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Management of Water Demand in GCC using GIS

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Abstract
Water shortages and the degradation of water supplies threaten the development activities and health of people in many parts of the world. This is particularly true in GCC countries that are experiencing rapid population and development growth but have limited water resources and poor water resources management. GCC (Gulf Councel Countrie) is facing potential water shortages. The alarming increase in the scarcity of water in various parts of the world. Water is a main issue in many countries especially in those GCC, it has focused a global attention on the need for a stronger and more appropriate water resource management and availability solutions. imperative for nations to come up with more focused and direct measures that would address and stem this resource scarcity. Water sustainability needs a balance between demand and availability. The main objective of this paper is the application of these concepts to Arabs countries. Water demand management is about achieving a reduction in the use of water resources, normally through increased efficiency of water application. The management of water resources was not explicitly included in the past from thirty-five years in all most of those countries normative system partly because water was believed to be a free good in mind, and was not accepted to have a price to pay to use it. This work contributed to a low efficiency of water use and waste of it, and water prices are often well below levels needed to cover the costs of the system. Moreover, this contributes to a worse quality of water, and, as quality of water decrease, the management of water resources becomes more challenging and the need to integrate water quality into an overall water resources management grows. The main goal of this paper is showing, how Geographical Information Systems (GIS) can be used to support infrastructure planners and analyst on water demand of a local area in GCC, they are (Saudi Arabia ,Kuwait, Bahrain, Oman and UAE). The results indicated an increase of about 110%, 135%, 139% and 281% in water demand due to future development in, agriculture, forestry, amenity and domestic sectors respectively.
Keywords: GIS, Water Resources Management, Water Demand Centers, Water Supply Sources, Groundwater Management, ArcGIS , GCC

1. Introduction

Water shortages and the degradation of water supplies threaten the development activities and health of people in many parts of the world. This is particularly true in GCC countries that are experiencing rapid population and development growth but have limited water resources and poor water resources management. Water management is the efficient and effective use of the water resource available by minimizing wastage, promoting recycling, and increasing water quality alongside sustainable economic development. Water management is a crucial issue to the survival of humans and all living things in the present era as it is a resource, which is getting scarcer. The amount of water we need and the availability is unbalanced. With proper water management we could minimize the effect of drought and thus famine being faced by developing countries. The Gulf Cooperation Council (GCC) contains six countries: the kingdom of Saudi Arabia, Oman, UAE, Kuwait, Bahrain, and Qatar. In general, The GCC countries have a similar socio-economic situation in terms of features and development with the discovering of oil industry and high revenues during the last 40 years. The economy is dominated by oil, which accounts for 90% of merchandise export earnings and the relation between them so strength due to the same history, language, the religion and relatives relations. Natural water resources are in short supply and lack of renewable water resources, while demand for water is growing. The dilemma arises from continuing growth in demand, which is the result of population increase and other social factors, in conjunction with the fact that the region is already exploiting all its annual surface water resources, while its aquifers are becoming depleted in some countries. Desalination plants play a great role in modifying the fresh water shortage.

1.1. Problems associated

The specter of an impending water crisis is slowly growing in the Gulf region. As local populations continue to rapidly increase and economic development soars, it is becoming very clear that government policies relying solely on investing revenues from hydrocarbon exports in hundreds of desalinization plants, while at the same time pouring even more capital into subsidizing the agricultural sector and household desalinization programs will aggravate the region's growing water crisis. Leaders of the Gulf Co-Operation Council (GCC) countries are slowly coming to terms with this fact.**[5].**

1.2. Material and methods

Schultz [8] discussed the use of Arc-GIS as a tool for water resources management through producing digital maps and digital elevation models which can be processed together with remote sensing and other data within GIS databases thus increasing the potential for working with multi-temporal imagery (what do you mean by this?). Also he discussed how the combination of remote sensing with other information leads to new data types that allow integrated planning of water resources systems. The ArcGIS ESRI shapes for the gulf countries was downloaded from the DIVA-GIS for all countries in the word, the administratives, inland water, roads, elevations, land cover and population can be down loaded for each country see figure 3 the dialog of downloading ArcGIS ESRI shape files form the table 1 show bellow may shape file can be selected in our research we select the administrative , water inland and the population shape files. Using ArcGIS 10.2. the shape files was downloaded for GCC see figure 4 .DIVA-GIS.GIS Formats files have been compressed and grouped in ZIP files. You can use programs such as 7-zip, PKZIP or StuffIt to decompress the files. Vector data are stored as ESRI shape files Grid (raster) data are stored as DIVA grid files Each "shape file" consist of at least three actual files. This is a commonly used format that can be directly used in Arc-anything, DIVA-GIS, and many other programs. It can be imported to most other GIS programs. Shape files contain a single class of "vector" data such as points, lines, or polygons. Grid files are used in DIVA-GIS. From DIVA-GIS they can be exported to a number of other grid formats including IDRISI and Arc or to shape files.[5] http://www.diva-gis.org/gdata

Figure 1 Free download geographic (GIS) data by countries in the world

1.3.ArcGIS 10.2 Overview

ArcGIS has much more functionality than simple map display and navigation. It has many tools for collecting, creating and analyzing data. This 3-day class teaches finer skills for using ArcGIS. See how to connect information between tables and mark locations on the map. Practice managing data files, creating new data, and putting the data to work to generate answers to questions.

1.4.ArcGIS Data Management in the Geodatabase

For many GIS projects, there is a simplified way to accomplish a task, as well as a more advanced approach to complete the same task. Now that you're comfortable with the basic functionality of ArcGIS, you may be looking for some more advanced methods of accomplishing your goals. Maybe you want to set some restrictions on your datasets to make sure the appropriate attribute values are always used, or to ensure that there are never gaps between parcel boundaries. Maybe you want to make more permanent connections between datasets and tables. Or perhaps you'd like to tie events – such as a set of bus stops or seismic shot points – along line features with automated ease. These advanced operations are often overlooked, but can greatly enhance the efficiency and effectiveness of GIS**.**

