GIS approach in Urban Growth Assessment on Groundwater Tanneries

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ABSTRACT

India is one among the country of low level of urbanization. In the last sixty years, the population of India has grown two-and-a-half times, but urban India has grown nearly five times. In 2015, 466.9 million Indians (42.5%) were living in nearly 4200 towns and cities spread across the country, and it is expected to increase to over 450 million and 633 million by 2020 and 2030 respectively. Most urban settlements are characterized by shortfalls in housing and water supply, urban encroachments in fringe area, inadequate sewerage, traffic congestion, pollution, poverty and social unrest making urban governance a difficult task. The high rate of urban population growth is a cause of concern among India's urban and town planners for efficient urban planning. There are increasingly widespread indications of degradation in the quality and quantity of groundwater, serious or incipient, caused by excessive exploitation and/or inadequate pollution control. The scale and degree of degradation varies significantly with the susceptibility of local aquifers to exploitation–related deterioration and their vulnerability to pollution. This project is based on the investigation or review of the situation in a substantial number of developing cities worldwide. It aims to raise the awareness among policymakers of hydro-geological processes in urban areas, to highlight key urban groundwater issues, to provide a framework for the systematic consideration of the groundwater dimension in urban management, and to formulate approaches for more sustainable management of groundwater resources in urban areas using remote sensing method.Urbanization on account of demographic and economic growth leads to the wide variety of environmental problems. The supply of infrastructure cannot cope with the demand placed by urban development. It results inadequacy of urban infrastructure, which leads to degradation of the quality of natural resources such as air, water, land, vegetation, marine life. The present study is aimed to analyze the growth of urban development and its impact on ground water. To analyze the growth of towns near Vijaywada and its impact on ground water quality remote sensing techniques were used. For the assessment of ground water quality impact samples were taken in and around the town and analyses further. The results indicated that the samples nearer to the tanneries were exceeding the limits.

KEYWORDS: Land-use, Urban sprawl, land-cover change, Changedetection, geographic information system,

I.INTRODUCTION

Planning is a widely accepted way to handle complex problems of resources allocation and decision-making. It involves the use of collective. intelligence and foresight to chart direction, order harmony and make progress in public activity relating to human There is no universal definition for urban, it various from country to country.

Water pollution is a serious problem in India as almost 75% of its surface water resources and a growing number of its groundwater reserves arealready contaminated by biological, toxic organic andinorganic pollutants. Groundwater plays a fundamental role in shaping the economic and social health of many urban areas in the developing world.

Urbanization is a process of villages to be developed into towns and further into cities and so on. There is no universally accepted definition of urban settlement. Different countries adopt different criteria for defining the urban settlement. Urban places are not even similar in character.

Urbanization and modern civilization go together for in developing stage due to increasing economic specialization and advancing technology. The simplest and most common definition of urbanization is "Proportion of population living in urban settlement to total population".

Geographers have studied urbanization as a process of concentration of population in larger humansettlement either through multiplication or concentrated. However, urbanization is not merely a demographic phenomenon. It has its economic and other concomitant at the same time. It is a special concomitant phenomenon involving the complex process of change involving population.Improved management of urban groundwater resources is urgently needed to mitigate actual and potential derogation caused by excessive exploitation and inadequate pollution control. Unless groundwater is protected, in terms of both quantity and quality, there will be increased scarcity of water supply and escalating water supply costs with potential impacts on human health. Many industries require good quality and high reliability of water supply that if not available may cause them to locate elsewhere, thereby causing economic stagnation.

II.GROUNDWATER

Water is a renewable resource occurs in three forms viz., liquid, solid, vapour (gaseous), all these three forms of water are extremely useful to man. No life can exist without water. Since, water is an essential for life as like that of air, it has been estimated that in the human body two-third portion is constituted by water. The water is not only essential for survival of human beings, but also for animals, plants and other living beings.

2.1 TYPES OF GROUNDWATER DEGRADATION PROBLEMS

Thus, in a highly fractured aquifer where groundwater flow is easy and relatively rapid, contamination may become more widely dispersed in a given time than where flow is inter-granular, especially if the strata have only a modest permeability. Important issues when considering degradation are the use of water, the availability of alternative sources and the scale of impact on different users.

Degradation of groundwater often affects the poor most, as they are least able to afford alternative water supplies or to cope with changes in livelihood that deterioration may force upon them.

