Optimum Economic Uses of Precious Costly Ground Water in Marginal and Desert Lands; Case Study in Egypt

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Abstract This chapter explains the optimum economic using the precious, costly and nonrenewable desert ground water in different sectors. Egypt is a country suffering from water scarcity where the water share per capita/year does not exceed 600 m, and the total water shortage reached 42 billion cubic meter/year in year 2018. Thus any new discovered ground water especially deep or spring ones will need economic scientific thinking and wise decision for its uses. The first logical choice for the new ground water should be to reduce the current water gap; but in case of adaptation with this water scarcity; the second choice will be to deliver it into the high income sectors such as hotels, tourisms, industry, and finally agriculture sectors. The municipal and domestic sectors will be also in the focus to meet the demands of the new settlements for the next generation. The least economically feasible choice of using the valuable ground water is to use it in agriculture sectors with its low income, where the return back of using unit of water in industrial sector reached tenfold than agricultural sector. Sometime, the lack of enough foreign currency needed to imports the needed essential food obliged the country to uses desert ground water in producing food. Ground water in Egyptian desert is mostly nonrenewable, deep and costly. The uses of delta and valley renewable shallow ground water in irrigates alluvial soils are completely different than using the desert deep and costly and nonrenewable ground water in cultivates desert lands. The feasibility of using desert ground water in agriculture and growing of agronomy crops, fruit trees and vegetable crops is a waste of a valuable and costly natural resource. Kingdom of Saudi Arabia and Egypt have had negative results for exploiting the ground water in greening desert by planting wheat, barely, forage, vegetables, and fruit crops. In Egypt, most of ground water wells in Cairo-Alexandria desert road farms are exploited and be salinized. Officially, agriculture sectors consumes 62.5 BCM/yr, and shares in Egyptian GDP by only 11.9%, while the industrial sector, consume a little amount of water as low as 2.4 BCM/yr but shares in GDP by 17.1. According to the deep Egyptian water gap, and the valuable of desert water, the uses of ground water in agriculture extension (if necessarily) should be in the north of Egypt where the temperature is moderate, winter rains, high humidity with low water consumptive use. The different between

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the temperature in the North and South Egypt reached 15 centigrade especially in the summer season. Historically all the successes project of desert reclamation located in North Egypt and no any one single success project locates in warm, dry and low humidity South Egypt. In Egypt's desert, the water consumptive use in the warm and dry Upper Egypt is almost double of those in the temperate humid North of Egypt with limited valid of crop types that can be cultivated. Organic agriculture, cash crops, export crops and green house agriculture should be considered as a good investment in desert agriculture using ground water in irrigation to maximize both of net profit and the return back of unite of water.

Keywords Ground water · Desert · Industry sector · Agriculture · Water shortage · Organic farms · Cash crops · Feasibility · South and north Egypt

Introduction and Desert Soils

From the view of physical **geography; desert** is a land area that is hyper arid because it receives little amounts of precipitation; usually in the form of rain but also as well as snow, mist or fog, thus, it has little vegetation, and a low possibility to contain a good non saline ground water in logical depth [1]. **Desert biome** is a tolerant ecosystem that forms due to the low water level of rainfall received each year. **Deserts** cover about 30% of the earth surface. There are four major types of **desert** according to their **biome**—hyper arid and arid, semiarid, coastal, and cold. These low amounts of biomass are able to inhabit animal life that is able to survive there (Fig. 1).

Deserts may have high temperatures, which during the day may exceed 50 °C, but at night it may fall below 0 °C. This wide range between the day and night

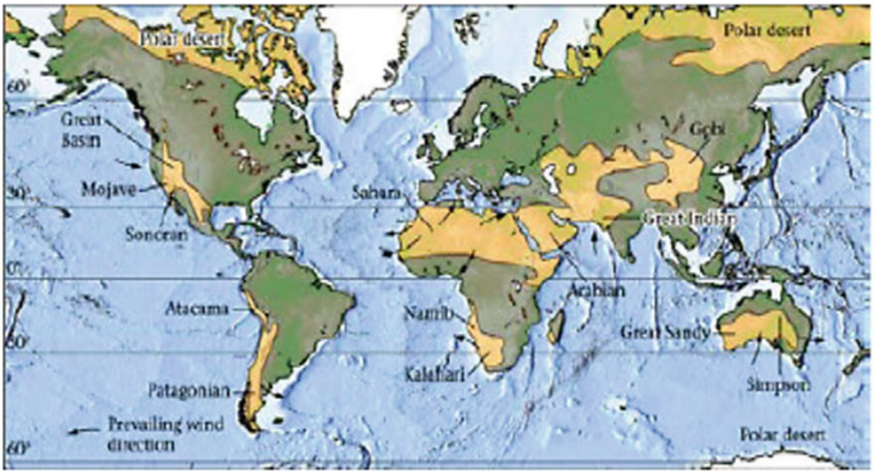

Fig. 1 Desert distribution in the world [1, 2]

temperature may cause a shock to most ordinary plant and only the desert flora can tolerate this wide range of temperatures. Deserts usually received less than 25 mm (10 inch) of rainfall a year, thus the temperature in not important in the definition of desert but the drought, dryness and the lack and water scarcity is the main rule of the desert definition. Some geographical features of the Sahara are **sand dunes**, **dry valleys**, **salt flats and salt crusts**, in addition to several hills and mountain ranges. The Sahara has a number of physical features, such as ergs, regs, hamadas, and oases. Ergs cover 20% of the Sahara [2].

