Impact of coastal salinity ingression essay

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Climate change can have many impacts upon human societies. The impacts will vary from region to region. These impacts include sea-level rise, melting of mountain glaciers, floods, droughts, changes in storm intensities, changes in biological variables that have impacts upon human societies. This paper is however concerned with the ‘ impact of sea level rise’ causing ‘ salinity ingression’ in Bhavnagar Taluka; a part of Gulf of Cambay, Gujarat. Over last two and a half decades, a process of rapid sea water ingress (at some places as deep as 10–15 km. from the seacoast) is observed along the coastal belt of Gujarat.

The major objective was to study the decadal changes in salt affected lands as well as agricultural lands. The change in High Tide Line along the study area was also studied using the same datasets of two periods. The resulted salinity ingress in the study area is mainly due to the large scale ground water extraction for agriculture as well as industrial purposes combined with intensive mining activity. Remote sensing data can be used in the objectives concerned with the monitoring changes in surface phenomena over time.

In this study IRS LISS III data representing two different tidal conditions of the period 2000-2010 were used to compute and analyze the salinity ingression over a decade. The results indicate that there has been an increase in the ingress of sea water into the agricultural fields. This is one of the strong reasons of increasing soil salinity of coastal areas along the Bhavnagar Taluka. At some places in the study area it was also found that salinity is increasing not only because of natural causes but there is a big human intervention in it, the prohibition of which is necessary for long term coastal resource management. This sort of study could help in the

monitoring of sea ingress and impact of salinity in an area over the successive periods.

The word salinity can be described as the saltiness i. e. the dissolved salt content of any water body. It includes levels of different salts such as sodium chloride, magnesium and calcium sulfates, potassium sulfate and bicarbonates. In oceanography, it has been traditional to express salinity not as percent, but as parts per thousand (‰), which is approximately grams of salt per kilogram of solution; other disciplines use chemical analyses of solutions, and thus salinity is frequently reported in mg/L or ppm i. e. parts per million. The typical seawater has a salinity of 35 ppt or 35‰. The average density of seawater at the surface is 1. 025g/ml. Seawater is denser than freshwater because of the added weight of the salts (Source: Wikipedia). Salinity in ground water can be broadly categorized into two types, i. e. (a) Inland Salinity and (b) Coastal salinity. (a) Inland salinity in ground water is prevalent mainly in the arid and semi arid regions caused mainly due to practice of surface water irrigation without consideration of ground water status. (b) Coastal salinity is mainly caused by individual or combined effects of inherent salinity, tidal effect, irrigation by saltwater and by seawater intrusion due to flooding and extensive pumping.

Salinity ingress has been a typical environmental issue seen largely in coastal region of maritime nations. India is no exception to this. This problem has conspicuously been seen in the Upper Western Coastal Region (UWCR) of India. For long, salinity ingress has been a curse in Gujarat. Central Ground Water Board (CGWB) has carried out extensive studies which indicate that intrusion of sea water would continue because of over-

exploitation of ground-water for drinking and agriculture purposes. Farmers in saline areas survive with rain-fed agriculture, growing ‘ jowar’ and horticulture crops like chickoo and coconut.

For more than 10 million people living along the coastline of Gujarat, growing salinity in water and land resources constitute a very real threat to their livelihoods. Problem of salinity ingress is being faced by Gujarat along Saurashtra and Kachchh coast for coastline of approximately 1125 kms. The problem is severe along Una-Madhavpur stretch of Saurashtra and Maliya – Lakhpat stretch of Kachchh Region. In these stretches in select tracts intensive agricultural development and exploitation of ground water and poor recharge from upland areas has resulted into sea water ingress even up to 5 to 6 Km inland causing salinity.

The phenomenon of salinity ingress has adversely affected the lives of people, both on agricultural front and drinking water front. Approximately 10. 80 lakh of people of 534 villages are badly affected by salinity. 700120 ha of cultivable land has become useless and about 32750 nos. of wells have gone dry (guj- nwrws. gujarat. gov. in/downloads/ water_related_issues. pdf). Agriculture productivity and soil fertility has reduced considerably due to the increased salt content in the soil. Due to the disruption of primary livelihood of agriculture, the per capita income has also gone down drastically. Due to the adverse impact on the ground water levels, farmers have been forced to change their cropping pattern taking two crops instead of the three that they used to take. Crop rotation also became difficult due to the decrease in the number of options. Besides this it has reduced availability of fodder for the animals.

