Using Remote Sensing and GIS Techniques in Counting, Representing the Areas of the Agricultural Lands and Classifying the Crops, Case Study: Technical Presentation for a Project in KSA

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Abstarct: ***Due torapid population growth and limited water resources, it became essential to manage the available scarce water resources in a rational way. Agriculture activities represent the major water demand in the Kingdom of Saudi Arabia (KSA) with a percentage more than 80% of total demands. Therefore, the use of new techniques such as Remote Sensing (RS) and Geographic Information Systems (GIS) are currently considered as powerful tools within Integrated Water Resources (IWR) planning and management. The main objective of this research is to provide a methodology for using such techniques for counting, representing, and classifying crops for estimation of the agriculture demand for water in KSA. A case study is provided to demonstrate this methodology based on technical presentation of a project in KSA.***

Keywords: Remote Sensing (RS), Geographic Information System (GIS), Integrated Water Resources (IWS), Agricultural Lands, Crops

1. Introduction

Accurate temporal information on crops during the growing period, and estimates at harvest provide important input for reliable estimates of food security and planning and formulation of agricultural policies and marketing strategies. Experience has shown that the quality of available agricultural data (agricultural censuses, crop monitoring, and yield estimates) is generally inconsistent and irregular. Therefore, improvement of data collectionand reporting methods is warranted. Recent advances in geospatial data and remote sensing processing along with reductions in cost and increases in satellite imagery coverage, frequency, and resolution offer powerful new data and approaches to enhance data systems [1].

Remote sensing data systems now provide robust first estimates of agricultural production and are no longer substitutes for ancillary data sets for validation.Traditional approaches to forecasting crop yields focus on models that integrate climate soil, fertilizer, irrigation water, and meteorology as response functions to describe crop yield and evaluate production [7]. These techniques are generally based on strong physiological and physical concepts However, it suffers from limitations when providing reliable outputs under conditions of wide spatial variation insoils, stressors, or poor management practices [6 & 7]. However, geospatial technologies(remote sensing) and geographic information systems(GIS) have been promoted as potentially valuable tools for agricultural monitoring because of their comprehensive coverage and temporal monitoring ability [3 & 5].

1.1. Remote Sensing (RS)

Remote sensing is the science and art of collecting information and data about the earth'ssurface from a distance (remote) [9]. Data-gathering sensors are usually installed on satellites that are constantly in orbit around the Earth, ensuring a continuous flow of data. Extracting information and data about the earth's surface and water bodies using an image taken from above, by recording electromagnetic radiation reflected or emitted from the earth's surface Remote sensing is concerned with the development of imaging and measurement methods and the use of technology to analyze and interpret phenomena to obtain useful information. Therefore, there are several theories to understand the recordings emitted or reflected to the recording devices and their relationship to the phenomenon to be explored or surveyed.

Remote sensors can be categorized depending on the source of radiation they are used to [8]:

- **Passive Remote Sensing**

In it, sensors record waves reflected from the surface of the earth resulting from natural energy sources such as sunlight or natural radiation emitted from the surface of the earth and the objects on it, and the amount of these reflections or emissions is known as digital data.

- **Active Remote Sensing** :

In it, reliance is placed on an industrial energy source that is installed on the satellite itself, such as radar, where the radar sends microwaves to the surface of the Earth, and then re-records them after their reflection. In both types, the sensors send the spectral recordings to Ground Reception Station in preparation for processing and using them.

The most important thing in remote sensing is measuring the reflective properties of the features on the surface of the earth, and this is called spectral reflectance, which is used to distinguish the different elements on the surface of the earth. This is because the spectral reflectance curve of plants differs from what it is in soil or water, so knowledge of the spectral characteristics of plants, soil, and others constitutes an essential source in the process of analysis and correct interpretation of remote sensing information.

