Using RS and GIS to access crop water productivity after canal improvement.

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Abstract;- The research study evaluated the cropping pattern by using special scientific tools like Remote Sensing and GIS technology, so that proper measurements could be taken for the sustainable agriculture and water management. Water is basic need for all living thing. Without water nobody can survive in this world. Efficient utilization of existing water is a pressing need. Due to rising population, reduction in present storage capacity and poor delivery efficiency of 30 to 40% from canal. A study to evaluate an irrigation system in the cotton-wheat zone of Pakistan, the study is made after the watercourse lining was conducted. The project will not only RS base for this field measurement also required for verification and correction. Several combinations of the ratio of signals received in different spectral bands were used for development of this index. Near Infrared and Thermal IR spectral bands proved to be most effective as this combination helped easy detection of cropping pattern of the study area,

Ket word;- field data, satellite images of different years.

1 Introduction

The demand for water has increased greatly, while the available amount of water is limited worldwide. The World Bank estimates that presently 80 countries of the world have been facing water shortage that poses threat to health and economy since 1990. The human use of fresh water has increased from 500 km3 per year to around 2500 km3 per year at present and consequently, at this rate, usage will become double the next 20 years [9]. However, supplies cannot cope with such a rising demand and increasing scarcities are inevitable regardless of whether change might alter rainfall patterns. There is ever increasing competition for water among agriculture, industry and domestic use. It is estimated that domestic and industrial water uses will increase by 15% of the available water resources in 2025 against the present use of 3% [7].

Most major irrigation projects worldwide employ extensive open channel conveyance systems to distribute available water supply to farmers. The conveyance systems, associated irrigation systems and the engineering works used to command the water to be used for irrigation constitute the system infrastructure. The sustainability of irrigation projects of this type depends to a great extent on the ability of the conveyance system to economically satisfy farm water needs and to ensure maximum utilization of water commanded for irrigation purposes.

Agriculture contributed 25 percent of the Gross National Product (GNP) in 2000- 001 and accounted for more than 60 percent of foreign exchange earnings that has been reduced to 19.4 percent in 2006-07. About 68 percent of the rural population depends on agriculture, as it employs over 46 percent of the labour force. Within the agricultural sector, the contribution from crop production is about 52 percent while livestock contributes almost 44 percent. The principal crops include wheat, maize, rice, cotton, sugarcane, oilseeds, fruits, vegetables and pulses. There have been noteworthy improvements in productivity of some commodities like wheat, cotton and sugarcane during the last three decades [1]

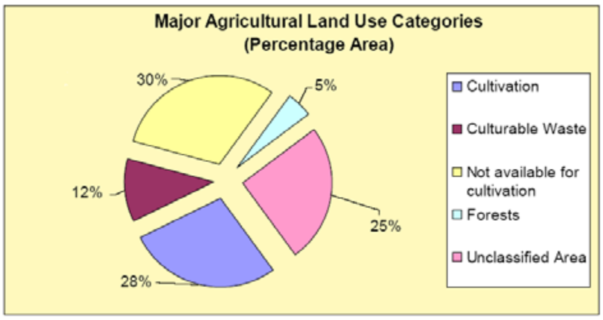

Fig.1 Agricultural land use of Pakistan [2]

Canal irrigation system of the country operates on a continuous flow basis. Water is allocated to canals and watercourses in fixed proportion on the basis of cultivable commanded area. Within a watercourse command, it is distributed amongst the farmers on a fixed turn system. [4.5]Each farmer, during his turn is allotted a specific time period in proportion of his land holding, with usually ranges from 15 to 22 minutes per 0.4 hectare depending on the mogha discharge. Thus an average farmer having 1.619 to 2.02 hectares of land gets water only for 1 to 1.5 hrs during his turn. In this allocated turn time, farmer is able to cover a small area of 0.4 to 0.5 hectare or even less. Water is considered a limiting factor for crop production in the country. Moreover field application efficiency prevailing in conventional flood irrigation method is very low because the fields are not properly levelled and their size is not in relation with stream size. Therefore Pakistan advance irrigation technique in order to increasing its application efficiencies. The new technologies like GIS doted in other countries to raise their agriculture production. GIS is a computer software which is apply to many fields agriculture is one of them using filed data and images it can be help us to manage all problems.