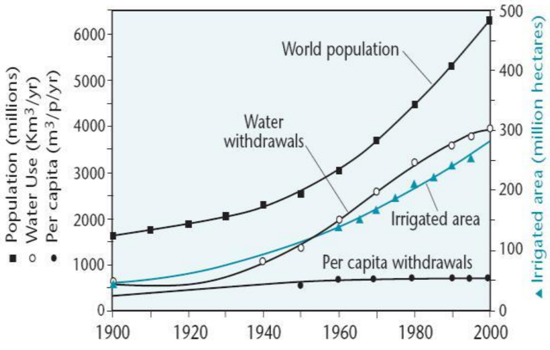

Fig 2.1 Global trends in water use (modified from Gleick, 1998)

2.1 GLOBAL WATER ISSUES THAT AFFECT GROUNDWATER

Some global trends affect all of Earth's freshwater reserves. Perhaps the three most far-reaching in terms of resource sustainability are those of salinization, trends in withdrawals and climate change.

- *Salinization*Salinity is the major threat to aquifersustainability because it does not reduce naturally, and salinized groundwater can only be made fit for purpose by energy-intensive desalination or by dilution. Salinization can occur as a result of poor irrigation practice in agricultural areas, and as a result of over-abstraction inducing saline intrusion.

The latter occurs usually, but not exclusively, in coastal aquifers. Mixing with just 3 to 4 per cent sea water (or groundwater of equivalent salinity) will render fresh groundwater unfit for many uses, and once this rises to 6 per cent the water is unfit for any purpose other than cooling and flushing. Once salinized, aquifers are slow to recover. In intergranular-flow aquifers, the enormous volumes of water in storage have to be displaced, and in some fracture-flow systems where the matrix is also porous, it is difficult to drain relatively immobile water that has entered by diffusion from the fracture network.

- *Global trends in withdrawals* Freshwater usecontinues to rise, often at the expense of environmental requirements for the maintenance of ecological diversity. Although separate global figures are not available for groundwater trends, Figure 3 shows a six-fold rise in the total freshwater use between 1900 and 2000, which is not simply related to the increase in global population, as per capita withdrawals during this period only increased by about 50 per cent. Rather, it is the increase in irrigated area and to a lesser extent the growing need for water for industrial uses and power plant cooling that has increased demand.

- *Climate change* Climate change in the 21stcenturywill influence the sustainable management of all Earth's water resources including groundwater. The effects of climate change are likely to be far reaching and in general more severe the faster the rate of change.

III.ROLE OF REMOTE SENSING ANDGIS

The pace and scope of development in most of the small island states have increased significantly in recent times, which is resulting in both visible and subtle changes in their landscapes. The common major concerns are: depletion of natural (forest, groundwater, mineral, etc.) and fishery resources, degradation of natural inland and coastal ecosystems, coastal erosion, safe disposal of liquid and solid wastes, land abuse, soil loss, increasing population density, etc.

Integrated approach using Geographic Information System provide cost effective support in resources inventory including land use mapping, comprehensive database for resources, analytical tools for decision making and impact analysis for plan evaluation.

GIS accept large volumes of spatial data derived from a variety of sources and effectively store, retrieve, manipulate. Analyze and display all forms of geographically referenced information. Maps andstatistical data can be obtained from the spatial integration and analysis of an area using GIS software's.

IRS 1D LISS III imagery in hard copy has beenused for the interpretation of Geology, Geomorphology, land use / land cover and lineaments on IRS 1D satellite data has clearly shown thepresence of geomorphologic and landform characteristics of the study area.

3.1 TYPES OF DATA PRODUCT:

The remotely sensed data products are available to the users in the form of (a) photographic products such as proper prints, film negatives, dia-positives of black and white and false color composite in a variety of scales and (b) digital form as computer compatible tape (CCT), CD etc, after necessary corrections.

3.2 REMOTE SENSING APPLICATIONS:

a. Geology and geomorphology mapping: geology has a long history of remote sensing application and its useful in
b. Preparation of large-scale reconnaissance maps of unmapped, inaccessible areas
c. Updating the existing geological maps
d. Rapid preparation of lineament and tectonic maps.
e. Identifying features favorable for mineral localization etc.

IV.PROFILE DETAILS

4.1 CREDIBILITY OF GIS

Geographic Information System is defined as an organized collection of computer hardware, software, geographic data, and trained personnel designed to efficiently capture, store, update, manipulate, analyze and retrieve all forms of geographically referenced information.

Two very important aspect which characterize GIS are (Burrough, 1982)

1. Defining the absolute location of earth feature over a coordinate system like latitude/longitude and
2. Ability to relate the geographic information (like X, Y & Z coordinates) information thatdescribe a feature.

General:

- Graphy: Indicates a process of writing so Geography means writing about earth.

Information:

- Refers well arranged data of particular object for decision making.

Systems:

This equation considers only one aquifer system and thus does not account for the interflows between the aquifers in a multi-aquifer system. However, if sufficient data related to water table and piezometric head fluctuations and conductivity of intervening layers are available, the additional terms for these interflows can be included in the governing equation. All elements of the water balance equation are computed using independent methods wherever possible.