1.5. Loading GIS file on ArcGIS 10.2 Platform

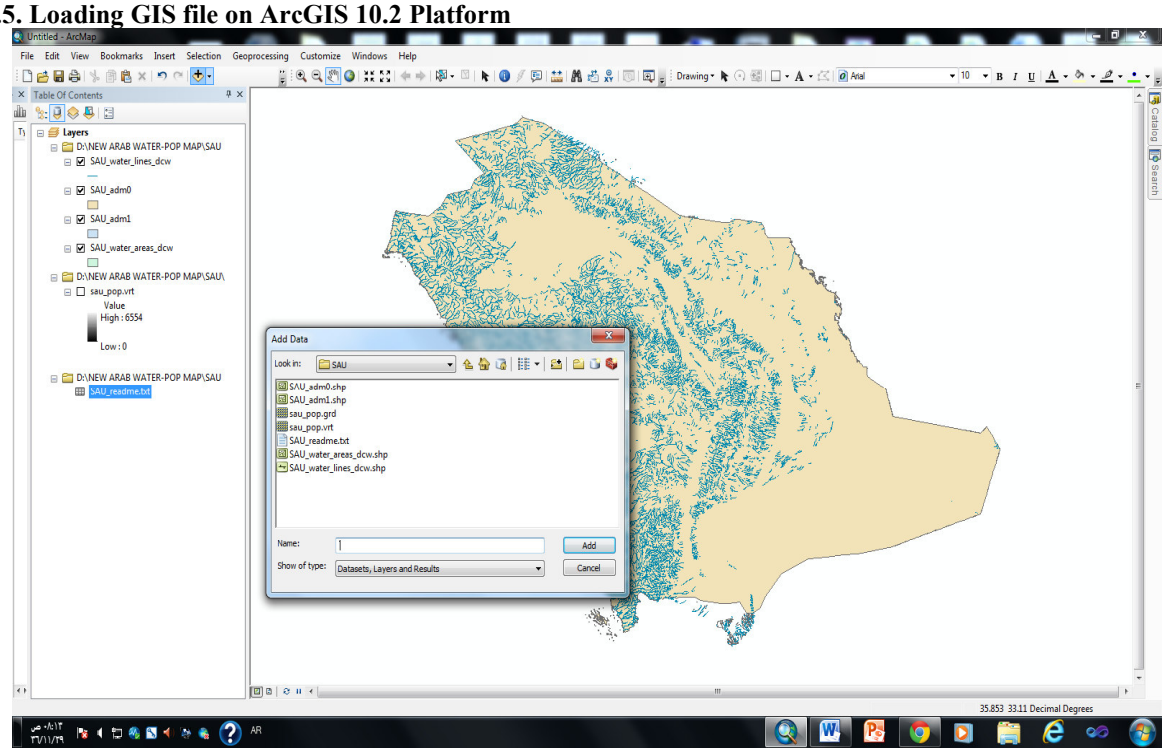


Figure 2 The dialogue of loading gis shape file using the Add Data tool in ArcGIS 10.2

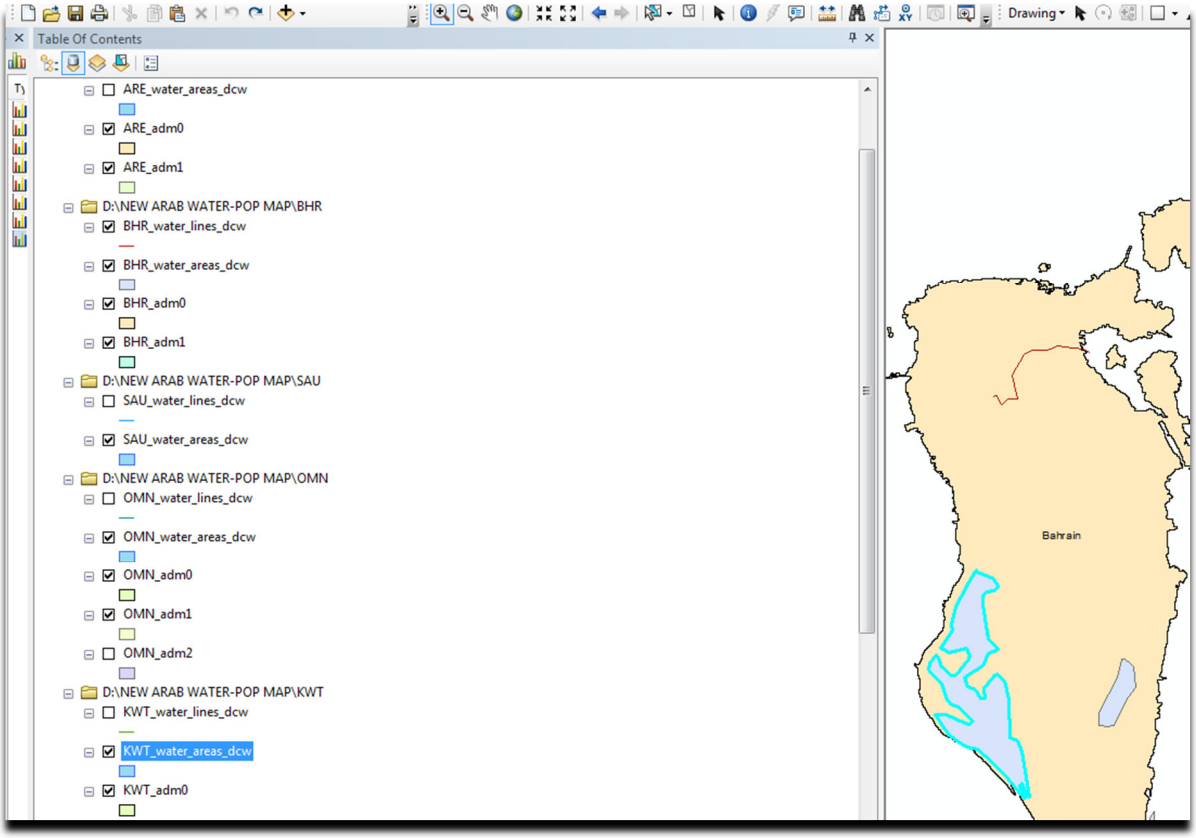


Figure 3 The ArcGIS 10.2 gis layers of GCC ,subareas, water layers

Subject	Description	Source	Format	Resolution
Administrative areas boundaries)	Country outlines and administrative subdivisions for all countries. The level of subdivision varies between countries	GADM, version 1.0	Vector (area)	-
Inland water	Rivers, canals, and lakes. Separate files for line and area features	Digital Chart of the World	Vector (line and area)	-
Population	Population density (old)	CIESIN, 2000. Global gridded population database	Grid	30 seconds

Table 1 the GIS Esri shape file downloaded for GCC

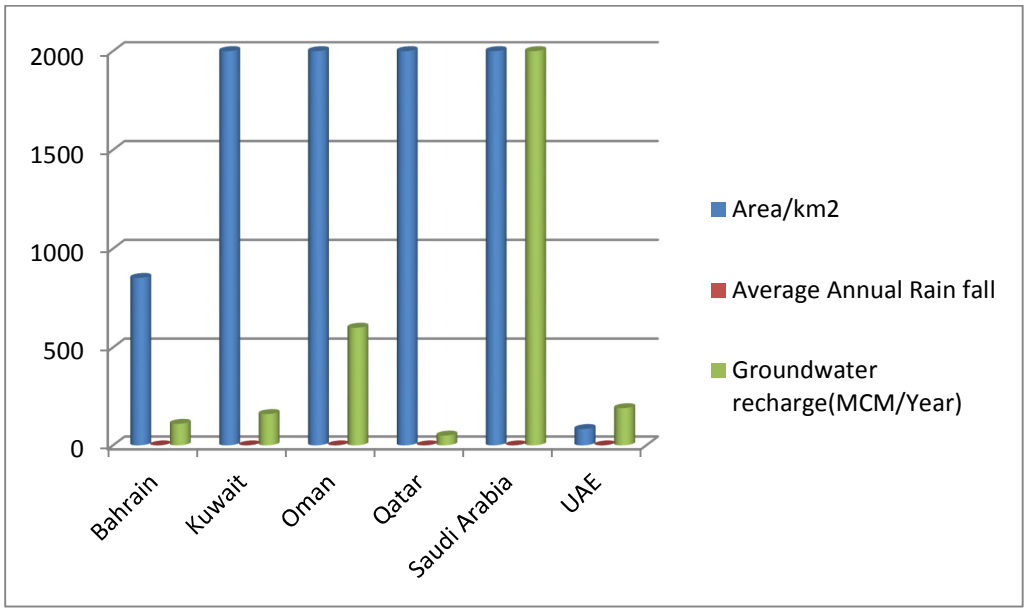
1.6.Water resources availability situation and demand in GCC