1.1 Problem Identification

The irrigation system of Pakistan, was primarily designed for cropping intensity of about 70 percent, is currently unable to meet food requirement of growing population. The semi-arid to arid climate and inadequate water resources make no irrigated agriculture almost impossible irrigated land; which accounts for 76 percent of total agriculture land and more than 90 percent of the value of agriculture production. Increasing demand for food to crop with ever increasing population has caused the annual cropping intensities to rise to about 150 percent. Since 1980s, increase in irrigated area has come from groundwater; the area irrigated by canals has reminded almost unchanged. Since the development of water resources is approaching its limit and there is a little potential for further increase in irrigated area, because of our government policies, the only option left is the sustainable management of existing land and water resources.

In order to study the impact of multiple activities carrying out simultaneously, there is a need to develop a model, which can quantify the response of groundwater system to change in surface water management options (irrigation and or agriculture) and/or groundwater pumping so that proper measure could be adopted for the sustainable management of surface and groundwater resources. This research is planned to develop a scientific tool (computer model) to evaluate the impact of different management option on the surface resources. GIS and Remote sensing (RS) are the computer model that use in this study.

2 Methods and techniques used

2.1.1 Geographical location

The study was conducted at Mungi bangla of Tehsil Gojra, District Toba Takh Singh, Punjab province of Pakistan. It is located between 30°33' to 31°2' N latitudes and 72°08' to 72°48' E longitudes, as shown in Fig. 2.

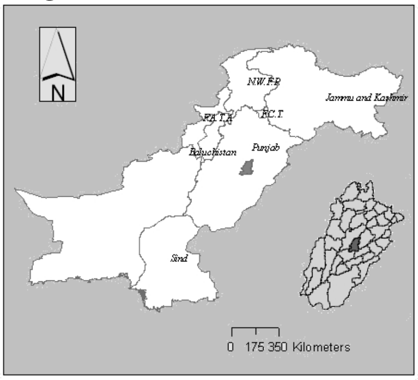

Fig 2. Geographic location of study area

2.1.2 Climate

The climate of Mungi Bangla touches two extremes. The maximum temperature in summer reaches up to 50°C. In winter, it may, sometimes fall below the freezing point at night. The summer season starts from April and continues till October. May, June and July are the hottest months. The winter season, starts from November and continues till March. December, January and February are the coldest months.

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2.1.3 Topography
The topography of the study area is relatively flat, with a land surface gradient ranging from about 0.25m-km-1 in the North and North-East to less than 0.2m-km-1 to the South and South-West. The study area is situated at 183 m above sea level ASP 2004).

2.1.4 Vegetation and land use
Almost all the area has been cleared of its natural vegetation with the commencement of canal irrigation. Only a few uncultured patches bear remnants of the original vegetation and provide indication to the previous natural flora of the area.

2.1.5 Analysis Framework
The analysis framework of the study is shown by the flow chart in fig.3. Before and after the watercourse lining the following procedure follow for the analysis..[5]

