Standing Committee for Economic and Commercial Cooperation of the Organization of Islamic Cooperation (COMCEC)

COMCEC Coordination Office

COMCEC

Increasing Agricultural Productivity in the COMCEC Region:

IMPROVING IRRIGATION CAPACITY

June 2013

Standing Committee
for Economic and Commercial Cooperation
of the Organization of Islamic Cooperation (COMCEC)

INCREASING AGRICULTURAL PRODUCTIVITY IN THE COMCEC REGION:

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June 2013

Cover Image: by İsmail Danyeli - The 2nd National Photography Contest with the theme of "Agriculture and Human" held by the Ministry of Food, Agriculture and Livestock of Turkey

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SYMBOLS

COMCEC	: Committee for Economic and Commercial Cooperation of the Organization of the Islamic Conference
DEV	: Developed Countries
ERWR	: External Renewable Water Resources
IRWR	: Internal Renewable Water Resources
LDC	: Least Developed Countries
OECD	: Organization for Economic Co-operation and Development
RWR	: Renewable Water Resources
TRWR	: Total Renewable Water Resources

1. INTRODUCTION

Agriculture plays a critical role in development of many countries including the COMCEC Member Countries. It plays an essential role in economic growth, employment and poverty reduction. In many COMCEC Member Countries, agriculture is not only about food production but also a very important means of broad-based income generation. It remains the function of being the largest contributor to the livelihoods of millions of people in the COMCEC region.

Agricultural production has considerably increased worldwide since 1960s. Ascending crop yields have crucial role in this increase. Progresses in quantity and quality of agricultural inputs, such as fertilizer, water, mechanization, fuel, seed, land and labor, have been the main reasons of crop yield increase. It is estimated that growing fertilizer and irrigation applications have been responsible for over 70% of the crop yield increase throughout the world.

Water is the most crucial input for agricultural production. Globally, agriculture accounts for more than 80% of all freshwater used by humans, most of which is for crop production. Besides being an indispensable input, water acts as an augmenting input in agriculture when combined with other inputs of production such as improved seeds and fertilizers. Thus, it has a tremendous role to play in agriculture in increasing both production and productivity.

Today, most of the COMCEC Member Countries are suffering from water scarcity or absolute water deficits. In addition, modern irrigation methods and water-saving technologies are either rare or totally absent.

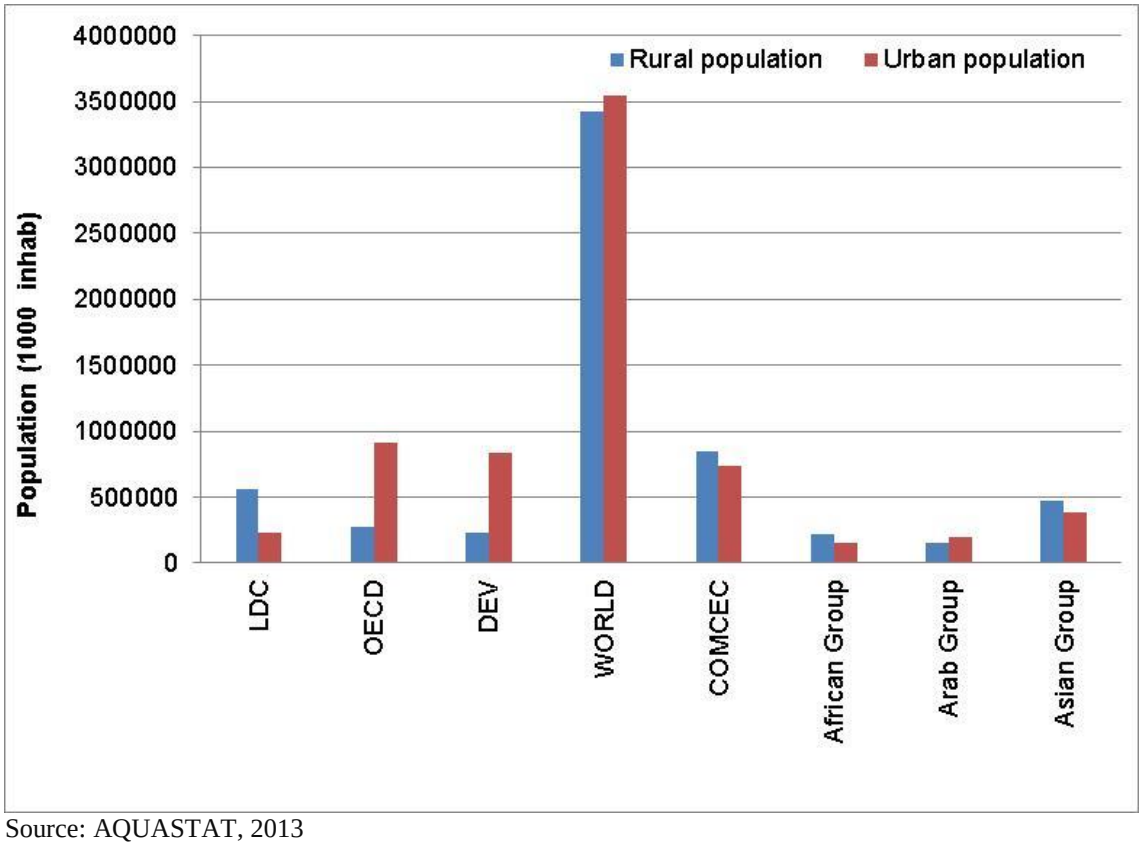
This study was prepared upon the request of the COMCEC Coordination Office to elaborate on the relationships between irrigation and agricultural productivity in the COMCEC Region. Within this framework, first of all, current agricultural status of the COMCEC Region including agricultural population and economy was disclosed briefly in this Report. Then, the issues regarding the irrigation in the COMCEC countries were analyzed comprehensively. The common problems experienced in irrigation were put forward and possible solutions were proposed and formulated for such problems.

The 57 COMCEC Member Countries have been divided into three regional groups based on geographical location namely African, Arab and Asian Groups (Annex11).

2. POPULATION

Analysis of rural and urban population density revealed higher urban population in OECD and Developed (DEV) countries than the rural population. The reason for this is just higher life standards of the cities in developed countries. The urban population is approximately 51% and the rural population is about 49% of the total world population (Figure 2.1). Lower life standards of the urban areas in the Least Developed Countries (LDCs) led to have lower urban population than rural population (almost twice as much of urban population). Rural population is also higher in the COMCEC Member Countries than urban population. With regard to population density, DEV group countries have the highest density with 323.97 people/km^2. World population density is 179.55 people/km^2 while LDC group has a density of 129.86 people/km^2 (Annex 1).

Figure 2.1. Distribution of Population



Source: AQUASTAT, 2013

2.1. African Group

In African group, Nigeria has the highest population (162.5 million) with an urban population of about 82 million and rural population of 80 million people. In Nigeria, 50.9 million people are economically active and 12.3 million of which deals with agriculture. In Uganda and Burkina Faso with relatively low urban life standards, majority of the population is rural. Gabon is the smallest country in this group; the total population is 1.5 million. Rural population of Gabon is about 0.21 million people and 0.18 million of which is economically active in agriculture.

2.2. Arab Group

Egypt is the most populated country in Arab Group. The population density of Egypt is 82.4 inhab/km^2, majority of the people (46.6 million people) live in rural parts of the country and approximately 35 million people live in urban of the country. Saudi Arabia is the wealthiest country with vast majority of people (23.1 million people) living in urban and a small portion (4.97 million people) living in rural parts of the country. Sudan and Yemen are less developed countries of this group and people prefer to live in rural parts of these countries. The most densely populated country of this group is Bahrain (1.742 inhab/km^2) (Annex 1). Total population of Bahrain is 1.3 million and the rural population is about 150 thousand.

2.3. Asian Group

Asian group, formed by relatively more developed countries like Turkey, Iran and Malaysia have higher urban population than rural population. The rural population of Turkey is 22 million and 8 million of which deals with agricultural activities. Turkey's urban population is about 51 million and most of the country population is gathered around the major cities. In less developed countries such as Afghanistan, Bangladesh, Indonesia, Pakistan, the rural population is more than the urban population. In Bangladesh, rural population is about 107 million and the urban population is about 43 million. Total population is 150.5 million and the population density of the country is 1045 inhab/km^2 (Annex 1). Maldives is the most crowded country (1.067 inhab/km^2) in this group. The total population of Maldives is about 320 thousand people. Of this population, 188 thousand live in rural areas and 132 thousand live in cities.

3. ROLE OF AGRICULTURE IN THE COMCEC ECONOMY

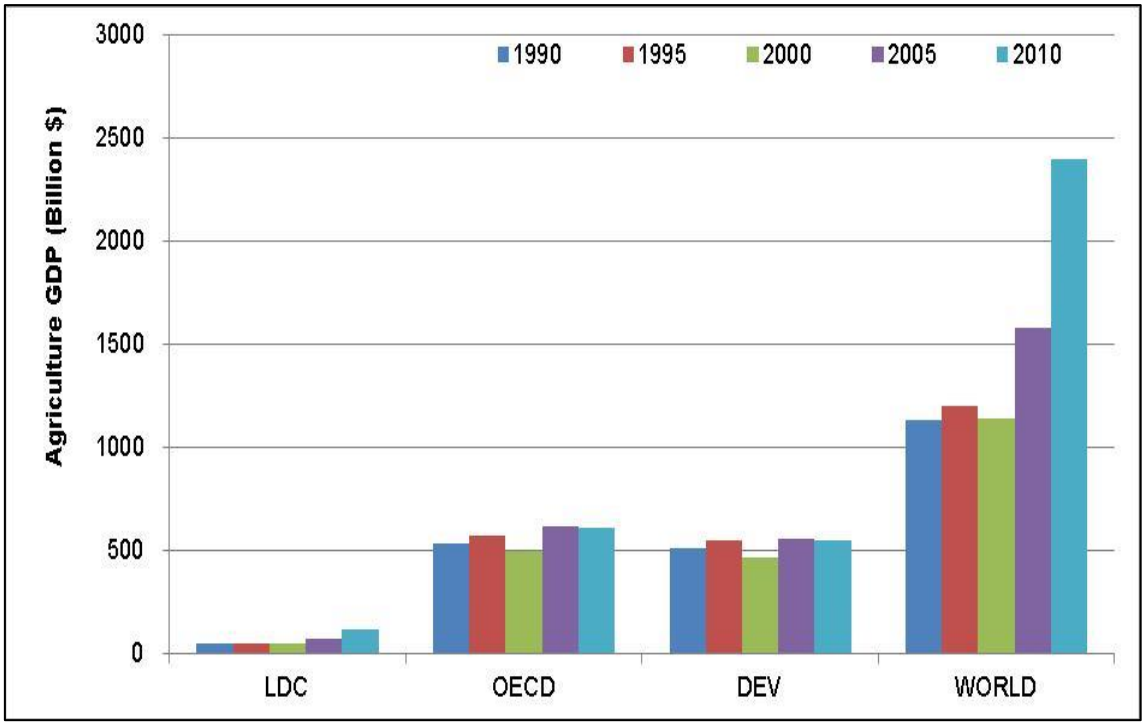
The 57 COMCEC Member Countries, as a group, account for more than one fifth of the world total population while they represent one sixth of the world surface area. The COMCEC Member Countries constitute a substantial part of the developing countries. The gap between the rich and the poor COMCEC Member Countries is substantial. In this context, 22 COMCEC Member Countries are currently classified by the World Bank as Low-income countries and 28 are Middle-income countries (20 less middle-income and 8 upper middle-income). In contrast, only 7 COMCEC Member Countries are classified as high-income countries.

The significance of agriculture in national economies varies extensively. While in many least developed countries, agriculture accounts for more than 50 % of GDP, in high income economies such as the members of Organization for Economic Co-operation and Development (OECD), agriculture constitutes less than 1,5 % of overall economic output. Thus, the role of agriculture in overall economic growth will vary from country to country, and in general agriculture is more important in poorer countries. In view of the fact that many COMCEC Member Countries are among the poorest countries of the world, it is seen agriculture is the one of the most important sector for the COMCEC as a group (COMCEC Coordination Office, 2013)

With 22.5% of the total world population, the COMCEC Member Countries accounted for only 7.2% of the world total GDP in 2009. At the individual country level in 2008, the agricultural sector dominates in only 7 Least-Developed countries, namely Afghanistan, Comoros, Guinea Bissau, Niger, Sierra Leone, Somalia, and Togo.

On the other hand, COMCEC Member Countries represent 21.7 % of the world agricultural GDP with almost 551.7 billion US Dollars agricultural value added in 2010.

Figure 3.1. Agricultural GDP in the World



Source: AQUASTAT, 2013

3.1. African Group

In African group, Nigeria has the highest share in agricultural GDP. The rate declined in 1995 compared to the previous periods but then increased again. There was more than 100% increase compared to the previous periods especially in the year 2005 (Annex 2).

In African Group Countries, share of agricultural GDP has increased steadily. Especially, compared to the previous periods, there had been approximately 134% and 87% increase in the years 2005 and 2010, respectively. Share of agricultural GDP in total GDP of Benin, Burkina, Faso, Chad, Gabon, Gambia, Guinea, Guinea-Bissau, Mali, Mozambique, Niger, Senegal, Sierra Leone and Togo are less than 1% (Annex 2).

3.2. Arab Group

Rate of agricultural GDP in Bahrain, Comoros, Djibouti, Jordan, Kuwait, Mauritania, Oman, Qatar, Palestine and Yemen are less than 1% in examined period. There was significant decline in the Saudi Arabia's agricultural incomes' share in total in 2005 and 2010 (Annex 2). There has been no change in the share of agricultural GDP

as a percent in Morocco in the respective period. There were significant decreases in the Iraq's agricultural incomes in GDP as a percent in 1995 and 2000 and it has not reached the level of 1990. Although there has been continuous decrease in the United Arabia Emirates' agricultural incomes in GDP as a percent since 2000, it has been constant in the same periods. Agricultural incomes in GDP of Arabic Countries have increased continuously and this increase was approximately 65% in 2010 (Annex 2).

3.3. Asian Group

The share of agricultural GDP in total was less than 1% in Albania, Azerbaijan, Brunei, Kyrgyz Republic, Maldives, Tajikistan, Turkmenistan, Guyana and Suriname. However, in Turkey and Indonesia, agriculture has more than 10% share in total domestic products.

Although there were declines in the share of agricultural GDP of Turkey and Pakistan, there had been general increase in agricultural incomes as an amount since 2000 except for 2010 (Annex 2).

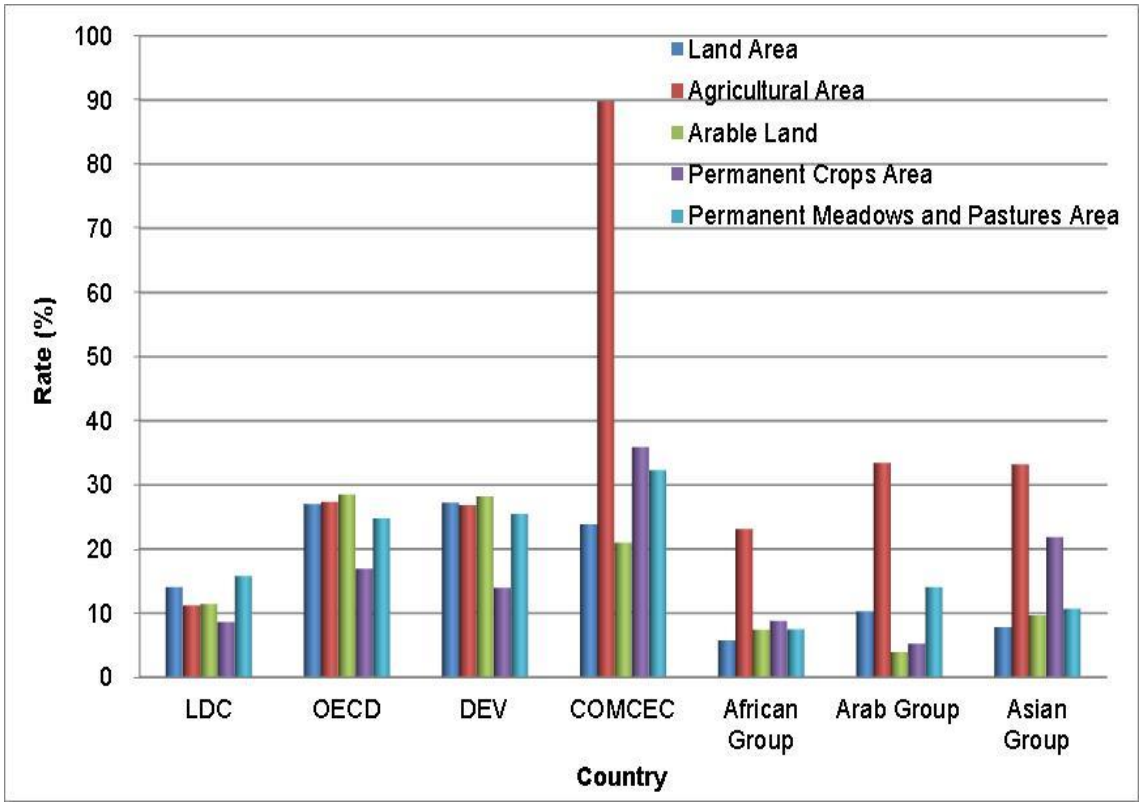
In addition, there was an increase in Indonesia, Iran and Malaysia's agricultural incomes share as a percentage in 2010 compared to the previous periods.

At this Group level, agricultural incomes declined in 2000 while it increased by approximately 42.5% and 95% in the years of 2005 and 2010 respectively compared to the previous years (Annex 2).

4. LAND USE AND POPULATION IN THE COMCEC MEMBER COUNTRIES

In addition to the agricultural labor force, the effective and productive use of land in agriculture is an essential element in the process of agricultural development. The COMCEC member countries have a total agricultural area of 1.4 billion hectares, corresponding to 36.4% of the total agricultural area of the developing countries and 28.4% of that of the world and accounted for 43.7% of their total land area compared to 38.7% and 37.9% in developing countries and world average, respectively (Figure 4.1 and Table 4.1).

Figure 4.1. Distribution of Land Use



Source: AQUASTAT, 2013

Table 4.1. Land Use in Agriculture

	Agricultural Area		Cultivated Area				Permanent Pasture	
			Arable Land		Permanent Crops			
	Million Hectares	% (1)	Million Hectares	% (2)	Million Hectares	% (2)	Million Hectares	% (2)
COMCEC Countries	1401	43.7	290	20.7	49	3.4	1076	76.8
Developing Countries	3846	38.7	1071	27.9	121	3.1	2671	69.5
World	4932	37.9	1411	28.6	143	2.9	3378	68.5
COMCEC as % of:								
World	28.4		20.6		34.3		31.9	
Developing Countries	36.4		27.1		40.5		40.3	

Source: FAOSTAT, 2007
(1) % of total land area; (2) % of agricultural area
Agricultural area is the sum of arable, permanent crops and permanent pastures land areas.
Arable land is the land under temporary crops, temporary meadows for mowing or pasture, land under market and kitchen gardens, and land temporarily in fallow.
Permanent crop land is the area cultivated with crops that occupy the land for long periods and that do not need to be replanted after each harvest. This does not include woodland and forests.

However, the arable land area of the COMCEC Countries amounted to only 290 million hectares, corresponding to 20.7% of their agricultural area, and accounted for 27.1% of the arable land of the developing countries and 20.6% of that of the world. Thus, the percentage of the arable land of the COMCEC Countries in their total agricultural area was lower than that of the developing countries (27.9%) and the world average (28.6%). In contrast, the permanent crops land of the COMCEC Countries (49 million hectares) accounted for 34.3% of the total permanent crops land in the world and 40.5% of that of the developing countries. Although the permanent crops land of the COMCEC Countries accounted for only 3.4% of their total agricultural area, this ratio was slightly higher than that of the developing countries (3.1%) and the world average (2.9%). As shown in Table 4.1, the bulk of the agricultural area in the COMCEC Countries (76.8% or 1.1 billion hectares) is permanent pastureland used for grazing of livestock.

Land use in agriculture in the COMCEC Member Countries reflects huge differences at both the individual country level and sub-regional levels. With large

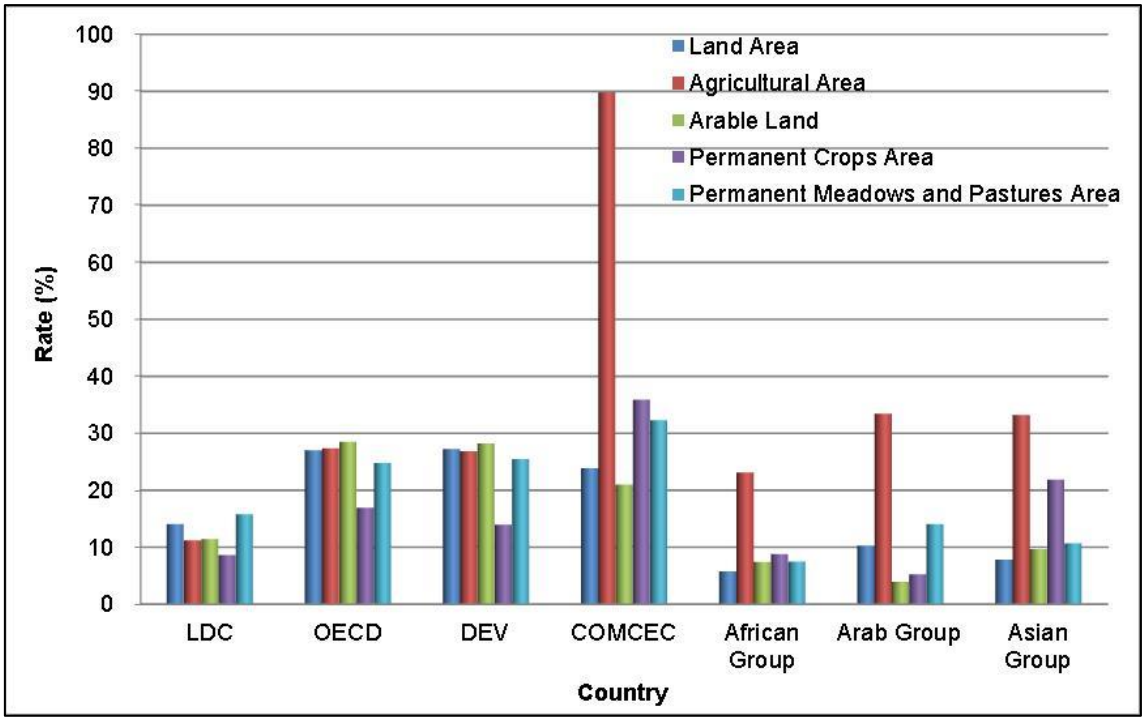
agricultural area relative to their total land area, some COMCEC countries, like Saudi Arabia (80.8%), Kazakhstan (77%), Djibouti (73.4%), Somalia (70.2%) and Turkmenistan (69.4%), have very small arable land areas (less than 10% of their agricultural areas) and even negligible permanent crops land areas. This is due to the fact that the bulk of the agricultural area in these countries is permanent pastureland (more than 90%) used for the grazing of livestock. In contrast, with small agricultural area relative to their total land area, some COMCEC countries like Egypt, Indonesia, Malaysia, Guyana, Suriname, Cameroon, Jordan, UAE, Qatar and Palestine have relatively large arable and permanent crops land areas in terms of the percentage of these areas in their agricultural areas.

The share of arable land area within agricultural area was over 50% in 11 COMCEC countries, namely Bangladesh (88.1%), Egypt (85.3%), Pakistan (78.8%), Benin (76.7%), Suriname (69.9%), Togo (67.8%), Cameroon (65.1%), Turkey (55.6%), Iraq (55%), Comoros (53.3%) and Albania (51.7%). This ratio was less than 10% in 11 COMCEC Member Countries. In contrast, the share of permanent crops land within agricultural area was higher than 30% in only 8 COMCEC countries, namely Malaysia (73.5%), Maldives (61.5%), Brunei (43.9%), Bahrain (40%), UAE (37%), Comoros (36.7%), Indonesia (32%) and Palestine (30.6%). Moreover, it is observed that permanent crops land is negligible (less than 1%) in 16 COMCEC countries (Annex 3).

All in all, while the percentage of agricultural area within total land area of the COMCEC countries is quite higher than that of the developing countries and the world average, the percentage of their arable land area within total agricultural area is still significantly below the world and developing countries average. Among other factors, this is due to the unsatisfactory use of land in agriculture, particularly due to the scarcity of water resources and the use of insufficient irrigation systems and techniques.

Cultivated area is around 10% of the total area in COMCEC Member Countries. This value is quite low when compared with world average and it must be increased to ensure food safety.

Figure 4.2. Distribution of Land Use



Source: AQUASTAT, 2013

4.1. African Group

The total area of the 17 countries in African Group is about 783 million ha, of which 116.9 million ha is being cultivated. The Chad and Mozambique have limited agricultural areas. More than 40% of total area is cultivated in Gambia, Nigeria and Togo. About 14.9% of the total area is used for agriculture in this country group (Annex 3).

4.2. Arab Group

Total area of Arab Group which covers 22 countries is over 1.379 billion ha and 62.5 million ha of which is under cultivation and this accounts for 4.53% of the total area. The percentage of the cultivated areas in Comoros, Lebanon, Morocco, the Syrian Arab Republic and Tunisia is more than 20%. This ratio is smaller than 2% in Djibouti, Kuwait, Libya, Mauritania, Oman and the United Arab Emirates (Annex 1).

4.3. Asian Group

There is about 168 million ha of farming area in the Asian Group countries, and this accounts for 16% of the total area. More than half of the Bangladesh area is

cultivated for agriculture. Brunei has the smallest cultivated area with 1.4%. The cultivated area in Kazakhstan, Kyrgyz Republic, Tajikistan and Turkmenistan is less than 10%.

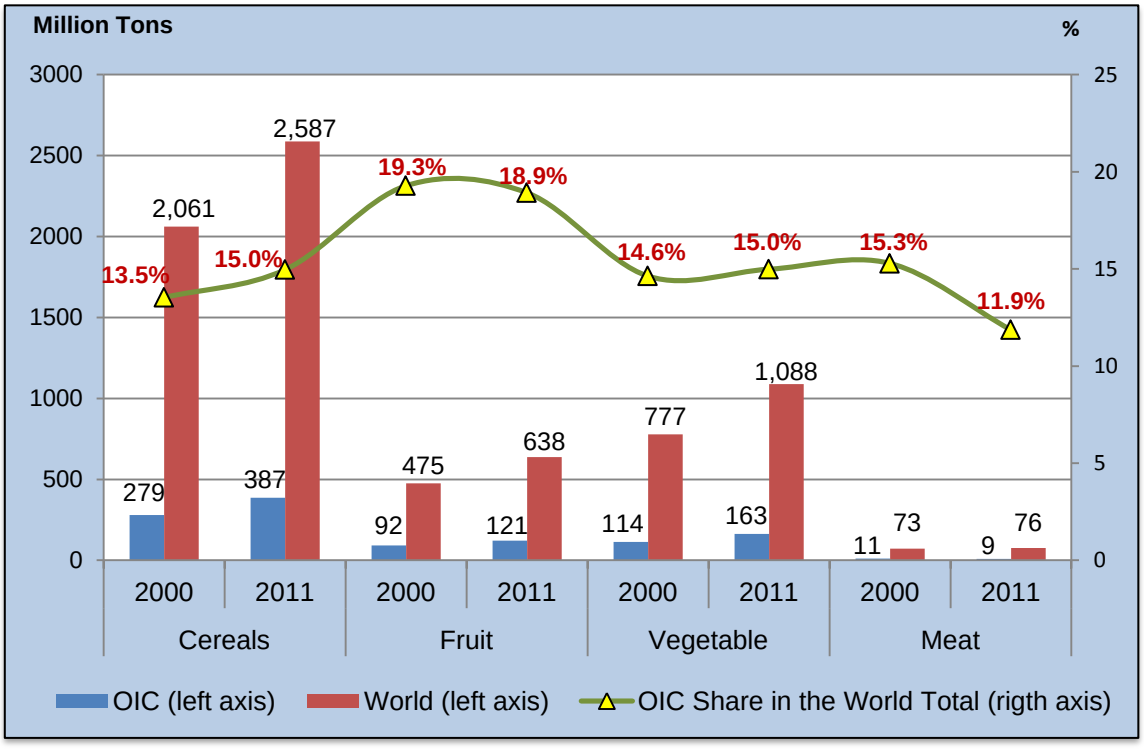
5. AGRICULTURAL PRODUCTION AND PRODUCTIVITY

Various crops are grown in the COMCEC Member Countries because of agro-ecological conditions. In order to compare the efficiency of agricultural production and productivity, the production amounts and yield values were analyzed. In production analysis, fruits, vegetables were used. On the other hand, in the yield analysis maize, rice, cotton, and potatoes which are the most common cultivated crops in irrigated areas were studied.