1.2. Digital Image Processing

When receiving satellite images from the sensors in their raw state, they contain a lot of distortion and noise, so the images are subject to various processing processes and techniques, and corrections using specialized programs to obtain good results from remote sensing images. Image processing processes can be collected as follows:
Primary processing of digital images from satellites: This treatment includes several correction operations, the most important of which are [10]:

Radiometric Corrections
The radiometric correction rearranges (includes all digital units DN) within the image, so that the relationship between them and the radiative or reflective values is linear in all digital image units.

Geometric Corrections
The need for a geometric correction appears when the pixels that make up the image are displaced from their real geographic positions, meaning that the cells within the image take coordinates that are lower or higher than their real Ground Coordinates. So, the image loses the geometric relationship with the area it represents on the surface of the earth. Distortions are treated in two ways:

- The first is concerned with systemic errors, which are due to sensor errors and the effect of the earth's rotation where the treatment is done by applying a mathematical model.
- The second method is concerned with irregular errors which are corrected using Ground Control Points (GCP) for specific points in the image that represent specific places on the surface of the earth with a reference source for these points that can be obtained from a topographical map of the imaged area or by using cadastral devices as GPS.

Special Processing
This stage of processing includes image enhancemen. Image Enhancement is a process of improving data in satellite images by increasing the differences between the spectral reflections of the spectral classes, which are expressed in color difference, so that this visual becomes more visible and visually interpretable. Distortion removal precedes improvement processes within the satellite visual, as it is characterized by a difference in the gray level values, i.e. the contrast in the luminosity values, which is the ratio between the highest value of the gray level to its lowest value within the image.

Linear Contrast Stretch

Non-linear contrast enhancement through histogram equalization, and in this technique the number of cells constituting each class is redistributed from the rows of the histogram of the original image, and this is done according to the aggregate frequency histogram that collects adjacent gray values and sets each within specific groups, as this results in a new spectral plane. Therefore, the gray values (luminosity) in the enhanced image are lower than they are in the original image due to the aggregation cells process.

Image filtering
Image filtering is another method of digital processing. Spatial filtering is based on adjusting the values of the cells in the original image based on the gray levels in neighboring cells. Spatial filtering aims to reduce the noise values in the image which helps the analyst to better interpret the image data.

Principal Component Analysis (PCA)
This process is used to process multiband images with strong interdependence between its layers, so the original layers bands are transformed into unrelated layers (Transformed images) and thus the size of the original layer group decreases.

There are several satellites used to photograph the Earth's surface, including the American Landsat, the French SPOT, the European Sentinel 2 and commercial satellites such as IKONOS, GeoEye, Worldview, and others [11]. These satellites vary among themselves in terms of spatial resolution and temporal resolution.

Nowadays, remote sensing techniques are used in agricultural studies due to the advantages they have compared to traditional methods of such studies. Due to the change of vegetation cover and the change of land use and land cover, remote sensing applications in the agricultural field are among the most important applications of these modern technologies. Due to the diversity of agricultural wealth, which calls for continued monitoring and follow-up of its development in order to develop management and investment programs, remote sensing techniques came to achieve all this because of the accuracy, comprehensiveness, spectral plurality and temporal recurrence of the sensors.

Remote sensing techniques are used to limit agricultural areas, estimate the general condition of crops, estimate their productivity, monitor their exposure to natural disasters such as floods hurricanes, agricultural pests and diseases, and take preventive or remedial measures in a timely manner, thus drawing plans to market them based on accurate and realistic information in order to obtain the optimal economic return. Which achieves the highest profit and helps support development plans and the national economy and achieve economic integration. Remote sensing techniques are also used to monitor the vegetation cover, identify the constituent plant species, estimate its condition and degree of deterioration, and study the changes that may occur to it as a result of drought, overgrazing or human activity, with the aim of rehabilitating and preserving it [12].

The expansion of the use of "remote sensing" technology in the agricultural field contributes to the establishment of an accurate and unified agricultural database for everything related to the agricultural field. To provide and flow agricultural information in a comprehensive and accurate manner, study and analyze it to manage agricultural resources in an effective and sustainable manner and support the decision-maker with ideas and applied recommendations to solve Chronic problems and the implementation of agricultural development plans within the framework of the state's general policy. Spot satellite with a resolution of 6 meters will be used in the periods from 2015 to 2023 at quarterly intervals (4 periods annually) to serve an accurate estimate of the quantities of water used for each of the different crops in each season of the year. The following map, figure (1), shows the main cultivation regions of the Kingdom, which are thirteen regions distributed over the entire surface of the Kingdom, according to the Saudi Ministry of Agriculture.

