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Determination of Water Demand Management in GCC Using GIS

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Abstract
Arab GCC((Gulf Corporation Councel) 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. The main goal of this paper is showing, how Geographical Information Systems (GIS) using ESRI (Environmental System Research Institute) or ArcGIS 10.2 product , can be used to support infrastructure planners and analyst on water demand of a local area in GCC
(Gulf Corporation Councel) they are (Saudi Arabia ,Kuwait, Bahrain, Oman and UAE).
Keywords: GIS, Water in land, Water area, XML Schema ESRI, ArcGIS ,GCC , DIVA-GIS

1-Introduction

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 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.

2-Problems associated & Material and methods

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]**. The ArcGIS ESRI (Environmental System Research Institute) shapes for the gulf countries was downloaded from the DIVA-GIS for all countries in the word, the administrative s, 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

3-Diva-GIS Free GIS shape file resource web site

DIVA-GIS is a free computer program for mapping and geographic data analysis (a geographic information system

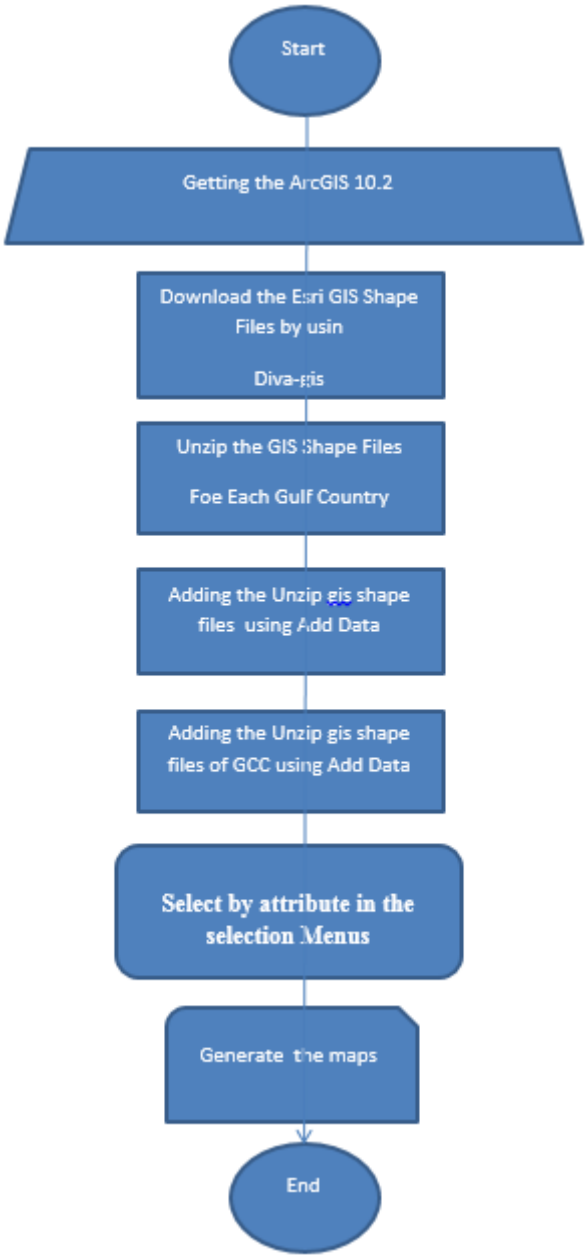
(GIS). With DIVA-GIS you can make maps of the world, or of a very small area, using, for example, state boundaries, rivers, a satellite image, and the locations of sites where an animal species was observed. We also provide free Spatial data for the whole world that you can use in DIVA-GIS or other programs. DIVA-GIS is particularly useful for mapping and analyzing biodiversity data, such as the distribution of species, or other 'point-distributions'. It reads and write standard data formats such as ESRI shape files, so interoperability is not a problem. DIVA-GIS runs on Windows and (with minor effort) on Mac OSX (see instructions). The program to analyze data, for example by making grid (raster) maps of the distribution of biological diversity, to find areas that have high, low, or complementary levels of diversity. And you can also map and query climate data. You can predict species distributions using the BIOCLIM or DOMAIN models.

Figure 1 Free download GIS data by countries in the world web site

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. Seperate files for line and area features	Digital Chart of the World	Vector (line and area)	-
Population	Population density (old)	CIESIN, 2000. Global gridded population dattabase	Grid	30 seconds

Table 1 the GIS Esri shape file downloaded for GCC from

4-Creation the map of GCC Countries



Creating the maps steps follow charting

5-The major water issues and challenges facing the GCC countries.

The Arab world is a generally arid region, and this is unlikely to change anytime soon. In 1950, renewable water resources in the Arab world amounted to more than 4,000m3 per capita per year. By 1995, this figure had declined to 1,312m3 and reached 1,233m3 by 1998. By 2025, this figure is expected to drop to as low as 547m3.It is worth noting that since the early 1990s, water consumption globally has been rising at more than double the rate of population growth. A study by the UK-based risk-assessment firm Maplecroft found that fourteen of the eighteen countries designated as having extremely stressed water resources are in the Middle East and North Africa. According to that study, **the countries are listed in the** GCC Countries

The following order with being the most stressed:

1. Kuwait
2. Oman
3. UAE
4. Saudi Arabia

In addition, the Maple croft report placed Iran and Qatar's water situation in the 'highly stressed'

category.(21) As such, all six GCC member states except Bahrain suffer from severe or high water stress. Clearly, it is impractical for the region to depend on its own natural water resources, as these are inherently just too scarce.

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.

7-The World Bank reality-based development strategies including.

Agricultural investment in water-rich countries such as Sudan, the Philippines, Ethiopia, Uganda and Turkey. Some GCC countries are already making such investments. Investing in agricultural projects in partnership with Turkey on Arab lands that are irrigated by Turkish water, with a framework for revenue sharing.

Expediting a comprehensive strategy for the development of water resource management policies in all the GCC countries. Expediting water interconnectivity projects between the GCC countries, along the lines of existing projects linked to electricity.