According to 2011 data, COMCEC Member Countries produced 15% of the world total cereals production with 2.6 billion tons. In the same year, its share in the world fruit production was 18.9% with 638 million tons. The share of the COMCEC Member Countries in the world total production of vegetables was 15% (Figure 5.1).

Looking at country level production, it is seen that there are huge differences among their production volume. Some countries like Indonesia, Turkey, Bangladesh, Nigeria, Pakistan, Iran, and Egypt dominate the COMCEC Region in terms of agricultural production in general.

Figure 5.1. Agricultural Production in the COMCEC Region

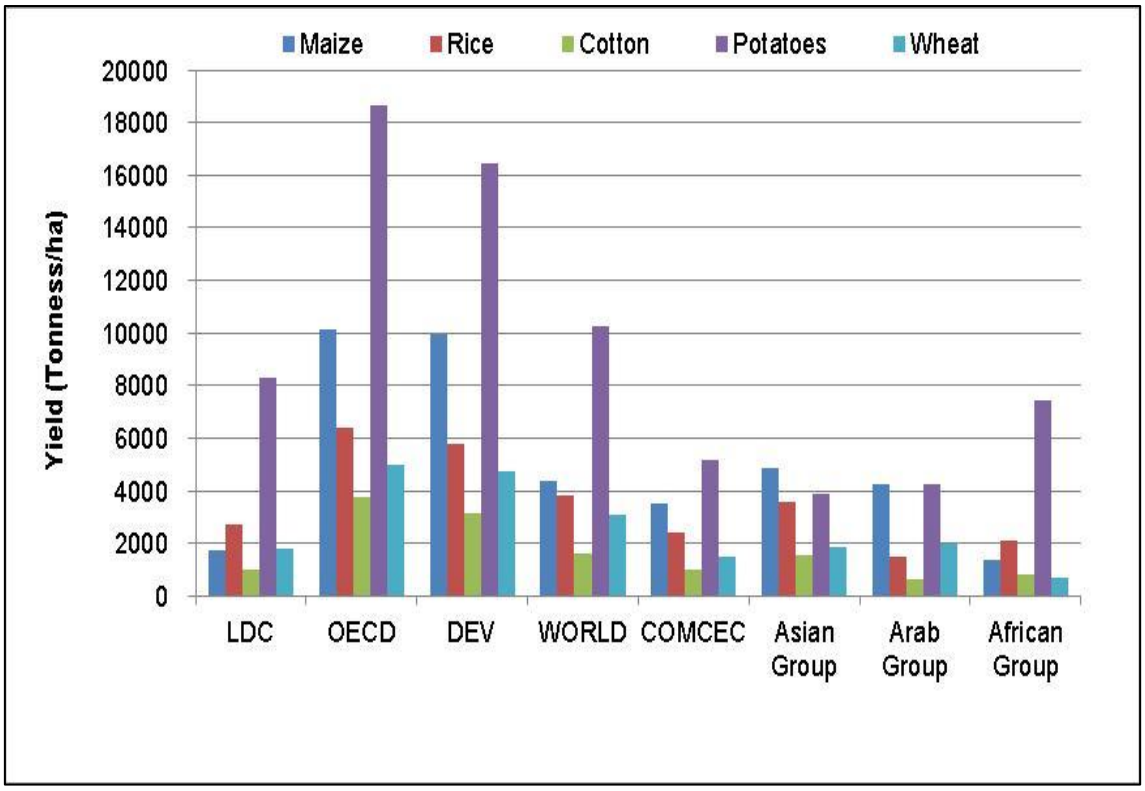


Source: COMCEC, 2013.

Another important issue for analyzing agricultural production in the COMCEC is agricultural productivity (yield). To analyze the yield level in the COMCEC Region, above-mentioned products' yields are given in Figure 5.2.

As can be seen from this Figure, average yields in the COMCEC Member Countries were lower than the values of developed countries, OECD countries and world averages. African Group countries decrease the COMCEC's average in corn, whereas Arab Group countries decrease the averages in rice and cotton and Asian Group countries decline the average of the COMCEC Region in potatoes.

Figure 5.2. Yield of Different Crops in the COMCEC Region



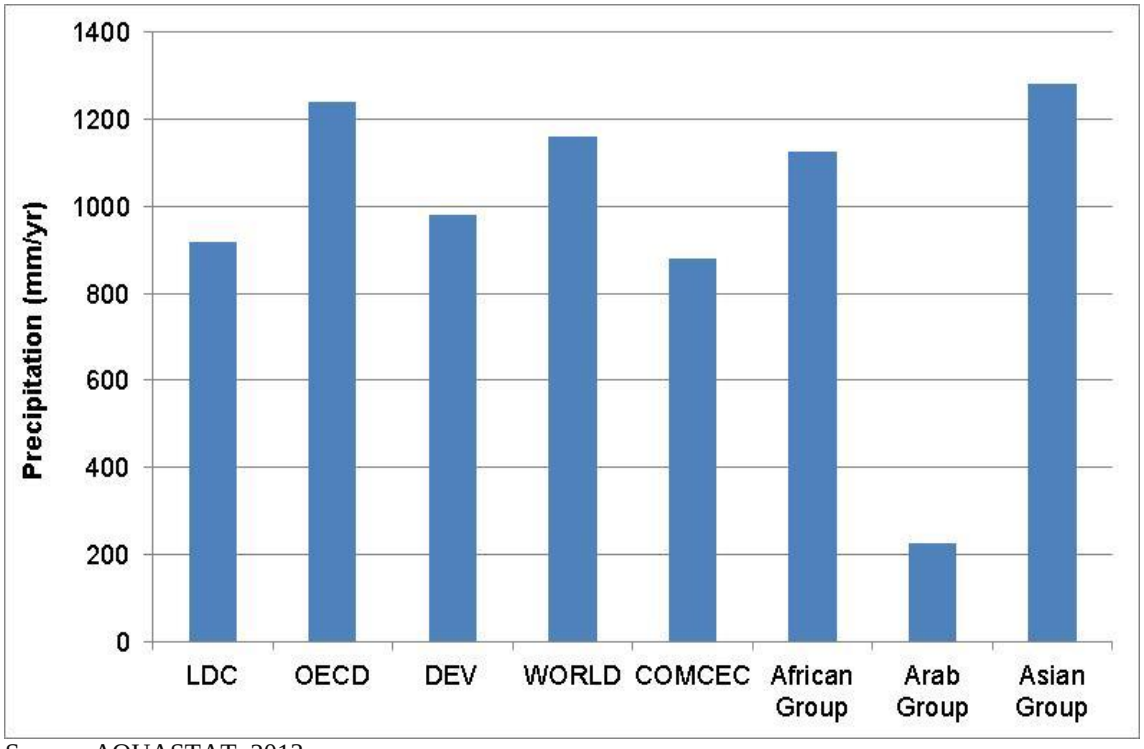
Source: AQUASTAT, 2013

6. CLIMATE

Climate is described in any part of the earth for many years in all weather conditions observed in the average state. This includes the region's general pattern of weather conditions, seasons and weather extremes, severe events, and includes all the variations. Two of the most important factors determining an area's climate are air temperature and precipitation. The extreme temperatures and inadequate precipitations in many COMCEC Member Countries affect agriculture by making irrigation imperative.

The total annual precipitation data for the different groups are presented graphically in Figure 6.1. Average precipitation is about 1159 mm in the entire world. Compared to the world averages, DEV and LDC have less but OECD countries have higher precipitations (Annex 5).

Figure 6.1. Precipitation



Source: AQUASTAT, 2013

6.1. African Group

Africa region has significantly contrasting natural habitats and ecosystems, geological and topographic configurations, climates (mostly arid and semiarid with permanent or semi-permanent hot and dry conditions) and patterns of settlements. This physical variation encompasses a wide range, for instance, desert and semi-desert areas that are virtually uninhabited (except for scattered oases) and constitutes more than 80 % of the total area of the Arab homeland (Barakat, 1993).

Annual average precipitation received by African Group of Countries changes according to their location and climate conditions. Especially, precipitation of Sierra Leone was the highest (2,526 mm). Annual precipitation of Niger, Chad and Mali were lower than the other African countries (Figure 6.2).

The African Group countries are apparently characterized with various climates, regions and zones. According to the Köppen-Geiger climate classification and the UNCCC aridity index (Türkeş, 2010, 2012), the tropical northern half of the Africa continent has primarily dry climate of semi-arid steppe and arid desert or semi-desert lands, while its central and southern areas contain both tropical savanna and tropical moist (rainforest) climate regions. Between these macro climate regions, there is a convergence, where biome patterns such as Sahel and steppe dominate. The seasonal summer movement of the ITCZ creates and controls a rainy season in summer across central portions of the continent to the south of the Sahara and the north of southern Africa. The Sahara desert region is the hottest and driest portion of the Africa continent due to the presence of the subtropical high pressure system, and the subsidence and stability during most of the year associated with this system.

In summary, according to the Köppen-Geiger climate classification and the UNCCC aridity index (Türkeş, 2010, 2012; Türkeş et al., 2011), the African continent as a large land mass existing across Equator and surrounded largely by ocean and sea masses has a wide variety of climates.

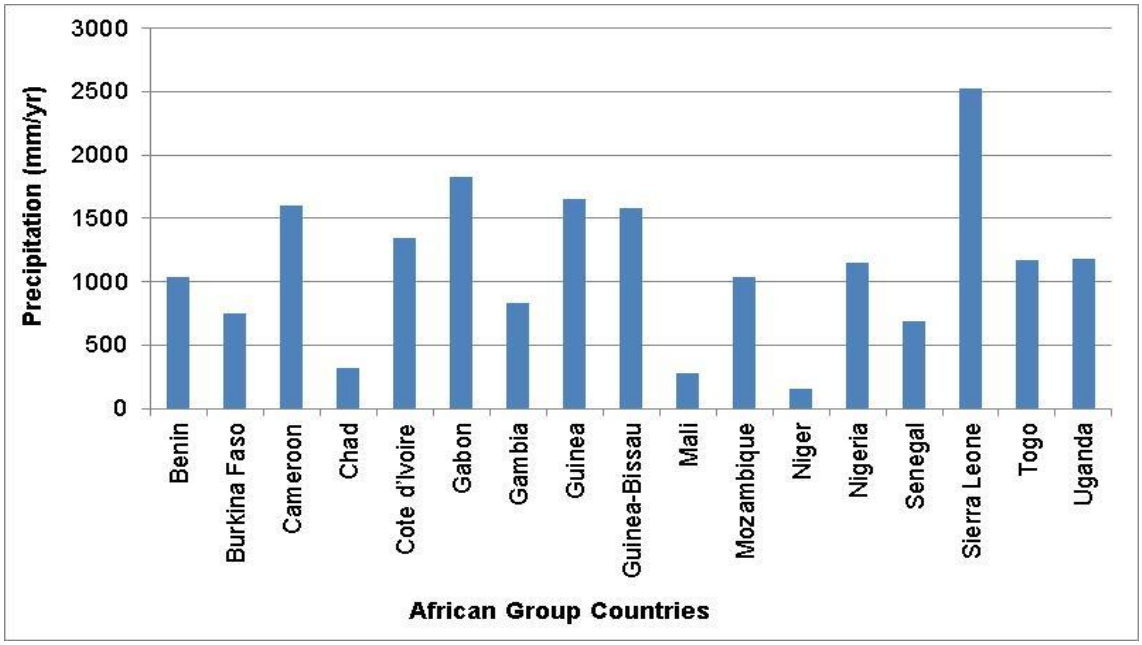
Tropical rainforest climate is found particularly in the center of the equatorial continent and also along the eastern coast of Madagascar.

The humid temperate (subtropical) Mediterranean climate, dominated over the southwest (Cap region) and over the Mediterranean, mostly on the northwest African coast.

Dry winter and wet summer tropical savanna climate is seen in the north and south of the Equator, where it replaces some north and south parts of the tropical rainforest climate region during course of the year. Consequently, there are distinct wet and dry seasons between summer and winter.

Dry and hot steppe climate, away from the Equator to the north and south, the savanna grades into drier semi-arid steppe. Dry and hot desert climate of the Sahara in the north is the Earth's largest desert. Highland climate is largely found in the east, below the Horn of Africa.

Figure 6.2. Precipitations in African Group Countries



Source: AQUASTAT, 2013

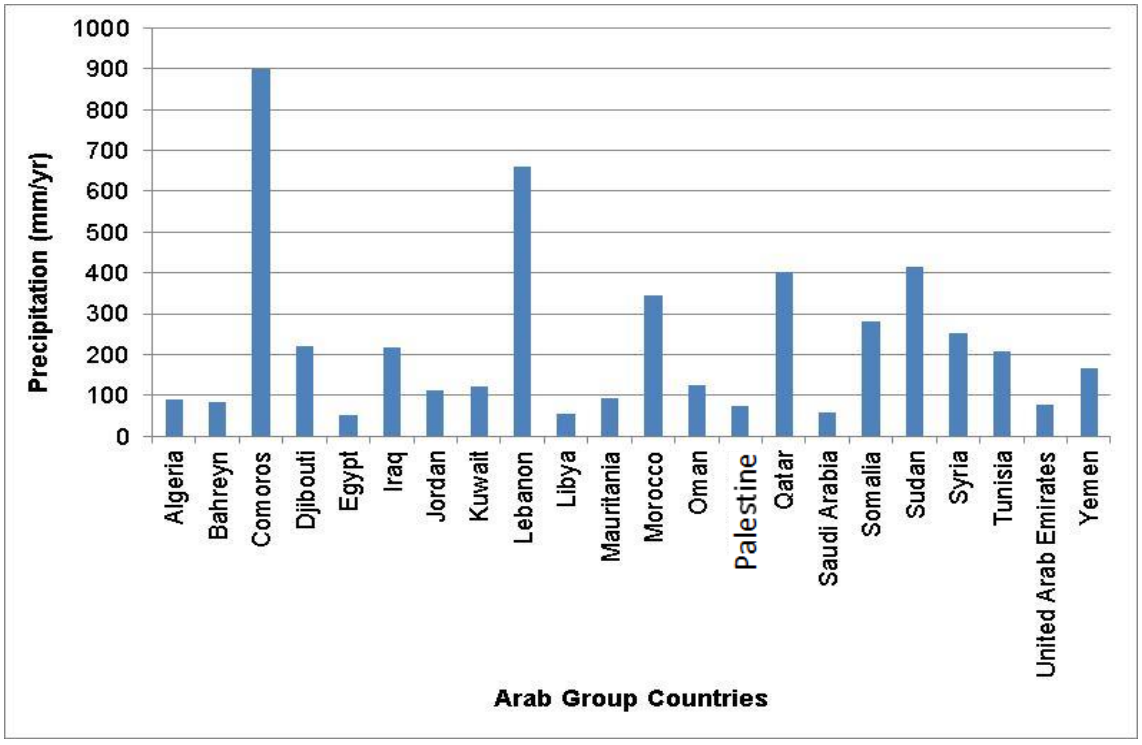
6.2. Arab Group

According to long term annual average precipitation records, average value for Arab countries was 227 mm. While Egypt had the lowest precipitation level (51 mm), the highest precipitation (900 mm) was received by Comoros (Figure 6.3).

Most countries of the Arab Group are found in the arid or semi-arid regions of the world. Additionally, 80% of the Arab Group of countries is geographically

characterized with desert and desert-like environments, extending from Mauritania and Morocco to Oman and United Arab Emirates. Second type of the most common lands, is the semi-arid terrain and it is also found in almost all Arab countries except Lebanon and Comoros. According to the Köppen-Geiger climate classification (Türkeş, 2010, 2012), the temperate dry summer (subtropical) Mediterranean climate has the highest population density in the Arab World, with most of its 350 million citizen living within this region. Only two terrains do not span the Arab League, the tropical wet and dry climate in southern Sudan and southern Somalia, and the tropical wet climate in Comoros Islands.

Figure 6.3. Precipitation in Arab Group Countries



Source: AQUASTAT, 2013

6.3. Asian Group

Bangladesh, Brunei, Indonesia and Malaysia in Asian Group have a total annual precipitation greater than 2500 mm. Guyana and Suriname have a value of more than 2000 mm. In addition to these countries, Albania and the Maldives have annual precipitations less than 1000 mm. Turkmenistan has the lowest amount total annual precipitation in Asian Group of countries. Additionally, Iran, Kazakhstan and

Uzbekistan in the Asian Group of countries have the lowest annual total precipitation (Figure 6.4).

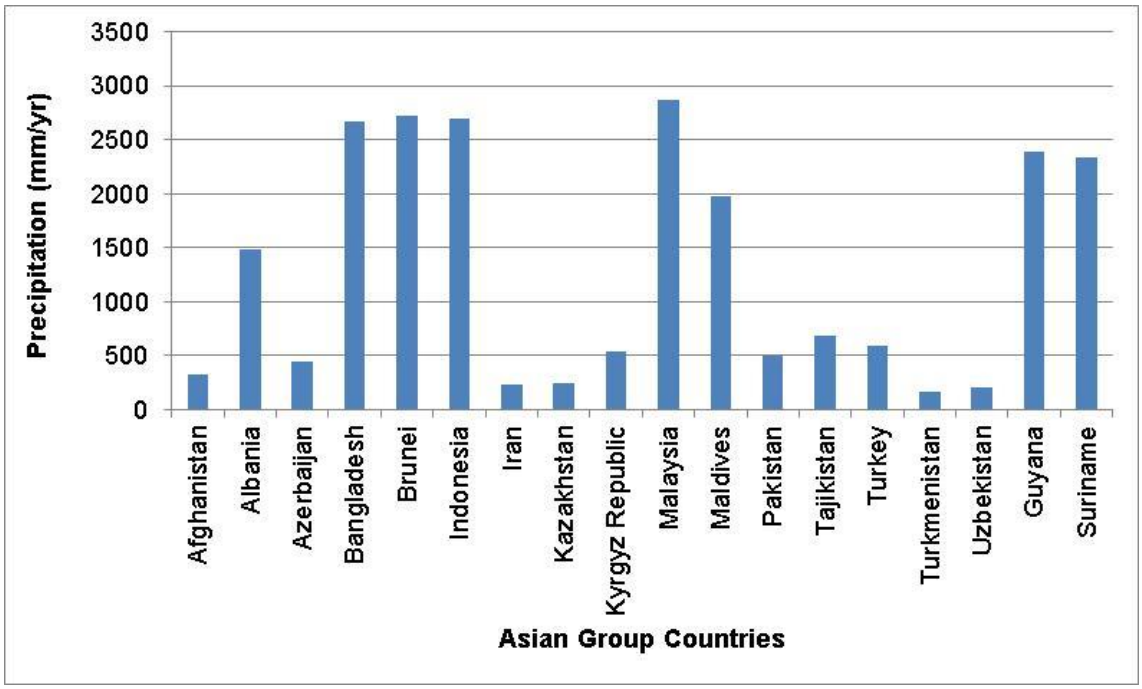
According to the Köppen-Geiger climate classification and the UNCCC aridity index (Türkeş, 2010, 2012), the climate of the Asia Continent in general is temperate, mid-latitude and moist tropical and sub-tropical over the maritime eastern and south-eastern regions, respectively; cold humid mid-latitude (and severe cold winters) in the northern and north-eastern regions, and dry (cold and warm) across much of the interior regions. The tropical monsoon circulation dominates across southern and south-eastern regions of the Asia continent in summer. This is mainly due to the presence of the Himalayas forcing the formation of a thermal low over these hot-summer southern land regions associated with also seasonal shift of the inter-tropical convergence zone towards north in the Northern Hemisphere summer, which draws in moist air masses from the Indian and Pacific oceans during the summer (Türkeş, 2010). On the other hand, the large Siberia region has the coldest places in the Northern Hemisphere, and can act as a source of dry and cold continental polar and sometimes extremely cold continental Arctic air masses not only for the southern Asia and the Europe but also for most regions of the Northern Hemispheric circulation and pressure patterns including the North America (Öztürk et al. 2012). Also, one of the most vulnerable place on the Earth in terms of the tropical cyclone (named geographically as tropical cyclone in the Indian Ocean, and typhoon in the Pacific Ocean) activity lies northeast of the Philippines and south of Japan.

Because the Asian monsoons may be classified into a few sub-systems, such as the South Asian monsoon, which affects the Indian subcontinent and surrounding regions, the Southwest Asian monsoon, which effects the Arabian Peninsula, the Arabian Sea and the east Africa highlands, and the Southeast Asian monsoon, which affects southern China, Korea and parts of Japan. Some of the Asian Group countries are influenced by the South Asian monsoon and some by the Southeast Asian monsoon during the warm and hot months of the years varying from the May to the October (Türkeş, 2010; Türkeş et al., 2011).

Guyana and Suriname have a humid tropical climate and temperatures do not vary much throughout the year because they are lying near the equator and

characterized with maritime temperate and tropical influences of the Atlantic Ocean. The year has generally two wet seasons, and most of the region is under the influence and variations of the northeast trade winds associated with the seasonal migration of the ITCZ during the year. According to the Köppen-Geiger climate classification, some parts of Suriname also feature a tropical rainforest climate.

Figure 6.4. Precipitation in Asian Group Countries



Source: AQUASTAT, 2013

7. WATER RESOURCES

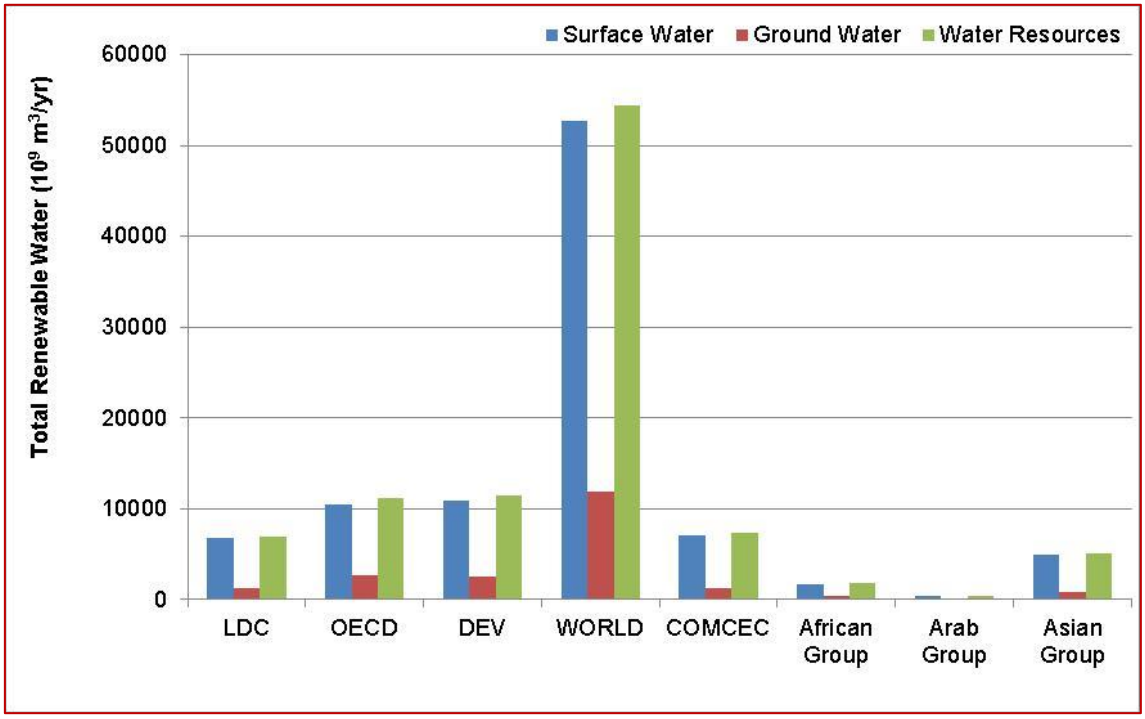
World water resources are composed of oceans, seas, lakes, rivers, snows and glaciers and ground waters. World total volume of water is 1,398,898,300 km^3. Entire amount is not available to be used. About 97% of this volume is saline water in oceans and seas and not available to be used for domestic, industrial and agricultural purposes. About 1.7% is in the form of ice in glaciers and ever-melting and mixing with saline seas and oceans. About 0.8% is not able to be reached for various reasons and constitutes ground waters. Remaining 0.2% is in the form of gas in atmosphere. Spatial distribution of water resources is not homogenous worldwide. While the South American countries have the richest water resources, African and Middle East countries have the poorest resources.

This section of the report briefly highlights the state of water resources in the COMCEC Member Countries In this report, a distinction has been made between renewable and non-renewable water resources. Renewable Water Resources (RWR) implies the water resources generated from endogenous precipitation. They are computed on the basis of the water cycle by adding up the long-term average annual flow of rivers and lakes (surface water) and recharge groundwater reservoirs. Total Renewable Water Resources (TRWR) are the total amount of a country's water resources and defined as the sum of Internal Renewable Water Resources (IRWR) and External Renewable Water Resources (ERWR), i.e. the incoming flows originating outside the countries' borders.

Water is a scarce resource in arid and semi-arid regions where many COMCEC Member Countries are located, particularly in West Asia and North-eastern Africa. Therefore, most of the COMCEC Member Countries in these regions are facing severe pressures due to limited opportunities for the exploitation of new water resources. These pressures are expected to increase in the face of expanding population and the increased per capita water use associated with economic development, as well as due to the expected negative impacts of climate change in the future.

All over the world, total annual renewable water resources is estimated as to be approximately 54365 x 10^9 m^3 (Annex 6). Renewable water resource of COMCEC, OECD and the DEV countries are 7425; 6886 and 11511 km^3, respectively (Figure 7.1).