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The integration of remote sensing and geographic information system in the agricultural sector and this survey aims to increase the accuracy and practical efficiency in identifying agricultural places and their types to increase production [13]. Currently GPS, GIS, and imagery are used together to support more efficient agricultural field surveys and censuses [2]. However, the use of remote sensing in agricultural monitoring, estimation, and reporting requires both data and technical resources capable of processing big data analytics that the new generation of geospatial modellers must be familiar with. The above situation encourages the use of satellite remote sensing to monitor crops and farming systems, enhancing skill sets and training in image processing and use in field operations. Despite the inherent challenges, these methods have been widely developed within other sectors. Therefore, the use of remote sensing in agriculture can often leverage data sources and processing for other goals and important options for institutional sharing. Agricultural sectors can benefit from the use of remote sensing data and geospatial processing in multiple ways, depending on a number of criteria and resource requirements. These vary with the aims and purpose of the surveys and range from:

- Geospatial mapping of distributions of specialized and minor crops and large andmedium commercial farms.
- Supporting field survey procedures for agricultural crops.
- Monitoring and predicting crop yields after determining the areas and type of cultivation.
- Mapping of status factors such as pests and diseases, natural hazards and derived indicators of seasonality.
- Crop productivity such as Standard Variation Vegetation Index or NDVI.

1.3. Disciplies of Remote Sensing in Agriculture

The multiple applications of remote sensing may be outside the scope of its direct application in agricultural statistics. For example, images are widely used in the assessment of animal pastures and rangelands, managing natural resources, monitoring sustainable agriculture and rural development, and agricultural land degradation. Table 1 provides the disciplines required to operate remote sensing in agriculture.

Table 1: Summary of the disciplines required to operate remote sensing in agriculture

Thematic areas and Experience	Description of requirements
Remote sensing and geographic information system	Satellite-extracted products such as NDVI L and Cover Index, land-use datasets, image processing (image enhancement, image classification, feature interpretation and extraction, generation of thematic maps, spectral signatures of crops, and remotely sensed phenological crops calendars and crop maps), and geospatial inputs
Statistical	Building sample frame design, area frame development, random clips selection, questionnaire design for field data collection, field data correction crop area. Estimates and Statistical Analysis for Crop Yield Prediction
Aagricultural Engineer	Calender satellite acquisition timeframe, and crop condition assessment using satellite and ground information
Agricultural Meteorology	Collect and update meteorological parameters
Software Developer	Develop desktop and web applications for field data collection and automation from data processing
Field Staff	Collect ground data using the Global Positioning System (GPS), validate data, and take samples
Support Team	Data entry, digitization and printing

2. Case Study: Technical Presentation for a Project in Kingdom of Saudi Arabia

The Kingdom of Saudi Arabia is the largest Arab country and the twelfth largest in the world in terms of area, with an area of about 2.15 million square kilometers. The kingdom extends between longitudes 36° and 56° east and latitudes 16° and 32° north. As a result of this large area and geographical extension between longitude and latitude the topography of the Kingdom varies between narrow plains on the sea coast. Al-Ahmar, which are the plains of Tihama , followed towards the east by mountain ranges that extend throughout the country which are the mountains of Hijaz and Asir, whose height exceeds 2000 meters, then deserts and rocky plateaus in the middle, representing 90% of the total area, the largest of which is the Nufud desert in the north and the Quarter Khali in the south. As for the far east and along the coast of the Arabian Gulf, wide coastal plains extend. Figure (2) shows the adminstrative regions of Kingdom of Saudi Arabia.