4.2 STUDY AREA

The study area is located at 10° 18' to 10° 25' N latitude and 77° 56'to 78° 01' E longitude, covering an area of 14.01 km2. There are about 80 tanneries spread within the four to 6 km radius in the south western part of the Gudavalli town, TamilNadu, South India. About 50% of the tanneries have been in existence for 30 to 40 years .

Gudavalli district was carved out of the composite Madurai District on 15.9.1985 and the first District Collector was Thiru.M.MadhavanNambiar, I.A.S. Gudavalli District had the names of GudavalliAnna , Quaid-e-Milleth and MannarThirumalai. Gudavalli, which was under the rule ofthe famous Muslim Monarch, Tippusultan, has a glorious past. The historical Rock Fort of this district was constructed by the famous Naik King MuthukrishnappaNaicker. It is located between 10005" and 100 9" North Latitude and 77030" and 78020" East Longitude.It is spread over on area of 6266.64 Sq. Km. It comprises of 3 Revenue Divisions, 8 Taluks and 14 Panchayat Unions, According to 2001 Census, its population is 19,23,014

Fig 4.1 Gudavalli District Map

V. REMOTE SENSING SOFTWAREAND SYSTEMS USED

The primary data source is the town map of Gudavalli town for the year 1981, 1991 and 2001 and ground water sample data collected from the field. The town map in the scale of 1:5000 was scanned and georeferenced using the latitude and longitudinal values and visually interpreted using the dataset in the map and projected as geographic wgs84 and datum wgs84.

For that line and polygon coverage were created and also errors were rectified using clean and build options. The cleaned coverage was further labeled by giving ids. Arc Remote sensing 9 software used for visual interpretation and layouts were prepared using Arc map 9 developed by ESRI. For the impact analysis of groundwater due to tanneries 21 samples were taken in and around the town using handheld gps and it was tested in the TWAD board laboratory and average mean values were taken for the final analysis.

Remote sensing is the acquisition of information about an object or phenomenon without making physical contact with the object. In modern usage, the term generally refers to the use of aerial sensor technologies to detect and classify objects on Earth

Passive sensors detect natural radiation that is emitted or reflected by the object or surrounding areas. Reflected sunlight is the most common source of radiation measured by passive sensors. Examples of

passive remote sensors include film photography, infrared, charge, and radiometers. Active collection, on the other hand, emits energy in order to scan objects and areas whereupon a sensor then detects and measures the radiation that is reflected or backscattered from the target.

5.1 DATA PROCESSING:

Generally speaking, remote sensing works on the principle of the inverse problem. While the object or phenomenon of interest (the state) may not be directly measured, there exists some other variable that can be detected and measured (the observation), which may be related to the object of interest through the use of a data-derived computer model. The common analogy given to describe this is trying to determine the type of animal from its footprints. For example, while it is impossible to directly measure temperatures in the upper atmosphere, it is possible to measure the spectral emissions from a known chemical species (such as carbon dioxide) in that region.

SPATIAL RESOLUTION
The size of a pixel that is recorded in a rasterimage – typically pixels may correspond to square areas ranging in side length from 1 to 1,000 metres (3.3 to 3,300 ft).

SPECTRAL RESOLUTION
The wavelength width of the different frequency bands recorded – usually, this is related to the number of frequency bands recorded by the platform. Current Land sat collection is that of seven bands, including several in the infra-red spectrum, ranging from a spectral resolution of 0.07 to 2.1 μm. The Hyperion sensor on Earth Observing-1 resolves 220 bands from 0.4 to 2.5 μm, with a spectral resolution of 0.10 to 0.11 μm per band.

RADIOMETRIC RESOLUTION
The number of different intensities of radiation the sensor is able to distinguish. Typically, this ranges from 8 to 14 bits, corresponding to 256 levels of the gray scale and up to 16,384 intensities or "shades" of colour, in each band. It also depends on the instrument noise.

TEMPORAL RESOLUTION
The frequency of flyovers by the satellite or plane, and is only relevant in time-series studies or those requiring an averaged or mosaic image as in deforesting monitoring.

RADIOMETRIC CORRECTION
Gives a scale to the pixel values, e. g. the monochromatic scale of 0 to 255 will be converted to actual radiance values.

TOPOGRAPHIC CORRECTION (ALSO CALLED TERRAIN CORRECTION)
In the rugged mountains, as a result of terrain, each pixel which receives the effective illuminationvaries considerably different. In remote sensing image, the pixel on the shady slope receives weak illumination and has a low radiance value; in contrast, the pixel on the sunny slope receives strong illumination and has a high radiance value.

ATMOSPHERIC CORRECTION
Eliminates atmospheric haze by rescaling each frequency band so that its minimum value (usually realized in water bodies) corresponds to a pixel value of 0. The digitizing of data also make possible to manipulate the data by changing gray-scale values.