Figure 7.1. Total Actual Renewable Water



Source: AQUASTAT, 2013

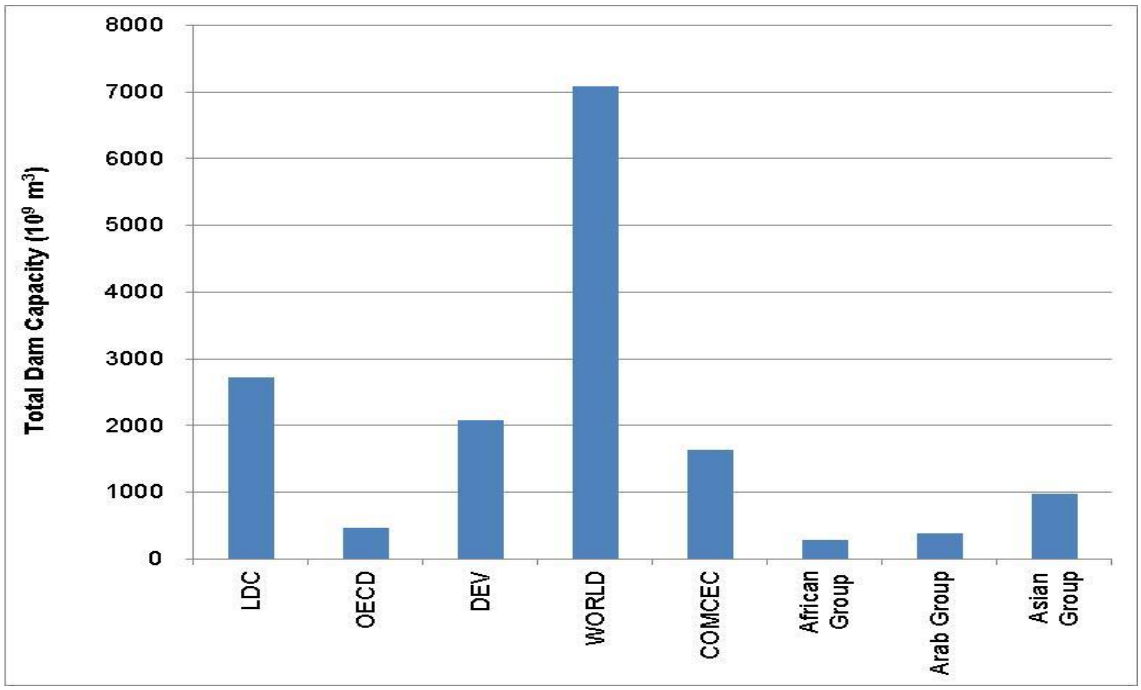
Total renewable water resources consist of surface and ground water resources. In general around the world, renewable ground water resources corresponds about 25% of total surface water resources. Among the LDC, OECD and DEV countries, LDC countries have the lowest level water resources (Figure 7.1).

Dams are built to meet domestic and irrigation water needs of people, to produce energy and to prevent floods. They arrange temporal water needs. Besides these basic functions, dams also play significant roles for fisheries, recreation sites, water sports and other activities. Dams are critical water storage structures for irrigation since they store the water when it is abundant and release it when it is needed.

All over the world, the total capacity of water storage structures reached to approximately 7085 x 10^9 m^3. The annual renewable water resources in LDC, OECD and DEV countries were at 2717x10^9, 461x10^9 and 2074x10^9 m^3 levels, respectively (Figure 7.2).

All over the world, while OECD and DEV countries mostly prefer to use produced wastewater, they preferred to use desalinated water. The second most preferred way for using wastewater is treated wastewater re-use (Annex 6). There is very little use of wastewater in COMCEC countries.

Figure 7.2. Total Dam Capacities



Source: AQUASTAT, 2013

7.1. African Group

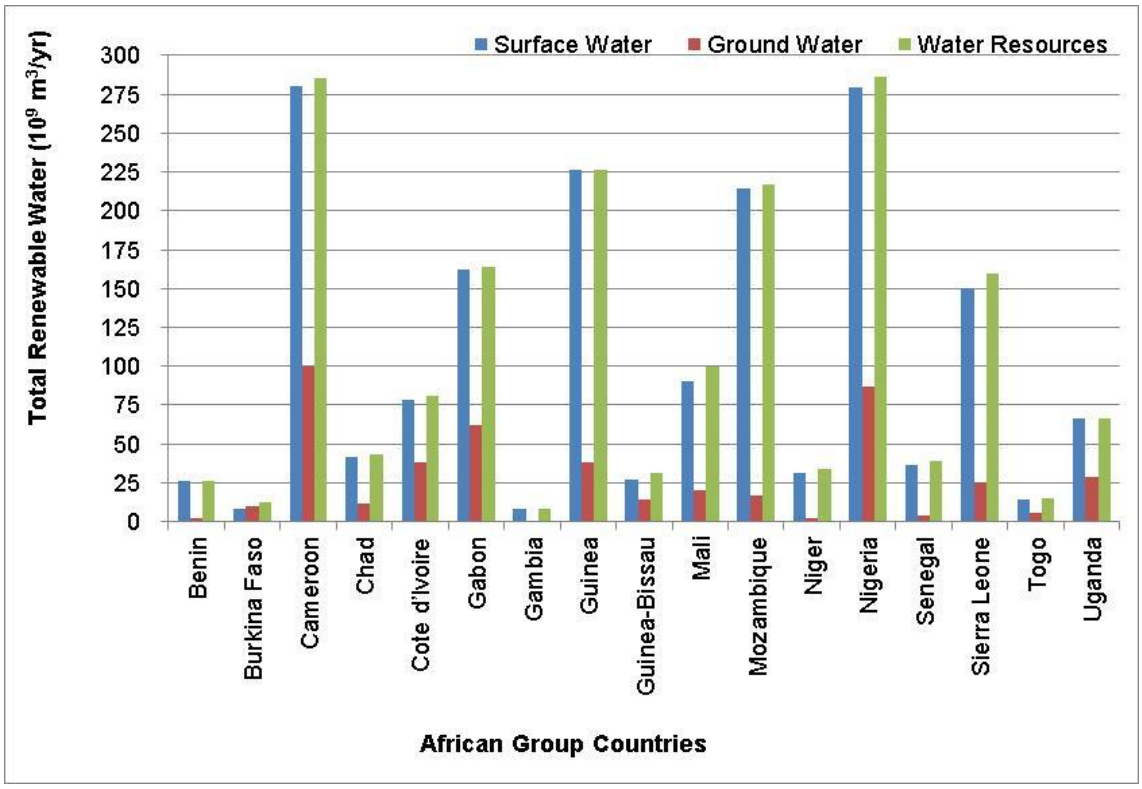
Most of the African countries are facing significant water scarcity. Especially in Libya and Saudi Arabia, the greatest water resources of the Northern African Countries are fossil water storages. Such resources are rarely fed by precipitations. In Africa, about 300 million population live in 11 countries and all of these countries have water per capita below the limits. Besides, spatial distribution of water resources is not homogeneous in Africa and water resources are largely located in countries with less demand. Ground waters constitute the largest source to meet domestic water needs and more than 75% of people use ground water for domestic purposes. Africa is also exposed to most severe impacts of global warming. African countries with rapid increase in their populations have serious infrastructural problems and exposed to poverty, drought and epidemics. Natural disasters cause the death of millions each year.

Researches revealed that about 600 million people in Africa will be facing to clean water deficit in less than 20 years unless the relevant measures are taken.

In the African Group countries, Cameroon stands out with the highest potential of total renewable water resources. It is followed by Guinea, Nigeria, Gabon, and Sierra Leone. Gambia and Niger have the lowest levels of annual readily renewable water resources (Figure 7.3).

The average rate of groundwater resources to surface water resources is 30%. In African countries, this ratio ranged from 6 to 52%. In this Group of countries, the richest country in terms of the overall presence of water resources is Cameron (Figure 7.3).

Figure 7.3. Total Actual Renewable Water in African Group Countries



Source: AQUASTAT, 2013

With regard to storage capacities, capacities of existing dams in most of the countries were found to be insufficient. Uganda and Mozambique are the countries with the maximum water storage capacity (Annex 5).

The usage of wastewater in African countries is quite low. This certifies that there is no use of treated wastewater. Nigeria is the only country using desalinated water. In Senegal and Burkina Faso, the produced wastewater is being used (Annex 6).

7.2. Arab Group

Arab countries have also water scarcity since they are not included in a watershed. In these countries water resources are mostly the fossil waters which are rarely fed by precipitations. They deplete like oil resources when they are not used. These fossil water storages constitute the greatest amount of water resources of Northern African countries, especially of Libya, Saudi Arabia and Jordan.

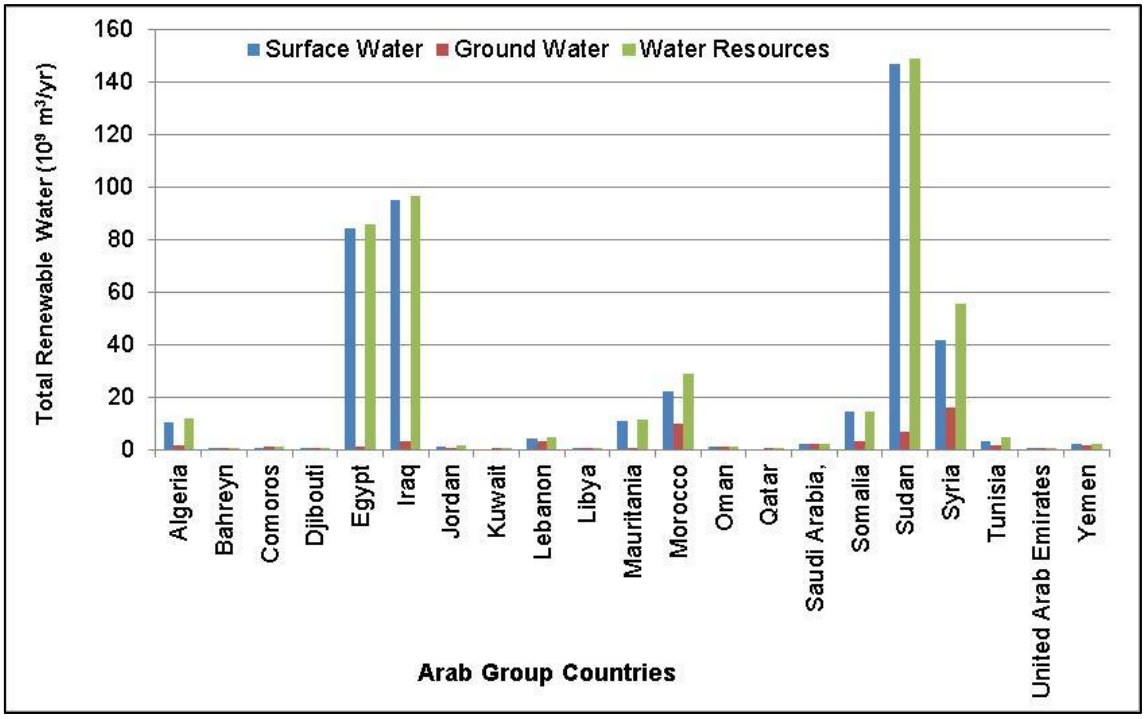
For the presence of total annual renewable water resources, there are important differences between Arab countries. While Iraq, Somalia and Egypt have the highest amounts, United Emirates, Bahrain, Kuwait, Palestine have the lowest amounts (Figure 7.4).

In Arab countries, the vast majority of surface water resources consist of renewable water resources. On the other hand, Syria, Sudan, Iraq and Somalia are considered as the countries with the highest groundwater reserves. In terms of existing surface and ground water resources, the United Arab Emirates were found to be insufficient. Generally, Sudan in Arab Group countries is considered as the poorest country with regard to both surface and groundwater resources (Figure 7.4).

In general, the Arab countries are quite able to store water in dams. Egypt and Iraq's total annual water storage capacity through dams are 168 and 152 km^3, respectively. They are followed by Algeria, Morocco, Syria, Sudan, and Tunisia. However, their annual amount of water storage in dams is less than 20 km^3 (Annex 5).

Egypt in Arab Group of countries is the most prominent country in wastewater use. Although in this country there is use of produced, treated, desalinated and reused water, mostly they use produced and treated wastewater. Syria is the second country about using produced wastewater. However, ratio of produced wastewater use of Syria is 15% of Egypt’s wastewater use. In Arab countries, usage of desalinated water is dominated by the United Arab Emirates (Annex 6).

Figure 7.4. Total Actual Renewable Water in Arab Group Countries



Source: AQUASTAT, 2013

7.3. Asian Group

About 20% of fresh surface water of the world is located in Baikal Lake in Asia. Despite such a great source, 34 countries in Asia, Africa and Middle East experience water scarcity. A disaster is expected in Asia in near future. For instance, it is expected that raising sea water levels due to global warming will bury about 2 thousand islands of Indonesia under water by the year 2030.

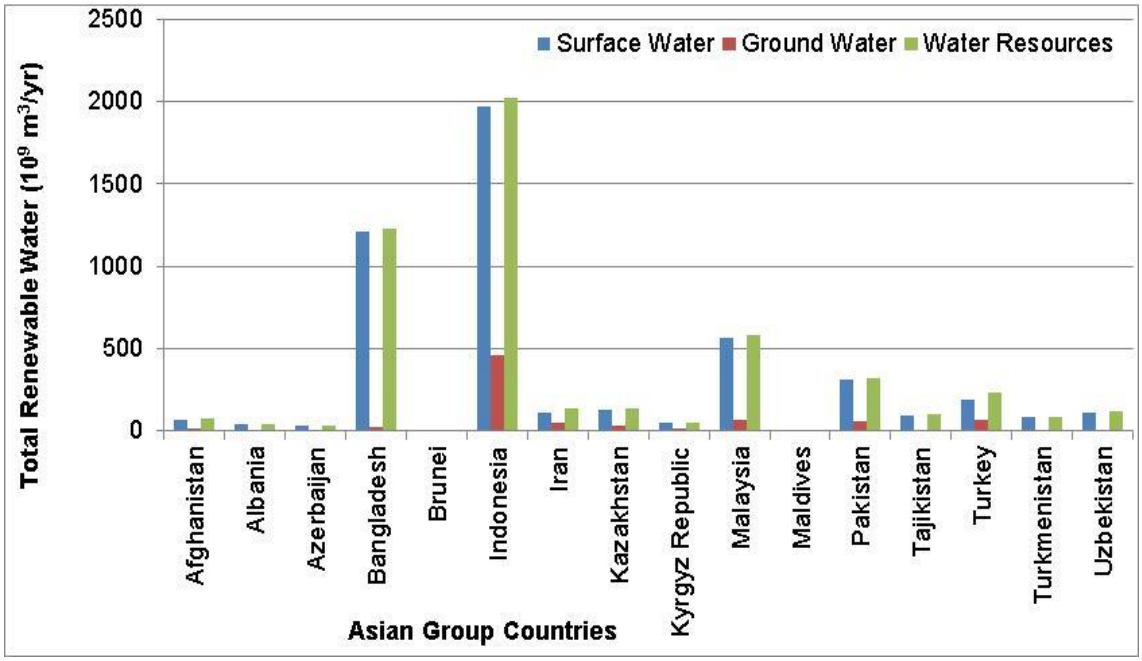
Indonesia has the highest total annual renewable water resources in Asian Group. This country is followed by Bangladesh and Malaysia. On the other hand, Brunei and the Maldives are among the poorest countries (Figure 7.5).

Among the countries of Asia, Indonesia has also the richest groundwater sources and it is followed by Turkey, Malaysia and Bangladesh (Figure 7.5).

In Asian Group, Turkey has the greatest infrastructure to control the renewable water resources and can store 651 km^3 of water supply in dams. On the other hand, with regard to water storage in dams, Maldives, Guyana, and Suriname do not have any

records. Brunei, Afghanistan, Albania are also quite inadequate in water storage (Annex 5).

Figure 7.5. Total Actual Renewable Water Resources in Asian Group Countries



Source: AQUASTAT, 2013

In Asian countries, produced wastewater is the most common type of wastewater use. Iran, Pakistan, Turkey and Kazakhstan are the largest wastewater user countries. Kazakhstan mostly uses desalinated water. With regard to use of treated and re-used wastewater, Turkey is located in the front row. Wastewater use in Indonesia, which has the highest level of water resources, is at negligible levels (Annex 6).

8. WATER WITHDRAWAL IN THE COMCEC MEMBER COUNTRIES

Since vast amount of world water resources is used in agriculture and global food demand is ever-increasing, water resources management through efficient irrigation systems and water-saving technologies has gained a greater significance during the last decade.

The efficient use of water resources in agriculture, through improving irrigation systems and techniques, is one of the most urgent needs and prerequisites for sustainable agricultural development and food security in these countries, particularly those in water-scarce regions.

The distribution of water resources within the COMCEC region is far from being uniform. Land relief, location with respect to the sea, latitude and resultant hydro-climatic conditions, diversity in hydrographical and geological structures all lead to extremely different water situations in the COMCEC Member Countries. At the individual country level, while TRWR per capita is higher than the world average of 8224 m^3/year in 12 COMCEC countries, 23 COMCEC Countries are suffering from water stress with TRWR per capita less than 1700 m^3/year.

The water withdrawals of different country groups are given in Table 8.1. LDC countries in Asia and Arab Groups withdraw more than 80% of water for agricultural irrigations. DEV and OECD countries withdraw more than 40% for industrial uses. Also in the same countries, more than 15% was withdrawn for domestic (municipal) uses. Municipal withdrawal is higher than industrial withdrawal in Arab and Asian countries (Annex 7).

Table 8.1. Sectorial Distribution of Water Withdrawal

Country	Agricultural water withdrawal		Industrial water withdrawal		Municipal water withdrawal	
	$10^9 m^3$/yr	%	$10^9 m^3$/yr	%	$10^9 m^3$/yr	%
LDC	172.7	90.5	3.5	1.8	14.6	7.7
OECD	436.7	43.6	402.0	40.1	163.5	16.3
DEV	366.4	39.8	398.5	43.2	156.8	17.0
WORLD	9795.4	89.1	731.1	6.7	468.4	4.3
COMCEC	782.9	10.5	69.5	0.9	80.2	1.1
African Group	19.6	0.3	2.9	0.0	7.4	0.1
Arab Group	207.4	84.6	17.4	7.1	21.2	8.6
Asian Group	555.8	87.3	49.2	7.7	51.6	8.1

Source: AQUASTAT, 2013

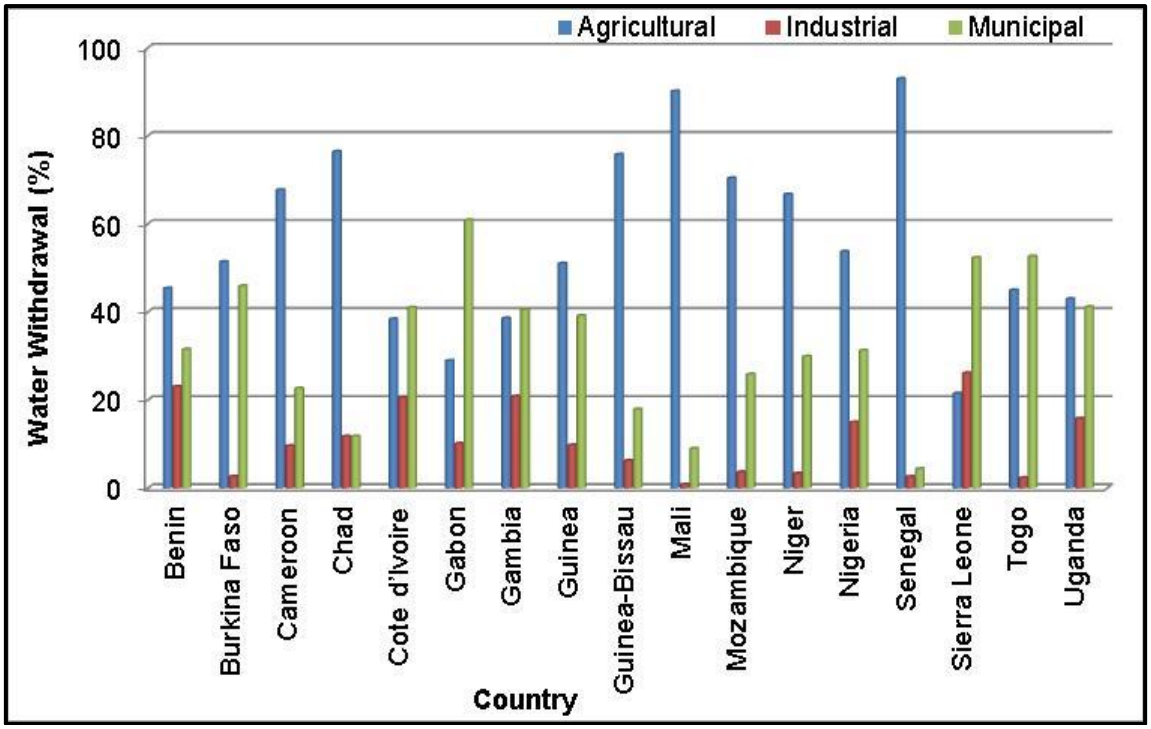
In general, agriculture is the largest water user sector worldwide and it was followed by industrial and domestic uses. However, industrial uses are higher than agricultural uses in developed countries. Agriculture has the first place in developing and less developed countries. Domestic uses have the second place and industrial uses have the last place in those countries. Allocation of water resources to different sectors in COMCEC Region countries is similar to world averages. Agriculture is still the largest water-user sector and it is followed by domestic uses. Industrial uses are at low levels in COMCEC Member Countries because of their low industrialization levels.

8.1. African Group

Regarding the worldwide figures, the water consumption per capita is 26 liters in industrialized countries, while the value is 184 liters in Latin America and 67 liters in Africa. Water consumption per capita is above 200 liters in Europe but the value is around 20 liters in dry sections of Asia and Africa.

Except for Gabon, Gambia, Sierra Leone and Togo, municipal withdrawal in African Group countries is lower than other sectors. Agricultural withdrawal is higher than 60% in Cameroon, Chad, Guinea-Bissau, Mali, Mozambique, Niger and Senegal (Figure 8.1).

Figure 8.1. Distribution of Water Withdrawal of Sectors in African Group



Source: AQUASTAT, 2013

8.2. Arab Group

According the World Health Organization (WHO), a person needs about 25 liter water daily for drinking, cooking and cleaning. However, considering the daily needs of modern healthy person, urban water consumption standard increases to 150 liters and this value is 158 liters in Arab countries.

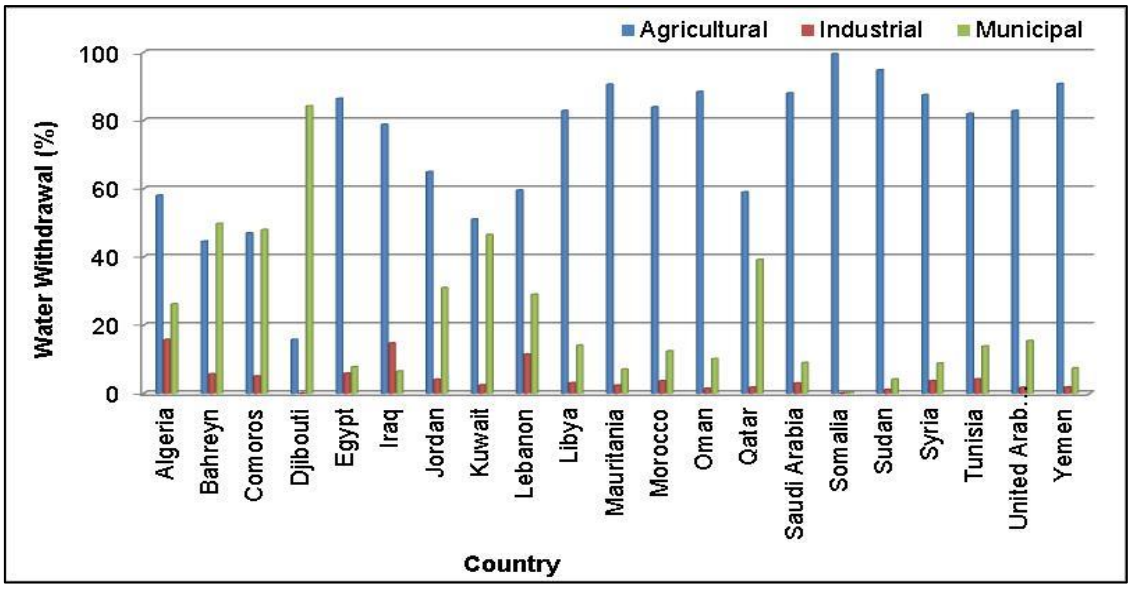
While municipal withdrawal is higher than other sectors in Bahrain, Comoros and Djibouti, in other countries of Arab Group agricultural withdrawal is higher than other sectors. Industrial withdrawal is the lowest in all Arab countries (Figure 8.2).

8.3. Asian Group

Asia has lower values with regard to water consumption per capita. While the value greatly varies from one country to another, the average value is 143 liters. The greatest problem in these countries is the rapid increase in population and insufficiency to access domestic water.

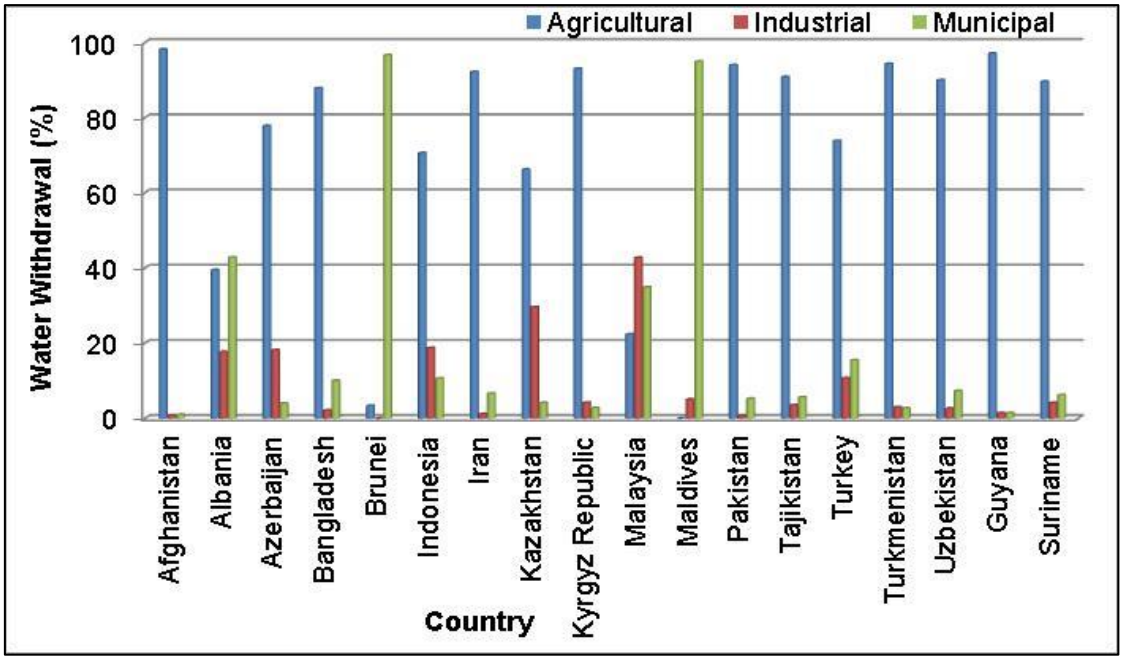
Municipal withdrawal is higher than other sectors in Albania, Brunei and Maldives. Industrial withdrawal is higher than other sectors only in Malaysia. Agricultural withdrawal is higher than other sectors in remaining countries of this Group (Figure 8.3).