According to [2, 3]**; deserts** are areas that have hardly any rain, are extremely dry and are usually have extreme temperature during day. Animals and plants have adapted to that severe environment and can survive under these extreme conditions of high temperature and little availability of water. The **geographic define the desert as** a "landscape form or region that receives very little precipitation". Generally **deserts** are defined as "areas that receive an average of scatter annual precipitation of less than 25 mm (10 inches)" [3]. Physically deserts are large areas with a lot of bare soil and low vegetation cover. Plants, animals and other organisms that live in deserts have adapted and evolved to survive with these harsh conditions, scarce water and **barren** landscapes. Some desert habitants usually have a short lived cycle to adapt with the season when the rain comes [3].

Desert land surfaces characterize by [1]:

- Lack and deep poor quality ground water.
- Exposed parent rock.
- Clasts accumulation.
- Un-weathered sediment and dominant of primary minerals with almost no secondary minerals.
- Dominance of mechanical weathering only; mostly by temperature and absence of chemical weather.
- High soil salinity and salt crust.
- Mainly wind erosion and little flash flood erosion and sand Mirages.
- Sand dunes and sand shifting.

Marginal Lands

Several definitions have been suggested for the marginal lands but all of them agreed about their low grade soils; soils under unfavorable climatic conditions, has no any feasibility or economic value in in potential production in agriculture which never give over 25% or the regular yield crop and finally it may be contaminated soils (www.miscomar.eu). Any discussion of marginal range lands should consider the impact of marginal soil properties on crop yield; the potential for production to improve soil health; and economically viable end uses of the crop in relation to biomass quality.

Land can be defined as marginal or under-utilized due to a range of factors. These can include:

• Unstable and vulnerable land.
• Economically sub-feasible—due to low returns on their current land use.
• Economically low-optimal—due to physical limitations such as high degradation, low soil fertility, shallow soil and lack of access and good water quality.

Marginal land is "land on which cost-effective food and feed production is not possible under given site conditions and cultivation techniques" [4].

The term marginal land as it is used in the context of the "global land rush' generally refers to land that is arable yet difficult to farm". This is largely determined by biophysical characteristics such as shallow soil profile, temperature, rainfall and topography.

Marginal lands are characterized by extreme climate, poor physical and chemical characteristics to be cultivation. They include areas with limited precipitation, extreme temperatures, low soil quality, and several restriction problems for agriculture [5]. Examples include deserts condition as lack of water area, high mountains, land affected by salinity, waterlogged or marshy land, barren rocky areas, and glacial areas. Evidently, not all of these areas are suitable for agriculture. Various marginal land categories are identified as the following:

- Bare and herbaceous areas (not in use or with only low intensive pastoralism).
- It is not includes lands with intensive and extensive pastoralism.
- Lands with moderate (8–16%) and steep (16–30%) slope.
- Lands with soil problems such as shallow soils (depth < 50 cm)—poorly and weak drained soils—soils with low to moderate fertility—coarse textured—soils with heavy cracking clays—salt-affected soils (Saline–Sodic–Saline sodic and calcareous soils)—soils with gypsic and lime horizons—Acid soils—and peat soils [5].

Degraded Lands

Definitions of Most Degraded Lands and Other Types of Land Associated with Degraded Land

The low quality soils and degraded lands can be concluded in the following types [6]:

Abandoned agricultural land is "land that was previously used for agricultural production or as pasture but that has been abandoned and not converted to forest or urban areas" [6].

Degraded land is "land that has experienced the long-term loss of ecosystem function caused by disturbances from which the system cannot recover unaided" [7].

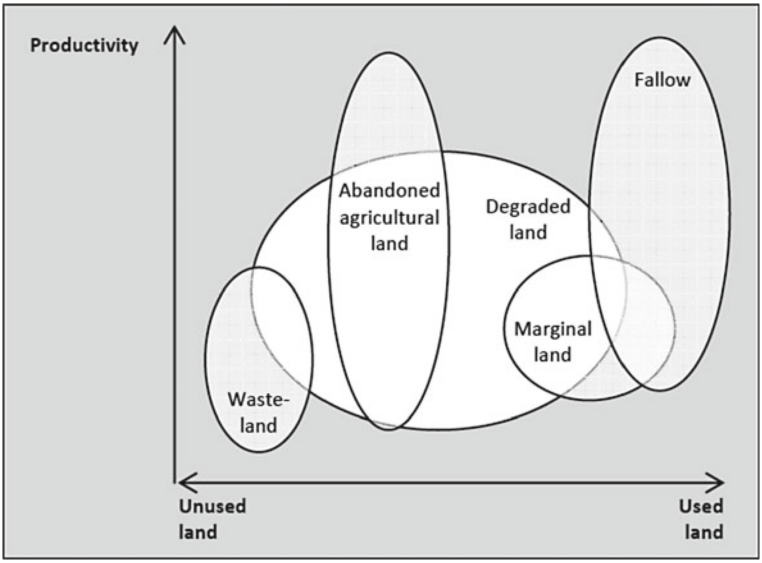

Fig. 2 The different types of lands according to soil quality [6]

Fallow land is "land on which cultivation has been temporarily suspended for one or more vegetation periods to allow recovery of soil fertility".

Low/high-productive land: "spectrum on which land gradually changes from low to high productivity for agriculture and forestry (reclaimed and improved soils)".

Marginal land is "land on which cost-effective food and feed production is not possible under given site conditions and cultivation techniques and never gives more than 25% of the yield crop standard".

Wasteland: is characterized by "natural physical and biological conditions that are unfavorable for land-associated human activities" [8].

The relation between the different soil types is given in the next figure (Fig. 2).