A principal concern of coastal zone management is to ensure a rational development of area and judicious use of its resources which is consistent with the surrounding natural systems and environment. Thus, environmentally effective coastal zone management depends on accurate and comprehensive scientific data on which policy decisions can be based. All these can be achieved only through the collection of accurate, reliable and comprehensive set of scientific data. Remote sensing technology in recent years has proved to be of great importance in acquiring data for effective resources management and hence could also be applied to coastal environment monitoring and management (Ramachandran, 1993, Ramachandran et. al., 1997, 1998).

Further, the application of GIS (Geographical Information System) in analyzing the trends and estimating the changes that have occurred in different themes helps in management decision making process. Therefore the coastal environment, ports, harbors and other coastal activities require active management if they are to remain productive and successful over the long term. Coastal zone management is thus immensely important for the sustainable use, development and protection of the coastal and marine areas and other resources.

Bhavangar taluka situated to the west of Gulf of Khambhat (Cambay) has been selected as the study area for this project work as this area has been under the major threat of salinity ingress for a long time. Bhavnagar Taluka is a part of Saurashtra peninsula, in central part of Gujarat, and is situated in Bhavnagar district which is spread between 21°28′ and 21°46’ of northern latitude and 72°05′ and 72°09’ of eastern longitude. Bhavnagar is 228 km

away from state capital Gandhinagar and to the west of Gulf of Khambhat. It is currently the administrative headquarters of the Bhavnagar District. It is the fifth-largest city of Gujarat, and the second-largest city in the Saurashtra region. Bhavnagar is also known as the cultural capital of Saurashtra.

IRS 1D LISS III data of the period 2000-2010 was used to study the salinity ingress in Bhavnagar Taluka. CATOSAT data of three sample villages i. e. Ganeshgadh, Sanes and Narabd of Bhavnagar taluka was also used for the analysis of soil properties of the study area. “ Soil Health Cards” were used as an ancillary data for three sample villages; to determine the soil properties of the study area.

Image geo-referencing and subset of study area: The software ENVY 4. 5 was used to geo-reference the two sets of digital images (LISS III; 2000 and 2010) from the master image (georeferenced image). To accomplish the transformation from latitude and longitude coordinates on the scanned photographs to X and Y coordinates on a map, a suitable map projection has to be established. In the present study, the Transverse Mercator projection was used, along with the World Geodetic System 1984 (WGS 1984) datum. After the georeferencing, subset of the study area from the images (2000, 2010) was extracted and the subset images were linearly enhanced.

Superimposition of cadastral boundaries: After the subset and enhancement of the image the cadastral boundaries of Bhavnagar Taluka and three villages of Bhavnagar Taluka namely Ganeshgadh, Sanes and Narbad (prepared by BISAG) were superimposed on the image in the Arc GIS 9. 2 software.

Superimposition of soil health card information on cadastral boundaries of three sample villages in terms of Nitrogen, Potassium, Phosphorus, pH and EC status: Soil health plays a vital role to ensure Agricultural production in a sustainable manner. The result of the soil analysis is communicated to the respective farmers in the shape of soil Health card. The “ Soil Health Card scheme” was launched by the Gujarat government in November 2003 to increase the agricultural productivity and crop quality. This unique card would benefit 37 lakh farmers in the state and help them in taking major decisions about the crop and fertilizers suitable for their land.

Supervise Classification: The satellite images (2000 and 2010) of selected study area have been classified into land use-land cover classes. Initially unsupervised classification was performed to have an idea about the distribution of various classes. Afterwards, supervised classification was done by using training sites. The quantification of the various classes in two different time periods i. e. 2000 and 2010 was done and plotted as shown in histograms. Area under each class is estimated and shown in the table. And also the maps showing the change were prepared.

Accuracy assessment by the preparation of thematic layers: According to the requirement of the study, various thematic layers of land use-land cover (level II classification) namely; coastal wetlands, agriculture (cropland, fallow land), wasteland (salt-affected land, land with scrub, land without scrub), water body (reservoirs), built-up (urban, rural), Forest, sea and others (including prosophis and quarry) were prepared from LISS III data (2000 and 2010 respectively) in the Arc GIS 9. 2 software. After then the area quantification of the various classes in two different time periods i. e. 2000

and 2010 was done and maps showing the change were prepared in GIS environment.

High Tide Line Change detection: The HTL data of 2000 and 2010 (acquired from BISAG) was collected and these two linear vector themes of two different years were overlaid in ArcGIS 9. 2 software, the lines intersected in some areas and form polygons. The two overlaid line themes were then merged using ‘ Geoprocessing Wizard’. After that the shapefiles were converted into coverages using ArcTool. Thereafter all coverages were cleaned using ArcTool. After cleaning the merged coverages formed polygons and their areas were computed automatically. After that the map showing the change in HTL of two different years were prepared.