Figure 8.2. Distribution of Water Withdrawal of Sectors in Arab Group



Source: AQUASTAT, 2013

Figure 8.3. Distribution of Water Withdrawal of Sectors in Asian Group



Source: AQUASTAT, 2013

9. IRRIGATION

Irrigation is a technique of applying water artificially to the soil. Water losses during irrigations mostly depend on method of irrigation and network used in water conveyance and delivery. Surface irrigation has the highest water loss and sprinkler irrigation has much lower water loss than surface irrigation methods. Furthermore, drip irrigation has the least water loss.

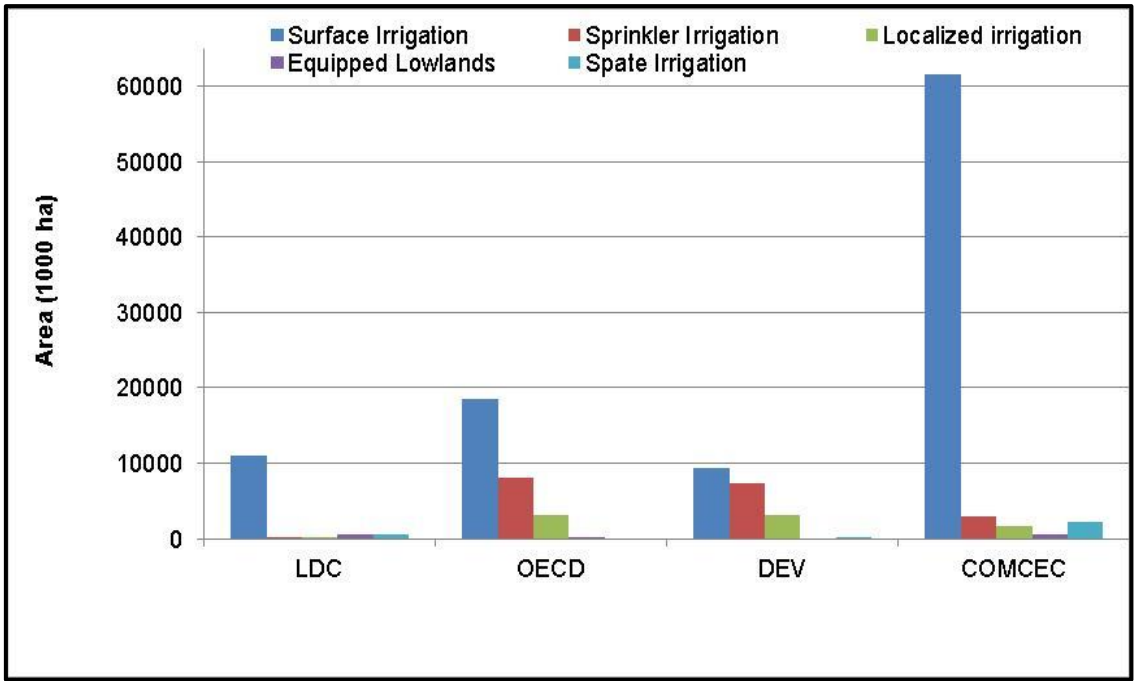
In designing an irrigation system expected to serve a certain area for 50 years, a decision will have to be made at the very outset whether the subject area is suitable for organic agriculture or for production under other standards and the irrigation system (open or pressurized) and method (sprinkler or localized) and the water source should be selected according to this method. The use of pressurized irrigation methods and fresh water sources should be particularly emphasized especially in organic farming.

The irrigation potential of the COMCEC Member Countries is slightly higher than 100 million ha. According to country group evaluation, the Asian Group countries, have the highest irrigation potential (80 million ha). On the other hand, both Arab and African Group countries, show very low irrigation potentials (Annex 8).

The potential for irrigation in LDC countries is approximately half of the COMCEC countries (45 million ha). Irrigation potential in the COMCEC Member Countries is one fifth of the world's irrigation potential (500 million ha).

Areas irrigated by surface irrigation methods in the COMCEC Member Countries are slightly above 60 million ha. Asian Group countries have a higher area under surface irrigation compared to the rest (54 million ha). Surface irrigation, in both Arab and African Group countries is very low. Surface irrigated areas in the LDC, OECD and DEV Countries are quite low compared to the OIC countries (the highest in OECD countries with 11 million ha). The total amount of surface irrigated area in COMCEC Member Countries is about a quarter of the world's (230 million ha) surface irrigation areas (Figure 9.1).

Figure 9.1. Irrigation Methods



Source: AQUASTAT, 2013

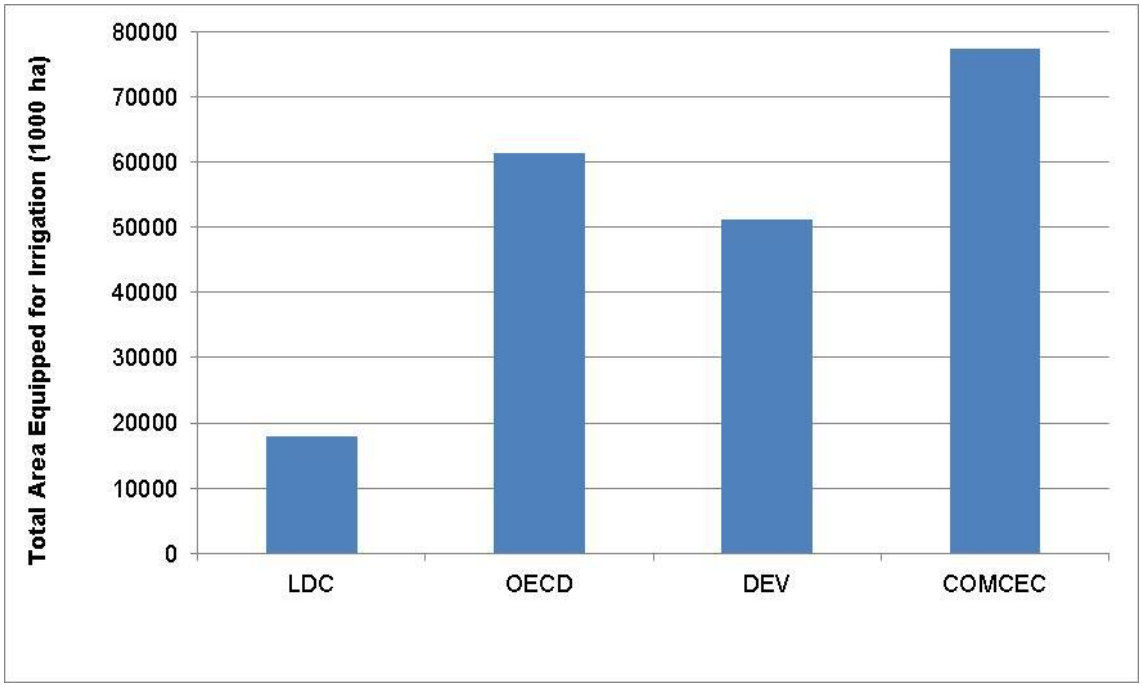
Sprinkler irrigation methods in COMCEC Member Countries cover about 3 million ha. As a matter of fact, Arab and Asian Group countries have more areas under sprinkler irrigation than the African Group Countries which have a little or no amounts of sprinkler irrigation technology.

About 1.5 million ha land is irrigated by localized (drip and micro sprinkler) system in the COMCEC Countries. According to analyses, Arabic and Asian Group countries have the highest amount of lands under localized irrigated systems. The amount of localized irrigation in African Group countries is almost negligible. Total localized irrigation area in OECD and DEV countries is 2 times higher than in the COMCEC Countries (3 million ha). The amount of localized irrigation in the COMCEC Member Countries is equal to one-fifth of the world localize irrigation area (approximately 7 million ha).

The equipped lowland of the COMCEC Member Countries is about 600 thousand ha. When all Member Countries are examined, African countries have the most lowlands (400 thousand ha) in area. There is almost no area of the lowlands in Arab countries. The irrigated lowlands area in the COMCEC Countries is equal to the area of LDC countries (500 thousand ha). The equipped lowlands are negligible in DEV

countries. The lowlands area in the COMCEC Member Countries is about three-quarters of the world's figure. The area covered by spate irrigation in the COMCEC Member Countries is about 2.2 million hectares. Asian countries have the largest area under spate irrigation (three-quarters). The African Group of countries has little or no spate irrigation. The total area under spate irrigation in LDC countries is one-quarter of the COMCEC (500 thousand ha). The amount of spate irrigation in the COMCEC Member Countries is almost 95% of the world's total (Annex 8). With regard to distribution of irrigation methods, the COMCEC Member Countries mostly have surface irrigation (80%) (Figure 9.2).

Figure 9.2. Total Area Equipped for Irrigation



Source: AQUASTAT, 2013

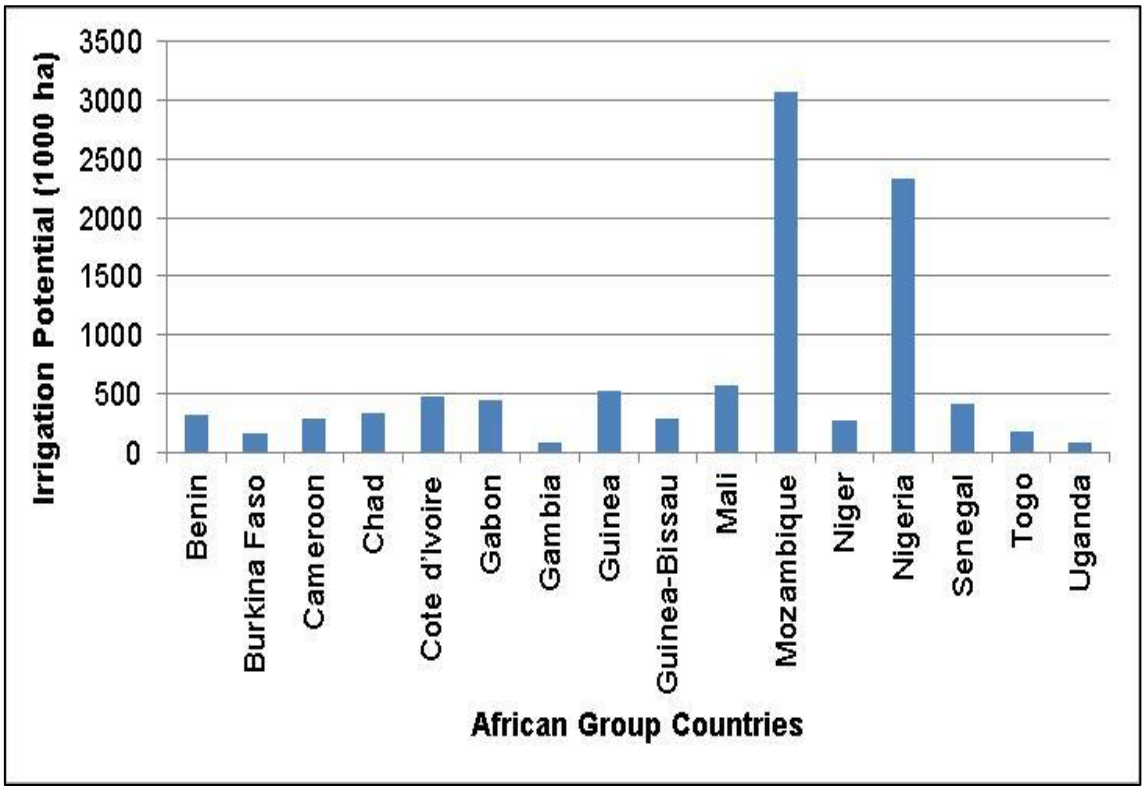
The irrigated area in COMCEC Region is slightly higher than 77 million ha. The highest amount of irrigated land (61 million ha) is found in Asian Group of countries. Arab countries are the second with a total of 15 million ha. Furthermore, African countries have close to 1 million ha, while, LDC, OECD and DEV countries have a smaller area of irrigated land compared to the COMCEC countries. OECD countries have 61 million ha of irrigated area and this amount is higher than LDC and DEV countries.

9.1. African Group

Africa is faced with various problems such as poverty, hunger and access to clean water. According to WHO statistics, by the year 2002, about 12-14 million people in northern sections of Africa were affected from poverty, drought and adverse health conditions. A 50% increase was observed in infant mortality rates just because of adverse health and nutrition conditions. There are available lands in Africa for agriculture but agriculture is implemented with primitive methods and there are serious problems in irrigation practices of the continent. Only 4% of total land resources of Africa are irrigable, while this value is around 15% in Asia.

African Group countries have an irrigation potential of approximately 10 million ha. Mozambique and Nigeria represent the majority of this sum respectively with 3 million and 2.3 million ha. The potential for irrigation in other countries is very low (Figure 9.3).

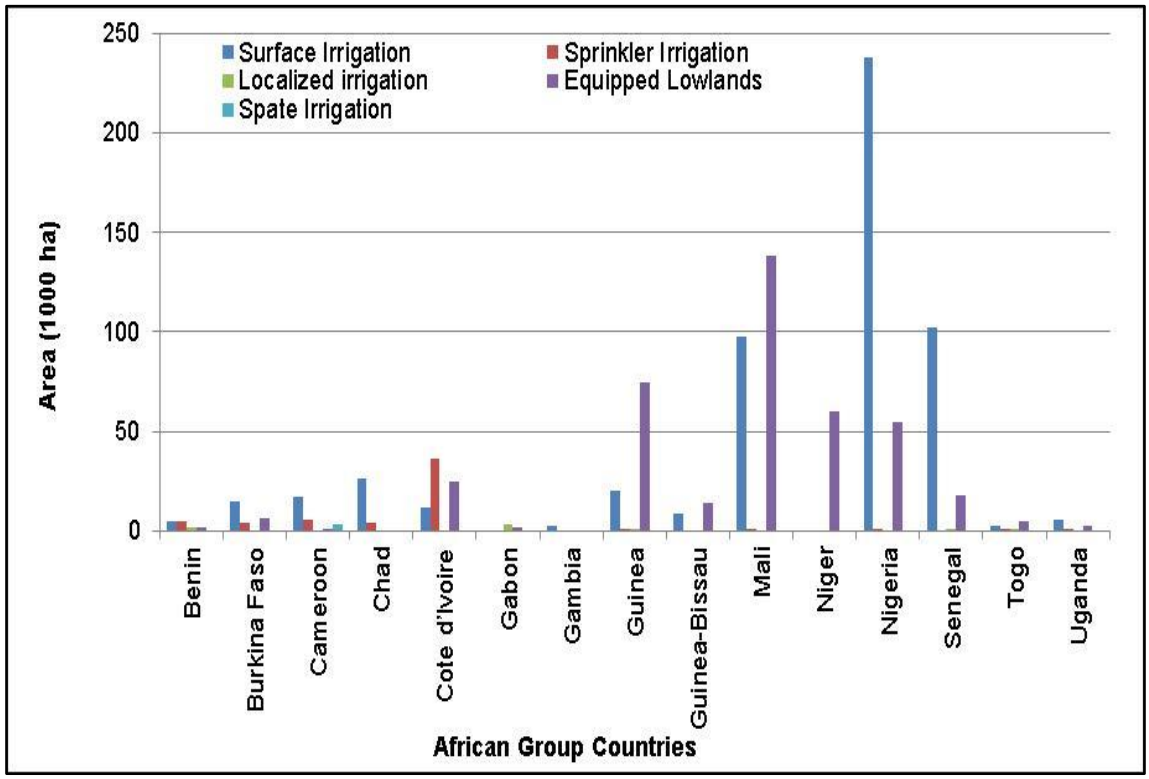
Figure 9.3. Irrigation potential in African Group



Source: AQUASTAT, 2013
Note: Data not available in Sierra Leone

The total amount of surface irrigation in African countries is about 550 thousand ha and Nigeria, Senegal, and Mali have the largest area of this Group. Surface irrigation in other countries is very low. The total amount of sprinkler irrigation is about 55 thousand ha. Cote d'Ivoire has the highest proportion of this Group (36 thousand ha). Sprinkler irrigation in other countries is very low. The total amount of localized irrigation is around 5 thousand ha and Benin and Gabon has the biggest share in this Group. However, other countries have very low amounts of localized irrigation. The total equipped lowlands area is about 400 thousand ha. Mali, Guinea, Niger, and Nigeria represent the highest proportions. Conversely, other countries represent a smaller area. The total area under spate irrigation in Africa is about 3 thousand ha and such sites are solely located in Cameroon (Figure 9.4).

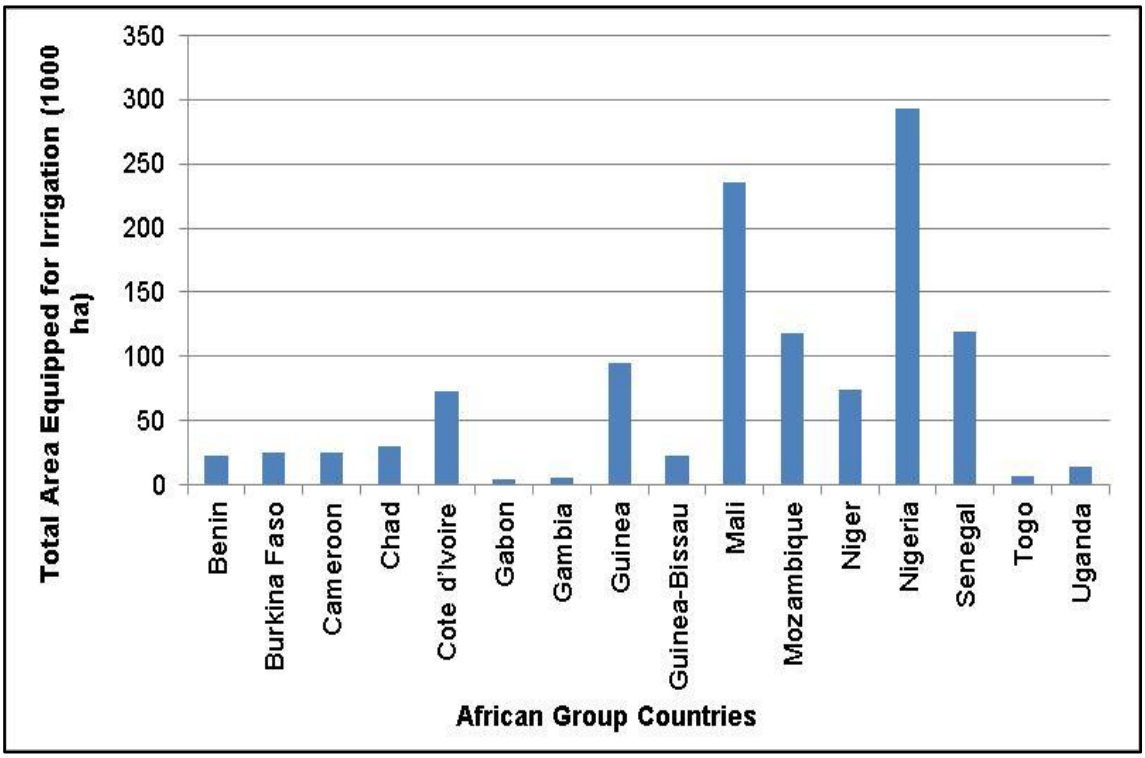
Figure 9.4. Irrigation methods in African Group



Source: AQUASTAT, 2013
Note: Data not available in Mozambique and Sierra Leone

The total irrigated area of African countries is around 1.2 million ha. Nigeria, Mali, Senegal, Mozambique, Guinea, Niger and Cote d'Ivoire represent the largest share, respectively. The other countries have relatively low potential for irrigation (Figure 9.5).

Figure 9.5. Total Area Equipped for Irrigation in African Group



Source: AQUASTAT, 2013
Note: Data not available in Sierra Leone

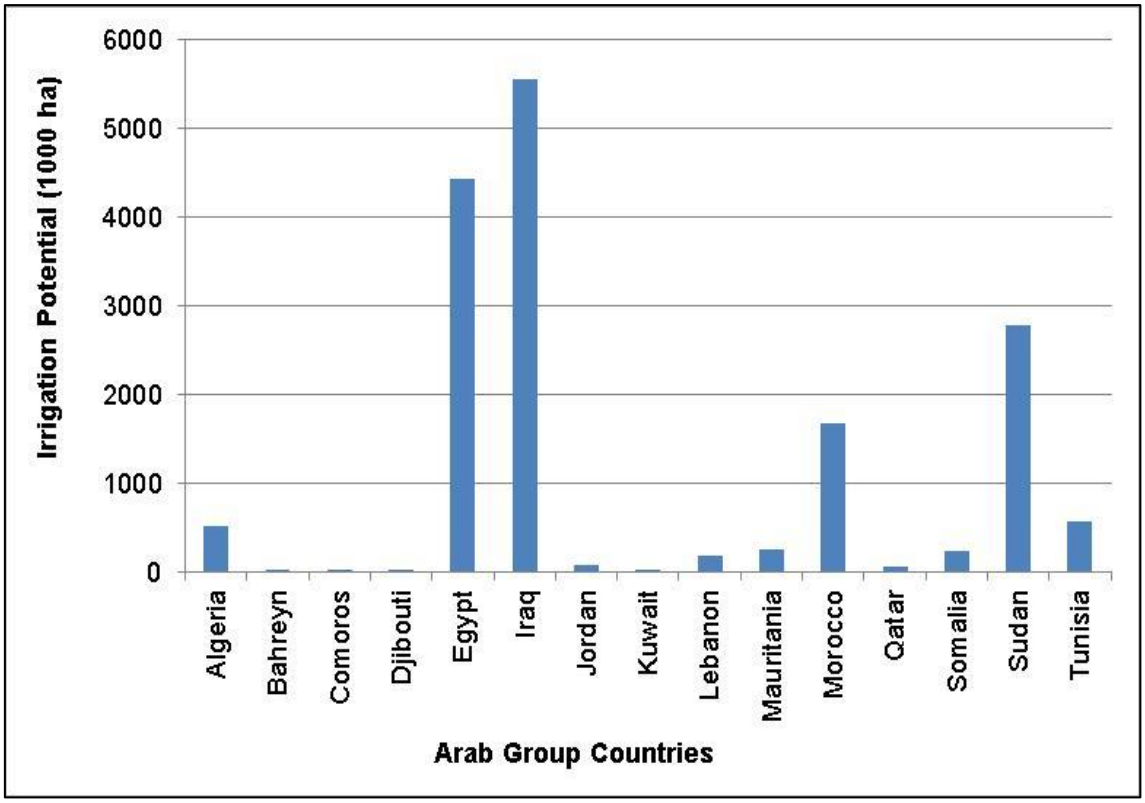
9.2. Arab Group

As in the most of the developing countries, more than 80% of water resources are allocated to agricultural activities in arid and semi-arid Arab countries. In these countries, a negative balance exists in fresh water resources. Resources are gradually consumed at a rate faster than the replenishment of these resources.

Since the greatest portion of world water resources is used for agricultural purposes and especially for irrigation, efficient water saving technologies and methods should be used in irrigation for sustainable use of ever-depleting water resources and to reliably meet the food demands of ever-increasing world population. Present researches on water resources should focus on efficient water-saving technologies or sustainable water resources management implementations.

The Arab Group has a total of 16 million hectares of irrigation potential. Iraq, Egypt, Sudan and Morocco have the largest share in this Group. However, the potential for irrigation is very low in other countries (Figure 9.6).

Figure 9.6. Irrigation potential in Arab Group

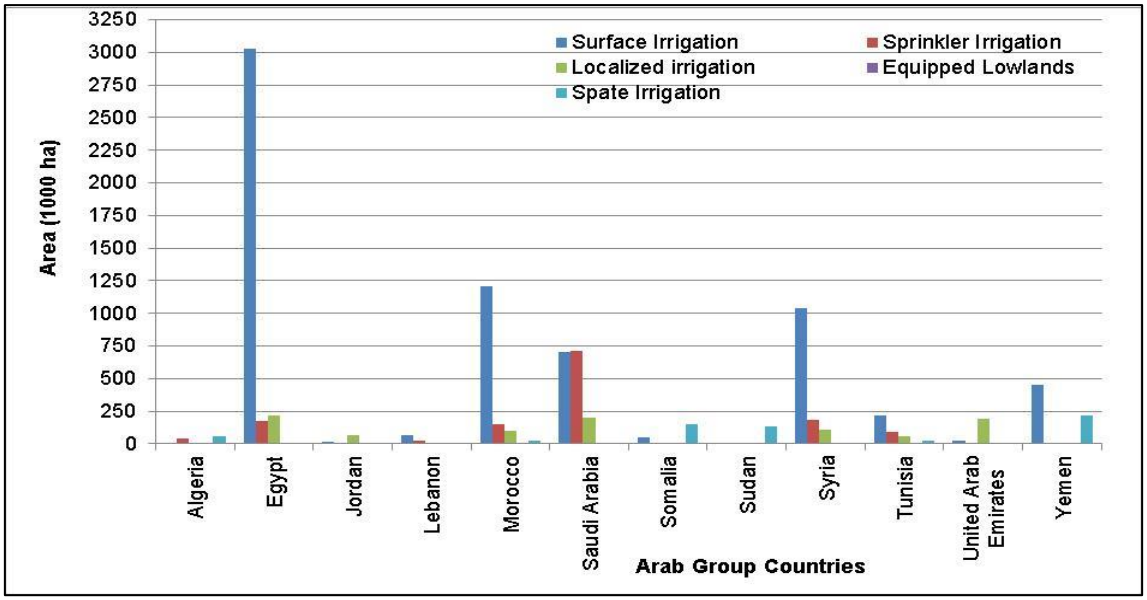


Source: AQUASTAT, 2013
Note: Data not available in Libya, Oman, Palestinian, Saudi Arabia, Syria, United Arab Emirates and Yemen

In the Arab Group of countries, total amount of surface irrigation is around 7 million ha. While Egypt, Morocco, Syria, and Saudi Arabia have the largest share, other countries exhibit lower levels of surface irrigation. The total area under sprinkler irrigation in this group countries is 1.4 million ha. While Saudi Arabia, Syria, Egypt, and Morocco have the largest shares, sprinkler irrigation is very low in other countries.

On the other hand, localized irrigation is about 976 thousand ha and Egypt, Saudi Arabia, the United Arab Emirates and Syria have the largest shares. The total amount of lowland area is around 8 thousand ha and the entire area is located in Yemen. The total amount of spate irrigation is about 610 thousand ha in the Group of Arab countries. While Yemen, Somalia, and Sudan have the largest shares, other countries have lower levels of spate irrigation (Figure 9.7).