Country	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

Country	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

8-The future water security of the GCC states

Recent studies predict that global demand for water is going to be around 40 per cent higher in 2030 than it is today, with population growth usually being the biggest cause of increased demand. The world's population already exceeds seven billion. If the growth rate continues at the current level, approximately 60 per cent of the world's population will suffer severe water shortages by 2025.(27)The situation is only going to get worse as shown in table 4

Country	**2010 population (million)**	**Projected 2035 population (million)**	**Per capita water supply (m3/person/year)**
UAE	7.512	11.042	13.6
Qatar	1.759	2.451	21.6
Saudi Arabia	27.448	40.444	59.3
Bahrain	1.262	1.711	67.8
Yemen	24.053	46.196	88.8
Kuwait	2.737	4.328	4.6

Table 4: The availability of water in world's driest places in 2035 Source: http://www.beatona.net/CMS/index.php

Four of the GCC's six member states – including Qatar – are among the world's top ten countries in terms of vulnerability to severe water scarcity. Kuwait (at only 10m3 per capita per year) tops the list; the UAE (at 58m3 per capita per year) is third; Qatar (at 94m3 per capita per year) is fifth, and Saudi Arabia (at 118m3 per capita per year) is eighth. In addition, Qatar and Bahrain are reportedly already consuming 2.8 and 1.5 times than their available water resources respectively.(28)

9-ArcGIS 10.2 Overview & Data Management

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. 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**.**

10-Loading GIS file on ArcGIS 10.2 Platform

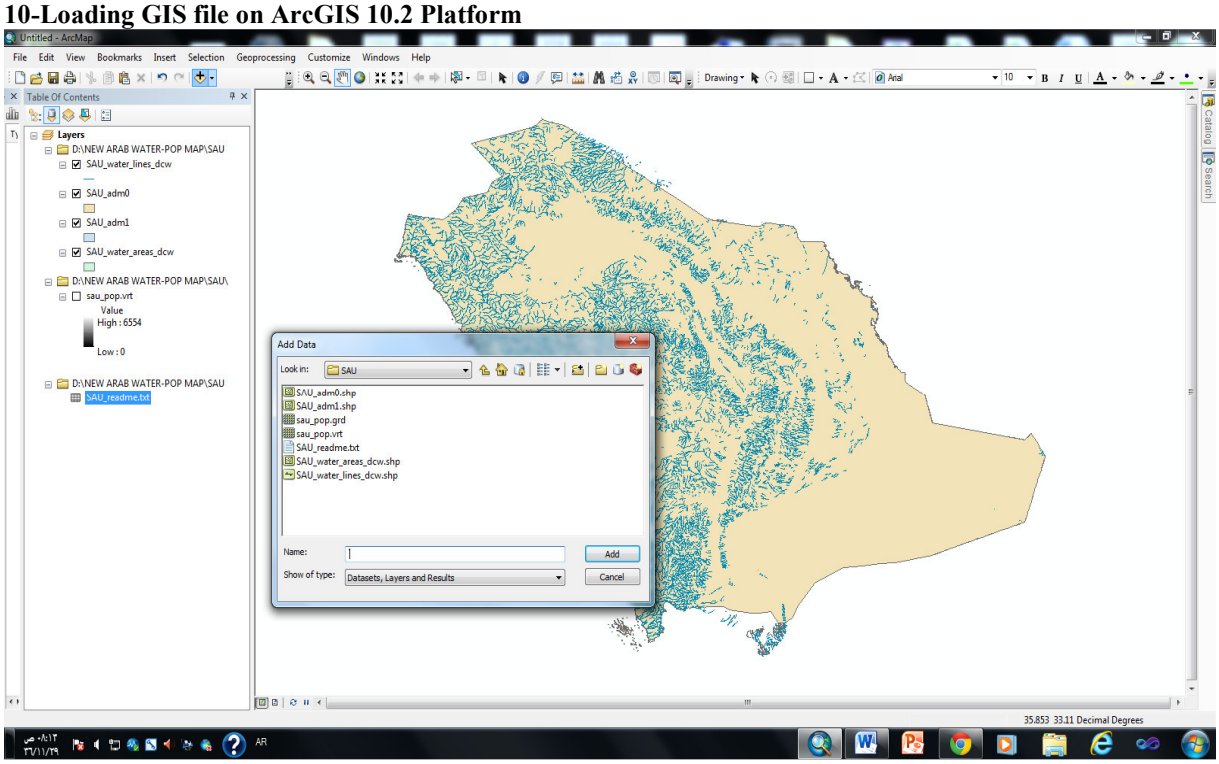


Figure 2 The dialogue of loading gis shape file using the Add Data tool in ArcGIS 10.2