DATA REQUIREMENT:
The data required for carrying out the ground water balance study can be enumerated as follows:

1. Rainfall data:
   - Monthly rainfall data of sufficient number of stations lying within or around the study area should be available.
   - The location of rain gauges should be marked on a map.

2. Land use data and cropping patterns
   - Land use data are required for estimating the evapo-transpiration losses from the water table through forested area.
   - Crop data are necessary for estimating the spatial and temporal distributions of the ground water withdrawals and canal releases, if required.
   - Evapo-transpiration data and monthly pan evaporation rates should also be available at few locations for estimation of consumptive use requirements of different crops.

3. River data:
   - River data are required for estimating the interflows between the aquifer and hydraulically connected rivers.
   - The data required for these computations are the river gauge data, monthly flows and the river cross-sections at a few locations.

4. Canal data:
   - Month wise releases into the canal and its distributaries along with running days each month will be required.
   - To account for the seepage losses, the seepage loss test data will be required in different canal reaches and distributaries.

VI.REMOTE SENSING INTERNSHIPS

One effective way to teach students the many applications of remote sensing is through an internship opportunity. NASA DEVELOP is one such opportunity, where students work in teams with science advisor(s) and/or partner(s) to meet some practical need in the community. Working through NASA, this program gives students experience in real-world remote sensing applications, as well as providing valuable training. (More information can be found on the NASA DEVELOP website.
Another such program is SERVIR. Supporting by the US Agency of International Development

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(USAID) and NASA, SERVIR provides students with valuable hands-on experience with remote sensing, while providing end-users with the resources to better respond to a whole host of issues. More information can be found on the SERVIR

6.1 LANDUSE PATTERN OF GUDAVALLI TOWN: Landuse depends upon the nature of the land, purpose of the usage and technological know-how and management.

Table 6.1 Pattern of Gudavalli Town

Sl. No	Landuse	Area in ha	%to the total developed area	% to the town area
1.	Residential	486.72	63.60	34.74
2.	Commercial	24.65	3.22	1.76
3.	Industrial	50.07	6.54	3.57
4.	Educational	30.05	4.71	2.57
5.	Public & Semi Public	55.32	7.23	3.95
6.	Roadways &Railways	112.44	14.70	8.03
7.	Non – urban area	242.44	-	17.27
8.	Vacant	322.60	-	23.04
9.	Land under water	43.10	-	3.07
10.	Hillock	28.00	-	2.00
	Total	1401.00	100.00	100.00

Source: Town Planning Office, Dindigul

6.2 POPULATION GROWTH OF THE TOWN:

The population has grown from 25,132 in 1901 to 1, 96,619 in 2001. Population in each Table 6.2 Population growth 1901 -2001

Total area of the town is about 1401 hectares (Table.1). decade with decadal growth rate is show in the Table 2. The town has its highest decadal growth rate of 41.05 % between 1921 to 1931 and the lowest growth rate of 11.20 % between 1981 to 1991.There is a gradual decrease in growth rate after 1971 this may be due to exodus of population to other major cities mainly for economic opportunities. The central part of the town has the highest growth rate.

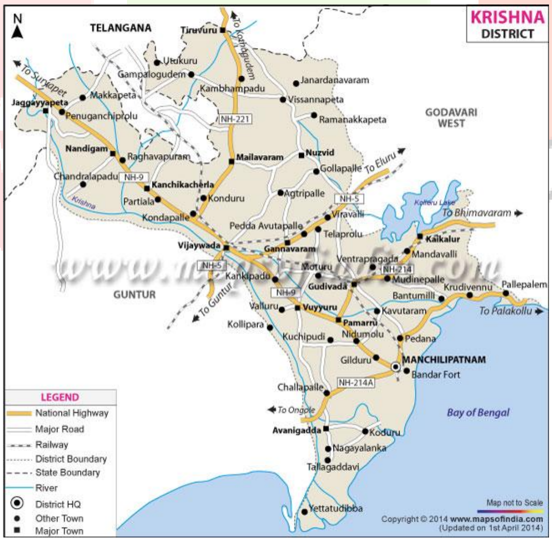

Fig 7.1 Location of the Samples

VIII.CONCLUSION

Gudavalli town has not been having physical expansion since 1993. Only wards are increased by enjoying the rapid growth of population. Town is having moderate literacy rate. Male working population is high. Slums are increasing tremendously because of the low-income group.

There are about 80 tanneries spread within 4-6 kms radius in the south western part of the town. According to the ground water sample analysis, school ground water pollution is very high compared to other places.

Neighboring villages having high pollution because it is a low class residential area and also slums are more. Improper maintenance and household wastage also larger in nature. In future work various thematic maps has derived out and conclude the real application of the tanneries and where it should construct with help of remote sensing technology.

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