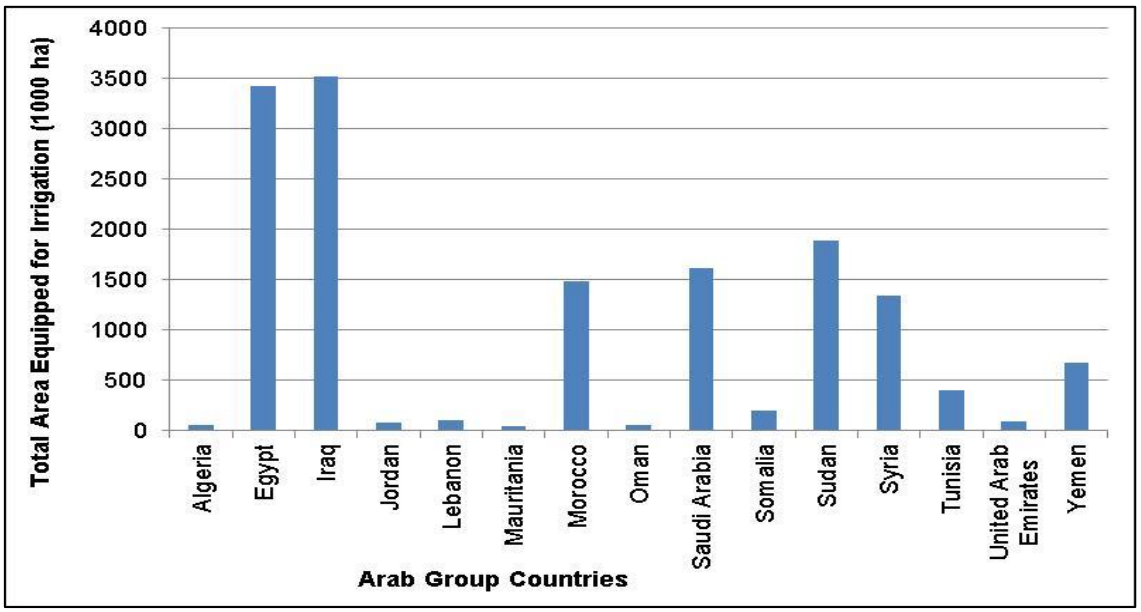
Figure 9.7. Irrigation Methods in Arab Group



Source: AQUASTAT, 2013
Note: Data not available in Bahrain, Comoros, Djibouti, Iraq, Kuwait, Mauritania and Palestinian

Arab Group countries have 15 million hectares of irrigated area. In this Group, Iraq, Egypt, Sudan, Saudi Arabia, Morocco and Syria, have the largest shares, respectively. The amount of irrigated area is relatively low in other countries (Figure 9.8).

Figure 9.8. Total Area Equipped for Irrigation in Arab Group



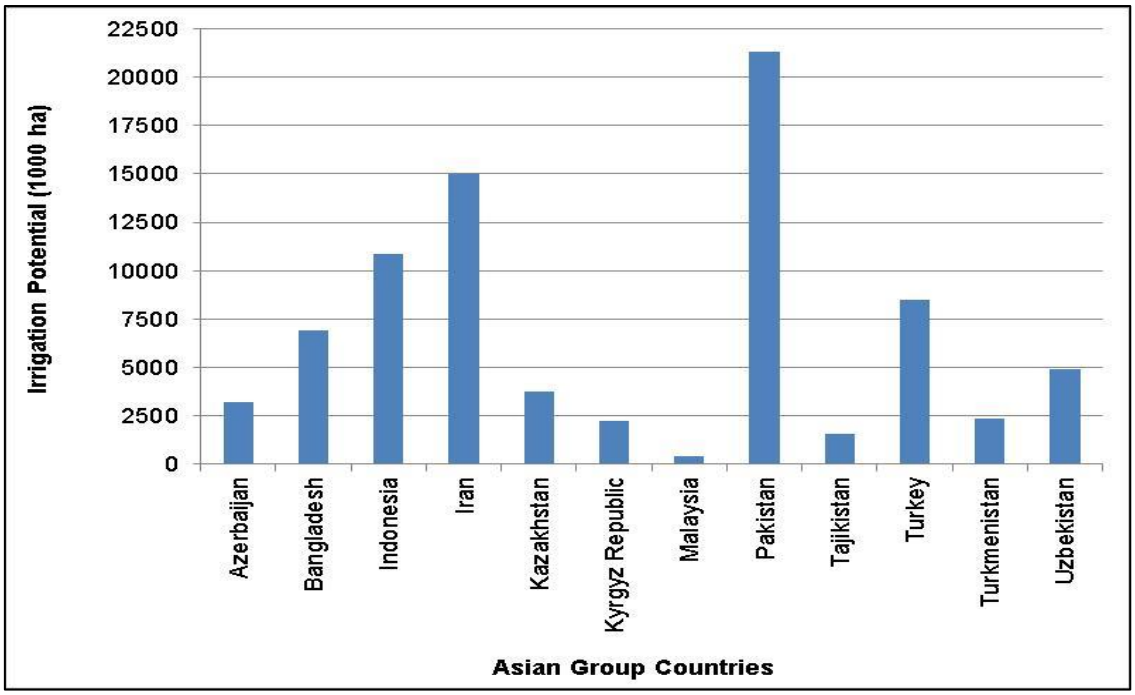
Source: AQUASTAT, 2013
Note: Data not available in Bahrain, Comoros, Djibouti, Kuwait, Palestinian and Qatar

9.3. Asian Group

Asian Group is very rich in terms of rivers and streams (Irtysh, Yenisei, Indus, and Ganges).Therefore most of the continent is composed of large alluvial plains. Dams are also common in Asian countries to store the waters of these large rivers for irrigation and hydroelectric power generation.

Total irrigation potential is about 81 million hectares in Asian Group countries. Pakistan, Iran, and Indonesia have the largest shares in this group. The other countries have lower levels of irrigation potential (Figure 9.9).

Figure 9.9. Irrigation Potential in Asian Group



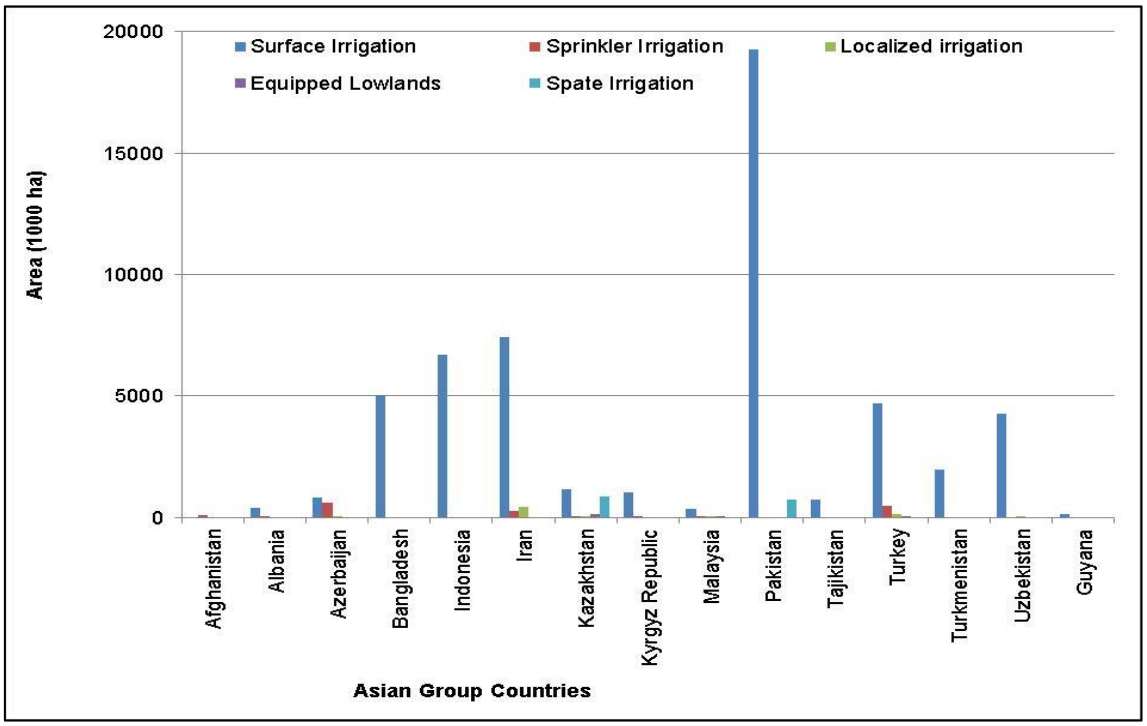
Source: AQUASTAT, 2013
Note: Data not available in Afghanistan, Albania, Brunei, Maldives, Guyana and Suriname

The total amount of surface irrigation is about 54 million ha within the Asian Group countries. While Pakistan, Iran, Indonesia, Bangladesh, Turkey, and Uzbekistan have the largest shares, surface irrigation is at lower levels in other countries.

Within the Asian Group countries, the amount of sprinkler irrigation is about 1.5 million ha. In this Group, Azerbaijan, Turkey, Iran, and Afghanistan have the largest shares. Sprinkler irrigation in other countries compared to the former is very low. Total

amount of localized irrigation is about 590 thousand ha in Asian countries. Iran and Turkey have the highest proportion of this irrigation system. The other countries have lower levels of localized irrigation. In Asian countries, the total amount of the lowlands is close to 170 thousand ha. Kazakhstan represents large portion of this area (about 140 thousand ha). The amount of spate irrigations is about 1.5 million ha and it is totally found in Kazakhstan and Pakistan (Figure 9.10).

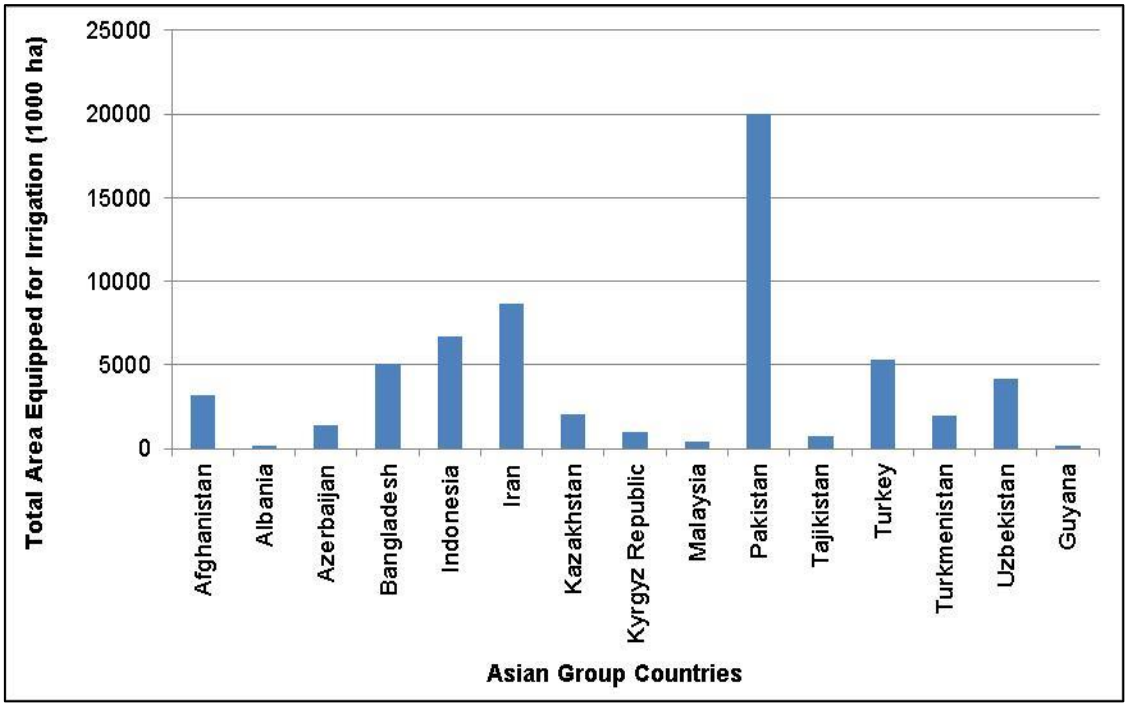
Figure 9.10. Irrigation Methods in Asian Group



Source: AQUASTAT, 2013
Note: Data not available in Brunei, Maldives and Suriname

The amount of the total irrigated area is about 61 million ha in Asian Group countries. Pakistan has the largest share with 20 million ha. The amount of irrigated land area in Iran, Indonesia, Turkey, Bangladesh and Uzbekistan is between 4 to 9 million ha. The amount of irrigated area in other countries is relatively low compared to the above mentioned ones (Figure 9.11).

Figure 9.11. Total Area Equipped for irrigation in Asian Group



Source: AQUASTAT, 2013
Note: Data not available in Brunei, Maldives and Suriname

10. DRAINAGE, SOIL SALINITY

Excess water in the crop root zone soil is harmful to plant growth. Crop yields are drastically reduced on poorly drained soils, and, in cases of prolonged waterlogging, plants eventually die due to a lack of oxygen in the root zone. Sources of excess soil water that result in high water tables includes: high precipitation in humid regions; surplus irrigation water and canal seepage in the irrigated lands; and artesian pressure. Waterlogging in irrigated regions may result in excess soil salinity, i.e., the accumulation of salts in the plant root zone. Artificial drainage is essential on poorly drained agricultural fields to provide optimum air and salt environments in the root zone. Drainage is regarded as an important water management practice, and as a component of efficient crop production systems. World food supply and the productivity of existing agricultural lands can only be maintained and enhanced if drainage improvements are undertaken on cropland currently affected by the excess water and high water tables (FAO, 1997).

The primary benefits of drainage go beyond the control of excess soil water and accumulation of excess salts in the crop root zone. The coincident environmental and socio-economic benefits associated with disease vector control and public health must be fully recognized. One of the major environmental benefits of drainage is its positive impact on improving the health of people, plants and farm animals. Drainage of wet, swampy areas has led to a reduction in mosquito breeding sites in all parts of the world. The effect has been a drop in the incidence and prevalence of important water related and mosquito transmitted diseases. Furthermore, drainage of stagnant water can eliminate foot-rot in large animals and, to a certain extent, the breeding environment of aquatic and semi-aquatic snails, which are the intermediate host of schistosomiasis. Drainage also reduces or eliminates mildew infections and various root rots of plants. The overall impact of improved drainage has been an improvement in hygienic conditions, in the health sector and in the productivity of human beings. By growing high value food crops in well-drained soils, the health, nutrition and economic status of rural populations can be improved. There are also increased opportunities for employment, as new industries may develop in prosperous areas (FAO, 1997).

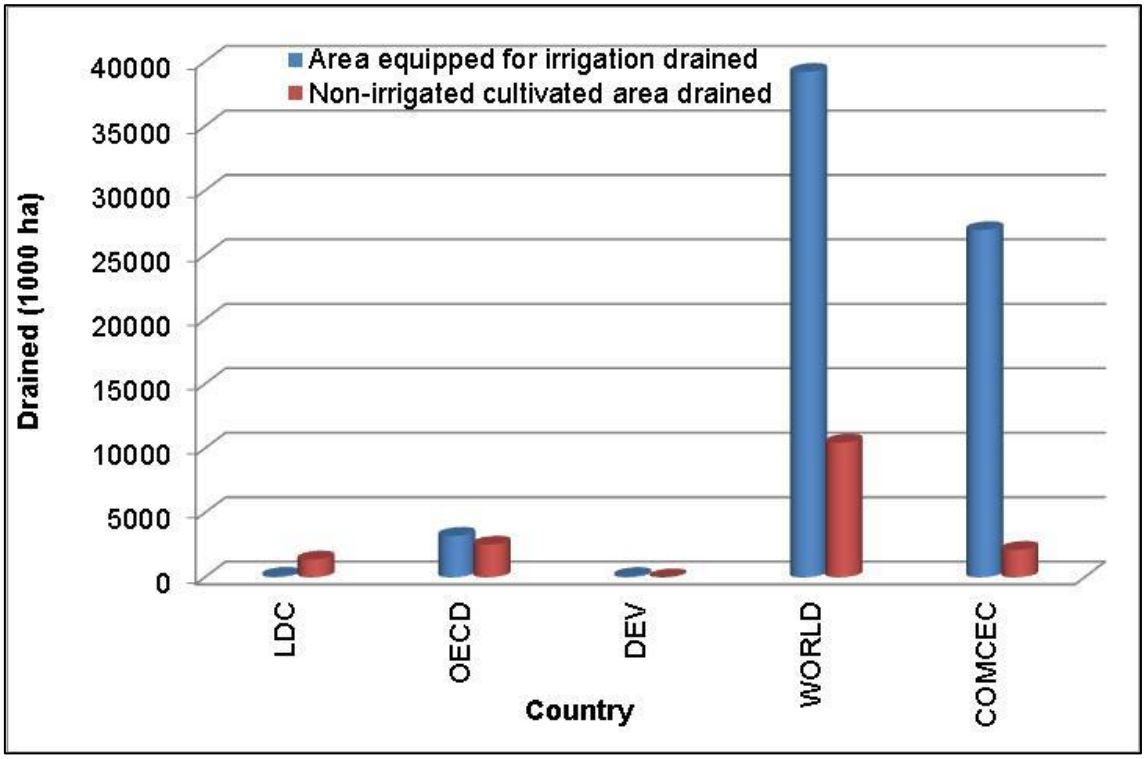
Where drainage is used to reclaim salinized and waterlogged lands, it is an environmentally beneficial practice, because the land is returned to its full productive potential. The adaptation of subsurface drainage systems to serve as sub-irrigation or controlled drainage systems leads to other benefits, i.e., the reduction of nitrate pollution. Drainage (both surface and subsurface) is not simply the conversion of wetlands, but the improvement of naturally inadequately drained cropland. It is complementary to irrigation and is viewed as an essential component of irrigated agriculture. The objective is to increase production efficiency, crop yields and profitability on naturally poorly drained agricultural lands (FAO, 1997).

In the wetter regions, flooding and waterlogging still limit crop production in many parts of the world. In the inland valleys of Sub-Saharan Africa with shallow groundwater tables, controlled drainage may help to increase crop production and improve the health of rural population. In certain lands of the humid tropics, drainage is also needed in order to increase rice production and promote crop diversification. As the global population and the demand for food increase, additional new drainage systems will be installed in a broader range of climate, soil and hydrological conditions, and existing systems will be renovated (FAO, 2007).

In many irrigation projects, crop yields are reduced due to waterlogging and salinization of the land. In some cases, there is total loss of production and therefore the land is abandoned. Waterlogging may also cause human health problems, particularly malaria, because of ponded water. Of the estimated 235 million ha of irrigated land in the world, 10 to 15% has been affected by waterlogging and salinization. Two important causes of waterlogging and salinization are: (a) excessive application of irrigation water; and (b) lack of adequate drainage. Thus provision of adequate drainage is a solution to the waterlogging and salinization problems of irrigated lands. However, it must be pointed out that improving drainage should not be a substitute for reducing excessive application and that improved drainage should not be implemented without first assessing whether waterlogging may be reduced by optimizing application. Countries do not have sufficient information on their drainage problems. Existing information is incomplete, inadequate and not reliable. According to available data, Egypt has to work more to drain the country (FAO, 1996).

Globally, the existing drainage system is estimated to be 35 million ha within the irrigated areas (Figure 10.1). COMCEC countries have the majority of this amount (about 25 million hectares). Asian countries have 20 million ha of drainage system in the COMCEC Region. Data is unavailable for the African Group countries, hence it couldn't be assessed (Annex 9).

Figure 10.1. Distribution of Drainage Areas



Source: FAOSTAT, 2013

A similar situation is observed in non-irrigated cultivated areas (dry farming areas). Approximately 10 million hectares of agricultural land in the non-irrigated cultivated area of the world is needed to be drained. Approximately 2 million ha of this amount is in the COMCEC Member Countries, which is close to that of OECD Countries (2.5 million ha area). In Arab countries, totally 32 thousand ha of land that is required to be drained is exist. However, there is an insufficient data for making sound analysis for this sub-region.

A general evaluation indicates that more than half of the drained irrigated land area all around the world is in the COMCEC Region when a comparison is made between the total drained irrigated lands in the COMCEC Member Countries and

world's total. The situation differs a little bit in the case of non-irrigated cultivated area drained. Approximately a quarter of drained non-irrigated land area all around the world is in the COMCEC Member Countries. The detailed information is given in Annex 9.

When an evaluation is made as of drainage requirement, it is necessary to drain the irrigated and non-irrigated lands completely in terms of both environmental health and sustainable agricultural production. For that reason, when soil salinity is concerned, it is very important to establish the necessary drainage systems in the COMCEC Region where needed.

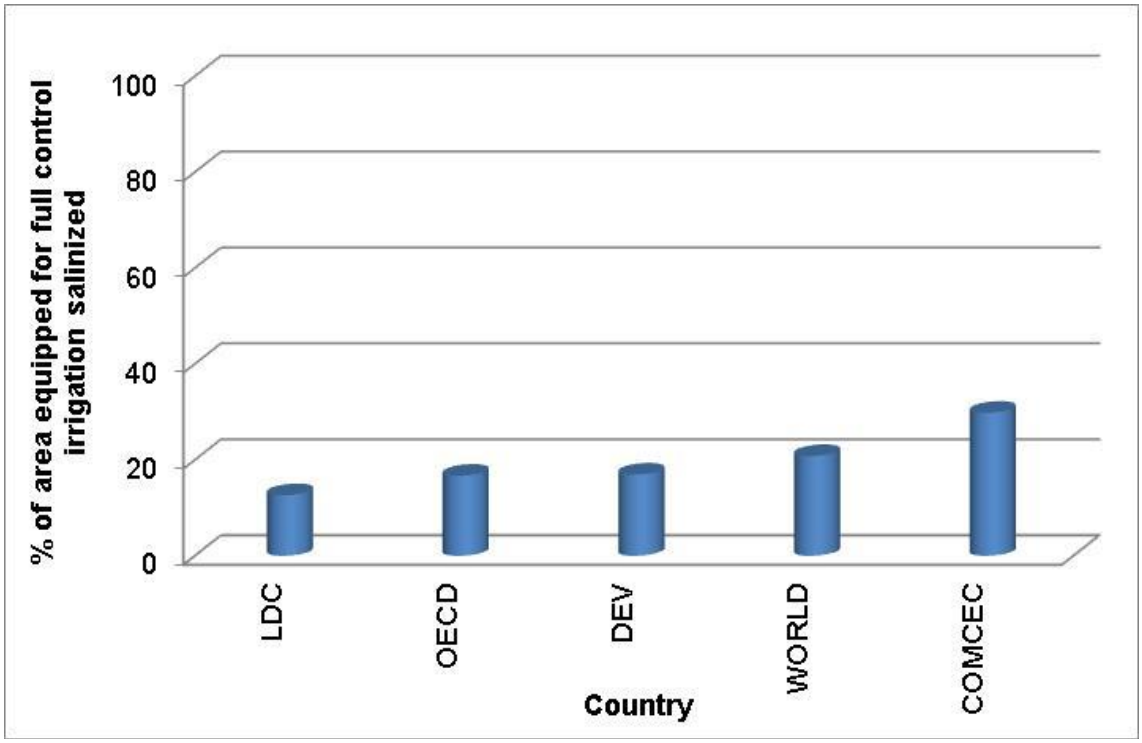
In addition to drainage, other important problem facing in irrigation is salinization. Salinization is a process involving an accumulation of salt in topsoil and is of particular concern in irrigated arid and semi-arid regions. Salinization is usually associated with elevated water tables, which transport dissolved salts to the soil surface. Water tables rise gradually when the hydrologic balance of the system is disrupted through removal of deep rooted native vegetation or application of irrigation water. Once the water table nears the soil surface, a disturbance such as heavy irrigation or rainfall can draw water levels into the root zone, where evapotranspiration by plants quickly aspirate salts to the soil surface. Soil salinization appears suddenly, immediately impeding crop growth and imposing long term limitations on land productivity (Siebert et. al., 2010). Salinization is a worldwide problem, particularly acute in semi-arid areas which use lots of irrigation water, are poorly drained, and never get well flushed. These conditions are found in parts of the Middle East, in China's North Plain, in Central Asia, in the San Joaquin Valley of CA, and in the Colorado River Basin; all areas where the soil profile never (or rarely) gets well flushed (FAO, 2002).

Figure 10.2 shows the distribution of soil salinity in areas equipped with fully controlled irrigation in the world. This Figure realizes that about 20% of fully controlled irrigation area is salinized in the world. LDC, OECD and Developed (DEV) countries have salinized areas below the world rate. On the contrary, the COMCEC Member Countries have 20% of the world's total salinized area.

In general, when soil salinity is considered, value of the COMCEC Region is above the world's average. The factors such as climate, topography, wrong agricultural policies and production systems cause the area of saline-affected lands to increase.

Salinity must be monitored and necessary measures must be taken immediately for a sustainable agriculture. This is a necessity for both conserving environment and agricultural production and sustainable agricultural production.

Figure 10.2. Distribution of Soil Salinity



Source: AQUASTAT, 2012

Soil salinization is a problem in 14 countries in Africa. The situation is of particular concern in Morocco, Nigeria and Sudan, where the area salinized by irrigation exceeds 100 thousand ha although less so in Kenya, Tunisia and United Republic of Tanzania. Salinization also requires monitoring in; Djibouti, Gambia and Mozambique, where soils are naturally saline; Namibia; Niger, where 350 ha have been abandoned and others risk being so shortly; Somalia; and Zimbabwe. Finally, Egypt has controlled its salinization since the 1970's on a large part of its irrigation schemes through the installation of drainage systems (Annex 9).

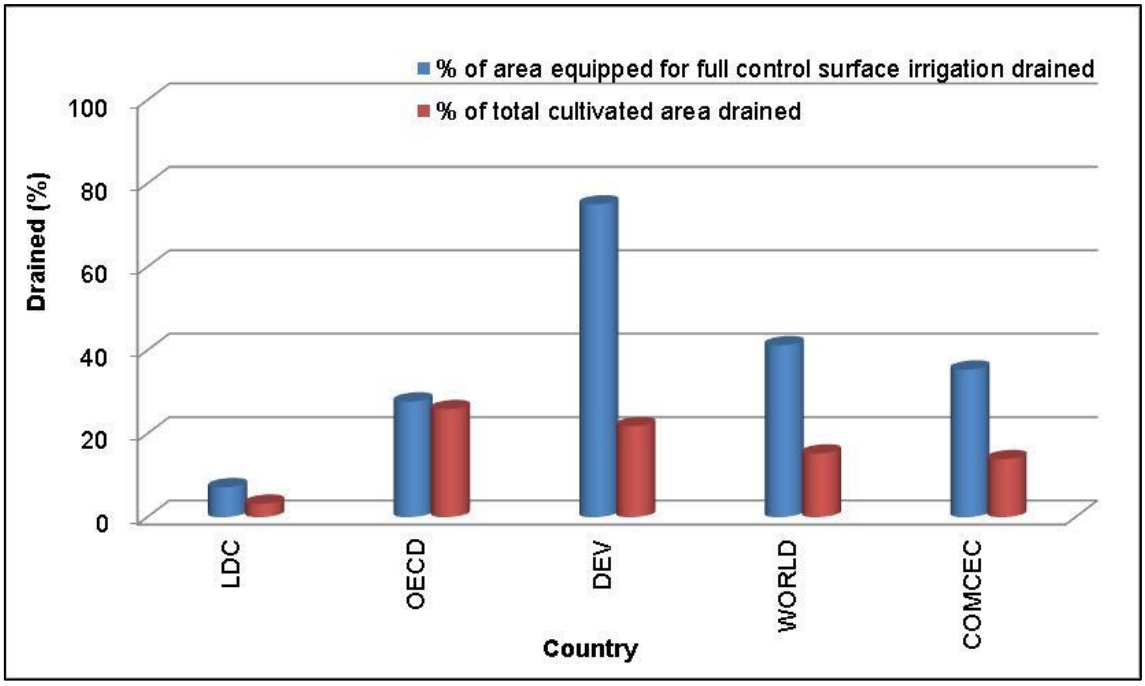
Other major environmental problems related to irrigation in Africa are: (i) erosion and its consequences and silting up or sedimentation of water bodies, dams and canals (ten countries); (ii) proliferation of aquatic vegetation (six countries); and (iii) the drying up or the risk of drying up of wetlands (four countries). An estimated 70% to

90% of all cases of malaria in the world occur in Africa. Africa remains by far the worst affected continent, with 365 million cases of malaria in 2002. The WHO (2005) report on malaria in Africa indicates that malaria is the cause of at least one death in five among very young children. More than 80% of deaths caused by this pathology occur in Africa, where it threatens an estimated 66% of the population. According to the WHO, the only African countries where the disease is not endemic are Lesotho, Libyan Arab Jamahiriya, Seychelles and Tunisia (Annex 9).