Water Scarcity, Water Shortage and Related Concepts

Before discussing the value of water in a hyper arid country such as Egypt; we will explain the concept of water scarcity to know the value of water as a costly and precious nature resource.

Water Scarcity

"An imbalance between supply and demand of freshwater in a specified domain (country, region, catchment, river basin, etc.) as a result of a high rate of demand compared with available supply, under prevailing institutional arrangements (including price) and infrastructural conditions". Its features are: over demand, tensions and conflicts between users, high competition of different sectors for water, over-extraction of groundwater [9].

In addition, there are more definitions related with water scarcity.

Chronic Water Scarcity

"The level when all freshwater resources available for uses are being used". Beyond this level, water supply for use can only be made available through the use of non-conventional water resources such as agricultural drainage water, treated and non-treated wastewater (industry and sanitation) or desalinated water, or by managing demand and changes agricultural policies. A range between 500 and 1000 m^3/person/year has often been used as a proxy to indicate chronic water scarcity [10].

Absolute Water Scarcity

"Insufficiency of water supply to satisfy aggregate total demand (agriculture, municipal, environment and industry) after all feasible options to enhance supply and manage demand has been implemented". This situation leads to restrictions on water use (such as forbidden of rice, sugar can, forage, and banana cultivation). A threshold of 500 m^3/person/year is often used as a proxy to indicate absolute water scarcity [10].

Water Shortage

"A shortage of water supply of an acceptable quality; low levels of water supply at a given place and a given time relative to design supply levels as a result of insufficient water resources, lack of infrastructure or poorly maintained infrastructure; or low levels of water resources as a result of annual or seasonal differences in precipitation, climate or a range of hydrological or hydro-geological factors" [9, 10].

Water Stress

"The symptoms of water shortage, causing conflict between users, and competition for water, declining standards quality of reliability and service, harvest failures and food insecurity". This term is used to describe a variety of circumstances and causes [9, 11].

Type of Water Scarcity

Three main dimensions of water scarcity can be summarized as follows [9]:

1. "Scarcity in water resources of acceptable quality with respect to total demands", which call "physical water shortage";
2. "Scarcity due to the lack of adequate technical technology and infrastructure, regardless of the level of water resources". This due to financial, technical or other constraints; "technical and economical water scarcity" and
3. Scarcity in access to water services, because of the failure of institutions (including legal rights) in place to ensure reliable, secure and equitable supply of water to users [11].

Some Important Parameters Related to Water Uses in Scarce and Arid Areas

In developing and poor countries especially that located in arid regions, which are usually suffering from various types of water scarcity; there are some parameters that should be considered during their little water managing such as:

Cost of Water

The cost of water relates to the direct expenses to delivering the service of water supply. Full supply cost includes operation, maintenance and replacement costs. The full cost of water to society should include its opportunity cost, and both economic and environmental externalities associated with water supply [12, 13].

Water Pricing

Is the action of establishing a price for a water service. The price can be calculated to cover all or part of the costs of the water service and its delivery, or to induce a change of behavior in water use through less wasteful water use. In irrigation, it can be calculated per area of land, type of crop, or on a volumetric basis. The price assigned to a water service is often called “water tariff”.

Therefore in water resource planning, cost-benefit analysis needs to adjust observed prices or estimate prices altogether. These adjusted or estimated prices are commonly referred to as shadow prices [12, 13].

Impacts of Water Pricing

Pricing water will create several problems especially in developing countries and downstream rivers such as:

1. If the downstream river countries sell the river water to their users, the upstream river countries will have a right to obtain a price of their boarder transient water. Then the water will be a good not a service. The downstream country could claims this will be the cost of water delivery not a price of water.
2. The International Rivers such as Nile River will be a private river to upstream countries not a cross boarding natural water resource for all riparian countries; which will create conflicts.
3. The downstream countries may be obliged to pay all its GDP for obtaining their river water share, i.e., if the pricing is similar to the cost of desaline of sea water as the World Bank recommended.
4. No country had chosen its location in the world map, thus no advances to the upstream countries and no any fault or mistakes on downstream countries.
5. This matter will open the door to the upstream countries to sell their water to any other countries out of the river basin or even by shipping or piping for any delivery orders.
6. Water pricing will cause rising of food prices which will make severe problems in the poor’s and threaten the UN principal of “Right to food”.

Water Productivity

“The quantity or value of output in relation to the volume of water used to produce this output”. Crop water productivity is the amount “kg” or “calories” or “values” that product per unit of water supply per cubic meter [12, 13].

Water Situation in Egypt

Officially, according to the ministry of Water Resources and irrigation [14, 15], Egypt is suffering from a deep shortage of water resources where the water shortages reaches 42 billion cubic meter a year (BCM/yr). The total water resources is a sum of 62 BCM/yr (55.5 from the Nile River + 5.5 ground water + 1.3 rainfalls) for 104 citizens which present the total population of Egypt. This population deserves

Table 1 Conventional definitions of levels of water stress [16]

Annual renewable fresh water (m^3/person/yr)	Level of water stress
<500	Absolute water scarcity
500–1000	Chronic water shortage
>1750	Occasional of local water stress

104 BCM/yr; at rate of one southland cubic meter per capita to be above the stress level of water scarcity [16]. Thus the differences between total aggregates demands by the various sectors (domestic, municipal, industry, agriculture) in addition to the water needed for environmental protection, cannot be satisfied by the existing supply of the resources (at a given place and at any moment in time (FAO) [9] reached 42 BCM/yr (Table 1).