Figure 2: Admistrative Regions of Kingdom of Saudi Arabia

The Kingdom enjoys a continental climate characterized by cold winters and very dry summers.The climate of Saudi Arabia is generally classified as a very dry desert climate with little rain. However due to the wide area of the Kingdom and the multiplicity of terrain, the climate varies from one place to another and from one season to another. In the summer temperatures rise because of the proximity to the equator and the intensity of exposure to the sun's rays, which reach almost vertically. The average maximum temperature in July in the high mountainous regions is 26°C, and it rises in the coastal areas where the relative humidity is high to 37°C, and reaches a peak of 49°C in the Najd Plateau and other inland areas where the air is dry and the nights are relatively cold. Temperatures are moderate in the winter, but in January they may drop below the freezing point in large parts of the center and north of the country.

As for the rains, they are very few, but they differ in their quantities, distribution and characteristics. Rain falls in the winter in amounts ranging from 15-200 mm in most parts of the country, with the exception of the southwestern highlands, which receives heavy rain in the summer, ranging between 200-500 mm. Rainfall amounts change spatially and temporally and their duration is usually short, causing torrential rains in many regions of the Kingdom. It may also fall in large quantities in one year and then stop completely in the next year or years. The country is exposed to sand and dust storms in the late spring and during the summer, due to the strong winds due to low atmospheric pressure. The severity of the impact of these storms is aided by the widespread distribution of loose sand and dry soil.

The results of the demographic characteristics of the Kingdom of Saudi Arabia showed that the population amounted to about 32.55 million people in 2017 AD, compared to about 31.47 million people in the 2016 demographic survey with an average annual growth rate of 2.52%, according to the Authority for the public statistics. This population is distributed according to sex, at a rate of 57.48% for males compared to 42.52% for females of the total population in 2017 AD. The estimated population of citizens according to the results of the survey, Saudis are about 20.41 million, or 62.69% of the total population of the Kingdom. The population of Saudi citizens is distributed according to sex, with 50.94% of males and 49.06% of females out of the total population of Saudi citizens in 2017.

This classifies Saudi society as a young society, where 30.3% of Saudi citizens are under the age of fifteen, and 60% of them fall into the age group 15-54 years.

Due to the vast area of the country, the Kingdom is one of the lowest countries in the world in terms of population density, as it recorded in 2017 AD 15.1 people/km2 The Kingdom's population is geographically distributed over 13 administrative regions. Approximately 50% of the population is distributed among the main urban areas: Riyadh (the capital) 6.907 million people; Jeddah 4.433 million; Mecca 1.967 million; Medina 1.43 million Dammam 1.197 million people.

It is clear from the previous review that there is great diversity in the Kingdom of Saudi Arabia in terms of topography, terrain, climate, and the distribution of the population to urban and rural areas. All these differences and this diversity have led to many differences in the available water sources as well as in the water needs according to the sectors of use and that these needs increase annually. Therefore, it is imperative that the different sources of water be identified accurately and that the water needs be determined at the present time and the changes that will occur to them in the future be predicted.

3. The Aim of the Project

According to the tender brochure presented by the Ministry of Environment, Water and Agriculture, the project aims mainly to estimate the quantities of water used for all purposes in the Kingdom, with a focus on agricultural consumption through information on the water needs of crops and calculating the cultivated areas by digital analysis of satellite visuals that cover all regions of the Kingdom with a strong impact in the national economy, which depends on irrigation with water from its various sources. The project also aims to create a digital map for listing and classification of existing crops and digital databases (Geographic Information Systems). That can be updated annually.