Water in the GCC countries is very scarce resource while water is ultimately precious and it situated in one of the most water-stressed regions of the world, have an extremely poor endowment of water resources. From this point, since 1950 all of these countries began develop and built desalination plants and later on wastewater treatment plants to help and sustain the groundwater resources to meet their demand.

The main sources of fresh water are groundwater, most of which is nonrenewable, and a limited amount of renewable near surface water.

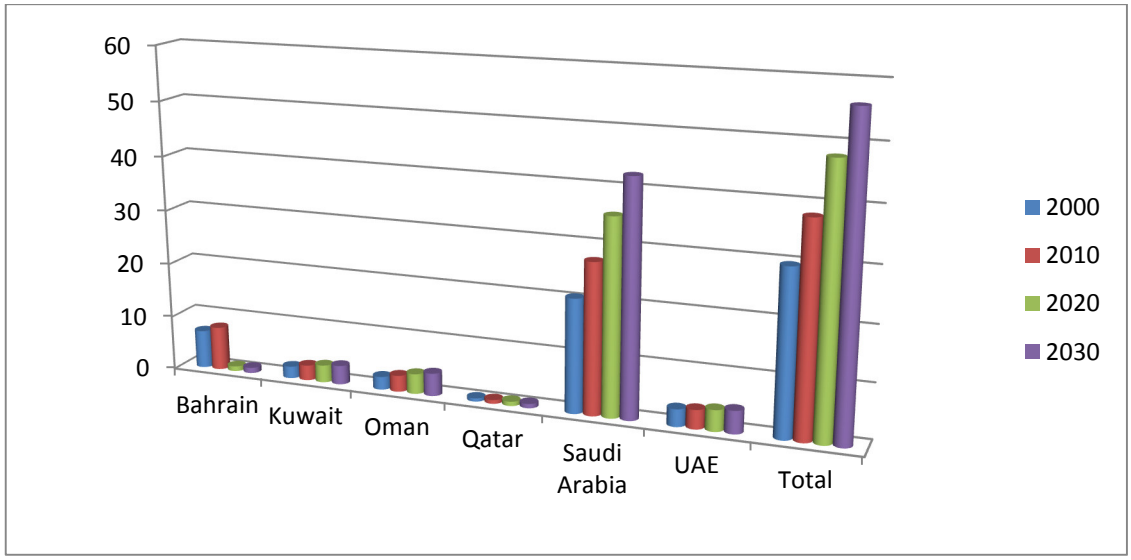
	Area/km2	Average Annual Rain fall	Groundwater recharge(MCM/Year)
Bahrain	852	30-140	110
Kuwait	17818	30-140	160
Oman	212460	80-400	600
Qatar	11610	20-150	50
Saudi Arabia	2149690	30-550	3650
UAE	83.600	80-160	190

Table 2 Water rail fall , water recharge in GCC. Source The world bank 2004



	2000	2010	2020	2030
Bahrain	07	08	0.9	1.0
Kuwait	2.2	2.8	3.2	3.5
Oman	2.4	3.0	3.7	4.2
Qatar	.6	0.7	0.8	0.8
Saudi Arabia	20.7	27.4	35.5	42.5
UAE	3.2	3.5	3.9	4.2
Total	29.8	38.1	47.9	56.2

Table 3 Population Growth in GCC (Millions) Source The world bank 2004



1.7. Implementation of system

The download Esri GIS shape file was loaded using ArcGIS 10.2 for all five Gulf countries , Saudi Arabia, United Arab Emirates , Kuwait , Qatar ,Bahrain and Oman