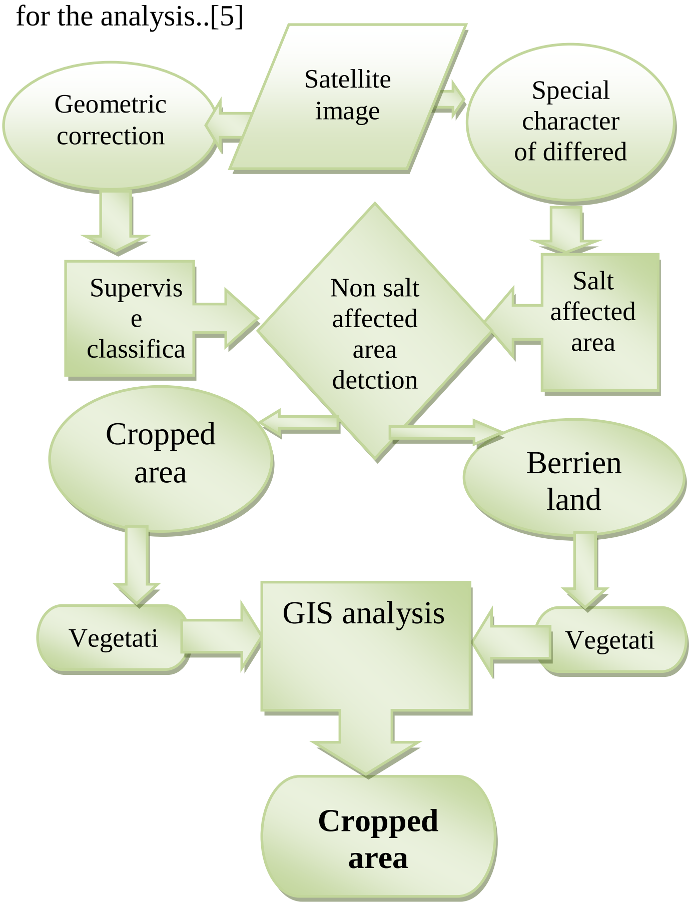

Fig.3 GIS analysis.

2.2 Satellite imagery
Landsat ETM+ satellite image of year 1992, 2000, and 2005 were acquired to delineate the salt affected soils, cropping pattern and for the performance evaluation of the study area. The selected date for the image was based on the availability of image and surface salinity status. In these months the surface salinity was visible at the surface.

2.3 Satellite Data Analysis
Using the temporal growth pattern of the various crop types in the command area, hierarchical classification approach was followed to classify the scene into various land cover classes. Soil Adjacent Vegetation Index (SAVI), as defined by [3], was calculated for each crop pixel as given in .

$$SAVI = \frac{NIR - R}{NIR + R + L}(1 + L)$$

Where R and NIR is reflectance in Red and Near Infrared wavelength regions and L an adjustment factor to minimize soil brightness influence. Although, [3] found that the optimal adjustment factor varies with vegetation density. Heused a constant L. [3] suggested a value of 0.5 for annual field crop. Therefore this value was use for present study. The Digital Number (DN) values from the sensor were converted into radiance using saturation radiance information and then to appear using solar spectral irradiance and zenith angle information [8].

2.4 Delineation of Cropped Area
The Normalized Difference Vegetation Index (NDVI) is use to find out the crop area from the satellite imagery. This is most commonly used index for satellite imagery. The difference in reflectance is divided by the sum of two reflectance. This compensates for different amounts of incoming light and produces a number between 0 and 1. The typical ranges of actual values are about 0.1 for barren soils to 0.9 for dense vegetation. NDVI is thought to be more sensitive to low level of vegetation cover, while the RVI is more sensitive vegetation in dense canopies. Digital data was used for crop acreage estimation of selected distributions. Crop acreage was estimated using a supervised classification approach with the ground truth data, collected from the field visits. Crop condition assessment was done by computing the NDVI values of crop pixel as given in eq.2:

$$NDVI = \frac{NIR - R}{NIR + R}$$

3 Results and Discussions

The NDVI of area provides the health of plant

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on the basis of their response towards ET. It can be concluded that how much area is under healthy vegetation and same is the case with MSI which provides the clear look of stressed vegetation . The results of cropping pattern significant reflection in thermal IR band, minimum in Near Infrared band for all three year those are under find out according to the NDVI value the maps are given in fig. 4.