4. Methodology

The Landsat and Sentinel satellites are distinguished by the possibility of obtaining their images for free and by the multiplicity of their channels, as they reach thirteen channels covering visible light (blue, red, and green), near short, and thermal infrared radiation. Sentinel is distinguished from Landsat by higher spatial accuracy and temporal accuracy, and the French satellite is distinguished by higher spatial accuracy than the previous two, but it has fewer channels. As for commercial satellites, they are characterized by very high spatial accuracy, reaching meters. With the multiplicity of spectral channels, it is possible to take advantage of these capabilities in the study of different land use types. On the other hand, SPOT data is characterized by the small size of the floor area represented by each cell (spatial accuracy), and this is reflected in the spatial discrimination of this data, which increases its explanatory power. Therefore, it is preferable to use SPOT data to study agricultural lands, as is the case in the project areas, which are formed from fields of small sizes, because the high spatial resolution helps in distinguishing small size fields and also reduces the elements of distortion that appear when classifying the image, which it helps to produce clear classification maps, and through the high spatial resolution also increases the accuracy of the geometric features of the image, as it facilitates the engineering correction process and then comes out with accurate detailed results. Spot also has a reprogramming feature. When a satellite passes over the space station in Toulouse specialists can direct it to change the overlap ratio, the ground area in a single cell, and the nature of the scene in its vertical or inclined position. In addition to this, SPOT's high ability to repeat the visit to one terrestrial site during the full satellite cycle around the Earthis High Revisit Capability.

The process of classifying SPOT satellite image data of a study area depends on the Maximum Likelihood classifier method asone of the methods of supervised classification, due to the accuracy of classifying cells in this method compared to other classification methods. The Normalized Difference Vegetation Index (NDVI) can also be used in addition to the un-supervised classification. Machine learning techniques can also be used to classify crop types. Some studies also indicated the successful use of radar imaging in the process of classifying plants. In this project and since it is required to use images with a spatial resolution of less than 10 m SPOT satellite images will be used with a spatial resolution of 6 m and wave spectra that include blue, green, red and infrared IR, Remote sensing image analysis software are software applications that process remote sensing data. Remote sensing applications are similar to graphing software, but they enable the generation of geographic information from airborne and satellite sensor data. Remote sensing applications read specialized file formats that contain sensor image data, georeferencing information, and sensor metadata. Some of the most popular remote sensing file formats include GeoTIF, NITF, JPEG, 2000ECW, MrSID, HDF and NetCDF.

Examples of Remote Sensing Software
- Geomatica, PCI Geomatics
- SAGA GIS (Open Source)
- TNTmipsgis, MicroImages, USA
- ERDAS IMAGINE
- ENVI
- Google Earth
- GRASS GIS
- OpenEV (Open Source)
- Opticks (Open Source)
- Orfeo toolbox (Open Source)
- RemoteView
- SOCET SET
- IDRISI
- ECognition
- ArcGIS
- SNAP

The integration of remote sensing applications and geographic information systems has provided researchers with advanced tools for managing the environment by assisting the data that these applications provide us with in the comprehensive Synoptic Analysis of the system at the local, regional and global levels across different time stages. In addition, to the importance of these applications in monitoring and revealing the important relationships between natural dimensions and human dimensions in changing patterns of land cover and its uses, the location, directionrate and size of its contribution to determining and the nature of this change to reach the method of detecting digital change in the land cover and its uses.

Factors Affecting the Cost of Satellite Images in the Classification of Crops:
- The project covering area
- Each district area
- Project study period
- The number of study times

The cost of the images required for each study will be calculated and then the total cost of the project.

5. Project Scope of Work

5.1 Estimating Agricyltural Consumption

Agriculture demand represents more than 80% of the total water demand in KSA. More than 1.1 million hectares were cultivated in 2007. Water uses ranges between 9100 and 39000 m3 per hectare according to the type of crop and season of cultivation. The water demand for agricuture exceeded 12.5 BCM in 2019. The tender brochure indicated that the Ministry of Environment, Water and Agriculture will provide the consultant with data and sites for agriculture together with recent agricuture census. The consultant will perform the following tasks:
- Coordination and tabulation of data according to each administrative region and according to each source of water.
- Aquire remote sensing data with the suitable resolution for the analysis.
- Use of available data from meteorological stations to estimate evapotranspiration following FAO recommendations by using latest softwar version.
- Classify crops according to type and season of growing using remote sensing data and check by field data.
- Estimate evapotranspiration using models supported by remote sensing. Provide comparison with estimated calculated data.
- Tabulating data and entering it into the database in an interactive way that allows addition, deletion and modification.