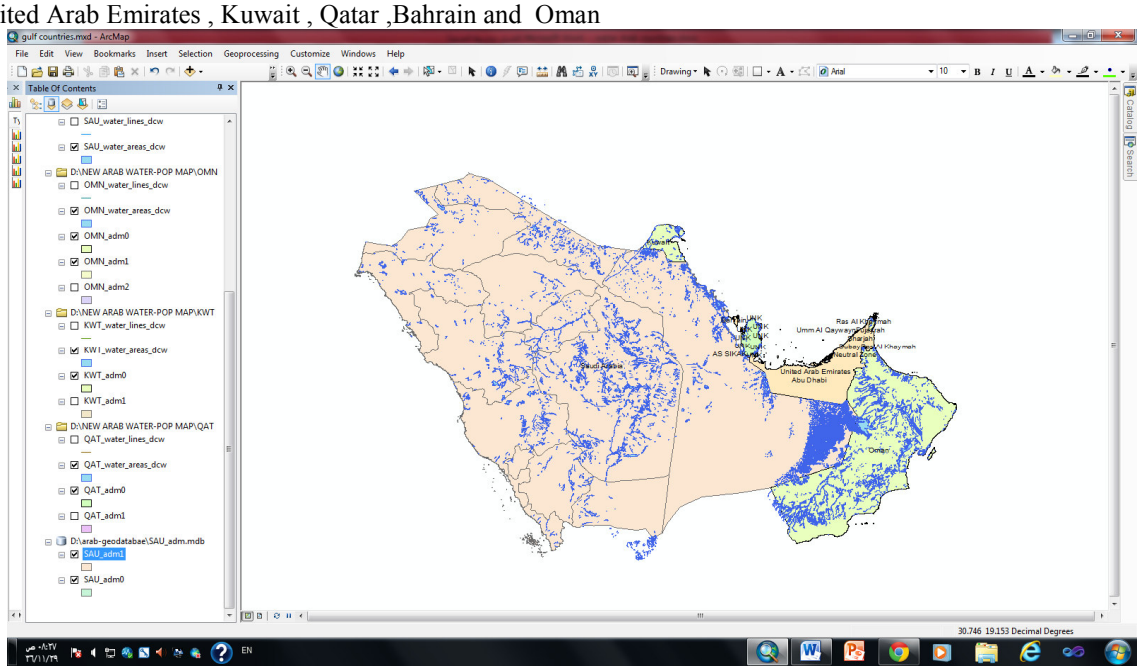


Figure 4 GCC Water areas and water in land ArcGIS Map

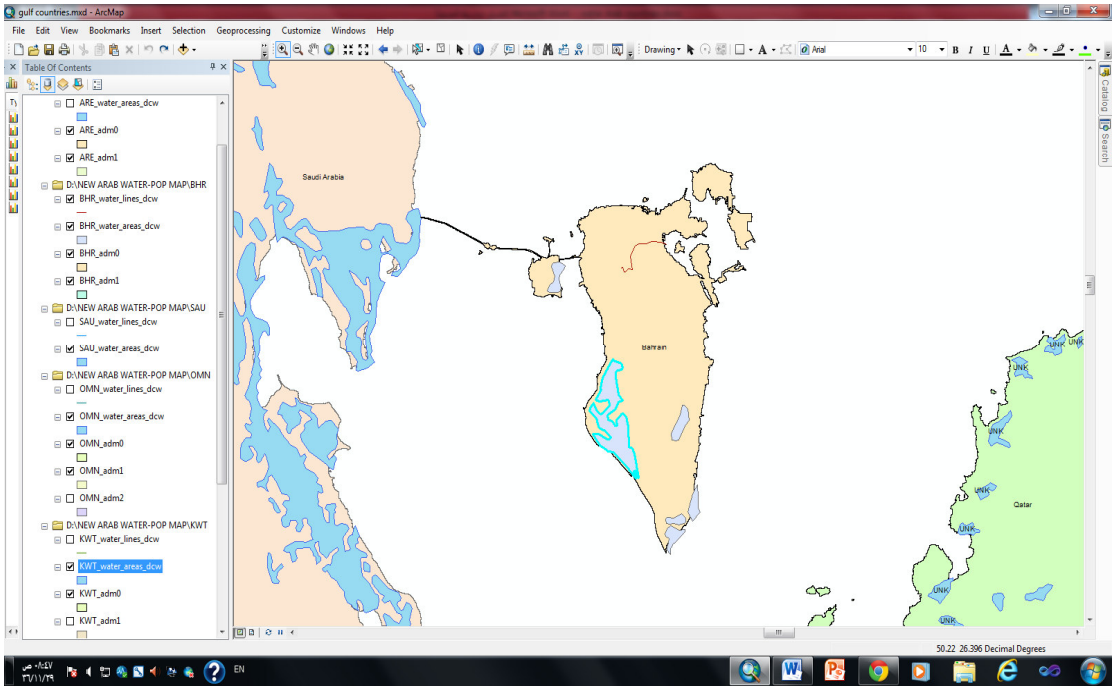


Figure 5 Bahrain administrations and the water area ArcGIS Map

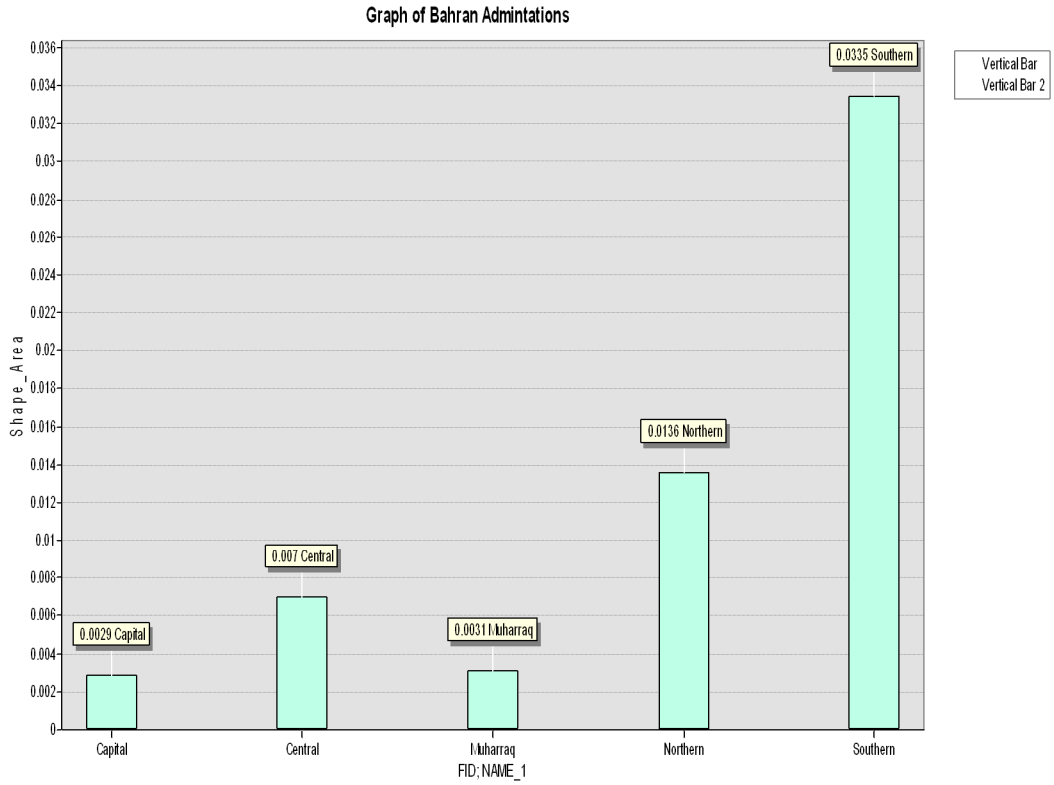


Figure 6 Bahrain administrations areas graph

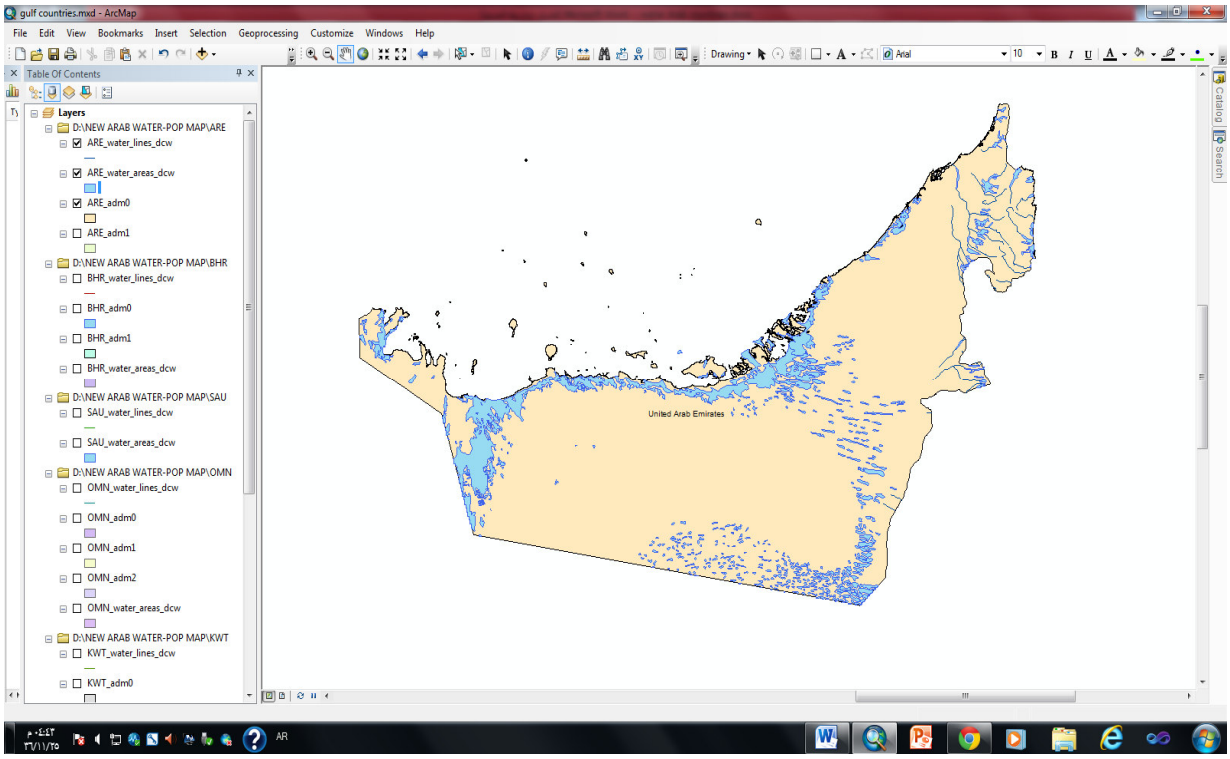


Figure 7 United Arab Emirates Water area and water inland

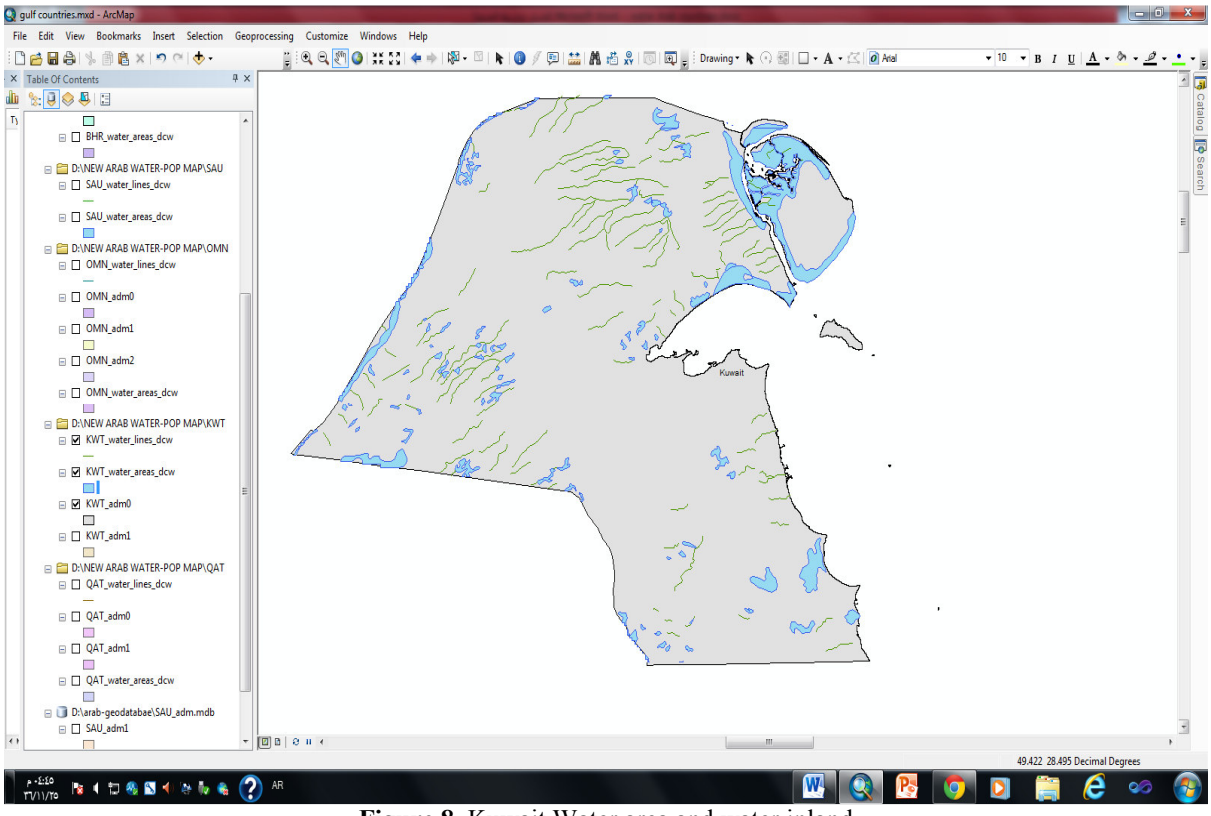


Figure 8 Kuwait Water area and water inland

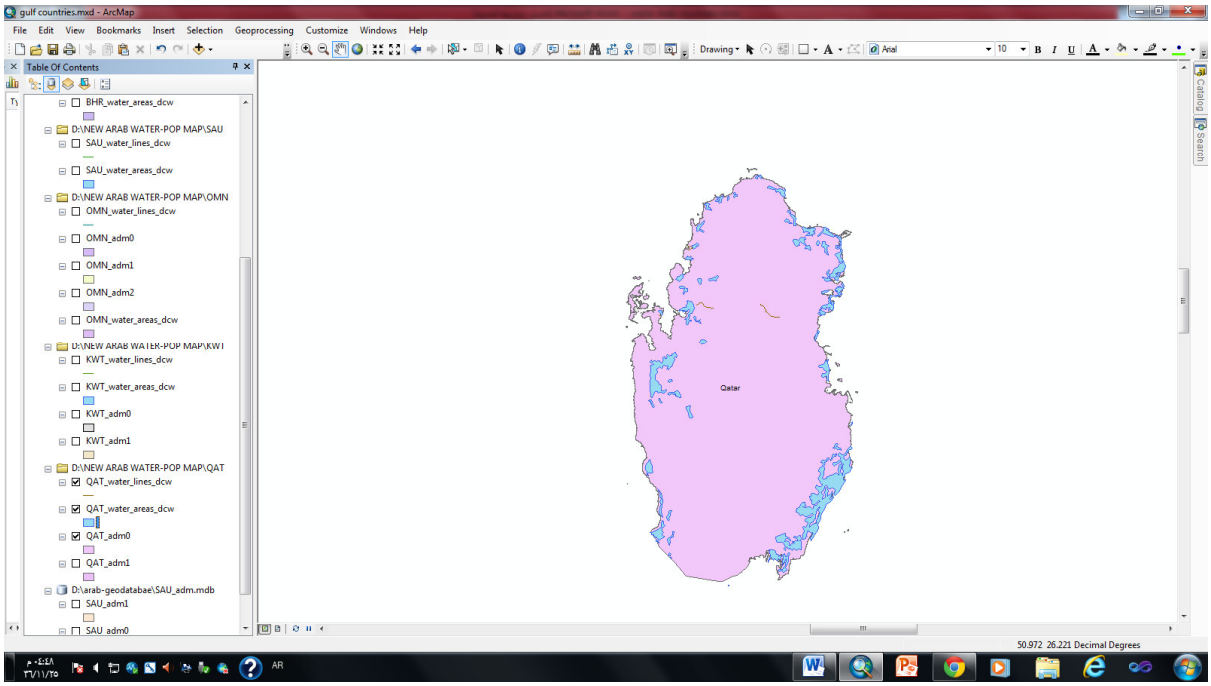


Figure 9 Qatar Water area and water inland

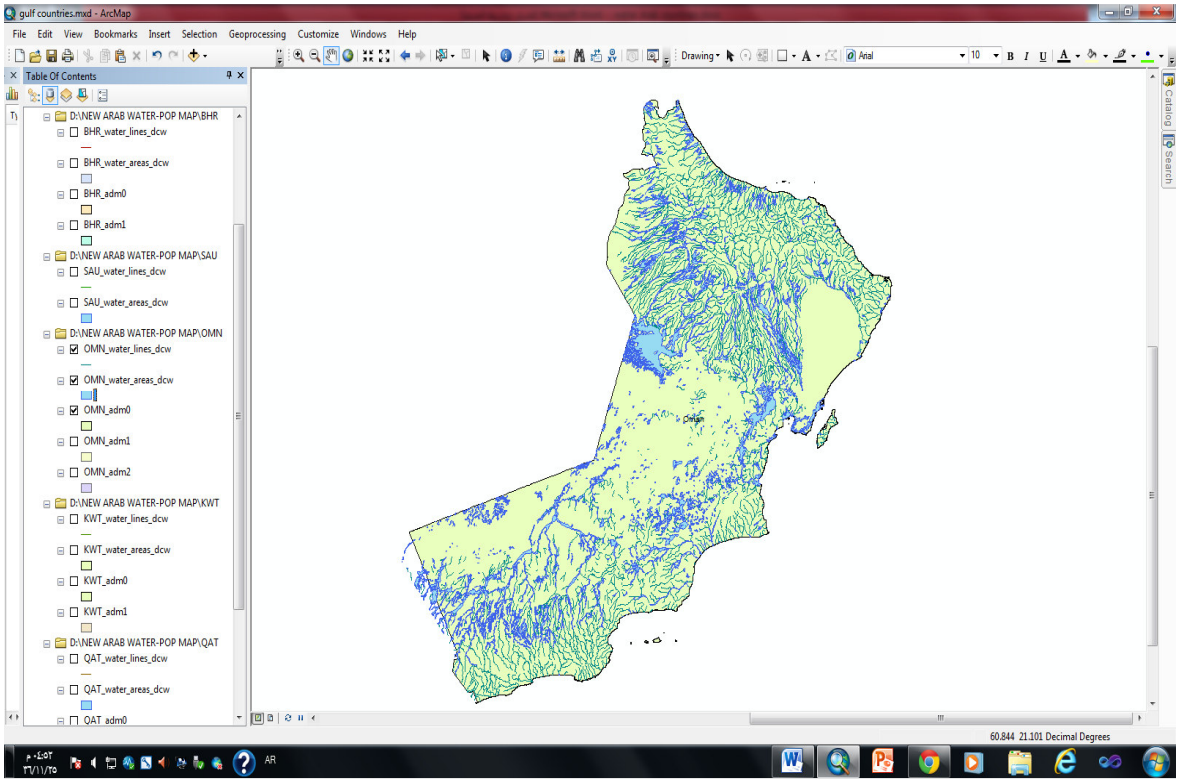


Figure 10 Oman Water area and water inland

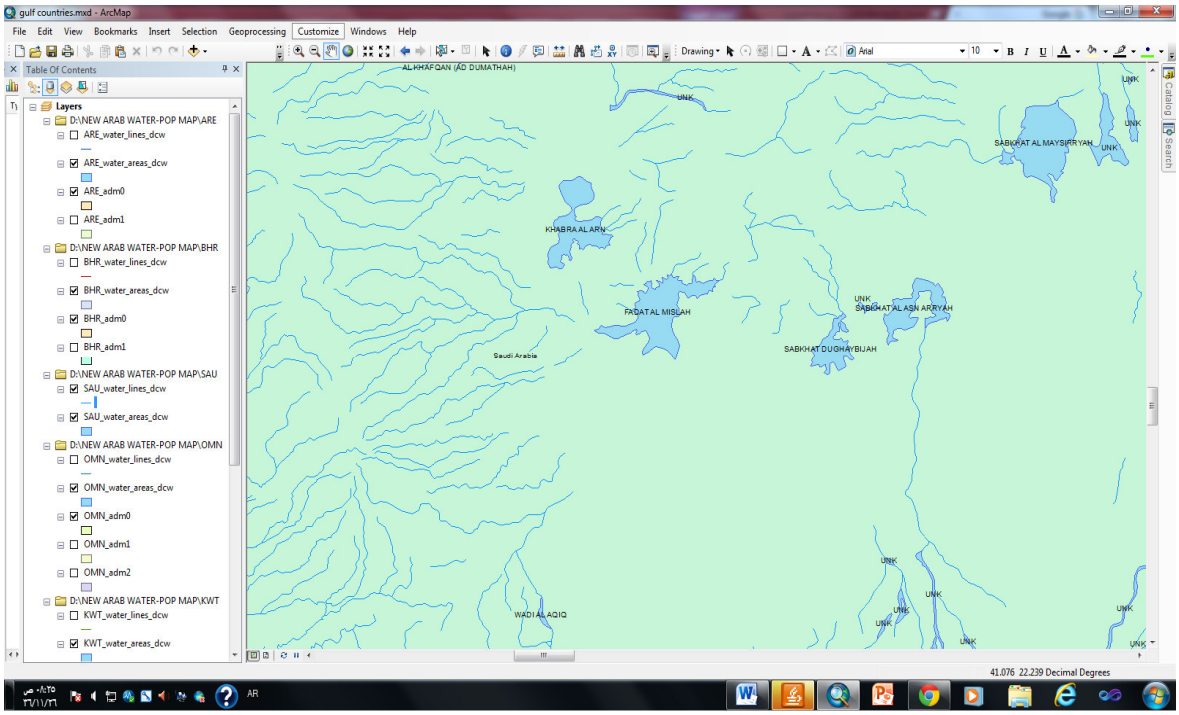


Figure 11 Unite Arabia Emirates Shape Areas Graph

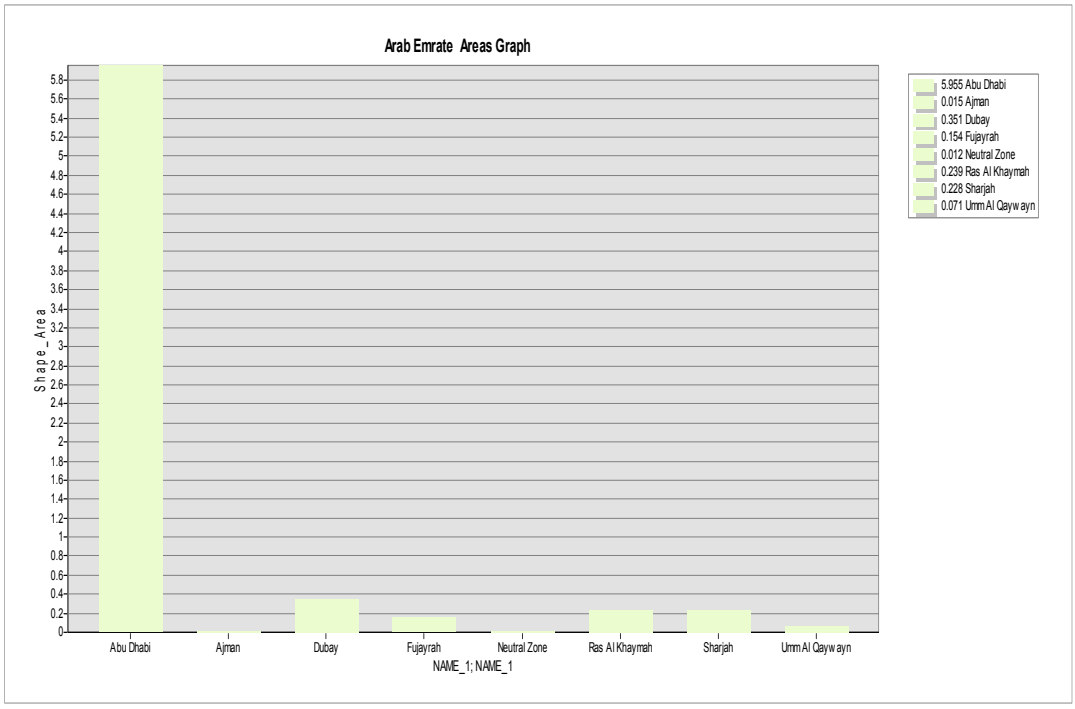


Figure 12 Unite Arabia Emirates Shape Areas Graph

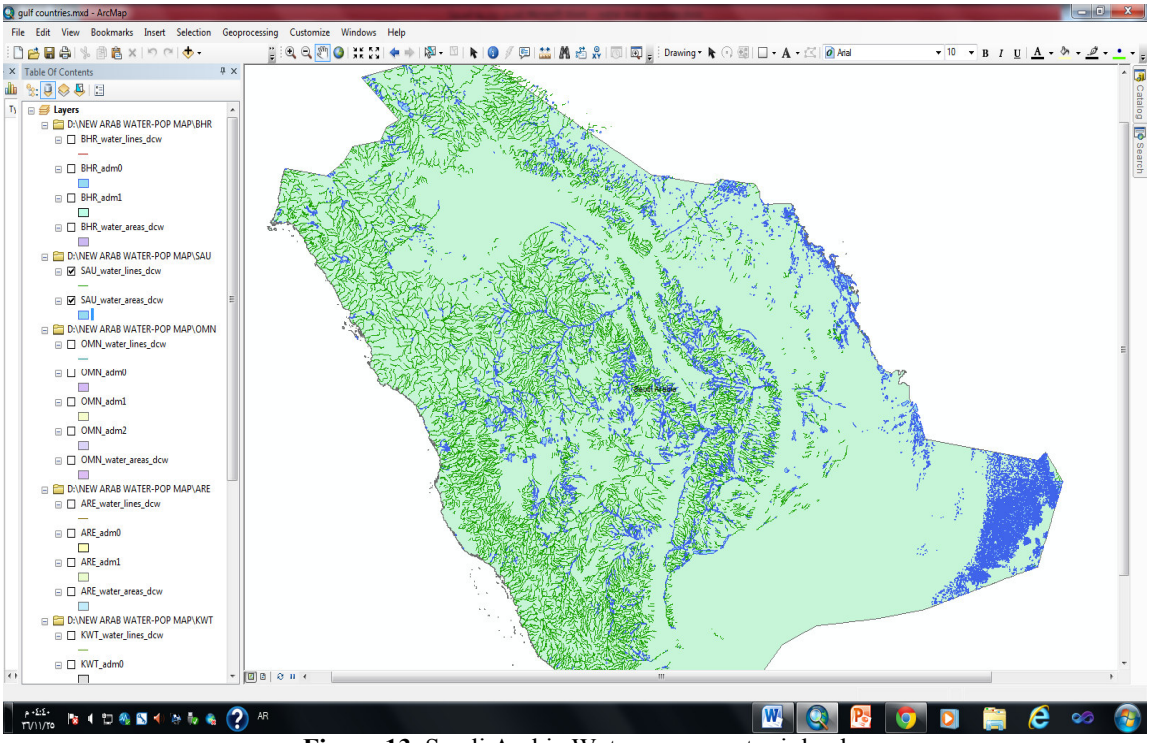


Figure 13 Saudi Arabia Water are an water inland

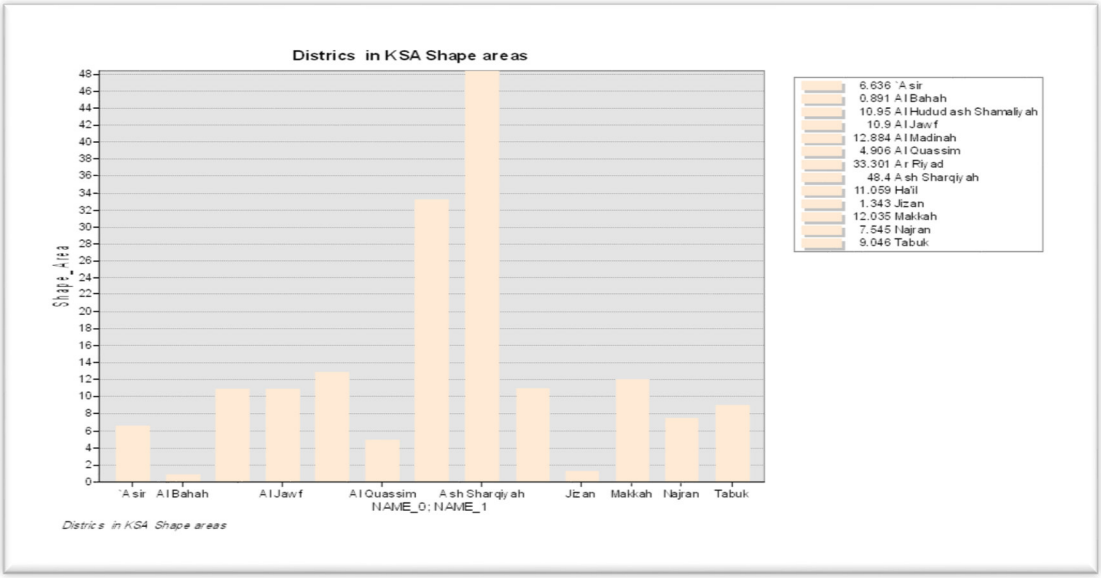


Figure 14 Saudi Arabia Districts Areas Graph

2. Results

This work shows how Geographical Information Systems (GIS) can be used to support water demand invitation the water areas and water inland in GCC. We are founding the GIS several useful functions and tools that can be used in water area The present study has been covered these issues by using ArcGIS 10.2 for GCC. GIS is used to analyse the water areas in different Gulf Countries and the water in land. ArcGIS tools and layers were used the locations of water areas and water inland for the all GCC countries. This study have many graph created using the graph tool in ArcGIS [10] includes many tables showing some facts about