The areas having fully controlled drainage system under surface irrigation in the world is close to 40%. In the countries of DEV, the areas having fully controlled drainage system under surface irrigation is close to 75% (Figure 10.3). In COMCEC Member Countries as a whole, this figure is close to 35%. Total cultivated area drained is close to 15% in the world. This rate is higher than those of DEV, OECD and Asian Group countries which are 21%, 25% and 30% respectively. The areas having fully controlled drainage system under surface irrigation in COMCEC countries is close to 14% (Annex 9).

It is an absolute necessity to have a drainage system in areas under surface irrigation for a sustainable and high quality production. As known, in the areas where surface irrigation method used, there is an excessive use of water. The mentioned excessive water accumulates in time depending on the conditions and causes soil and groundwater salinity. And this consequently leads to both environmental (health, deterioration of natural resources) and agricultural production (decrease in quality and yield) problems.

Figure 10.3. Distribution of Full Control Surface Irrigation Drained



Source: AQUASTAT, 2013

10.1. African Group

Distribution of drainage areas in Benin has a value which is 5630 ha (Annex 10). A similar situation is observed in non-irrigated cultivated area drained (dry farming) areas. Non-irrigated cultivated area drained in Nigeria is close to 100% (Annex 10).

The same situation occurs in the areas having fully controlled drainage system under surface irrigation in the African Group Countries. Sufficient data is unavailable for the African Group countries that could be assessed. It is only 11% control surface irrigation drained in the Benin (Annex 10).

10.2. Arab Group

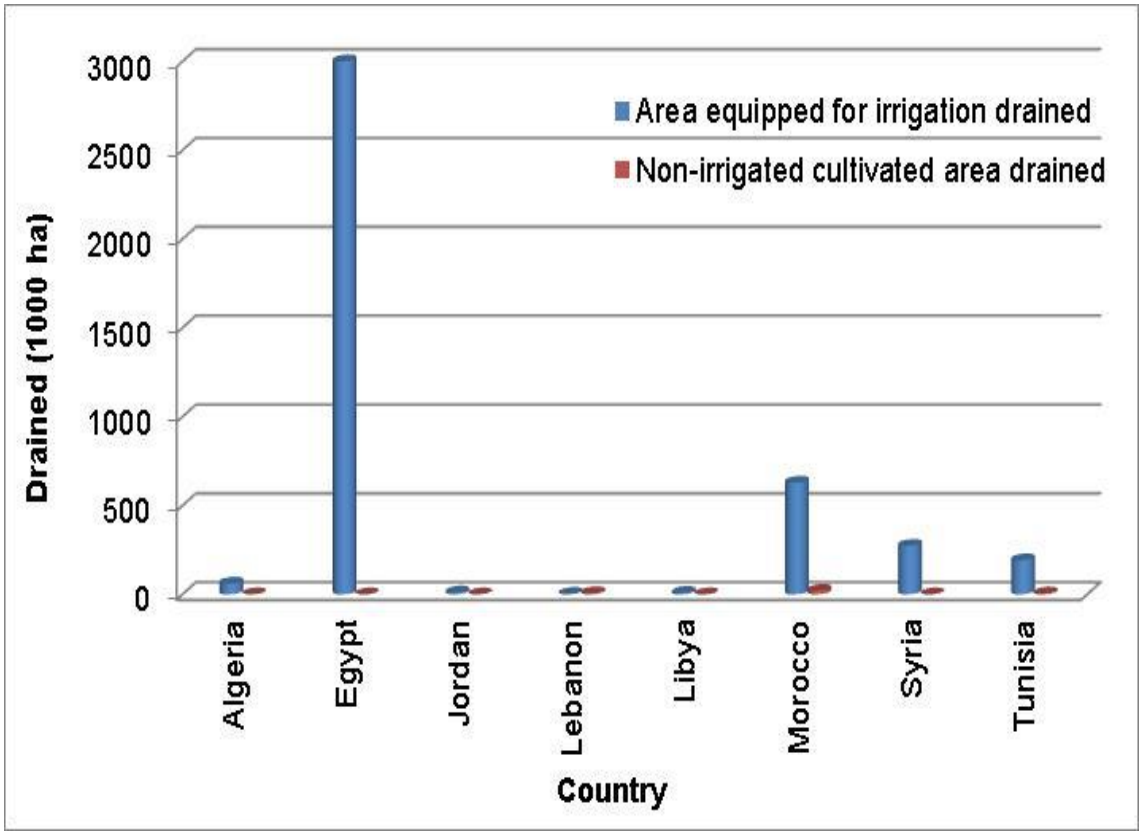
Assessment of area of drainage under irrigated and non-irrigated areas of Arab Group countries is the same as African Group countries. The data concerning the area of drainage under irrigated and non-irrigated areas is not sufficient. Figure 10.4 shows that Egypt has 3 million ha, Morocco has 0.6 million ha, Syria has drainage area of 0.25 million ha and Tunisia has 0.2 million ha area of irrigation that has drainage system.

Figure 10.5 shows the distribution of soil salinity in the areas having fully controlled drainage system under surface irrigation in the Arab Group countries. Soil

salinization demonstrates difference from one country to another. For example, it is close to 85% for the soils of Kuwait. At the same time, it is salinized of full control irrigation in the 50% of Iraq, 40% Libya, 33% Bahrain, 28% Sudan and 23% Tunisia.

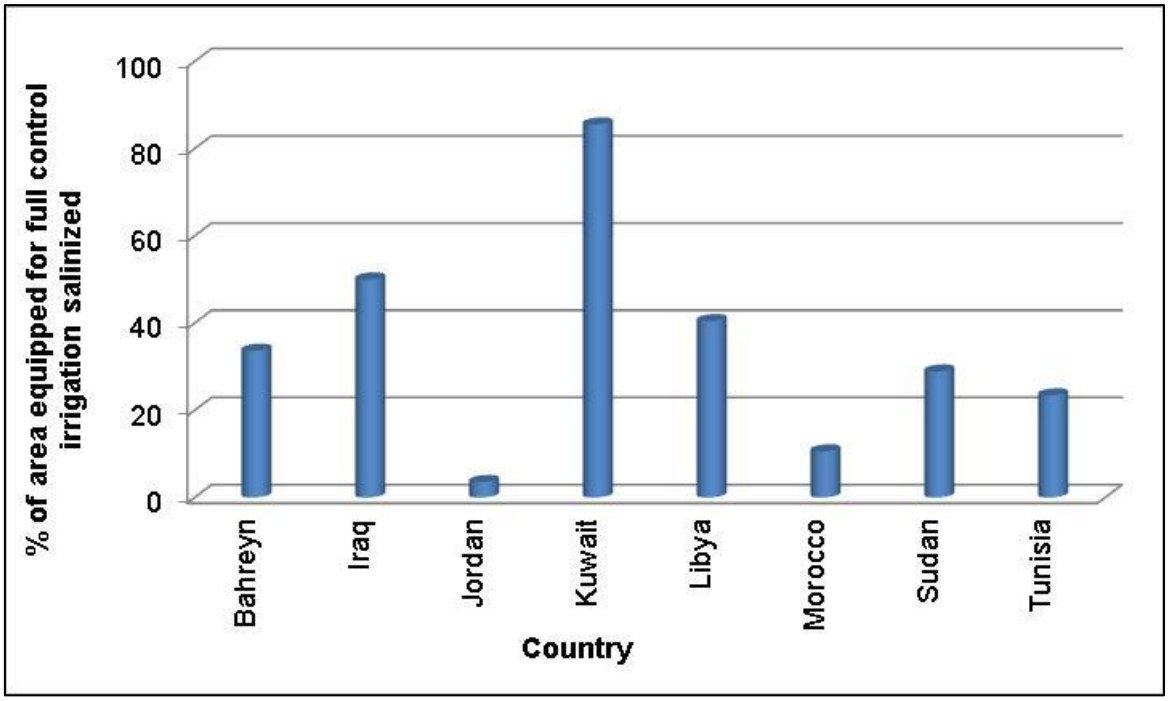
The areas having fully controlled drainage system under surface irrigation in the Arab Group countries are presented in Figure 10.6. The highest value is 90% and is in Tunisia. In other words, the percentage of areas having fully controlled drainage system under surface irrigation in Tunisia is close to 90%. This figure for Jordan, Morocco and Syria is 75%, 50% and 30% respectively. Considering the total production under drained areas in Arab Group countries, Egypt has the highest value with 85%.

Figure 10.4. Distribution of Drainage Areas in Some Arab Group Countries



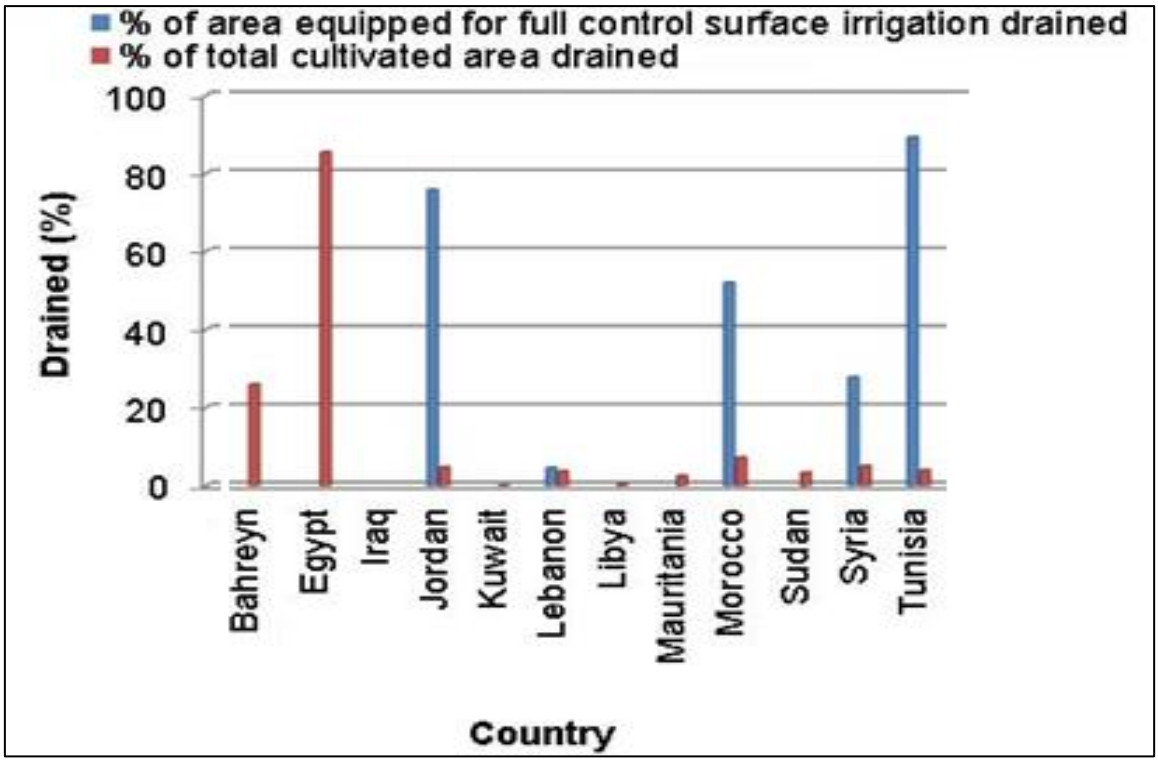
Source: AQUASTAT, 2013

Figure 10.5. Distribution of Soil Salinity in Some Arab Group Countries



Source: AQUASTAT, 2013

Figure 10.6. Distribution of Full Control Surface Irrigation Drained in Some Arab Group Countries



Source: AQUASTAT, 2013

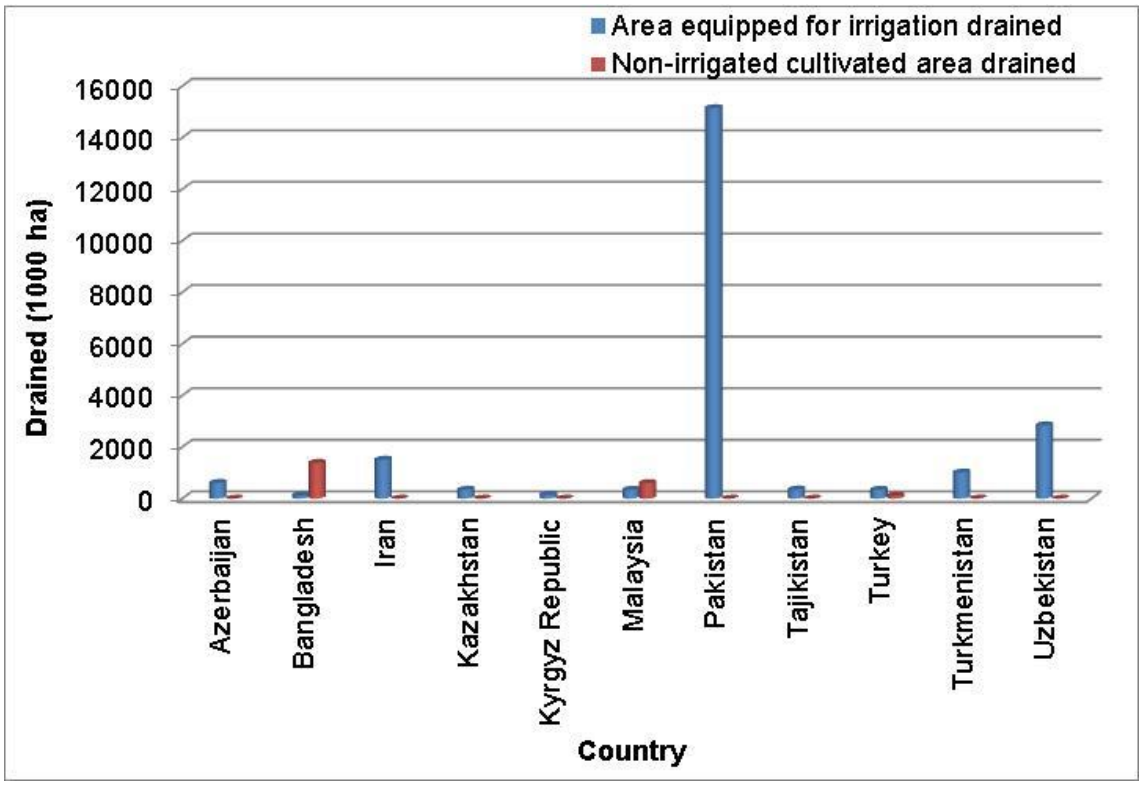
Note: Data of full control surface irrigation drained not available in Bahrain, Egypt and Morocco

10.3. Asian Group

Assessment of drained in irrigated and Non-irrigated areas of Asian Group countries, there are significant differences between countries (Figure 10.7). Taken into consideration the available information in irrigated drained area, Pakistan has over 15 million ha drained area. This country is followed by Uzbekistan with 3 million ha drained area. Other countries have close by 1 million ha and less than 1 million ha equipped for irrigation drained area.

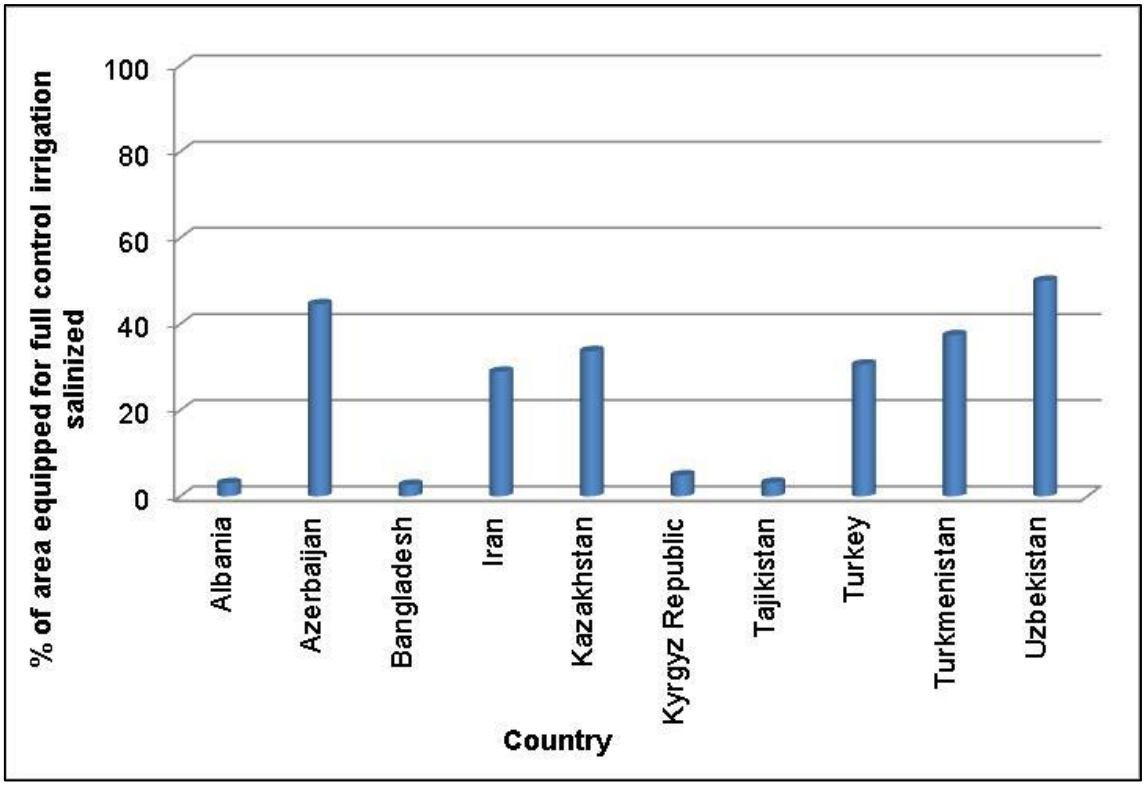
Figure 10.8 shows the distribution of soil salinity in the areas having fully controlled drainage system under surface irrigation in the Asian Group countries. Soil salinization demonstrates difference from a country to another. For example it is close to 50% for the soils of Uzbekistan, 45% for the soils of Azerbaijan, 40% for the soils of Turkmenistan and 30% for the soils of Iran, Kazakhstan and Turkey.

Figure 10.7. Distribution of Drainage Areas in Some Asian Group Countries



Source: AQUASTAT, 2013

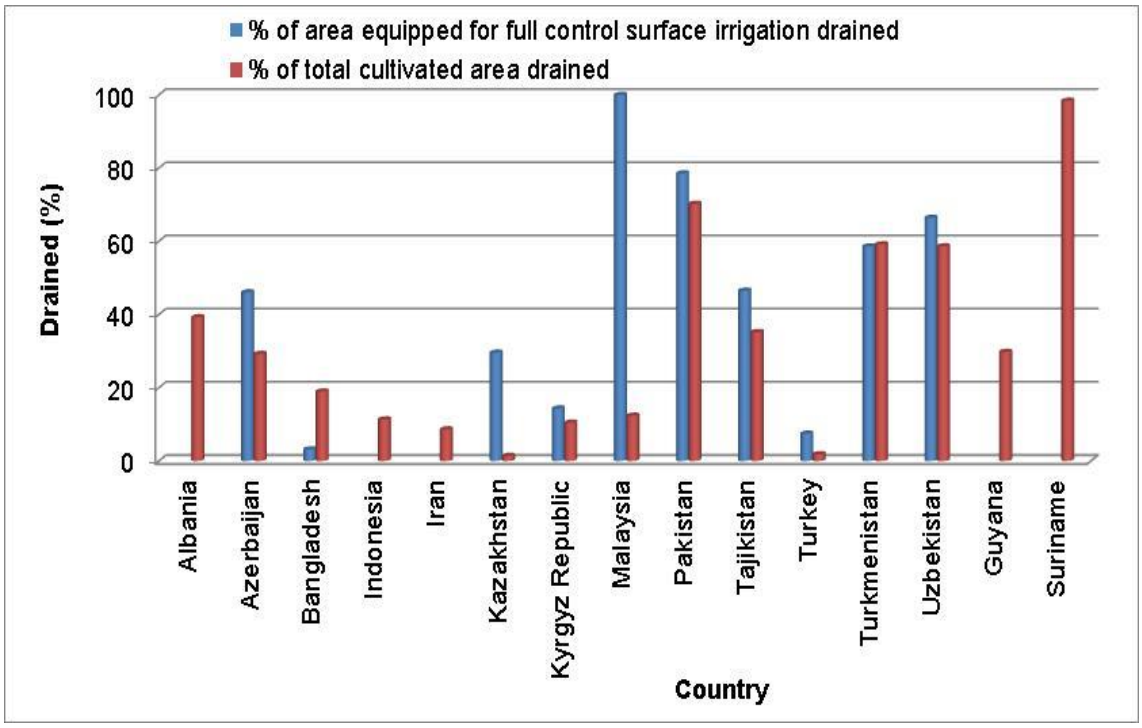
Figure 10.8. Distribution of Soil Salinity in Some Asian Group Countries



Source: AQUASTAT, 2013

The areas having fully controlled drainage system under surface irrigation in the Asian Group countries are presented in Figure 10.9. The highest value is 100% in the Malaysia. In other words, the percentage of areas having fully controlled drainage system under surface irrigation in Malaysia is close to 100%. The areas having fully controlled drainage system under surface irrigation in Pakistan is close to 80%. Considering the total production under drained areas in Asian Group countries, Suriname has the highest value. This country has 100% total production under drained areas. Suriname is followed by Pakistan with 70%, Turkmenistan and Uzbekistan with 60% and Tajikistan with 50%.

Figure 10.9. Distribution of Full Control Surface Irrigation Drained in Some Asian Group Countries



Source: AQUASTAT, 2013

11. TRENDS IN IRRIGATION INVESTMENT

Water-saving methods are promoted in the COMCEC Member Countries which have limited water resources. Irrigation areas increased over large part of the COMCEC region between the years 1988 and 2012. Surface irrigation is used over the majority of these areas. In the COMCEC region, especially in the countries having relatively advanced economy and agriculture, sprinkler and localized irrigation are preferred. (Annex 10).

11.1. African Group

In the African countries, large areas were put under irrigation in Mali, Senegal, Cameroon, Chad, Niger and Uganda between the years 1993 and 2002. The limited areas have been opened for irrigation in Burkina Faso, Gambia, Togo and Guinea. A surface irrigation method is used in the majority of newly irrigated areas. In Mali, Mozambique, Niger and Senegal, irrigation investments were made in lowland areas. While localized irrigation is realized in Cameroon and Guinea, sprinkler irrigation has been preferred in Chad.

11.2. Arab Group

There is an increasing irrigation investment in Arab countries just because of both the limited land and water resources. When surface irrigation decreased in Jordan and Tunisia, sprinkler and localized irrigation areas have increased. Surface, sprinkler and localized irrigation areas have increased in Morocco. Localized irrigation development is remarkable in Qatar and the United Arab Emirates. In Libya, Sudan, South Sudan, Tunisia and Yemen, irrigation investments were made on the spate irrigation. The surface irrigation areas decreased in Oman and sprinkler and localized irrigation systems were established in these areas.

11.3. Asian Group

Irrigation is very important for countries in Asian Group. Irrigation areas decreased in Kyrgyzstan and Uzbekistan and increased in other countries. Bangladesh, Indonesia, Iran, Pakistan and Turkey are the countries with the highest areas opened to irrigation. The surface irrigation is replaced by sprinkler irrigation in Azerbaijan. Sprinkler and localized irrigation areas significantly increased in Iran. In Turkey, the

modernization of irrigation systems is on-going under the project for the use of pressurized irrigation methods. Also the use of on-farm irrigation sprinkler and localized irrigation systems are rapidly increasing in Turkey.

12. CONCLUSION AND RECOMMENDATIONS

Water is one of the most important inputs in agricultural production. About 40% of the world food needs is supplied from 17% of the crops that are irrigated. Hence, in order to ensure food security by increasing agricultural production, it is crucial to expand the irrigated area and effective use of water. Land and water resources development efforts, well-operation and sustainability of irrigation schemes and networks are the significant issues for countries.

With a total land area of 3.2 billion hectares and a total population of 1.5 billion in 2008, the 57 COMCEC member countries account for almost one-fourth of the world's total land area and slightly over one-fifth of its population. With a total agricultural area of 1.4 billion hectares which are 43.7% of their total land area, the COMCEC Region constitutes 28.4% of the world's total.

Total renewable water resources consist of surface and ground water resources. In general around the world, renewable ground water resources corresponds about 25 % of total surface water resources. Water is a scarce resource in arid and semi-arid regions where many COMCEC countries are located, particularly in West Asia and North-eastern Africa. Therefore, most of the COMCEC countries in these regions are facing with severe pressures due to limited opportunities for the exploitation of new water resources. These pressures are expected to increase in the face of expanding population and the increased per capita water use associated with economic development, as well as due to the expected negative impacts of climate change in the future. Therefore, the efficient use of water resources in agriculture, through improving irrigation systems and techniques, is one of the most urgent needs and prerequisites for sustainable agricultural development and food security in these countries, particularly those in water-scarce regions.

The irrigation potential of COMCEC Member Countries is slightly higher than 100 million ha. According to country group evaluation, the Asian Group countries have the highest irrigation potential (80 million ha). On the other hand, both Arab and African Group countries show very low irrigation potentials. Irrigation potential in the COMCEC Member Countries is one fifth of the world's irrigation potential (500 million ha) (Annex 8).

Areas irrigated by surface irrigation methods in the COMCEC Member Countries are slightly above 60 million ha. Asian Group countries have a higher area under surface irrigation compared to the rest (54 million ha). Surface irrigation, in both Arab and African Group countries is very low. Sprinkler irrigation methods in the COMCEC Member Countries cover about 3 million ha.

As a matter of fact, Arab and Asian group countries have more areas under sprinkler irrigation than the African Group Countries which have a limited sprinkler irrigation technology. About 1.5 million ha land is irrigated by localized (drip and micro sprinkler) system in the COMCEC Member Countries. According to analyses, the Arabic and Asian Group countries have the highest amount of lands under localized irrigated systems. The amount of localized irrigation in African Group countries is almost negligible. The equipped lowland of the COMCEC Member Countries is about 600 thousand ha. When groups of countries are examined, African countries have the most lowlands (400 thousand ha) in area. There is almost no area of the lowlands in Arab countries. With regard to distribution of irrigation methods, the COMCEC Member Countries mostly have surface irrigation (80%).

In many irrigation projects, crop yields are reduced due to waterlogging and salinization of the land. In some cases, there is total loss of production and therefore the land is abandoned. The situation is of particular concern in Africa. Salinization also requires monitoring in: Djibouti, Gambia and Mozambique, where soils are naturally saline; Namibia; Niger, where 350 ha have been abandoned. Finally, Egypt has controlled its salinization since the 1970's on a large part of its irrigation schemes through the installation of drainage systems. According to available data, Egypt has to work more to drain the country. Asia countries have 20 million ha of drainage system in the COMCEC Region. The data for African Group Countries is unavailable.