5.2 Estimating Urban Consumption

Domestic water uses amounted to about 2.33 billion cubic meters in 2008. Due to the increase in the population and the high standard of living as well these uses were estimated at 3.268 billion cubic meters in 2020. Consumption rates vary between urban areas and rural areas, and even these rates vary between different neighborhoods within the same city. There are three main water sources to cover these uses, which are groundwater, water stored behind some dams, and desalinated water from desalination plants spread across the Red Sea and the Arabian Gulf.

The tender brochure indicated that the Ministry of Environment, Water and Agriculture will provide the consultant with data and sites for producing drinking water from groundwater from comprehensive water fields and separate wells, as well as data and sites for producing drinking water from surface water from dams designated for drinking.

The study will also require providing the consultant with data and locations of the desalination plants and the areas that feed them. The study will also require the Ministry's assistance to the consultant to contact the secretariats of the various governorates to obtain the distribution of the quantities of urban consumption on the neighborhoods and their sources, given that many neighborhoods receive water from different sources and in varying quantities. It is also necessary to obtain data on water purification plants and the current quantities of water produced, as well as future expansion plans. It is also necessary to obtain future plans for the expansion of urban consumption from its various sources and the financial funds allocated for this.
Since the Kingdom of Saudi Arabia is divided into 13 administrative regions (as shown in figure 1) the consultant will perform the following tasks:

- Coordination and tabulation of data according to each administrative region and according to each source of water.
- Determine the current urban consumption rates for each of the neighborhoods, whether current or future rates.
- Determining plans for future expansions in the various water sources and the financial funds allocated to them.
- Tabulating data and entering it into the database in an interactive way that allows addition, deletion and modification.
- Suggesting the appropriate mechanism for determining the daily quantities of water produced from different sources. It is suggested that there be a point of contact at each production site (water source) that reports daily data through a dedicated e-mail site at the Ministry of Environment, Water and Agriculture.

5.3 Estimating Urban Consumption

Industry water needs were about 713 million cubic meters in 1990, and it was estimated that these needs will increase in 2020 to range between 795 and 1216 million cubic meters. The tender brochure indicated that the Ministry of Environment, Water and Agriculture will provide the consultant with data and locations of the current industrialmining and oil activity, the quantities of water consumed and its sources, as well as the targeted industrial sites until 2030.

Accordingly, the consultant will perform the following tasks:

- Estimating the volume of current consumption for each type of activity, whether industrial mining or oil activities, for each region of the Kingdom in which these activities exist.
- Since each industrial, mining or oil activity has an optimal amount of water consumption according to the type of activity and volume of production, the consultant will determine these optimal quantities for the production unit.
- Linking the quantities of consumed water to the water source, with the special use of triple treated industrial wastewater, taking into account the environmental conditions in the use of this water.
- Estimating the expected consumption for the year 2030, taking into account the expansion of activities according to the available funding and in accordance with the Kingdom's Vision 2030, and linking this consumption to the appropriate water sources for each activity.
- Tabulating data and entering it into the database in an interactive way that allows addition deletion and modification. It is suggested that there be a point of contact at each production site (water source) that reports daily data through a dedicated e-mail site at the Ministry of Environment, Water and Agriculture.

5.4 Estimating Environmental Consumption

The tender brochure indicated that the Ministry of Environment, Water and Agriculture will provide the consultant with data and sites of environmental activities such as national parksforests and afforestation sites, whether current or proposed in the future. As well as the consumed quantities of water, its sources, and the targeted environmental sites until the year 2030 AD. Accordingly, the consultant will perform the following tasks:

- Estimating the volume of current consumption and the volume of optimal consumption according to the nature of environmental activity.
- Estimating the future consumption volume for each environmental activity and the water resources that can be used for this activity in each region of the Kingdom based on the estimated optimal consumption volume.
- Coordinating with the Ministries of Environment, Water and Agriculture and Municipal and Rural Affairs with regard to the first and second tasks.
- Tabulating data and entering it into the database in an interactive way that allows addition deletion and modification.

