, water efficiency, and economic viability are main factors influencing mega development projects. The national food security strategy of Egypt is influenced in particular by the following points:

8.3.1. The dominance of cash crops on new lands

The new lands are all high investment agriculture. Due to economic considerations, cash crops with a high economic return are planned. Cash crops such as organic fruit and vegetables are partly sold on the national market. When they are sold on the international market, however, they are not grown for food security, but in order to gain foreign exchange earnings. Thus the new lands - this includes Toshka and Sinai - contribute to basic food security indirectly, mainly in the sense of aiming at a net balance in agricultural trade, and *not* in self-sufficiency in cereals.

8.3.2. An increase of cereal production on old lands

In the old lands, a compromise is sought between self-sufficiency and export crops. Production of wheat has increased, while the production of cotton remains stable, indicating that this compromise over the years has tended towards keeping or increasing the level of self-sufficiency of cereals, rather than promoting cotton. World market price of cotton and wheat also play an important role. The bread subsidy can be seen as stemming from considerations of social stability and have supported the production of wheat.

8.3.3. The limitation of rice and sugar cane

The agricultural policy has aimed at limiting rice and sugar cane in order to save water losses. So far this policy has not been very successful. Considerations of social stability outweigh considerations of water efficiency (understood quantitatively) especially to safeguard groundwater quality and prevent the seawater intrusion.

8.3.4. The positive effects of market oriented economy

The effect of market liberalization on agricultural production has been positive. The liberalization of the agricultural sector has progressed cautiously, however, in order to maintain social and political stability. Compared to many other countries of the Middle East and North Africa region, the gap between food imports and food exports has not grown (Yang and Zehnder 2002).

9. NATIONAL WATER POLICY

The Egyptian water policy has three aims: 1) to promote water quality protection, 2) to use the available resources optimally and efficiently, and 3) to foster international cooperation to safeguard and increase the supply in the Nile Basin.

One of the main aims of the National water policy is the optimal use of available water resources in order to be in harmony with the developed agricultural plans, and the country's economic sustainability. To achieve such aim, the Egyptian government has consulted and collaborated with international institutes which have long term and sound experience in water resources management. The result of such collaboration was the use of a numerical model designed to satisfy all the Egyptian action plans within the Agriculture Sector (Agriculture Sector Model of Egypt = ASME). The model simulation matches domestic demand for final crop and livestock commodities and export on one side, with crop and livestock production, agro-processing, and import on the other side. The simulation is driven by maximizing the consumer-producer surplus in addition to the net revenues from international trade under the constraints of land and irrigation water availability. Irrigation water availability assumes priority for municipal and industrial use, and considers reuse of irrigation water and wastewater, and the use of deep and shallow groundwater. The model has been built to accommodate all possible options until the year 2017 (NWRP 2001). However, the extensive database prepared to be the input data for this model as well as the ongoing and continuous updating of the model information will make its use continuously valid as a well-established simulation and predictable tool. The use of the model results will certainly help the decision makers and stakeholder to be focused in making correct and well-studied choices and decisions.

Based on the model results the optimal use of available water resources in Egypt is targeted with a multi-facetted package of policies that range from encouraging technical solutions, such as the use of closed pipelines to transfer water to the new lands, to economic instruments, such as cost recovery through greater farmer participation. Policies aim at an increased efficiency in irrigation, cost recovery of infrastructure, the use of water efficient crops (e.g. less rice and sugar cane), groundwater use, the reuse of agricultural drainage water and sewage water, the desalination of brackish water and the harvesting of rainfall and flash floods. While water pricing is not an option for Egypt due to cultural reasons, cost recovery of infrastructure that brings water to the end user is an option that is increasingly being promoted.

The economic analysis shows that water consumption and economic return varies for different crops. In order to enhance the cultivation of water efficient crops, an indicative crop mix for each region in the country is in the process of being designed. This is to be based on the climatic conditions, the soil characteristics and the water resources availability in terms of quantity and quality. Farmers will be supported to follow this plan, and those that do not may have to pay for excess water (Egypt 2000).

10. CONCLUSIONS

The Egyptian challenges in water and food security sectors have been accepted by the government due to both internal and external stresses i.e. demographic and political stresses respectively. Egypt's food security strategy can be viewed as a compromise between purely economic considerations and purely political ones. Thus Egypt imports about 40% of its food – which makes sense economically, but Egypt also maintains a high level of self-sufficiency, i.e. 60% self-sufficiency – which makes sense from a sovereignty point of view. This strategy, together with the three pronged National Water policy of water protection, efficiency increase and international cooperation, will suffice to meet the needs of Egypt's growing population until about the year 2017.

Afterwards, various other measures will have to be considered, e.g. greater food imports and a re-allocation of water out of the agricultural sector into the domestic and industrial sector. To do this, however, not only national issues of economic development have to be considered. The stability of the international food market is central in allowing water scarce countries develop a sustainable and economically viable food security strategy. Thus initiatives are needed to minimize the power of the major food exporters in favour of the food importers. This will not happen based on the "good will" of the major food exporters. Efforts must be undertaken to make the interplay of water scarcity and oil abundance in the region into a source of international cooperation and mutual "give and take" – benefiting both those in the region and the rest of the world.

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