The downloaded 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

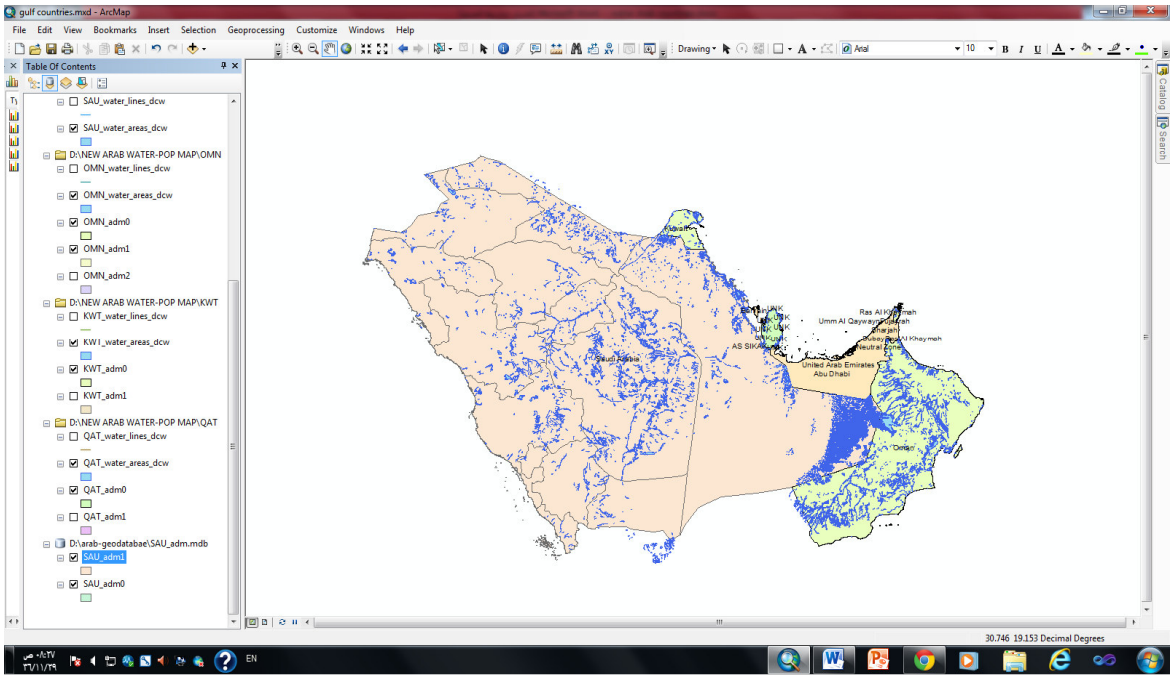


Figure 4 GCC Water areas and water in land ArcGIS Map

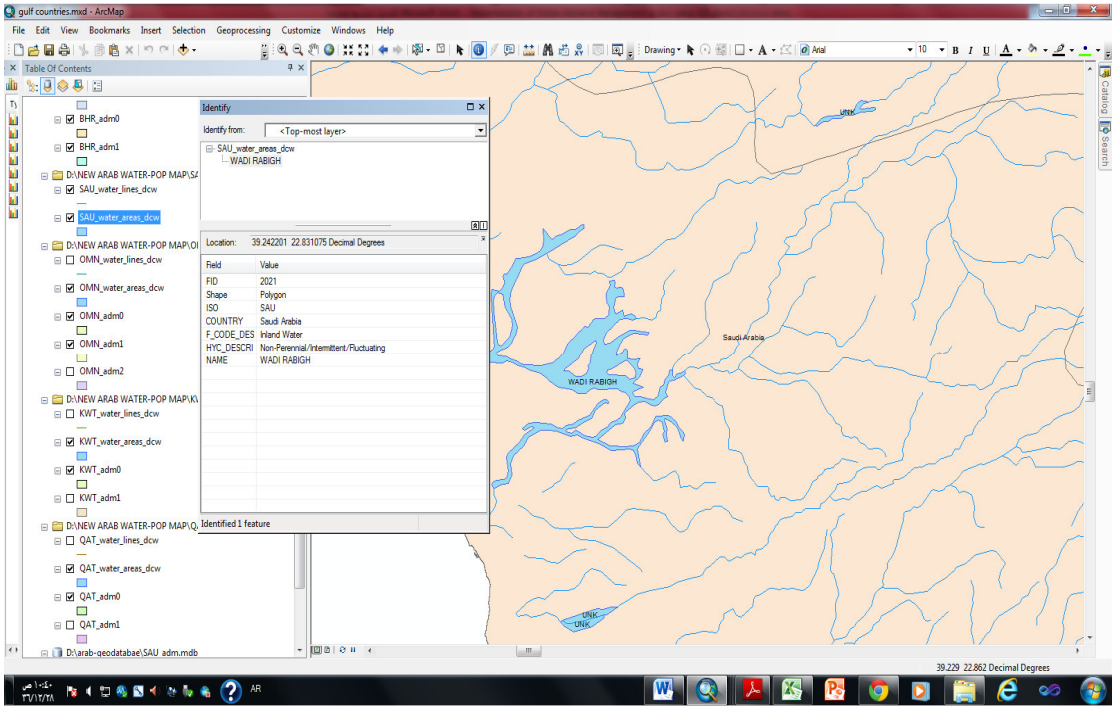


Figure 5 KSA Water areas OF WADI Rabigh

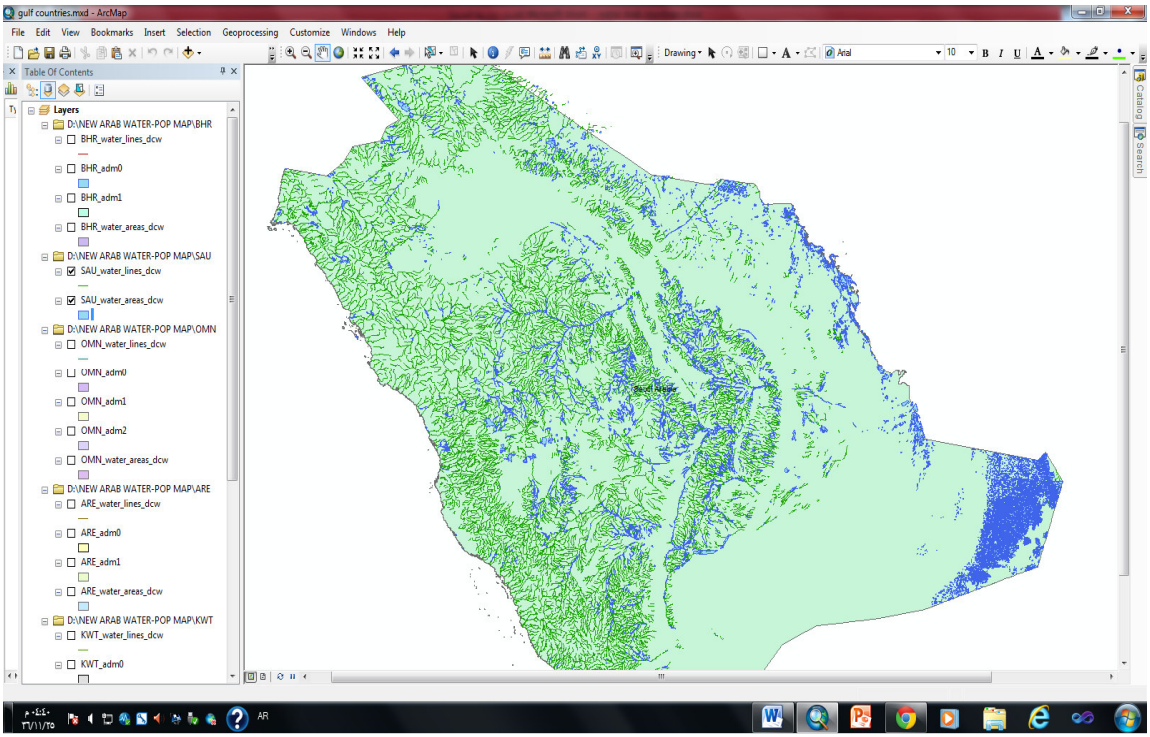


Figure 13 Saudi Arabia Water area an water in land

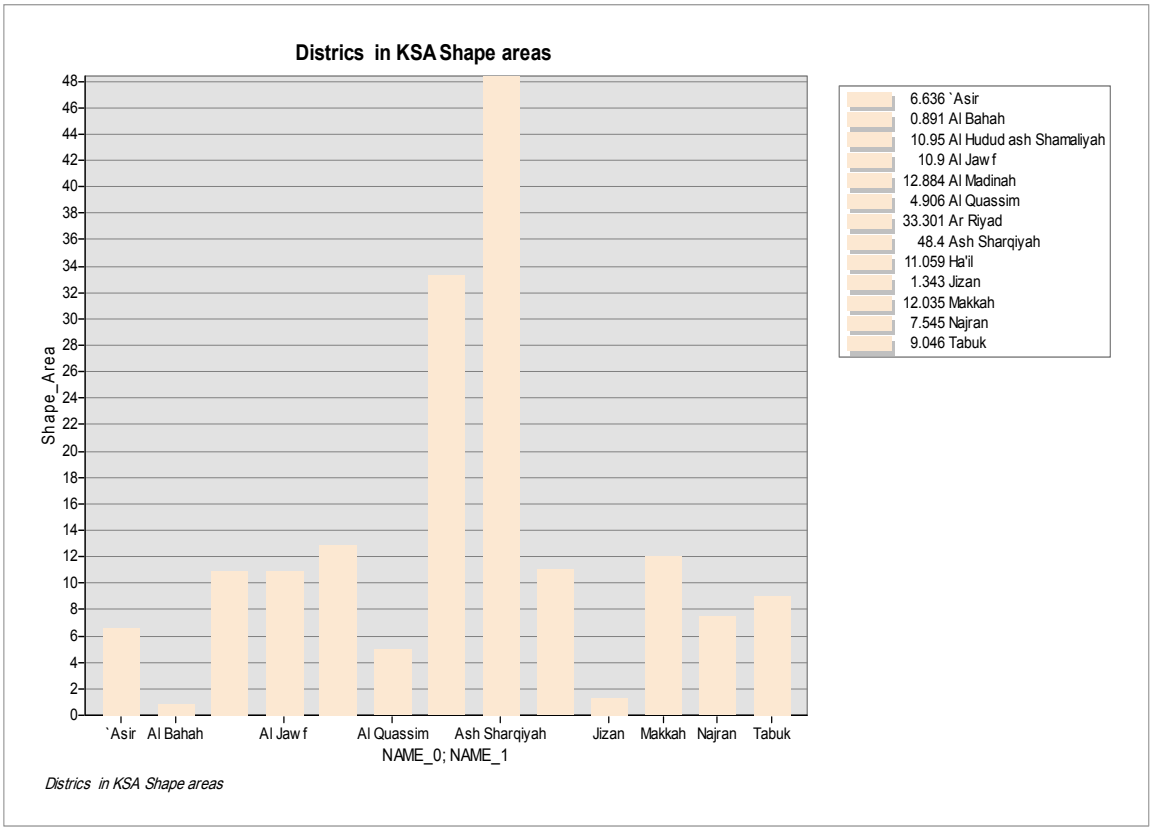


Figure 14 Saudi Arabia Districts Areas Graph

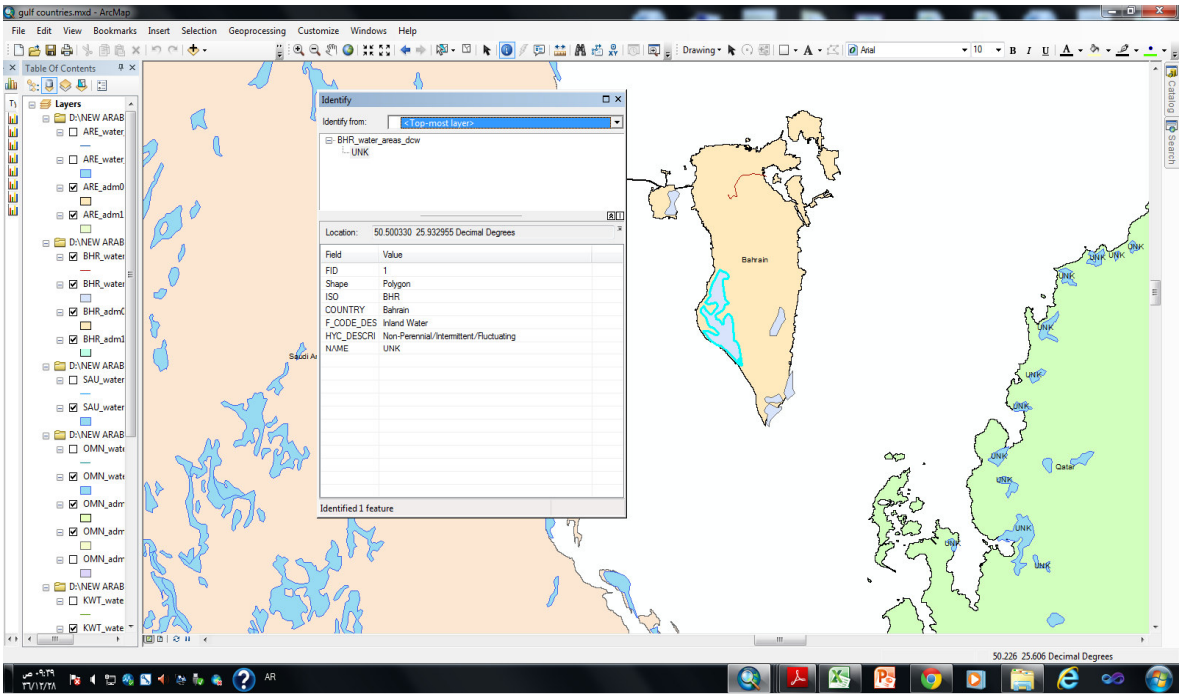


Figure 5 Bahrain administrations and the water area ArcGIS Map

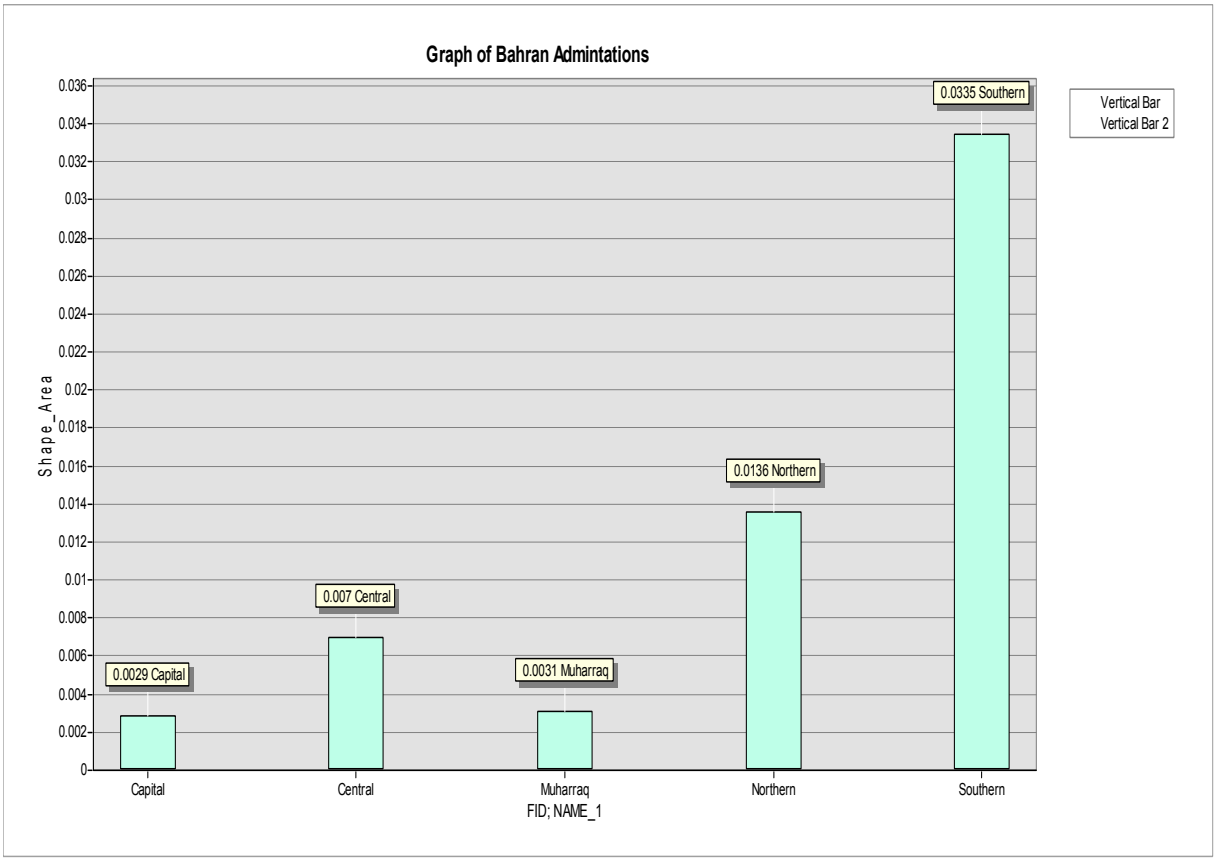