demands and water researches. Using ArcGIS 10.2 tools show the variation of water under ground and water in land which is useful for decision supports of water managements in GCC based upon the average driving speed along each ArcGIS. Shape areas and shape length, names of water places and description in the geo database. The results indicated an increase of about 110%, 135%, 139% and 281% in water demand due to future development in, agriculture, forestry, amenity and domestic sectors respectively. The resulted cost is saved as an arc attribute and used during the process of creating drive-

time service area of the selected city.

3. Discussion

The main goal of GIS analytical technique that is used within the water areas and water inland is called overlay analysis. It is observed that the result of this application of GIS is very useful for Water planners and demands on a micro-scale and explore the possibilities of using GIS for determination of water demand and water management in GCC; because they evaluate the water level of service provision at the selected area. Another advantage is found that the existing water areas and water in land per populations in GCC Graph was done for GCC administrative areas and water activities and the relation between populations and geographical areas, and importation criteria was taken to help reaching to neighborhood for water supply. Finally, the same technique can be applied at the other activities in GCC like land cover and roads in GCC doing the ArcGIS tools for planning and demanding different issues in GCC.

Future of water in GCC

Some GCC states are already experiencing sporadic shortages of electricity and gas, while water supplies are already strained and food shortages loom as risks for an import-dependent region. A key challenge for the Gulf in the next decade, will be to manage energy, water and food resources to ensure both high living standards and sustainable growth in the long term. Aware of these challenges, Gulf Arab states are undertaking a variety of measures to ensure long-term sustainable growth. We improving water efficiency; investing in new water desalination capacity; and buying or leasing agricultural land abroad. Although governments have recognized the challenges involved in boosting resource supply security in the long term, much remains to be done to ensure the success of policy initiatives. For example, public attitudes towards energy and water conservation—including curtailment of subsidies—remain resistant to change. New infrastructure to produce water and electricity require massive additional investment. Political controversies arising from investment in farmland abroad require continued management. Despite these challenges, however, the GCC states have a positive outlook for long-term security of key resources, as their young populations and significant capital resources create good conditions for implementing the necessary changes

4. Conclusions

Nawday, Gulf countries needs a broad strategy for addressing water security that does not simply rely on energy export revenues to finance short-term solutions to the problem. And while creating a more conscientious society through awareness campaigns and education programs is a long-term project that may not bear fruit immediately, there is no reason to