Questions About the Water Shortage in Egypt

Under this deep water shortage we need to answer the following questions:

1. When we have a new ground water in desert and marginal lands, what the optimum economic using of this water?! Should we use it to lower the water shortages level?!, or should we use it in some economic activity to increase the GDP and to cover the people demands; such as agriculture extension, industry, hotel, domestic and housing uses to provide new houses with drinking water for the next generations?!
2. What is the priority of using this new ground water in different sectors?! should be agriculture extension, or industry, or municipal and new housing?!. Or it is better to be with economic vision of the highest return back of using unit of water?!
3. Regarding the economic value and the return back from the unit of water, should water shortage countries omit the priority of its agriculture sector because it has the less return back value and change their economic activity to industry and hotel/tourist activity?!, which means losing their food security and rely on importing food with its rapid change and soaring of food price from time to time?!.
4. If the decision maker command in using the new water in agriculture extension in desert lands; where should we apply; warm or cold areas; rainy or dry lands?! And in which crops (cash or regular crops)?!.
5. What agriculture policy should be followed?! Increase the food production and enhance food security or crop for export?! Cash crops of organic farms?! Regular and traditional crops or to translocate some crops suffering from epidemic chronic diseases in the old lands such as potato, onion and tomato to be cultivated in the new pure virgin reclaimed areas?!

Water Use Priority in Egypt

Let us answer the previous questions:

The Priority of Using Ground Water

Groundwater provides drinking water to at least 50% of the global population and accounts for 43% of all water used for irrigation. Groundwater also sustains the base flows of rivers and important aquatic ecosystems [17].

A country suffering from deep water shortage (such as Egypt), where the share water per capita is 600 m and became so narrow from absolute water scarcity, should be thinking seriously on ground water. Moreover; when the desert ground water in this country is limited and unrenewable; this needs more and more thinking about the use of this precious ground water.

The first question may come in the mind of policy makers; is: should water be used to refill or to lower the deep water shortage?! Some researcher believes that; when the people adapt with water scarcity; we should invest this new water in economic sectors to increase the country income and to achieve development progress. Policy maker in arid and poor countries believes that; the person in Africa and Asia doesn't need the amount of 1000 cubic meter/year; as the person who lives in industrial and developed countries in Europe and North America. Thus the people in developing countries may adapt and alive without suffering at a rate of water share of 500 m^3/year. This trend is so theoretical because most of developing countries especially that located in hyper and arid regions rely on the agriculture sector as a main activity on their GDP and this cost them more water consumption than in developed countries. In developing countries the agriculture sector consumes 82% of the total water resources compared with 30% in the industrial developed countries. On vice versa; the industrial sector in developed countries uses 59% of the total water resource compared with 10% in the developing countries [18, 19], as seen in Fig. 3.

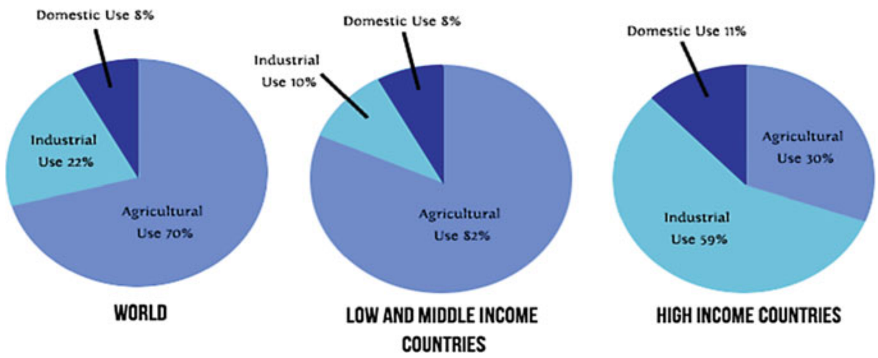

Fig. 3 Competing water uses by sectors in high and low income countries [18, 19]

This data reflects that the return back of the water unite in the industry sector is higher than that of the agriculture sectors. Moreover, some report stated that only 2–6% of the total population employment in developed countries works in agriculture sector and still they are able to feed their people and make sufficiency for export. On the contrary, 33–66% of the population's labors work in the agriculture sector in developing country but they are not able to feed their people and they suffering from food insecurity [20]. For example, Egypt imports 65% of their total essential food which costs Egypt 15 billion dollars/year, with 33% of agriculture employment; and sharing in GDP by only 11.9% [21]. This data reflects the advanced techniques applied in agriculture sector in developed countries compared with those that are primary and out of time ones applied in developing countries and the urgent needs for modernization in this sector [22]. Tables 2 and 3 shows the low rate of using chemical fertilizers and agriculture machines in the Arab Countries compared with world rate and the low production of agriculture labor production in Arab world due to relying on hand work labors not on machine. Figures 4 and 5 explains the employment in Agriculture sectors in developed and developing countries and the low productivity of cereal in Arab countries.