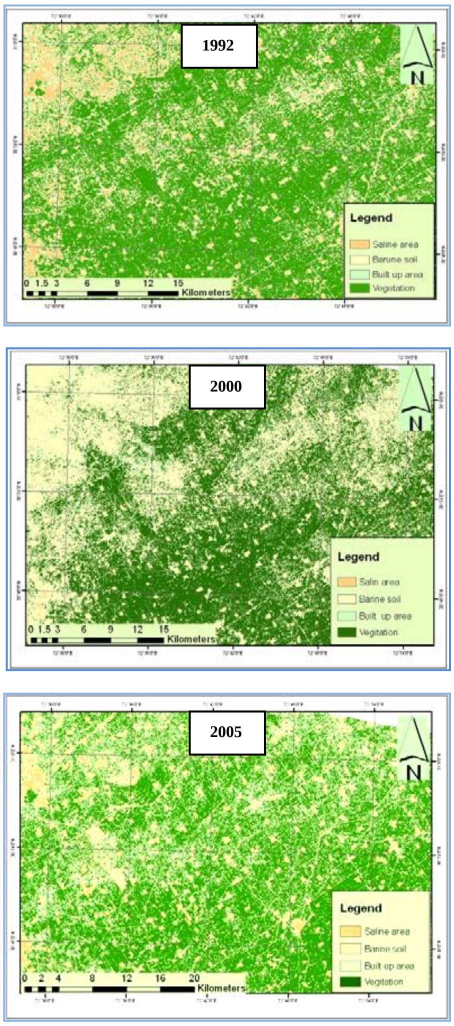

Fig 4 Cropping pattern maps

From the analysis it is shows that the cropping pattern is increase 20. In 1992 the 543. 54154km^2 area was covered by vegetation in 2000 it was 676 . 5399km^2 while in 2005 in increase 20% and area cover is 781 .8354km^2 . The total area study was 1191 .4641km^2.as shown in fig 5and table 1.

Table 1 Percentage increas in area

Group	Percentage increase for the year 2005
Built up area	14%
vegetation	20%

In the fig.5 series one shows the total area cover in the year 2005 by different land group (saline area, Built up area, Vegetation, Barren land), series 2 for the area covered in year 2000 and series 3 for the area covered in the year 1992. From the graph it is conducted that the cropping pattern is increase. In 1992 the 543.54154km2 area was covered by vegetation while in 2005 it increase to 781.8354km2. Table 1 shows the percentage increase in area.

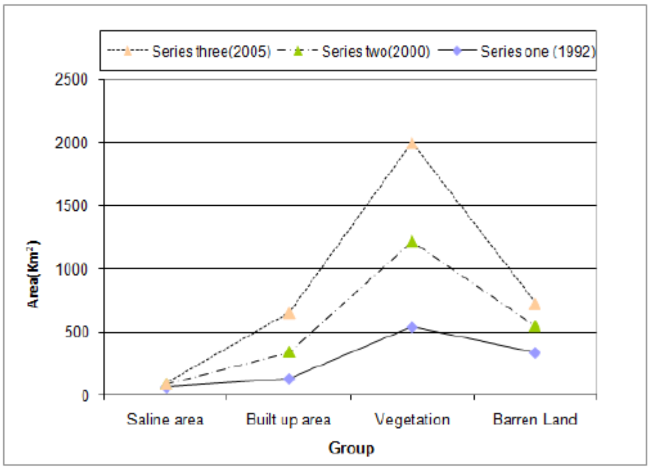

Fig 5 Change in vegetation area

4 Conclusions

At the tail end the vegetation growth is less than that in middle side of the canal embankment. After the lining of canal more vegetation in year 2005 as shown by maps in fig 4. More water more and healthy crop.]

The present performance analysis showed that RS-based performance indicators could identify the problem at its distributaries in the Mungi which is an intensively managed and studied irrigation system. The performance evaluation has shown the discrepancies and relative ranking of the distributaries vis-à-vis crop water requirements.[6]

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