Because of insufficient irrigation infrastructure, most of the COMCEC member countries depend on rain-fed agriculture. Dependence of agricultural industry on climate conditions of member countries with uneven or irregular precipitation regimes may only be reduced through improving irrigation systems and increasing irrigated lands.

For an efficient use of available water resources, irrigation scheduling works should take soil, climate (rainfall and water consumption), vegetation, topography,

irrigation system, irrigation method, water-yield relationships and farmer demands into consideration. And water distribution and delivery plans should consider water distribution network, parcel characteristics, cropping pattern and water management organizations.

The sustainability of water resources is a social, physical, economic and ecological concept. Sustainable water resources management covers the services to meet domestic irrigation and industrial water demands and to preserve ecosystems without creating any threats on such resources. Following issues should be taken into consideration for sustainability:

- Water preservation through preventing waste of water,
- Improving the efficiency of irrigation systems,
- Improving the quality of water,
- Limiting surface water withdraws based on soil, crop and irrigation method,
- Limiting the groundwater use and withdraws.

The primary objective of irrigation projects is to maximize the economic and social welfare. In addition to a proper operation-management-maintenance program, an efficient training and extension system and effective input supply and marketing systems should be established to realize such objectives. Expected benefits from the irrigation investments would not be obtained even long after the construction of these systems.

Irrigation infrastructure in the agricultural sector is a significant tool for efficient, high-quality and high-income-generating crop production and socio-economic development. Sustainability of irrigation infrastructures should be provided in parallel to land consolidation, on-farm development services (land leveling, field drainage, roads, land reclamation, soil conservation, etc.), farmers training and organization (irrigation associations, farmers data bank, banking services, etc.). Participation of producers in the activities implemented within the scope of development of environment-friendly agricultural infrastructure should be ensured, as well as natural resource preservation should be provided.

Excessive water use in irrigation should be prevented through re-arrangements to be made in demand-based water distribution, crop and area-based irrigation fee accruing system and constant water fee accruing regardless of number of irrigation. Excessive water uses cause yield losses and nutrient leach outs and create various environmental problems such as soil erosion, rise of water table and soil salinity.

Irrigation projects are intended to provide economic and social benefits, which can only be achieved through proper project operation and management systems. Effective operation and management of irrigation projects play a significant role in sustainable natural resource use and world food safety.

Irrigation facilities are usually constructed by states. Nonetheless operation and maintenance of constructed systems are carried out by the users. The COMCEC Member Countries construct several irrigation facilities with a significant amount of investments. Various environmental problems, such as soil erosion, rise of water table, soil salinity and alkalinity, have arisen because of improper implementations, operation and maintenance, lack of farmers training. Irrigation water fee collection rates are also very low in these systems. Therefore, operation, management and maintenance cost of state-operated systems bring a heavy load to national budgets (ICID, 2010).

Following issues should be taken into consideration to get the desired benefits from the irrigation projects constructed by allocating significant budgets from national economies:

- A bottom-up approach, organization and ensure the participation of water users,
- Improve the structure of agricultural enterprise and facilities,
- Encourage the use of modern irrigation and farming techniques,
- Prevent excessive water and fertilizer use,
- Introducing effective training programs on irrigated agriculture,
- The provision of inter-agency co-ordination,
- The prevention of the misuse of agricultural lands,

All these activities should take into consideration principles of environmental protection and sustainability.

The main problem in irrigation in the COMCEC member countries is the lack of awareness regarding the significance of water management. Water management institutions and organizations implement demand-based water distribution instead of a planned water delivery system based on current climate, soil and plant conditions and water-yield relationships. Users perform unconscious irrigation and use excessive amount of water which lead to erosion, water table and salinity problems. Improper usage of water has a negative impact on plants and yields thereby causes income losses. To overcome all these problems, the coordination among the irrigation-related public and private organizations and non-governmental organizations should be improved and users' awareness on these issues should be raised.

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ANNEXES

ANNEX 1. Population in the COMCEC Member Countries

Country	Total population (1000 inhab)	Rural population (1000 inhab)	Urban population (1000 inhab)	Population density (inhab/km^2)	Total economically active population (1000 inhab)	Total economically active population in agriculture	
						(1000 inhab)	as % of total population
African Group	**370594**	**215086**	**155508**	**66.66**	**135561**	**69849**	**18.85**
Benin	9100	5233	3867	79.30	3730	1616	17.76
Burkina Faso	16968	12464	4504	61.88	7764	7146	42.11
Cameroon	20030	8176	11854	42.13	7694	3572	17.83
Chad	11525	8279	3246	8.98	4645	2997	26.00
Cote d'Ivoire	20153	9812	10341	62.50	7626	2812	13.95
Gabon	1534	208	1326	5.73	730	184	11.99
Gambia	1776	729	1047	157.20	822	622	35.02
Guinea	10222	6554	3668	41.58	4931	3912	38.27
Guinea-Bissau	1547	1080	467	42.82	576	455	29.41
Mali	15840	10037	5803	12.77	4203	3122	19.71
Mozambique	23930	14544	9386	29.94	11033	8856	37.01
Niger	16069	13298	2771	12.68	5301	4377	27.24
Nigeria	162471	80389	82082	175.90	50891	12277	7.56
Senegal	12768	7318	5450	64.90	5626	3933	30.80
Sierra Leone	5997	3672	2325	83.59	2259	1344	22.41
Togo	6155	3438	2717	108.40	2477	1307	21.23
Uganda	34509	29855	4654	142.90	15253	11317	32.79
Arab Group	**365002**	**158809**	**206193**	**195.40**	**126840**	**29987**	**8.22**
Algeria	35980	11840	24140	15.11	15285	3187	8.86
Bahrain	1324	150	1174	1742.00	658	4	0.30
Comoros	754	504	250	405.20	330	227	30.11
Djibouti	906	215	691	39.05	396	291	32.12
Egypt	82537	46599	35938	82.42	26977	6599	8.00
Iraq	32665	11075	21590	75.05	8260	430	1.32
Jordan	6330	1354	4976	70.87	1851	112	1.77
Kuwait	2818	45	2773	158.10	1419	14	0.50
Lebanon	4259	537	3722	407.60	1571	27	0.63
Libya	6423	1407	5016	3.65	2351	68	1.06
Mauritania	3542	2065	1477	3.44	1523	764	21.57
Morocco	32273	13281	18992	72.27	11965	2973	9.21
Oman	2846	760	2086	9.20	1136	321	11.28
Palestine	4152	1064	3088	689.70	1422	109	2.63
Qatar	1870	77	1793	161.10	1214	8	0.43

ANNEX 1. Population in the COMCEC Member Countries (continue)

Country	Total population (1000 inhab)	Rural population (1000 inhab)	Urban population (1000 inhab)	Population density (inhab/km^2)	Total economically active population (1000 inhab)	Total economically active population in agriculture	
						(1000 inhab)	as % of total population
Saudi Arabia	28083	4974	23109	13.06	10355	492	1.75
Somalia	9557	5931	3626	14.99	3824	2489	26.04
Sudan	44632	26405	18227	17.69	14305	7231	16.20
Syria	20766	9105	11661	112.10	6839	1342	6.46
Tunisia	10594	3424	7170	64.75	3993	808	7.63
United Arab Emirates	7891	1233	6658	94.39	4972	148	1.88
Yemen	24800	16764	8036	46.97	6194	2343	9.45
Asian Group	**853911**	**472565**	**381346**	**198.69**	**373903**	**136408**	**15.97**
Afghanistan	32358	24948	7410	49.61	10474	6217	19.21
Albania	3216	1515	1701	111.90	1481	609	18.94
Azerbaijan	9306	4461	4845	107.50	4870	1090	11.71
Bangladesh	150494	107474	43020	1045.00	72000	31976	21.25
Brunei	406	97	309	70.36	195	0	0.00
Indonesia	242326	134304	108022	127.20	121445	49489	20.42
Iran	74799	21437	53362	42.86	30944	6562	8.77
Kazakhstan	16207	6671	9536	5.95	8682	1181	7.29
Kyrgyz Republic	5393	3532	1861	26.97	2491	507	9.40
Malaysia	28859	7803	21056	87.24	12957	1584	5.49
Maldives	320	188	132	1067.00	156	23	7.19
Pakistan	176745	112733	64012	222.00	64829	25022	14.16
Tajikistan	6977	5137	1840	48.94	2901	778	11.15
Turkey	73640	22015	51625	93.98	25131	7961	10.81
Turkmenistan	5105	2554	2551	10.46	2431	714	13.99
Uzbekistan	27760	17696	10064	62.05	12916	2695	9.71
Guyana	756	58.83	539	217.00	3.517	345	45.63
Suriname	529	41.17	159	370.00	3.229	197	37.24
COMCEC	**1589507**	**846460**	**743047**	**153.58**	**636304**	**236244**	**14.86**

ANNEX 1. Population in the COMCEC Member Countries (continue)

Country	Total population (1000 inhab)	Rural population (1000 inhab)	Urban population (1000 inhab)	Population density (inhab/km^2)	Total economically active population (1000 inhab)	Total economically active population in agriculture	
						(1000 inhab)	as % of total population
LDC	788308	557033	231275	129.86	350345	229437	29.10
OECD	1193357	274978	918379	134.80	577682	30924	2.59
DEV	1073008	236529	836479	323.97	537155	17086	1.59
WORLD	6969739	3423446	3546293	179.55	3322513	1311765	18.82
COMCEC	1585355	845396	739959	153.58	634882	236135	14.89
African Group	370594	215086	155508	66.66	135561	69849	18.85
Arab Group	360850	157745	203105	195.40	125418	29878	8.28
Asian Group	853911	472565	381346	198.69	373903	136408	15.97

Source: AQUASTAT, 2013

ANNEX 2. Agriculture GDP in the COMCEC Member Countries

Country	1990		1995		2000		2005		2010	
	%	Billion $	%	Billion $	%	Billion $	%	Billion $	%	Billion $
African Group		**26.5**		**24.3**		**25.4**		**59.6**		**111.8**
Benin	0.34	0.60	0.35	0.70	0.42	0.80	0.47	1.40	0.39	2.10
Burkina Faso	0.47	0.90	0.37	0.80	0.42	0.80	0.65	1.90	0.52	2.90
Cameroon	1.32	2.50	0.98	2.00	0.98	1.90	1.07	3.20	0.93	5.10
Chad	0.33	0.60	0.26	0.50	0.29	0.60	0.41	1.20	0.33	1.80
Cote d'Ivoire	1.89	3.50	1.34	2.70	1.31	2.50	1.30	3.90	1.08	5.90
Gabon	0.16	0.30	0.13	0.30	0.11	0.20	0.11	0.30	0.08	0.50
Gambia	0.08	0.10	0.08	0.20	0.10	0.20	0.06	0.20	0.05	0.30
Guinea	0.33	0.60	0.52	1.00	0.35	0.70	0.22	0.70	0.23	1.30
Guinea-Bissau	0.15	0.30	0.20	0.40	0.11	0.20	0.08	0.20	0.06	0.30
Mali	0.62	1.20	0.45	0.90	0.46	0.90	0.64	1.90	0.62	3.40
Mozambique	0.55	1.00	0.38	0.80	0.46	0.90	0.54	1.60	0.47	2.60
Niger	0.47	0.90	0.31	0.60	0.35	0.70	0.48	1.40	0.43	2.40
Nigeria	5.66	10.50	4.59	9.30	6.03	11.70	12.27	36.40	13.56	74.80
Senegal	0.58	1.10	0.42	0.90	0.41	0.80	0.43	1.30	0.36	2.00
Sierra Leone	0.22	0.40	0.26	0.50	0.20	0.40	0.28	0.80	0.25	1.40
Togo	0.30	0.50	0.24	0.50	0.23	0.50	0.28	0.80	0.24	1.30
Uganda	0.81	1.50	1.06	2.20	0.83	1.60	0.81	2.40	0.68	3.70
Arab Group		**47.30**		**48.40**		**54.50**		**73.20**		**121.20**
Algeria	3.78	7.00	2.03	4.10	2.36	4.60	2.65	7.90	2.45	13.50
Bahrain	0.02	0.00	0.02	0.10	0.03	0.10	0.02	0.10	0.02	0.10
Comoros	0.05	0.10	0.05	0.10	0.05	0.10	0.07	0.20	0.05	0.30
Djibouti	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00
Egypt	3.50	6.50	5.20	10.60	6.39	12.40	4.35	12.90	5.19	28.60
Iraq	2.80	5.20	0.38	0.80	0.50	1.00	1.16	3.40	1.30	7.20
Jordan	0.15	0.30	0.12	0.20	0.09	0.20	0.12	0.30	0.14	0.80
Kuwait	0.09	0.20	0.06	0.10	0.07	0.10	0.08	0.20	0.04	0.20
Lebanon	0.13	0.20	0.68	1.40	0.55	1.10	0.39	1.10	0.32	1.80
Libya	1.24	2.30	1.04	2.10	1.37	2.70	0.37	1.10	0.36	2.00
Mauritania	0.40	0.70	0.34	0.70	0.23	0.40	0.21	0.60	0.13	0.70
Morocco	2.87	5.30	2.76	5.60	2.53	4.90	2.65	7.80	2.28	12.60
Oman	0.17	0.30	0.19	0.40	0.21	0.40	0.16	0.50	0.13	0.70
Qatar	0.03	0.10	0.04	0.10	0.03	0.10	0.02	0.10	0.03	0.10
Palestine	0.13	0.20	0.19	0.40	0.21	0.40	0.09	0.30	0.08	0.40
Saudi Arabia	3.62	6.70	4.15	8.40	4.79	9.30	3.45	10.20	2.03	11.20
Somalia	0.38	0.70	0.34	0.70	0.58	1.10	0.41	1.20	0.10	0.60
Sudan	2.82	5.20	2.35	4.80	2.49	4.90	4.10	12.20	3.47	19.10

ANNEX 2 Agriculture GDP in the COMCEC Member Countries (continue)

Country	1990		1995		2000		2005		2010	
	%	Billion $	%	Billion $	%	Billion $	%	Billion $	%	Billion $
Syria	1.70	3.20	1.88	3.80	2.50	4.90	1.94	5.80	2.16	11.90
Tunisia	0.94	1.70	0.91	1.80	1.10	2.10	1.00	3.00	0.59	3.20
United Arab Emirates	0.29	0.50	0.58	1.20	1.21	2.40	0.85	2.50	0.49	2.70
Yemen	0.46	0.90	0.50	1.00	0.67	1.30	0.61	1.80	0.63	3.50
Asian Group		**111.60**		**130.60**		**114.70**		**163.50**		**318.70**
Afghanistan	0.70	1.30	1.05	2.10	1.03	2.00	0.77	2.30	0.81	4.50
Albania	0.48	0.90	0.67	1.40	0.44	0.90	0.51	1.50	0.39	2.20
Azerbaijan	0.95	1.80	0.38	0.80	0.44	0.80	0.41	1.20	0.53	2.90
Bangladesh	4.61	8.50	4.72	9.60	5.75	11.20	3.76	11.10	3.25	17.90
Brunei	0.02	0.00	0.03	0.10	0.03	0.10	0.03	0.10	0.02	0.10
Indonesia	11.92	22.10	16.9	34.50	13.23	25.70	12.66	37.50	19.64	108.40
Iran	8.57	15.90	9.85	20.00	7.02	13.70	6.34	18.80	7.65	42.20
Kazakhstan	5.44	10.10	1.25	2.50	0.76	1.50	1.23	3.60	1.21	6.70
Kyrgyz Republic	0.46	0.90	0.30	0.60	0.24	0.50	0.24	0.70	0.15	0.80
Malaysia	3.75	7.00	5.88	11.90	4.25	8.30	4.00	11.90	4.65	25.60
Maldives	0.01	0.00	0.02	0.00	0.02	0.00	0.03	0.10	0.01	0.10
Pakistan	5.81	10.80	8.05	16.40	8.85	17.20	7.45	22.10	6.32	34.90
Tajikistan	0.43	0.80	0.20	0.40	0.11	0.20	0.17	0.50	0.20	1.10
Turkey	13.65	25.30	12.6	25.50	13.82	26.90	15.25	45.20	11.18	61.70
Turkmenistan	0.53	1.00	0.17	0.40	0.58	1.10	0.87	2.60	0.36	2.00
Uzbekistan	2.65	4.90	1.86	3.80	2.11	4.10	1.28	3.80	1.22	6.80
Guyana	0.10	0.20	0.17	0.30	0.15	0.30	0.10	0.30	0.07	0.40
Suriname	0.07	0.10	0.13	0.30	0.12	0.20	0.08	0.20	0.08	0.40
COMCEC		185.4		203.3		194.6		296.3		551.7
LDC	36.4	47.8	34.4	47.0	30.8	48.2	27.3	69.6	25.5	114.5
OECD	6.0	535.6	4.9	573.0	3.7	498.9	2.9	614.3	2.5	613.3
DEV	6.4	507.7	4.6	548.9	3.5	464.2	2.8	555.3	2.4	547.3
WORLD	5.4	1136.0	4.4	1203.4	3.5	1138.7	3.0	1579.1	2.8	2396.6
COMCEC		185.4		203.3		194.6		296.3		551.7
African Group		26.5		24.3		25.4		59.6		111.8
Arab Group		47.3		48.4		54.5		73.2		121.2
Asian Group		111.6		130.6		114.7		163.5		318.7

Source: AQUASTAT, 2013

ANNEX 3 Land Use in the COMCEC Member Countries

Country	Land Area	Agricultural Area	Arable Land	Permanent Crops	Permanent Meadows and Pastures
	(1000 ha)				
African Group	**768029**	**358597**	**103416**	**13492**	**241689**
Benin	11276	3430	2580	300	550
Burkina Faso	27360	11765	5700	65	6000
Cameroon	47271	9600	6200	1400	2000
Chad	125920	49932	4900	32	45000
Cote d'Ivoire	31800	20500	2900	4400	13200
Gabon	25767	5160	325	170	4665
Gambia	1012	615	450	5	160
Guinea	24572	14240	2850	690	10700
Guinea-Bissau	2812	1630	300	250	1080
Mali	122019	41621	6861	120	34640
Mozambique	78638	49400	5200	200	44000
Niger	126670	43782	14940	60	28782
Nigeria	91077	76200	36000	3200	37000
Senegal	19253	9505	3850	55	5600
Sierra Leone	7162	3435	1100	135	2200
Togo	5439	3720	2510	210	1000
Uganda	19981	14062	6750	2200	5112
Arab Group	**1374940.1**	**518360.86**	**54925.86**	**8028.2**	**455406.8**
Algeria	238174	41383	7510	910	32963
Bahrain	76	8.36	1.36	3	4
Comoros	186.1	155	82	58	15
Djibouti	2318	1702	2		1700
Egypt	99545	3665	2870	795	
Iraq	43432	8210	4000	210	4000
Jordan	8878	1002.6	175.6	85	742
Kuwait	1782	152	11	5	136
Lebanon	1023	638	112	126	400
Libya	175954	15585	1750	335	13500
Mauritania	103070	39711	450	11	39250
Morocco	44630	30103.8	7943.8	1160	21000
Oman	602	260.5	44.5	66	150
Palestine	30950	1770.5	32	38.5	1700
Qatar	1161	66	14	2	50
Saudi Arabia	214969	173355	3110	245	170000
Somalia	62734	44129	1100	29	43000

ANNEX 3. Land Use in the COMCEC Member Countries (continue)

Country	Land Area	Agricultural Area	Arable Land	Permanent Crops	Permanent Meadows and Pastures
	(1000 ha)				
Sudan	250400	108678.8	17056	169	91453.8
Syria	18363	13864	4611	1054	8199
Tunisia	15536	10072	2839	2394	4839
United Arab Emirates	8360	397.3	50.6	41.7	305
Yemen	52797	23452	1161	291	22000
Asian Group	**1048684.8**	**514807.6**	**134866.6**	**33669.9**	**346271.1**
Afghanistan	65223	37910	7791	119	30000
Albania	2740	1201	622	74	505
Azerbaijan	8265.8	4768.7	1885.7	227.2	2655.8
Bangladesh	13017	9128	7628	900	600
Brunei	527	11.4	3	5	3.4
Indonesia	181157	54500	23500	20000	11000
Iran	162855	48957	17541	1892	29524
Kazakhstan	269970	209115	24035	80	185000
Kyrgyz Republic	19180	10608.5	1275.9	74.7	9257.9
Malaysia	32855	7870	1800	5785	285
Maldives	30	7	3	3	1
Pakistan	77088	26550	20714	836	5000
Tajikistan	13996	4855	850	130	3875
Turkey	76963	38247	20539	3091	14617
Turkmenistan	46993	32660	1900	60	30700
Uzbekistan	42540	26660	4300	360	22000
Guyana	19685	1677	420	27	1230
Suriname	15600	82	59	6	17
COMCEC	**3191653.9**	**1391765.46**	**293208.46**	**55190.1**	**1043366.9**
LDC	1881659	173240.5	159937.1	13303.4	509689
OECD	3613782	423826.3	397792.8	26034.2	801961.4
DEV	3646943	415705.8	394231.5	21474.9	822814.3
COMCEC	3191653.9	1391765.46	293208.46	55190.1	1043366.9
African Group	768029	358597	103416	13492	241689
Arab Group	1374940.1	518360.86	54925.86	8028.2	455406.8
Asian Group	1048684.8	514807.6	134866.6	33669.9	346271.1

Source: AQUASTAT, 2013

ANNEX 4. Yield

Country	Maize	Rice	Cotton	Potatoes	Wheat
	(kg/ha)				
African Group	**1354.2**	**2107.4**	**922.8**	**8409.3**	**1681.8**
Benin	1329.5	4047.6	1219.4	4216.2	
Burkina Faso	1535.6	1767.6	1116.3	19032.6	
Cameroon	2046.8	2818.2	1300	5272.7	1437.3
Chad	975	1159.9	652.8	2361.1	1660.5
Cote d'Ivoire	1896.9	1850	1159.1	1869	
Gabon	1673.1	2759.4		1963.7	
Gambia	934.9	1216.8	375.4		
Guinea	1216.5	1764.7	870.7	4160.6	
Guinea-Bissau	577.8	1831.1	1043.3		
Mali	1403.7	2097.1	1010.2	18818.2	3437.8
Mozambique	1292.7	988.2	463.7	7720.4	930.8
Niger	766.2	1154	1000	16058	1168.8
Nigeria	1527.9	1770.6	1090.9	2898.9	1368.4
Senegal	1133.1	3717.1	952.1	26397.9	
Sierra Leone	1065.9	1785		2641.8	
Togo	1245.3	2510.1	838.1	7926.4	
Uganda	2399.8	2588.9	750	4802.6	1769.2
Arab Group	**5822.1**	**4599.2**	**1721.7**	**13446.5**	**2431.1**
Algeria	3472.2	1530.7	296.6		1600
Bahrain					
Comoros	2615.4	1261.9		2448.4	
Djibouti	2000				
Egypt	7740.9	9567	2905.3	31824.9	6542.8
Iraq	2607.7	3576.2	2549.3		1955.2
Jordan	20678.4				1381.8
Kuwait	20169.3				2319.7
Lebanon	3630.3				3000
Libya	1957.6				775.3
Mauritania	661.1	5185.5		929.3	1601.8
Morocco	1176.5	4053.1	1786.9	17650.8	1478.3
Oman				22600	1621.5
Palestine					3306.4
Qatar	12555.6				2363.6
Saudi Arabia	6447.1				6418.2
Somalia	646	7019.9	454.5	9894.5	392.9
Sudan					

ANNEX 4. Yield (continue)

Country	Maize	Rice	Cotton	Potatoes	Wheat
	(kg/ha)				
Syria	5047.8		3834.9		2536.6
Tunisia			712.3		2079.1
United Arab Emirates					2625
Yemen	1747.3		1233.4	8777.8	1761.9
Asian Group	5158.7	4027.2	2157.3	8783.1	2760.3
Afghanistan	1640	3200	1000		1517.9
Albania	5170		1224.2		4230.1
Azerbaijan	4546	2094.7	1550.5		2437.6
Bangladesh	6151.2	4218.9	3582.2	9796.2	2601.2
Brunei		591.2		6692.3	
Indonesia	4565.4	4979.9	241.6	12325.9	
Iran	8730.2	5545.5	2434.8		2027
Kazakhstan	4989.6	3721	2181.1		1660
Kyrgyz Republic	6014.3	3089.8	2718.2		2144.5
Malaysia	5535.2	3898.2		10654.5	
Maldives	5000			973.7	
Pakistan	3943.4	2395.9	2327.2	9962.3	2832.8
Tajikistan	12122.8	5818.6	2040.5		2335.9
Turkey	7130.7	9054.3	4760.1		2692.7
Turkmenistan	1114.9	2593.7	1727.3		3758.5
Uzbekistan	7317.1	4275	2257.6		4885.3
Guyana	1441.6	4825.5		1896.9	
Suriname	2285.7	4133.1		17963	
COMCEC	4111.6	3577.9	1600.6	10213.0	2291.1
LDC	1741	2716	1024	8270	1781
OECD	10109	6376	3784	18679	4996
DEV	9923	5762	3124	16470	4721
WORLD	4384	3836	1629	10248	3109
COMCEC	3487	2384	999	5201	1507
Asian Group	4872	3580	1558	3904	1840
Arab Group	4234	1463	626	4278	1989
African Group	1354	2107	814	7420	693

Source: AQUASTAT, 2013

ANNEX 5. Renewable Freshwater Resources

Country	Precipitation (mm/yr)	Total Actual Renewable Water Resources (10^9 m^3/yr)	Total Dam Capacity (10^9 m^3)
African Group	**1125**	**10.3**	**278.786**
Benin	1039	12.5	0.024
Burkina Faso	748	273.0	4.298
Cameroon	1604	15.0	15.610
Chad	322	76.8	
Cote d'Ivoire	1348	164.0	37.800
Gabon	1831	3.0	0.220
Gambia	836	226.0	
Guinea	1651	16.0	1.837
Guinea-Bissau	1577	60.0	0.000
Mali	282	100.3	13.620
Mozambique	1032	3.5	77.470
Niger	151	221.0	0.100
Nigeria	1150	25.8	45.620
Senegal	686	160.0	0.250
Sierra Leone	2526	11.5	0.220
Togo	1168	39.0	1.717
Uganda	1180	**315.0**	80.000
Arab Group	**228**	12.0	**376.472**
Algeria	89	0.0	5.676
Bahrain	83	1.0	0.000
Comoros	900	0.0	
Djibouti	220	57.0	
Egypt	51	90.0	168.200
Iraq	216	1.0	151.800
Jordan	111	0.0	0.275
Kuwait	121	5.0	
Lebanon	661	1.0	0.228
Libya	56	11.0	0.385
Mauritania	92	29.0	0.500
Morocco	346	1.0	16.900
Oman	125	0.0	0.088
Palestine	74	1.0	
Qatar	402	2.0	
Saudi Arabia	59	65.0	1.004
Somalia	282	15.0	
Sudan	416	17.0	8.730
Syria	252	10.3	19.650

ANNEX 5 Renewable Freshwater Resources (continue)