Concluding remarks

According to the Fig. 7 and Table 4, Agriculture sectors in Egypt consume 62.5 BCM/yr, and share in Egyptian GDP by only 11.9%, while the industrial sector,

Table 2 Some agriculture development indicators in the Arab world and world [22]

Item	Unit	Arab world 2013	World 2013
Food standard production	%	118.8	122.9
Rate of using chemical fertilizers	Kg/ha	82.4	141.3
Rate of using machine	Tractor/1000 ha	11	20
Cereal production	Ton/ha	1.74	3.85
Rate of rural/urban	%	41.6	47

Table 3 Productivity of labor in agriculture sector in Arab and developed countries [24]

Country	Agric. labor productivity per dollar (2003–2005)	Cereal production (kg/ha)	Average of chemical fertilizers (kg/ha)
Egypt	497	7545	572
Syria	1196	1786	73
Morocco	719	1243	52
Sudan	371	650	4
Saudi Arabia	5523	4559	99
Holland	23,396	8309	564
United State	23,066	6443	114

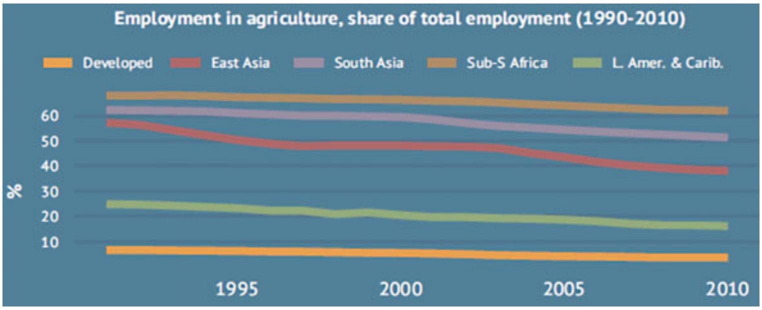

Fig. 4 Employment in agriculture, share of total employment (1990–2010) [20]

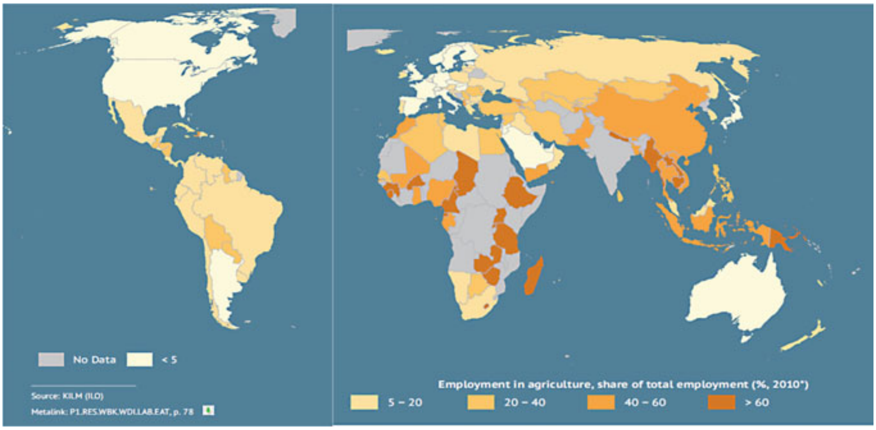

Fig. 5 Employment in agriculture, share of total employment (1990–2010) [20]

consumes a little water as low as 2.4 BCM/yr, but shares in GDP by 17.1. Moreover, we should add the sales of retail trade to the industry sector because all of their products are manufacturing and belongs to the industrial sector, then the total share of industrial sector in GDP will be 31.1%, from only 2.4 BCM/yr of water. In addition and according to Figs. 4, 5, 6 and Tables 3, 4, Agriculture sector in Egypt neither modern nor smart which lead to heavy intensive labor work with low usage of agriculture machines and chemical fertilizers with low production with high cost and low rate of labor production.

In this case industrial sector should have the first priority in using this valuable and costly ground water (in the water shortage and water scarcity countries) to enhance their weak economy and help in eliminate hunger and reduce poverty. This recommendation is also so fitted to Egypt and North Africa countries (Fig. 7).

Table 4 Water demands for different sectors in Egypt at different scenarios [26]

Water demands (BCM/yr)	Current scenario (BCM/yr) (2015)	2025 Normal scenario	2025 Ambitious scenario	2015 Extra scenario
Agriculture sector	62.5	66.6	33.2	33.2
Deep ground water consumes	9	7.4	5.9	5.9
750,000 Feddan reclamation project	–	5.1	4.1	4.1
Domestic sector	9.9	11.2	10	10
Industrial sector	2.4	4	3.3	3.3
Total	80.8	94.2	56.6	56.6

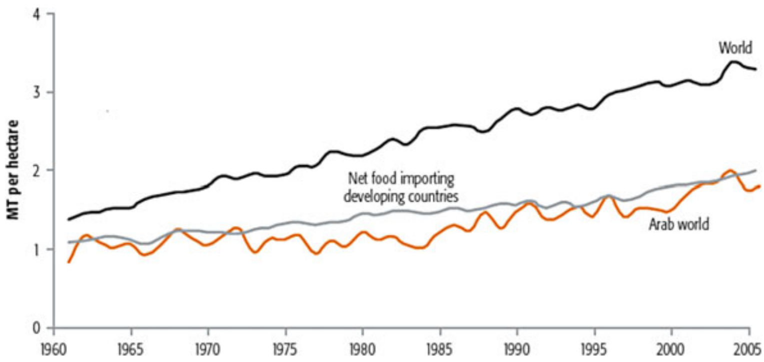

Fig. 6 Low cereal productivity in Arab states compared with world [23]

Using Ground Water in Desert Cultivation

In the scarce water countries especially those in warm and dry weather, the use of desert ground water should be carefully and according to deep scientific background. These countries should address (locate) firstly its needs for increase food shortage under the lack of their foreign currency needed to imports it. In case of adapting people with water scarcity as well as the possibility of attracting new investments to construct industrial factories should be put under consideration. This will be controlled according to its natural resource and the presence of some important raw and crude materials. The national natural resources (blue economy) needed for industry extension such as lime stone for cement production, iron hydro-oxides for steel industry, mud and some clay minerals and silica for ceramic industry, Bauxite for aluminum industry, and enough electricity power for all these factories in addition to the building of new chemical fertilizers factories and so on.