5.5 Estimating the Amount of Renewable Groundwater

Groundwater aquifers in the Kingdom are divided into two types: the first is non-renewable (fossil) groundwater aquifers, which usually consist of deep sandy and calcareous rocks that have little natural nutrition. The aquifers are 300 meters thick and lie at depths ranging from 150 to 1500 metres. The proven, probable and possible stocks are about 259.1, 415.6 and 760.6 billion cubic meters respectively. During the period 1996-2011, large quantities were withdrawn from these reservoirs which led to a decrease in hydraulic pressures and a depletion of storage.

The second type is the renewable groundwater aquifers, where 60% of the surface runoff occurs in the western parts of the Kingdom, 40% in the southwestern coastal parts.

Large quantities of this water seep into shallow alluvial deposits from unconfined strata. This water is used so intensively that it may exceed the safe normal extraction rates.

The tender brochure indicated that the Ministry of Environment, Water and Agriculture will provide the consultant with the data of the historical records of the hydrological monitoring network, records of water levels held behind dams, hydrological studies and different studies conducted for the aquifers, and the historical record of water levels in monitoring wells. Accordingly, the consultant will perform the following tasks:

- Collecting daily rainfall data from the records of the General Authority of Meteorology and Environment for all meteorological stations in the Kingdom.
- Perform a statistical analysis of the data, including for each month the sum, the mean the standard deviation, the coefficient of variation and the skewness coefficient.
- Doing a statistical analysis of the annual data to determine the total annual rainfall as well as the annual average.
- Dividing the Kingdom into hydrological regions that have similar characteristics.
- For each hydrological region, a precipitation distribution map is drawn, which represents the annual average rainfall depth, and contour lines are drawn for depths of equal values.
- Classification of soil, rocks and vegetation cover for all regions of the Kingdom.
- Using the maps of the Geological Survey soil maps are determined.
- The leakage rates are estimated according to the types of the soil or rocks in each area, which represents the recharge to the groundwater reservoirs.
- At the sites of storage dams, and by following up the water levels in the reservoirs in front of them, the recharge rates for the underground reservoirs in the area of each dam are determined.
- Estimating annual renewable water quantities in the Kingdom until the end of the decade.

5.6 Allocation of Renwable Water

This water is generally used in agriculture landscaping, and industry. The Food and Agriculture Organization (FAO) estimated that about 547.5 million cubic meters of wastewater in the Kingdom were treated in 2002. The average daily per capita use of water is about 226 liters. 38% of the wastewater is collected for treatment. Treated and untreated water is discharged to valleys, artificial lakes, the Red Sea and the Arabian Gulf.

The tender brochure indicated that the Ministry of Environment, Water and Agriculture will provide the consultant with data on the locations and production quantities of current and future treated wastewater plants. Accordingly, the consultant will perform the following tasks:

- Determine the water quality according to the two- or three-way treatment method for each station in each city belonging to each region of the Kingdom.
- Based on this, the possible type of use is determined, whether for agriculture, industry or environmental use.
- Determining future expansions and the quantities expected to be processed, and thus determining the type of expected use in the future, whether for agriculture, industry or environmental use.
- Tabulating data and entering it into the database in an interactive way that allows addition deletion and modification.

6. Conclusion

Rmote sensing is considered as one of the most powerfull technolgy tools to classifiy and count the crops and calculate the cultivated areas. Using the integration of remote sensing with the geographing information system, the demand of water consumption for different purposes can be estimated accuratly. The Ministry of Environment, Water and Agriculture in Kingdom of Saudi Arabia has presented a project to estimate the quantities of water used for all purposes with a focus on agricultural consumption through information on the water needs of crops and calculating the cultivated areas by digital analysis of satellite visuals that cover all regions of the Kingdom with a strong impact in the national economy, which depends on irrigation with water from its various sources.

In this paper, the project in detail including the methodology and scope of work has been presented to show the application of the integration between the remote sensing and geographic information system in such projects and their powerfull use.

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