Figure 6 Bahrain administrations areas graph

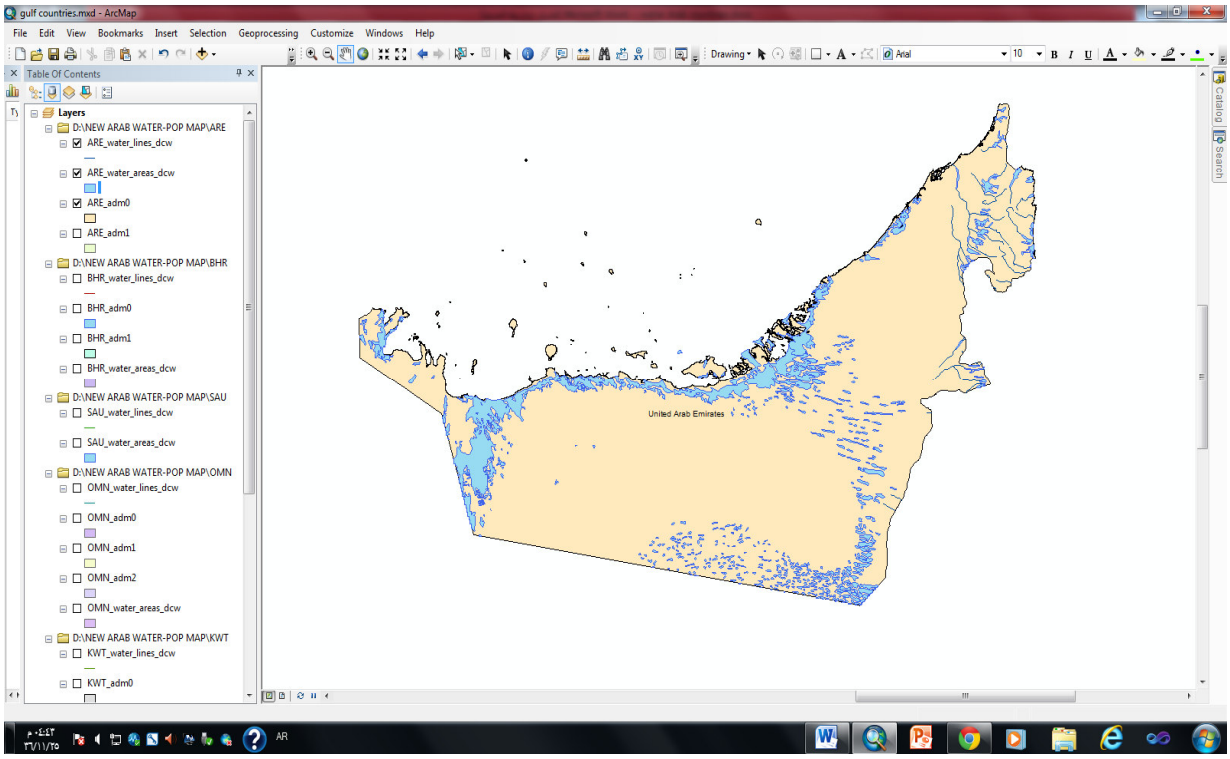


Figure 7 United Arab Emirates Water area and water inland

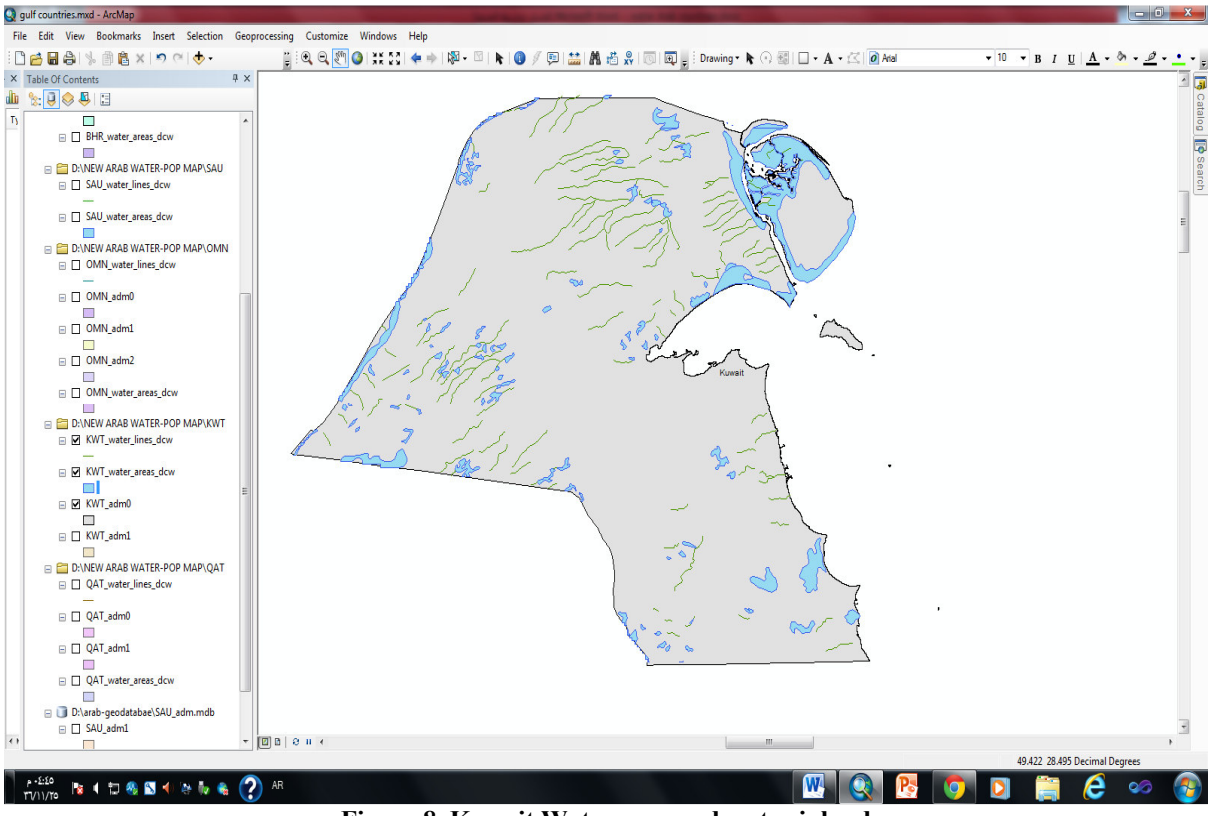


Figure 8 Kuwait Water area and water inland

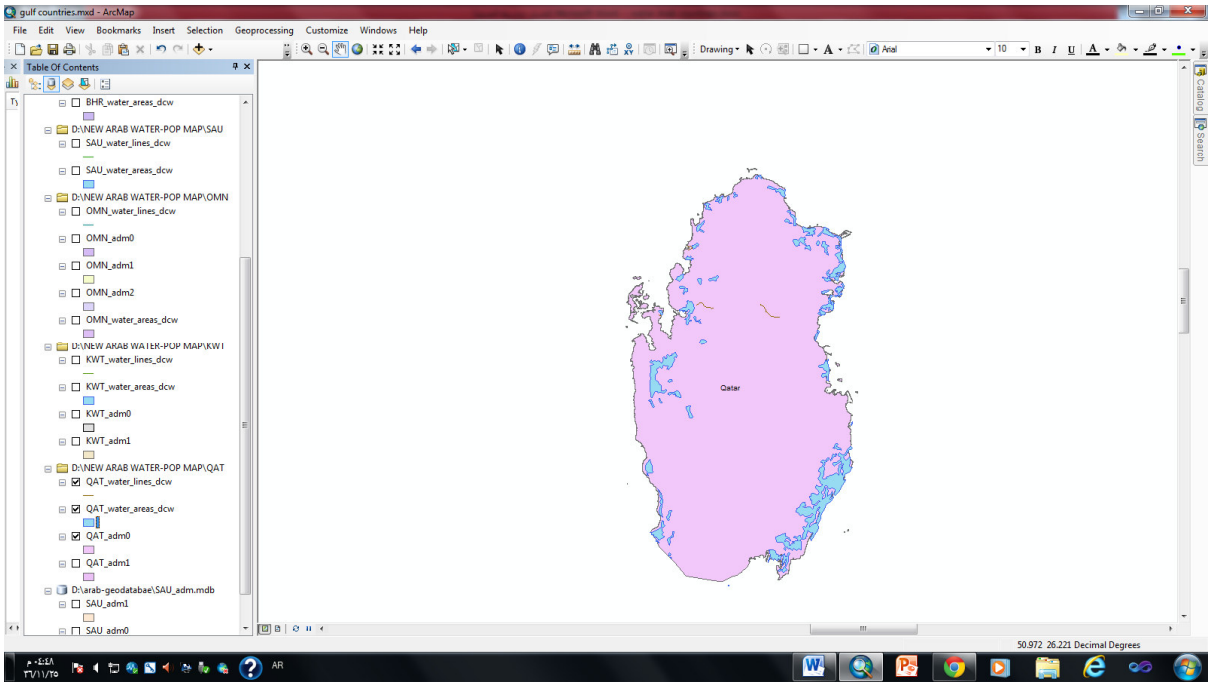


Figure 9 Qatar Water area and water inland

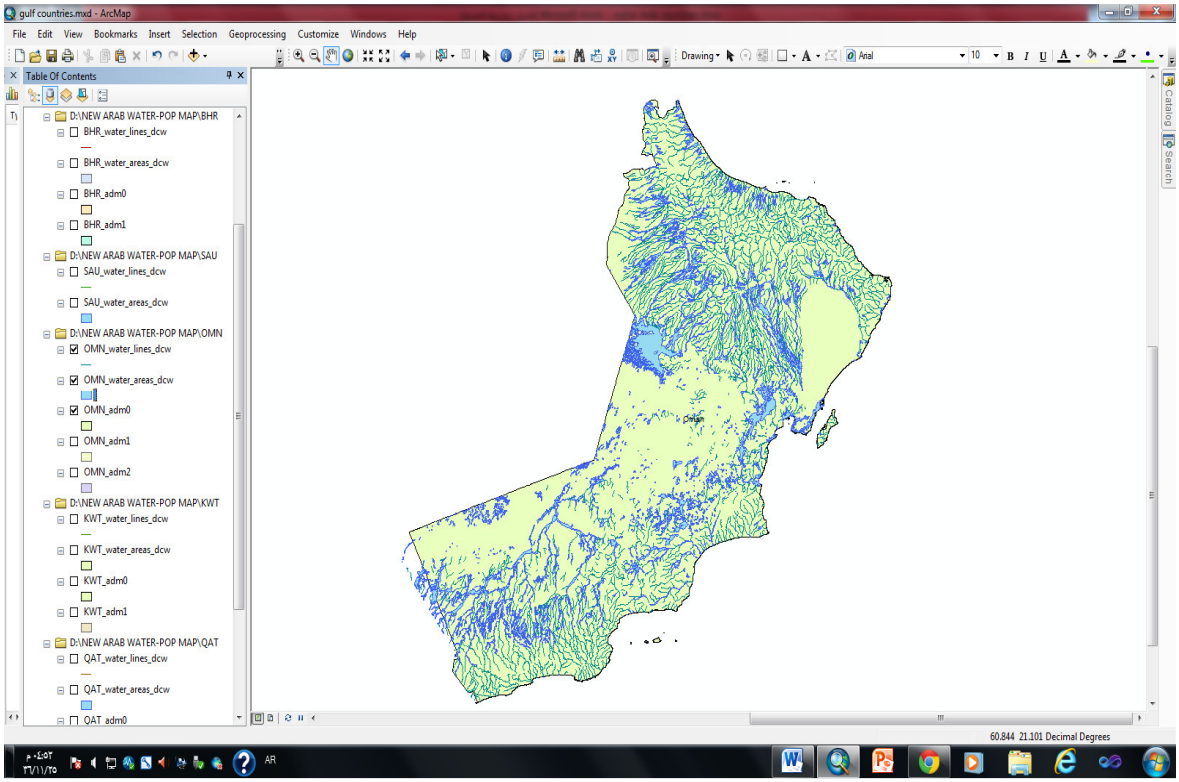


Figure 10 Oman Water area and water inland

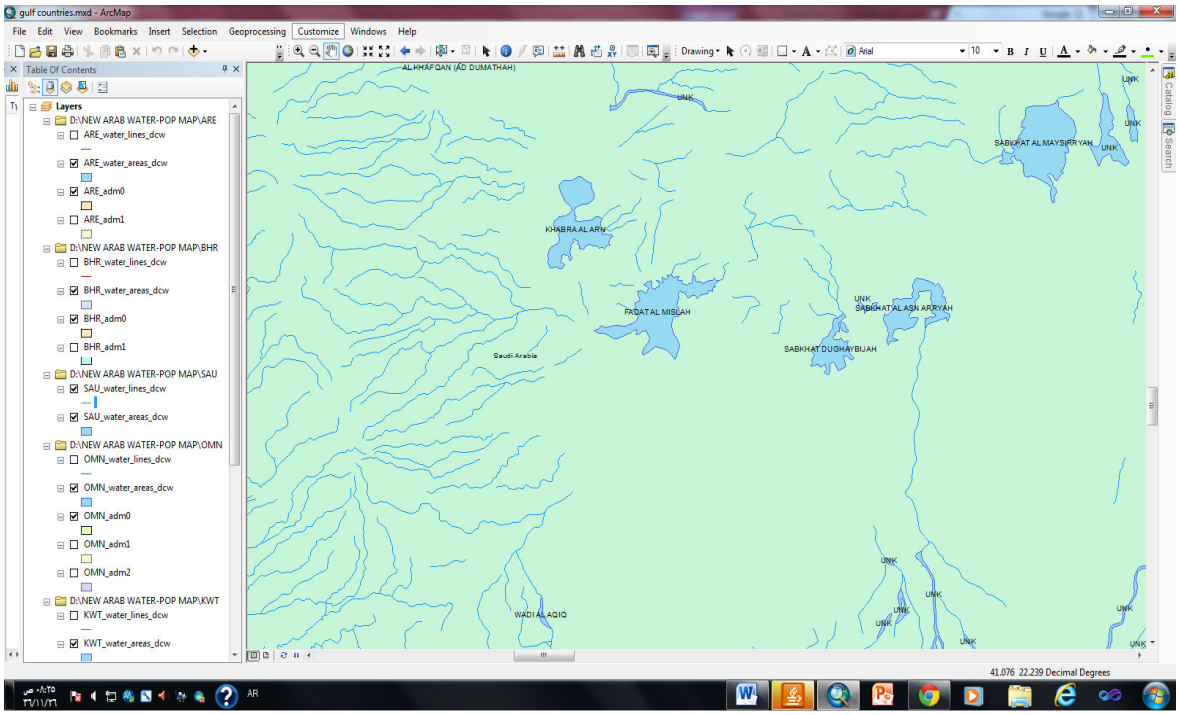


Figure 11 Unite Arabia Emirates Shape Areas Graph

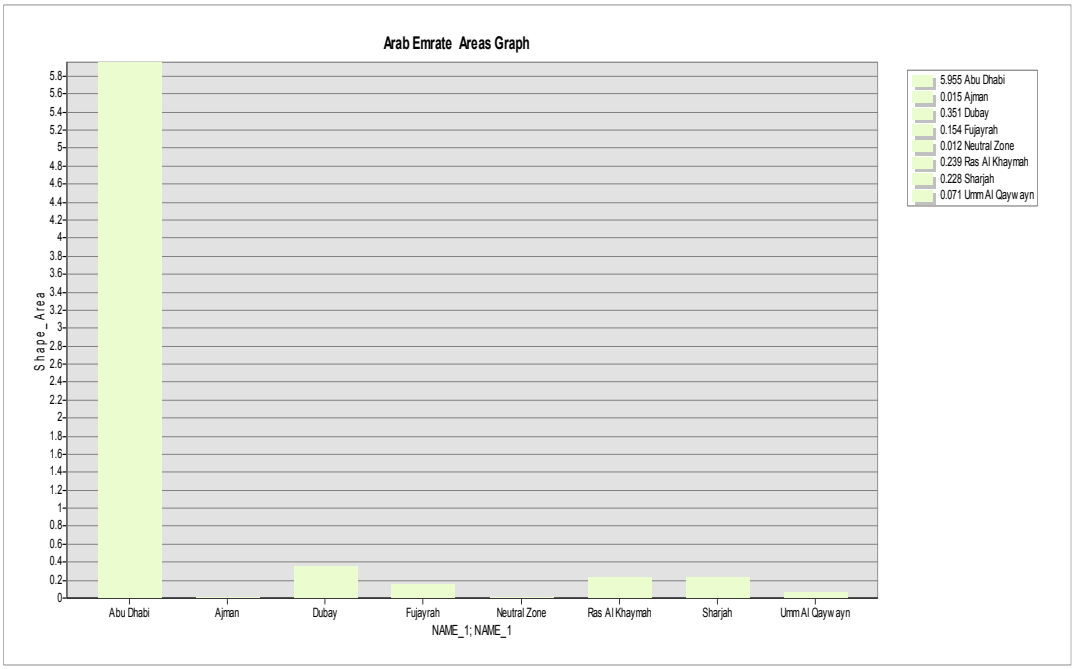


Figure 12 Unite Arabia Emirates Shape Areas Graph
Figure 4 GCC Water areas and water in land ArcGIS Map