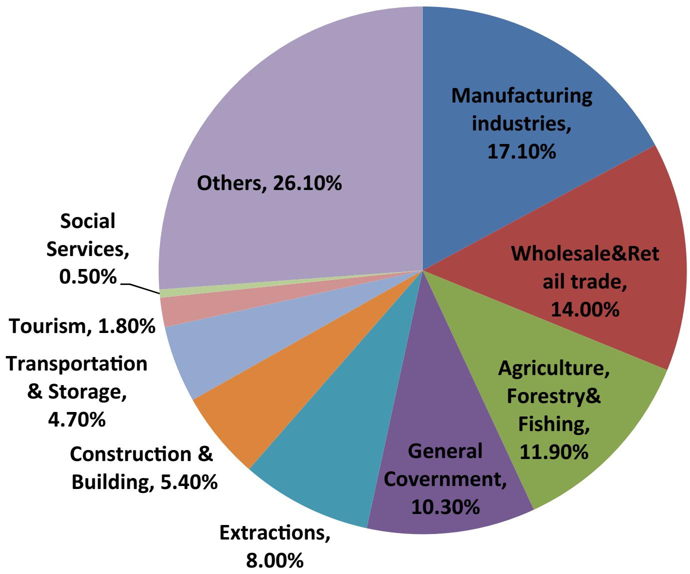

Fig. 7 GDP breakdown in Egypt by economic activity [25]

If one single country is suffering from economic and technical water scarcity (Scarcity due to the lack of adequate technical technology and infrastructure, regardless of the level of water resources [9]), then the use of their water in agriculture will be the easy way because the agricultural is usually the job of the poor's especially in the primitive and out of time agriculture (African countries).

Country with physical water scarcity (Scarcity in water resources of acceptable quality with respect to total demands) should think out of box (not out of scientific logic) and forget completely the revolution emblem or logo to create a fever in their follower people. For example, if one country such as Egypt, is suffering from a deep water gap that reached 42 BCM/yr, reduced it to be 22 BCM/yr by reusing of all types of wastewater. This country should not be planes for reclaiming four million acre (1.7 million hectare) in their warm tropical dry desert lands. The priority of this country and in the current time should be to use this water in industrial or housing and hotel (resorts) sectors. But, if they succeed on raising the efficiency of water distribution (delivery) in the irrigation canals, and also raise the irrigation efficiency inside the fields, that may save 30% of the total water resources (almost of 20 BCM) especially if the country relies on surface open (un-cemented, un-piped) irrigation and drainage canals, then in this case, the water saved may permit the country to use the new ground water in desert cultivations, but In which desert land we should start?!

Specifying the Location of Agricultural Extension

Egypt consists of three main climatic zones as seen in Fig. 8.

Delta and North Egypt (Lower Egypt)

North Egypt includes all Delta districts (8 governorates holding 55% of total population), the north cost of Mediterranean (Alexandria and Matrouh Governorate in the west and North and Sinai in the East), and three Suez Canal Governorates; Port Said, Ismailia and Suez). This area belongs to Mediterranean climate zone which has temperate weather, high humidity especially in the summer time, low evapotranspiration rate, and appreciable winter precipitation, which allow cultivating miscellaneously and large numbers of economic crops (vegetable, fruits, and field crops). This area has a good advantage for low water consumptive uses of all crops and high yield in addition to having a cold rainy winter that helps to save much water. This zone has a good advantage of the narrow differences between night and day temperatures and no frost or sharp decreases in temperature in the early morning

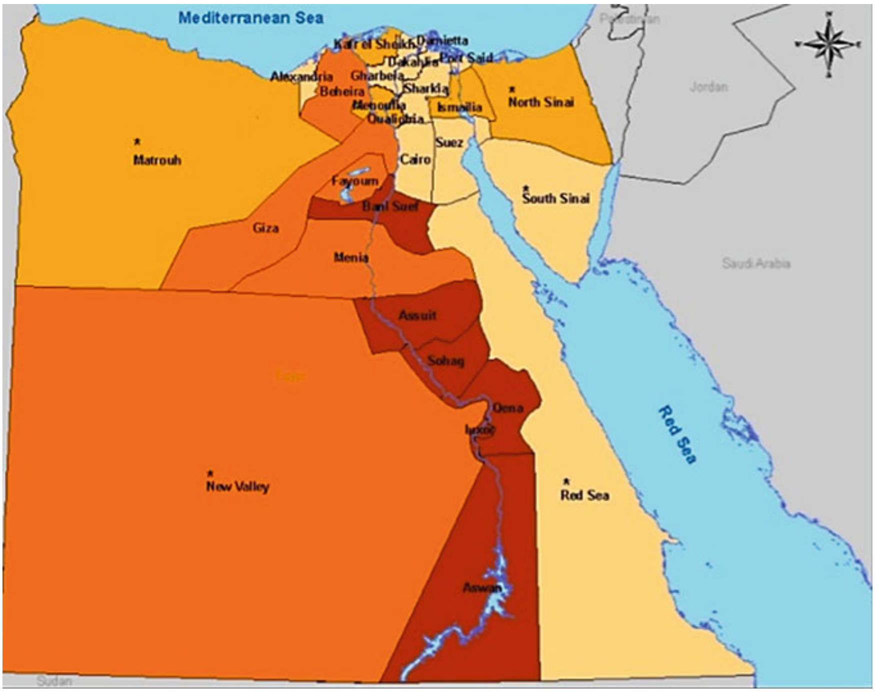

Fig. 8 Maps of Governorates in Egypt [27]

during winter season and never having frost that hurt the plant leafs so much, as it frequently happens in middle Egypt.