Country	Precipitation (mm/yr)	Total Actual Renewable Water Resources (10^9 m^3/yr)	Total Dam Capacity (10^9 m^3)
Tunisia	207	5.0	2.512
United Arab Emirates	78	0.0	0.061
Yemen	167	2.0	0.463
Asian Group	**1282**	**5056.0**	**982.263**
Afghanistan	327	65.0	3.658
Albania	1485	42.0	4.030
Azerbaijan	447	35.0	21.500
Bangladesh	2666	1227.0	20.300
Brunei	2722	9.0	0.045
Indonesia	2702	1911.0	22.490
Iran	228	137.0	31.610
Kazakhstan	250	108.0	95.500
Kyrgyz Republic	533	24.0	23.500
Malaysia	2875	580.0	23.720
Maldives	1972	0.0	0.000
Pakistan	494	247.0	27.030
Tajikistan	691	22.0	29.500
Turkey	593	212.0	651.000
Turkmenistan	161	25.0	6.220
Uzbekistan	206	49.0	22.160
Guyana	2387	241.0	
Suriname	2331	122.0	
COMCEC	**878**	**6788.7**	**1637.520**
LDC	917	11210.3	2717.110
OECD	1239	6885.7	460.532
DEV	979	11511.4	2074.414
WORLD	1160	54364.6	7085.204
COMCEC	878	6788.7	1637.520
African Group	1125	1417.7	278.786
Arab Group	228	315.0	376.472
Asian Group	1282	5056.0	982.263

Source: AQUASTAT, 2013

ANNEX 6. Total Renewable Water

Country	Total Renewable Surface Water	Total Renewable Groundwater	Total Renewable Water Resources
	10^9 m^3/yr		
African Group	**1738.640**	**464.840**	**1793.980**
Benin	26.090	1.800	26.390
Burkina Faso	8.000	9.500	12.500
Cameroon	280.500	100.000	285.500
Chad	41.500	11.500	43.000
Cote d'Ivoire	78.300	37.840	81.140
Gabon	162.000	62.000	164.000
Gambia	8.000	0.500	8.000
Guinea	226.000	38.000	226.000
Guinea-Bissau	27.000	14.000	31.000
Mali	90.000	20.000	100.000
Mozambique	214.100	17.000	217.100
Niger	31.150	2.500	33.650
Nigeria	279.200	87.000	286.200
Senegal	36.800	3.500	38.800
Sierra Leone	150.000	25.000	160.000
Togo	14.000	5.700	14.700
Uganda	66.000	29.000	66.000
Arab Group	**441.087**	**55.107**	**473.459**
Algeria	10.150	1.517	11.670
Bahrain	0.004	0.112	0.116
Comoros	0.200	1.000	1.200
Djibouti	0.300	0.015	0.300
Egypt	84.500	1.300	85.800
Iraq	95.330	3.280	96.610
Jordan	1.155	0.720	1.622
Kuwait	0.000	0.020	0.020
Lebanon	4.138	3.200	4.838
Libya	0.200	0.600	0.700
Mauritania	11.100	0.300	11.400
Morocco	22.000	10.000	29.000
Oman	1.050	1.300	1.400
Palestine			
Qatar	0.000	0.058	0.058
Saudi Arabia,	2.200	2.200	2.400
Somalia	14.400	3.300	14.700
Sudan	147.000	7.000	149.000

ANNEX 6. Total Renewable Water (continue)

Country	Total Renewable Surface Water	Total Renewable Groundwater	Total Renewable Water Resources
	10^9 m^3/yr		
Syria	41.810	15.970	55.780
Tunisia	3.400	1.595	4.595
United Arab Emirates	0.150	0.120	0.150
Yemen	2.000	1.500	2.100
Asian Group	**4960.840**	**802.055**	**5157.810**
Afghanistan	64.200	10.650	73.850
Albania	37.850	6.200	41.700
Azerbaijan	32.520	6.510	34.680
Bangladesh	1206.000	21.120	1227.000
Brunei	8.500	0.100	8.500
Indonesia	1973.000	457.400	2019.000
Iran	107.400	49.300	138.600
Kazakhstan	127.600	33.850	135.400
Kyrgyz Republic	47.020	13.690	49.490
Malaysia	566.000	64.000	580.000
Maldives	0.000	0.030	0.030
Pakistan	312.500	55.000	320.100
Tajikistan	94.650	6.000	97.650
Turkey	190.700	69.000	231.700
Turkmenistan	81.200	0.405	81.610
Uzbekistan	111.700	8.800	118.500
Guyana			
Suriname			
COMCEC	**7140.567**	**1322.002**	**7425.249**
LDC	6777.540	1240.349	6885.665
OECD	10529.390	2674.365	11210.260
DEV	10907.650	2609.577	11511.430
WORLD	52733.070	11891.680	54364.580
COMCEC	7140.567	1322.002	7425.249
African Group	1738.640	464.840	1793.980
Arab Group	441.087	55.107	473.459
Asian Group	4960.840	802.055	5157.810

Source: AQUASTAT, 2013

ANNEX 6. Non-Conventional Source of Water

Country	Produced Wastewater	Treated Wastewater	Reused Treated Wastewater	Desalinated Water Produced
	(10^9 m^3/yr)			
African Group	**0.006**	**0.0011**	**0**	**0.00305**
Benin				
Burkina Faso	0.001			
Cameroon				
Chad				
Cote d'Ivoire		0.0001		
Gabon				
Gambia				
Guinea				
Guinea-Bissau				
Mali				
Mozambique				
Niger				
Nigeria				0.003
Senegal	0.005	0.001		0.00005
Sierra Leone				
Togo				
Uganda				
Arab Group	**14.363**	**7.3856**	**2.1596**	**3.4675**
Algeria	0.73	0.15		0.017
Bahrain	0.084	0.0619	0.0163	0.1024
Comoros				
Djibouti			0.0001	0.0001
Egypt	8.5	4.8	0.7	0.1
Iraq				0.0074
Jordan	0.18	0.111	0.0835	0.0098
Kuwait	0.254	0.25	0.078	0.4202
Lebanon	0.31	0.004	0.002	0.473
Libya	0.546	0.04	0.04	0.018
Mauritania		0.0007	0.0007	0.002
Morocco	0.7	0.124	0.07	0.007
Oman	0.09	0.037	0.037	0.109
Palestine				
Qatar	0.055	0.058	0.043	0.18
Saudi Arabia,	0.73	0.674	0.217	1.033
Somalia				0.0001
Sudan				0.0004

ANNEX 6. Non Conventional Source of Water (continue)

Country	Produced Wastewater	Treated Wastewater	Reused Treated Wastewater	Desalinated Water Produced
	(10^9 m^3/yr)			
Syria	1.364	0.55	0.55	
Tunisia	0.246	0.19	0.068	0.013
United Arab Emirates	0.5	0.289	0.248	0.95
Yemen	0.074	0.046	0.006	0.0251
Asian Group	**15.9194**	**3.2405**	**1.8451**	**1.078**
Afghanistan				
Albania				
Azerbaijan	0.659	0.161	0.161	
Bangladesh	0.525			
Brunei				
Indonesia				0.019
Iran	3.075	0.13	0.154	0.2
Kazakhstan	1.833	0.274	0.194	0.853
Kyrgyz Republic	0.1435	0.1421	0.0001	
Malaysia	1.4	0.398		
Maldives	0.0037			0.0043
Pakistan	3.06	0.0306		0.0012
Tajikistan	0.0922	0.0888	0	0
Turkey	2.77	1.68	1	0.0005
Turkmenistan	1.275	0.336	0.336	0
Uzbekistan	1.083			
Guyana				
Suriname				
COMCEC	**30.2884**	**10.6272**	**4.0047**	**4.54855**
LDC	0.6486	0.0068	0.0479	0.03075
OECD	133.7219	3.708	89.204	1.0962
DEV	122.2674	2.862706	85.2582	2.2825
WORLD	251.4111	9.206806	131.6444	5.86335
COMCEC	30.2884	10.6272	4.0047	4.54855
African Group	0.006	0.0011	0	0.00305
Arab Group	14.363	7.3856	2.1596	3.4675
Asian Group	15.9194	3.2405	1.8451	1.078

Source: AQUASTAT, 2013

ANNEX 7. Water Withdrawal in the COMCEC Member Countries

Country	Agricultural		Industrial		Municipal		Total Water Withdrawal
	10^9 m^3/yr	%	10^9 m^3/yr	%	10^9 m^3/yr	%	10^9 m^3/yr
African Group	**19.6008**	**65.40**	**2.933**	**9.79**	**7.4378**	**24.82**	**29.9716**
Benin	0.059	45.38	0.03	23.08	0.041	31.54	0.13
Burkina Faso	0.4207	51.43	0.0217	2.65	0.3756	45.92	0.818
Cameroon	0.737	67.71	0.1046	9.61	0.2468	22.68	1.0884
Chad	0.6722	76.42	0.1037	11.79	0.1037	11.79	0.8796
Cote d'Ivoire	0.5953	38.43	0.318	20.53	0.6359	41.05	1.5492
Gabon	0.0403	28.97	0.0141	10.14	0.0847	60.89	0.1391
Gambia	0.0392	38.58	0.0212	20.87	0.0412	40.55	0.1016
Guinea	0.2929	51.04	0.0562	9.79	0.2248	39.17	0.5739
Guinea-Bissau	0.144	75.79	0.0119	6.26	0.0341	17.95	0.19
Mali	5.9	90.13	0.056	0.86	0.59	9.01	6.546
Mozambique	0.69	70.42	0.0362	3.69	0.2537	25.89	0.9799
Niger	0.6565	66.74	0.0327	3.32	0.2944	29.93	0.9836
Nigeria	7.047	53.75	1.965	14.99	4.099	31.26	13.111
Senegal	2.065	92.98	0.058	2.61	0.098	4.41	2.221
Sierra Leone	0.0457	21.54	0.0555	26.15	0.111	52.31	0.2122
Togo	0.076	44.97	0.004	2.37	0.089	52.66	0.169
Uganda	0.12	43.00	0.0442	15.84	0.1149	41.17	0.2791
Arab Group	**207.442**	**84.32**	**17.4223**	**7.08**	**21.1507**	**8.60**	**246.015**
Algeria	3.502	58.04	0.9509	15.76	1.581	26.20	6.0339
Bahrain	0.1592	44.54	0.0203	5.68	0.1779	49.78	0.3574
Comoros	0.0047	47.00	0.0005	5.00	0.0048	48.00	0.01
Djibouti	0.003	15.79	0	0.00	0.016	84.21	0.019
Egypt	59	86.38	4	5.86	5.3	7.76	68.3
Iraq	52	78.79	9.7	14.70	4.3	6.52	66
Jordan	0.6112	64.96	0.0384	4.08	0.2913	30.96	0.9409
Kuwait	0.4919	51.05	0.0233	2.42	0.4483	46.53	0.9635
Lebanon	0.78	59.54	0.15	11.45	0.38	29.01	1.31
Libya	3.584	82.85	0.132	3.05	0.61	14.10	4.326
Mauritania	1.223	90.58	0.0318	2.36	0.0954	7.07	1.3502
Morocco	11.01	83.95	0.4766	3.63	1.628	12.41	13.1146
Oman	1.168	88.42	0.019	1.44	0.134	10.14	1.321
Palestine							
Qatar	0.262	59.01	0.008	1.80	0.174	39.19	0.444
Saudi Arabia	20.83	88.00	0.71	3.00	2.13	9.00	23.67
Somalia	3.281	99.48	0.002	0.06	0.015	0.45	3.298
Sudan	26.15	94.77	0.3001	1.09	1.143	4.14	27.5931

ANNEX 7. Water Withdrawal in the COMCEC Member Countries (continue)

Country	Agricultural		Industrial		Municipal		Total Water Withdrawal
	10^9 m^3/yr	%	10^9 m^3/yr	%	10^9 m^3/yr	%	10^9 m^3/yr
Syria	14.67	87.53	0.6154	3.67	1.475	8.80	16.7604
Tunisia	2.165	82.01	0.11	4.17	0.365	13.83	2.64
United Arab Emirates	3.312	82.84	0.069	1.73	0.617	15.43	3.998
Yemen	3.235	90.74	0.065	1.82	0.265	7.43	3.565
Asian Group	**555.829**	**84.65**	**49.1558**	**7.49**	**51.6392**	**7.86**	**656.624**
Afghanistan	20	98.17	0.1695	0.83	0.2034	1.00	20.3729
Albania	0.5176	39.49	0.2318	17.69	0.5613	42.82	1.3107
Azerbaijan	10.1	77.81	2.36	18.18	0.521	4.01	12.981
Bangladesh	31.5	87.82	0.77	2.15	3.6	10.04	35.87
Brunei	0.0053	3.38		0.00	0.1515	96.62	0.1568
Indonesia	92.76	70.59	24.65	18.76	13.99	10.65	131.4
Iran	86	92.18	1.1	1.18	6.2	6.65	93.3
Kazakhstan	14	66.22	6.263	29.62	0.878	4.15	21.141
Kyrgyz Republic	7.447	93.01	0.336	4.20	0.224	2.80	8.007
Malaysia	2.505	22.38	4.788	42.77	3.902	34.85	11.195
Maldives	0	0.00	0.0003	5.08	0.0056	94.92	0.0059
Pakistan	172.4	93.98	1.4	0.76	9.65	5.26	183.45
Tajikistan	10.44	90.82	0.4078	3.55	0.647	5.63	11.4948
Turkey	29.6	73.82	4.3	10.72	6.2	15.46	40.1
Turkmenistan	26.36	94.30	0.839	3.00	0.755	2.70	27.954
Uzbekistan	50.4	90.00	1.5	2.68	4.1	7.32	56
Guyana	1.363	97.09	0.0204	1.45	0.0204	1.45	1.4038
Suriname	0.4311	89.61	0.02	4.16	0.03	6.24	0.4811
COMCEC	**782.8718**	**83.94**	**69.5111**	**7.45**	**80.2277**	**8.60**	**932.6106**
LDC	172.6631	90.53	3.4649	1.82	14.606	7.66	190.734
OECD	436.6603	43.57	402.031	40.12	163.462	16.31	1002.1533
DEV	366.3395	39.75	398.4607	43.23	156.8347	17.02	921.6349
WORLD	9795.4101	89.09	731.0677	6.65	468.3535	4.26	10994.8313
COMCEC	782.8718	10.51	69.5111	0.93	80.2277	1.08	932.6106
African Group	19.6008	0.30	2.933	0.04	7.4378	0.11	29.9716
Arab Group	207.442	84.55	17.4223	7.10	21.1507	8.62	246.015
Asian Group	555.829	87.33	49.1558	7.72	51.6392	8.11	656.624

Source: AQUASTAT, 2013

ANNEX 8. Full or Partial Control Irrigation: Equipped Area

Country	Irr. Potential	Surface	Sprinkler	Localized	Equipped Lowlands	Spate Irr.	Total Area Equipped for Irr.	
	(1000 ha)							%
African Group	**9826.3**	**551.1**	**54.9**	**5.1**	**401.1**	**2.8**	**1165.8**	**11.9**
Benin	322	5.043	4.57	1.36	1.285	0	23.04	7.16
Burkina Faso	165	14.7	3.9	0	6.4	0	25	15.15
Cameroon	290	17.02	5.43		0.404	2.8	25.65	8.84
Chad	335	26.52	3.754	0	0	0	30.27	9.04
Cote d'Ivoire	475	11.75	36		25	0	72.75	15.32
Gabon	440			3.15	1.3	0	4.45	1.01
Gambia	80	2.149	0	0	0	0	5	6.25
Guinea	520	19.93	0.3	0.16	74.53	0	94.92	18.25
Guinea-Bissau	281.3	8.562			14	0	22.56	8.02
Mali	566	97.5	0.1	0	138.3	0	235.8	41.66
Mozambique	3072				0	0	118.1	3.84
Niger	270				60	0	73.66	27.28
Nigeria	2331	238.1	0.05		55	0	293.2	12.58
Senegal	409	102.2		0.4	17.5	0	119.7	29.27
Sierra Leone								
Togo	180	2.3	0.55	0.01	5	0	7.3	4.06
Uganda	90	5.35	0.23		2.336		14.42	16.02
Arab Group	**16328.9**	**6875.7**	**1400.4**	**975.7**	**7.8**	**609.1**	**15022.6**	**92.00**
Algeria	510.3		40		0	56.05	56.94	11.16
Bahrain	4.23	3.39	0.16	0.465	0	0	4.015	94.92
Comoros	0.3				0	0	0.13	43.33
Djibouti	2.4				0	0	1.012	42.17
Egypt	4420	3029	171.9	221.4	0	0	3422	77.42
Iraq	5554			8	0	0	3525	63.47
Jordan	85	13.86	1	64	0	0	78.86	92.78
Kuwait	25	3.02	0.6	1.15	0	0	8.6	34.40
Lebanon	177.5	66.13	29.04	8.838	0	0	104	58.59
Libya								
Mauritania	250				0	0	45.01	18.00
Morocco	1664	1209	151.7	97.97	0	26	1485	89.24
Oman		46.66	6.654	5.538	0	0	58.85	
Palestine								
Qatar	52.13	9.707	1.813	1.415	0	0	12.94	24.82
Saudi Arabia		706	716	198	0	0	1620	

ANNEX 8. Full or Partial Control Irrigation: Equipped Area (continue)

Country	Irr. Potential	Surface	Sprinkler	Localized	Equipped Lowlands	Spate Irr.	Total Area Equipped for Irr.	
	(1000 ha)							%
Somalia	240	50			0	150	200	83.33
Sudan	2784					132	1890	67.89
Syria		1043	187.1	110.9	0	0	1341	
Tunisia	560	215	90	62	0	27	397	70.89
United Arab Emirates		27.1	4	195.5	0	0	92	
Yemen		453.8	0.35	0.485	7.799	218	680.1	
Asian Group	**81095.7**	**54142.4**	**1534.3**	**590.4**	**173.7**	**1586.3**	**61222.8**	**75.49**
Afghanistan			114		0	0	3208	
Albania		397	0.026				188.4	
Azerbaijan	3200	817.9	607	0.1	0	0	1425	44.53
Bangladesh	6933	5050	0	0	0	0	5050	72.84
Brunei		1	0	0	0	0	1	
Indonesia	10886	6722	0	0	0	0	6722	61.75
Iran	15000	7432	280	420	0	0	8700	58.00
Kazakhstan	3768	1159	30	10.8	138.7	866.3	2066	54.83
Kyrgyz Republic	2247	1021	0.4	0	0	0	1021	45.44
Malaysia	413.7	373	2	5	21.97	0	380	91.85
Maldives							0	
Pakistan	21300	19270			0	720	19990	93.85
Tajikistan	1580	742.1	0	0	0	0	742.1	46.97
Turkey	8500	4690	500	150	13	0	5340	62.82
Turkmenistan	2353	1991	0	0	0	0	1991	84.62
Uzbekistan	4915	4276	0	4.51	0	0	4198	85.41
Guyana		150.1	0	0	0	0	150.1	
Suriname		50.32	0.858	0	0	0	50.18	
COMCEC	**107250.9**	**61569.2**	**2989.5**	**1571.2**	**582.5**	**2198.2**	**77411.1**	**72.2**

ANNEX 8. Full or Partial Control Irrigation: Equipped Area (continue)

Country	Irr. Potential	Surface	Sprinkler	Localized	Equipped Lowlands	Spate Irr.	Total Area Equipped for Irr.	
	(1000 ha)							%
LDC	44922.6	11020.7	197.3	13.7	506.3	517.5	17926.1	39.9
OECD		18439.6	8030.1	3166.8	13.0	0.0	61256.0	
DEV		9379.4	7303.4	3107.0	0.0	0.4	51172.4	
WORLD	503665.5	228524.9	24722.5	6927.4	793.6	2324.6	309638.1	61.5
COMCEC	107250.9	61569.2	2989.5	1571.2	582.5	2198.2	77411.1	72.2
African Group	9826.3	551.1	54.9	5.1	401.1	2.8	1165.8	11.9
Arab Group	16328.9	6875.7	1400.3	975.7	7.8	609.1	15022.5	92.0
Asian Group	81095.7	54142.4	1534.3	590.4	173.7	1586.3	61222.8	75.5

Source: AQUASTAT, 2013

ANNEX 9. Drainage and Soil Salinization

Country	Area equipped for irrigation drained	Non-irrigated cultivated area drained	Total cultivated area drained (1000 ha)	% of area equipped for full control surface irrigation drained	% of total cultivated area drained	Area salinized by irrigation	% of area equipped for full control irrigation salinized
	(1000 ha)			%		(1000 ha)	%
African Group	**0.563**		**20.803**	**11.16**	**0.34**	**102.35**	**34.83**
Benin	0.563		0.563	11.16	0.02		
Burkina Faso							
Cameroon							
Chad							
Cote d'Ivoire							
Gabon							
Gambia							
Guinea			20.24		0.6658		
Guinea-Bissau							
Mali							
Mozambique						2	1.874
Niger						0.35	2.622
Nigeria						100	100
Senegal							
Sierra Leone							
Togo							
Uganda							
Arab Group	**4201.67**	**32**	**4818.602**	**49.90**	**11.05**	**2946.422**	**30.78**
Algeria	61.06	0	61.06		0.7441		
Bahrain			1.3		26	1.065	33.65
Comoros							
Djibouti							
Egypt	3024	0	3024		85.47	250	
Iraq						1762	49.99
Jordan	10.51	0	10.51	75.83	4.749	2.277	3.541
Kuwait			0.002		0.03	4.08	85.53
Lebanon	3	7	10	4.537	3.69	1	0.9615
Libya	9	0	9		0.4186	190	40.43
Mauritania			12.78		2.556		

ANNEX 9. Drainage and Soil Salinization (continue)

Country	Area equipped for irrigation drained	Non-irrigated cultivated area drained	Total cultivated area drained (1000 ha)	% of area equipped for full control surface irrigation drained	% of total cultivated area drained	Area salinized by irrigation	% of area equipped for full control irrigation salinized
	(1000 ha)			%		(1000 ha)	%
Morocco	629.1	20	649.1	52.03	7.244	150	10.59
Oman							
Palestine							
Qatar							
Saudi Arabia,			10.85		0.2952		
Somalia							
Sudan			560		3.365	500	28.89
Syria	273	0	273	27.82	5.032		
Tunisia	192	5	197	89.3	4.014	86	23.43
United Arab Emirates							
Yemen							
Asian Group	**22741.3**	**2099.6**	**28667.88**	**45.07**	**30.32**	**15741.83**	**23.88**
Afghanistan							
Albania			276.1		39.27	12	3.023
Azerbaijan	608.3	0	608.3	46.08	29.26	635.8	44.59
Bangladesh	118.4	1383	1501	3.156	18.95	100	2.666
Brunei							
Indonesia			3350		11.34	400	
Iran	1508	0	1508		8.645	2100	28.91
Kazakhstan	343	0	343	29.59	1.422	404.3	33.69
Kyrgyz Republic	144.9	3	147.9	14.33	10.48	49.5	4.848
Malaysia	340.6	600	940.6	100	12.37		
Maldives	0	0	0		0		
Pakistan	15140	0	15140	78.57	70.26	7003	
Tajikistan	345.2	0	345.2	46.52	35.22	23.23	3.13
Turkey	341	113.6	454.5	7.456	1.826	1519	30.56
Turkmenistan	1012	0	1012	58.6	59.18	1354	37.4
Uzbekistan	2840	0	2840	66.42	58.64	2141	50.01
Guyana			150.1		29.78		
Suriname			51.18		98.42		
COMCEC	**26943.533**	**2131.6**	**33507.285**	**35.38**	**13.90**	**18790.602**	**29.83**

ANNEX 9. Drainage and Soil Salinization (continue)

Country	Area equipped for irrigation drained	Non-irrigated cultivated area drained	Total cultivated area drained (1000 ha)	% of area equipped for full control surface irrigation drained	% of total cultivated area drained	Area salinized by irrigation	% of area equipped for full control irrigation salinized
	(1000 ha)			%		(1000 ha)	%
LDC	118.963	1383	2332.503	7.16	3.22	652.35	12.64
OECD	3223.9	2533.6	6497.7	27.71	25.88	6364.62	16.70
DEV	100.015	0	840.215	75.00	21.81	5045.42	16.94
WORLD	39218.80	10447.60	87310.53	41.22	15.25	37038.92	20.81
COMCEC	26943.533	2131.6	33507.285	35.38	13.90	18790.602	29.83
African Group	0.563	0	20.803	11.16	0.34	102.35	34.83
Arab Group	4201.67	32	4818.602	49.90	11.05	2946.422	30.78
Asian Group	22741.3	2099.6	28667.88	45.07	30.32	15741.83	23.88

Source: AQUASTAT, 2013

ANNEX 10. Trends in Irrigation Investment (Million $)

Country	1988-1992	1993-1997	1998-2002	2003-2007	2008-2012
African Group	**27576**	**42164**	**18184**	**0**	**0**
Benin		17258	20911		
Burkina Faso	41520		41520		
Cameroon			15827		
Chad	41308		3754		
Côte d'Ivoire		36			
Gabon					
Gambia	0				
Guinea		1594	0		
Guinea-Bissau					
Mali	0	0			
Mozambique					
Niger					
Nigeria				0	
Senegal					
Sierra Leone	0				
Togo	1				
Uganda			0		
Arab Group	**1233**	**174468**	**292913**	**1009554**	**187**
Algeria	40				
Bahrain		0	0		
Comoros					
Djibouti					
Egypt		117	172		
Iraq					
Jordan	41460			1	
Kuwait		1			
Lebanon		21	41393		
Libya					
Mauritania					
Morocco	103			152	
Palestinian					
Oman		23377		6654	
Qatar			1813		
Saudi Arabia	1029			716	

ANNEX 10. Trends in Irrigation Investment (Million $) (continue)

Country	1988-1992	1993-1997	1998-2002	2003-2007	2008-2012
Somalia					
Sudan					
Syrian		30		130	187
Tunisia	55		90		
United Arab Emirates		3748		4	
Yemen		0			
Asian Group	**0**	**1047**	**1**	**579**	**1139**
Afghanistan					
Albania	0				
Azerbaijan		149			607
Bangladesh		0			
Brunei Darussalam		0			
Indonesia		0			
Iran		47		280	
Kazakhstan		550			30
Kyrgyzstan		37		0	
Malaysia		0			2
Maldives					
Pakistan					
Tajikistan		0			0
Turkey		264		298	500
Turkmenistan		0		0	
Uzbekistan		0			
Guyana	0				
Suriname			1		
COMCEC	**1240676**	**1263232**	**311955**	**1588204**	**1326**
LDC	36	6514	82269	0	0
OECD	117	821	2506	6137	1777047
DEV	182	261652	2508068	5843737	1278721
WORLD	7543993	3920183	6508707	14784	6170725
COMCEC	1240676	1263232	311955	1588204	1326
African Group	27576	42164	18184	0	0
Arab Group	1233	174468	292913	1009554	187
Asian Group	0	1047	1	579	1139

Source: AQUASTAT, 2013

ANNEX 11. Classification of the OIC Member Countries by Sub-Region

African Group	Arab Group	Asian Group
Benin	Algeria	Afghanistan
Burkina Faso	Bahrain	Albania
Cameroon	Comoros	Azerbaijan
Chad	Djibouti	Bangladesh
Cote d'Ivoire	Egypt	Brunei
Gabon	Iraq	Indonesia
Gambia	Jordan	Iran
Guinea	Kuwait	Kazakhstan
Guinea-Bissau	Lebanon	Kyrgyz Republic
Mali	Libya	Malaysia
Mozambique	Mauritania	Maldives
Niger	Morocco	Pakistan
Nigeria	Oman	Tajikistan
Senegal	Palestine	Turkey
Sierra Leone	Qatar	Turkmenistan
Togo	Saudi Arabia	Uzbekistan
Uganda	Somalia	Guyana
	Sudan	Suriname
	Syria	
	Tunisia	
	United Arab Emirates	
	Yemen	