believe that environmental and social awareness programs that have been successful in countries such as Sweden cannot achieve similar results in the GCC states. In terms of needed projects, investment in water recycling for irrigation and municipal use presents great opportunities for reducing demand for desalinated water. Kuwait has been a pioneer in this field, aiming to use 100% of its treated sewage effluent by this year. Furthermore, research and development in renewable and even nuclear technology for desalinization may provide sustainable, long-term fixes. Other creative solutions include the construction of dams that would improve rain capture and groundwater recharge, and the use of cloud seeding to enhance rainfall. While there may be no quick fix, and though there will likely be some resistance as societies are forced to alter their habits, a competent strategy to tackle water secarity from both the supply and demand side is necessary for ensuring that the economic development that has defined this region in the previous decades continues for next years to come.

References

1. Raouf, Mohamed A. “Water Issues in the Gulf: Time for Action” *The Middle East Institute, Policy Brief No. 22*, January, 2009, pg. 1.
2. Russel, James A. “Environmental Security and Regional Stability in the Persian Gulf”*Middle East Policy, Vol. XVI, No. 4*, Winter 2009. p 91
3. Bazza, Mohamed. “Policies for Water Management and Food Security under Water-scarcity Conditions: The Case of GCC Countries” *Food and Agriculture Organization of the United Nations*, Nov, 2005. p 3