Middle Egypt

The middle Egypt is located south to the capital Cairo and includes another 6 Governorate in the upper Nile Valley. These governorates are: Giza, Fayoum, Beni-swef, Minia, Assuit, Sohag in addition to the north part of Red Sea Governorate in the east, South Sinai. Moreover, it includes the north part of the largest desert Governorate area in the western desert which is "New Valley or Wadi Jadid" that occupies 44% of the total Egypt area. In the Middle Egypt zone, the temperature starts to increase by 2° to 5° than the Delta and North Egypt, the humidity is lower and behaves in a reversed way to the Delta where it decreases in the summer and increases in the winter, but never exceeds 50% while it may be saturated as high as 90% in the Delta. The weather in the Middle Egypt almost has no rain, but some of their parts exposed to extreme flushing floods (heavy rains in short time) causing severe hazards even in the Nile Valley or south Sinai and Red Sea Governorates, as seen in Fig. 8. Middle Egypt is characterized by sharp decreases in night temperature especially in the winter months (December to March) which may become as low as below zero degrees with frost formations that may cover and harm the growing plants. Thus, Middle Egypt has higher evapotranspiration and water consumption than north Egypt due to high temperature, low humidity and high dryness. Middle Egypt weather allows for cultivation of all crops that are cultivated in North Egypt such as sugar beet, alfalfa, beans, with the first appearance of sugar cane cultivation in the Mania Governorate.

Upper Egypt

Upper Egypt means the extreme south of Egypt that includes, Qina, Luxor, Aswan, the south part of Wadi Jadid that includes Toshka and Sharq El-Oainate (east of the Oainate mountain) in the west, and the south part of the Red Sea Governorate and the triangle of Halieb and Shalateen (Fig. 9). Upper Egypt records the highest temperature, as seen in Fig. 10 may become 14° more than the North Coast, as seen in the temperature map in the summer, with high aridity, zero rainfall in addition to the lowest humidity percent in Egypt. Moreover, the aridity in Upper Egypt also increases in winter and decreases in summer which leads to high water consumptive uses by plants. Under this condition the evapotranspiration and water consumptive uses are the highest in Egypt. The numbers of different kinds of plants that can tolerate the high temperatures in the Upper Egypt are so limited and need high water demands. The sugar cane is the main field crop in Upper Egypt with some of aromatic and medicine halophyte crops such as hibiscus and some spicery crops. Table 5 shows the comparative water consumptive uses on different crops in north, middle and south Egypt.

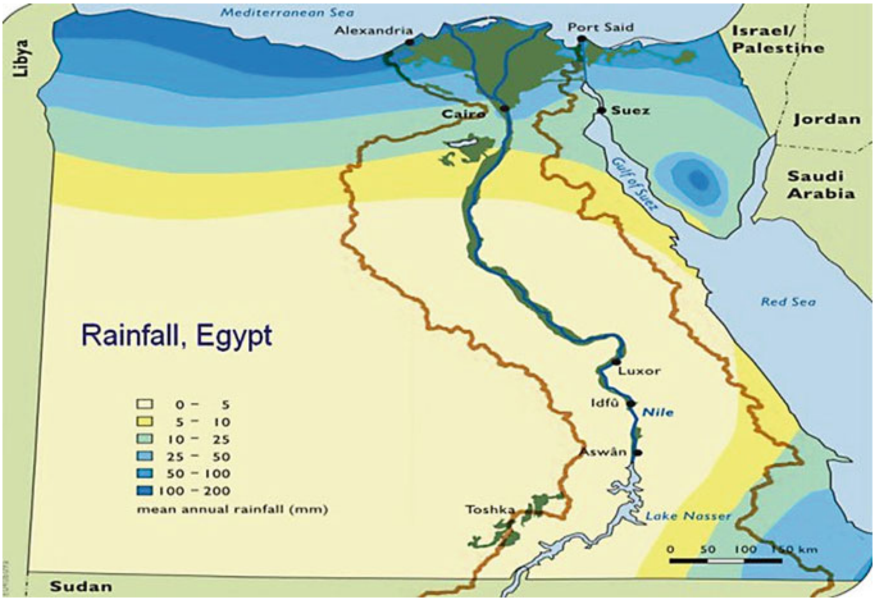

Fig. 9 Rainfall distribution in Egypt [28]

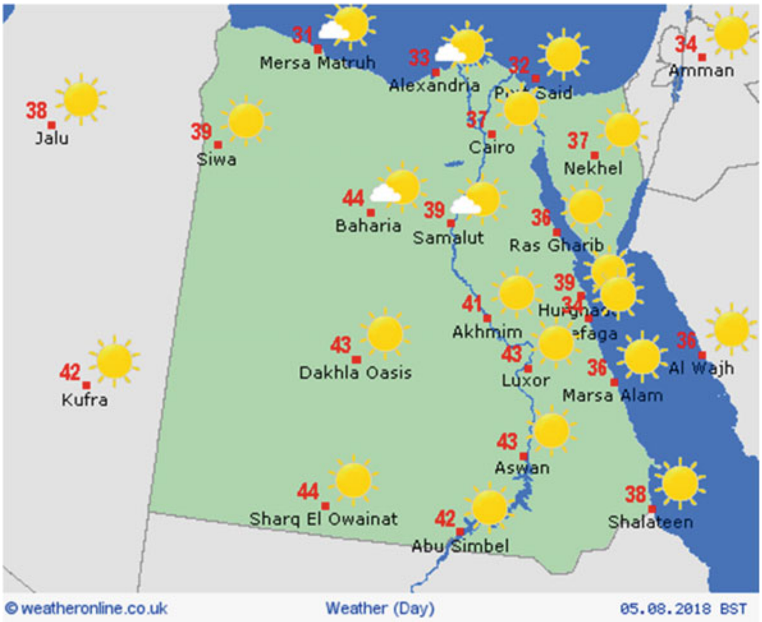

Fig. 10 Example for maximum temperature in upper, middle and lower Egypt (august, 4th, 2018) [29]