11-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 .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 analyses the water areas in different Gulf Countries and the water in land. ArcGIS tools and layers was use to find the locations of water areas and water inland for all GCC The presented 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 on the average driving speed along each ArcGIS Shape areas and shape

length , names of water places and description in the geo database .. The resulted cost is saved as an arc attribute and used during the process of creating drive-time service area of the selected hospital. The main goal of GIS analytical technique that is used within the water areas and water ind land is called overlay analysis. It is observed that the resulting 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 activites in GCC like land cover and roads in GCC doing the ArcGIS tools for planning and demanding different issues in GCC.

12-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 therefore 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. l improving water efficiency; investing in new water desalination capacity; and l 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.

13-Conclusions

What in GCC countries need is 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.7Furthermore, 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.8 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 security 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 years to come. Potable water is becoming an increasingly rare commodity, and factors such as runaway population growth, poor management and climate change are making water management and allocation exceptionally complex. Desalinated water is invaluable in fulfilling the demands of the GCC member states and their economies. However, any disruptions of water supply would have dire consequences for the political and social stability in the affected countries. A better understanding of the dangers threatening water supplies is crucial, and the capacity of the relevant government institutions to issue early warnings should be publicly accessible. At the same time, preventative and mitigating procedures must be put in place to ensure water security for all, and plans to counter threats to water security should be expedited.

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