4. Alterman, Jon B. & Dziuban, Michael. “Clear Gold: Water as a Strategic Resource in the Middle East” *Center for Strategic and International Studies*, December 2010, p 3. and Ghazal, Rym. “Water is the greatest gift in the Desert” *The National*, December 11, 2010, and “Gulf Embraces Recycling Water” *MEED Issue 22*, May 28-June 3, 2010.
5. “Gulf Embraces Recycling Water” *MEED Issue 22*, May 28-June 3, 2010.6 Al-Otaibi, Abdulhadi & Abdel-Jawad, Mahmoud. “Water Security for Kuwait”*Desalination, Vol. 214,Issues 1-3, August 15, 2007*, p 304 and Hamoda, Mohamed F. “Desalination and water resource management in Kuwait” *Desalination, Vol. 138, Issues 1-3, September 20, 2001*, p 386.
6. “Gulf Embraces Recycling Water” *MEED Issue 22*, May 28-June 3, 2010.

7. Murad, Ahmed A., & Al Nuaimi Hind, & Al Hammadi, Muna. "Comprehensive Assessment of Water Resources in the United Arab Emirates (UAE)" Water Resources Management Volume 21, No. 9, 2007, p 1461.
8. Schultz GA, Potential of Modern Data Types for Future Water Resources Management, Water International 25 (1): pp. 96-109.
9. Dawoud, Strategic Water Reserve: New Approach for Old Concept in GCC Countries.
10. Background Report to Seminar on Water and Energy Linkages in the Middle East, August 2009, Stockholm International Water Institute.
11. Al Zawad, 2008, Impacts of Climate Change on Water Resources in Saudi Arabia.
12. AL-RASHED, 2000. Water Resources in the GCC Countries: An Overview.
13. M.J. Abdulrazzak, Water supplies versus demand in countries of Arabian Peninsula, J. 14-Water Resources Planning Management ASCE, 121(3) (1995) 227–234.
14. Al-Rashidi, 2008. Sea surface temperature trends in Kuwait Bay, Arabian Gulf. http://muftah.org/the-gulf-countries-water-crisis/