Table 5 Water consumption by crop type and region, Egypt [30]

Crop	Water consumptive by region (m^3/acre)			
	Delta	Middle Egypt	Upper Egypt	National average
Sugar cane	–	10,000	12,750	11,375
Rice	6470	–	–	6470
Fruits	5610	5798	7522	6310
Cotton	2645	4960	5434	4346
Peanuts	1162	2752	5738	3217
Maize	2400	2657	3947	3001
Wheat	2152	2795	3072	2673
Malts	1670	2520	3015	2402
Summer veg	1695	2138	3280	2371
Onions	2280	2410	2410	2367
Sesame	1866	2152	2630	2216
Beans	1790	2195	2558	2181
Winter veg	1604	2250	2450	2103
Lentil	1865	2105	2263	2078
Average of all	2555	2672	3409	

From the last discussion, and according to the deep Egyptian water shortage, the uses of ground water in agriculture extension should be in the north of Egypt where the temperature is moderate with low water consumptive use. Even when we follow the history of land reclamation projects and greening the desert projects we find that all the successful projects are located in Lower Egypt (such as: Nubaria, Salhia, Moderiat El-tahrer south Alexandria, Ramses, Wadi El-Natroun, Cairo Alexandria, Cairo Faioum, Cairo Ismailia desert roads, …) no one single successful project is located in Upper Egypt (complete familiar of Toshka project so far). Thus, Egypt should concentrate on having the land reclamation projects in the north desert and delta Frings, and use Upper Egypt for industry projects and extension. Egypt has several raw materials in Upper Egypt that are needed for different types of manufactories such as lime stone for cement, muds and clay minerals for ceramic, electricity and phosphates for chemical fertilizers, high quality fine sand for solar mirrors and lenses and many others.

Egypt Reduces the Rice Cultivation Due to the Water Shortages

The rice cultivation becomes the only alternative choice of the Nile floods which stopped after the construction of Aswan High Dam that ended on 1971. After this period, the salinity building up in the Delta lands continues according to the sea water intrusion to the shallow water table (water logging) and the active capillary rises in the clayey soil of the Delta. The absence river floods after High Dam, and the absence of leaching of the delta soils due to the lack of water results in; that the rice cultivation becomes the only valid and guaranteed way to leach out salts from some of the delta soils every year especially those located close to the Mediterranean coast, the main source of salinity. Delta lands are the capital of agriculture production in Egypt because it contains 72% of the total alluvial soils and produce 62% of agriculture production in addition to it having 55% of the Egyptian population [31]. The soil salinity in the north part of the delta reaches 46% of the total delta area, and in the middle delta 37 and 24% in the south delta with average of 37% for all the total area of the Delta which reaches 4.5 million acres [31]. Thus, the average area of saline soils in the Delta is 1.7 million acre which should be cultivated by rice every year to control the salinity building up and to save the soil's health and fertility. The rice cultivation is the only economic crop and at the same time is the reclamation crop that protects the delta lands from degradation.

As a result of the Ethiopian declaration about the beginning of the first fill of the lake of the Great Ethiopian Renaissance Dam (GERD), on June 2018; The Egyptian Government obliged a new policy for rice cultivation and reduced its regulate area to be only 700,000 instead of 1.5 million acre during the last 20 years.

For wondering, the agriculture policy recommended to increase the investment in the field of red meat production from cattle investment, cotton cultivation (long period crop needs 9 months growth period), forage crops such as alfalfa (Egyptian Beseem with 5 cuts), which all have high water consumption than rice; with no touching of other high water consumptive use crops such as sugar cane, banana and other wide leaf vegetable; just limited the rice cultivation. Moreover, the policy of greening the desert is still as it is and is recommended to reclaim 4 million acre (1.7 million ha) in the desert lands which needs at least 20 billion m^3/yr at a rate of 5000 m per acre!! No talk also about the possibility of getting usefulness from this the new discovered ground water to reduce the gap of water shortage in Egypt by delivering it to the domestic use or to the Nile and its canals.

Egypt Agricultural policy needs urgent reconstruction and to have new policies more suitable for our limited water resources and put good priorities for using every drop of water.

Conclusion and Recommendation

In countries that are suffering from water shortage especially in the arid and warm regions, strategy of priority of using ground water should be planned. The return back of the unit of water in industrial sector is ranged between 10 and 300-fold than the agriculture sector. The industry sector uses a little of water which does not exceed 10% of the total water resources in the developing countries, but share in the GDP of the country 10 times more than the agriculture sectors which consume 85% of the total water resources. The labor income in the industrial sectors is higher as 2–10 times that of the labor income in agriculture sector. Under specific conditions in some developing countries that are obliged to use the new discovered ground water in agriculture to reduce the food insecurity and the lack of foreign currency; scientific and logical policy should be followed. The priority of using ground water in agriculture should be to the low temperature and seasonal rainfall area. Thus the new greening desert and agriculture extension projects in Egypt should be in the North and the Mediterranean coast of North Egypt which have a low temperature than south Egypt by 14 centigrade. The south, warm and low humidity region should have a priority for industry investments to reduce poverty and maximize the return back of water unite.

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