BLOCKAGE OF NATURAL DRAINS DUE TO URBANISATION AND ITS AFTERFITS

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ABSTRACT :

With the 2005 heavy rainfall in western region of India, Gujarat state was worst effected part of the country. The city Vadodara 110 km south-east of Ahmedabad, Gujarat's main city has experienced a flash flood situation with most part of the city flooded due to the worst hit heavy rainfall. With overflowing major water bodies in the region authorities has to released a heavy water in the river that flows from middle of the city. HEAVY rain and the release of water caused havoc in Vadodara. With Government - Non Government Agencies and Indian army working round the clock water from most part of the city resided in less than 12 hours. However, the situation was far from normal in north west part of the city, this area was still inundated in knee deep waters. These areas remained waterlogged despite Vadodara not receiving any rain for 48 hours. Major reason of this as said by local people and news agencies is Bhukhi drain that was flowing from this part of city. With this study an approach has been made to access the deviation of Bukhi drain with time. Along with ground truth studies remote sensing data is used to know the changes in this area over the selected time period. The study shows how natural disasters enhances due to improper planning of resources and gives importance of consideration of natural water bodies in any town-planning scheme as the same situation may be faced in all developing cities.

INTRODUCTION

Water is part of a larger ecological system, a prime natural resource, a basic human need. The civilizations have grown on the banks of perennial rivers all over the world. As we know a major river is a third or fourth order drain fed by many first and second order tributaries. Population is increasing at exponential rate almost all over the world with urban areas growing even faster than the rural areas. Even though the rate of urbanisation in India is among the lowest in the world, growth of urban population in India has been extremely rapid during the course of this century. While the total population of India has grown by 3.5 times from 1901 to 1991, its urban population has increased by approximately 9 times over the same period. Well being of the urban areas is very important, as they contribute to nearly 55% of the GDP of India and this share is expected to rise further in the coming years. Water is a scarce and precious national resource to be planned, developed, conserved and managed on an integrated and environmentally sound basis, keeping in view the socio-economic aspects and needs of the area. Availability of water is highly uneven in both space and time. In Indian subcontinent precipitation is confined to only about three or four months in a year and varies from 100 mm in the western parts of Rajasthan to over 10000 mm at Eastern ghats of Meghalaya. Floods and droughts affect vast areas of the country, transcending state boundaries. One-sixth area of the country is drought-prone. Approach to management of droughts and floods have to be coordinated and guided at the national level. (Ministry of Water Resources 7 April1, 2002) Hear we are taking a case study of flash flood situation at Baroda city.

STUDY AREA

Location

The city Vadodara located at western part of India (Latitude: 22 deg 17' 59'' North Longitude: 73 deg 15' 18'' East) 110 km south-east of Ahmedabad, Gujarat's main city. Baroda enjoys a special place in the state of Gujarat. The city covers area of about 108.22 sq. km. situated at Altitude: 35.5 m. above mean sea level, with winter temperature min 11 ^{O}C and summer temperature max 45 ^{O}C. The study area of 20 sq. km. is taken that experienced stagnation of flood water (Figure1).

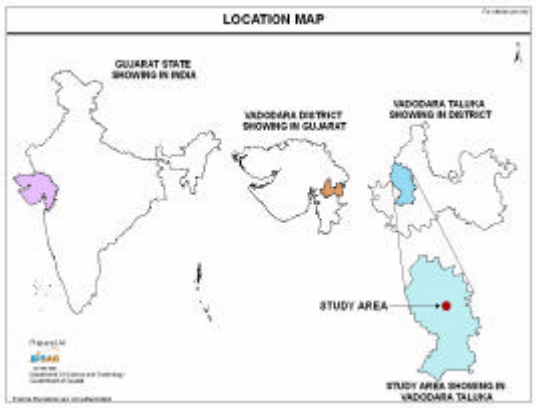

Figure 1 : Location of the study area

The terrain of area is flat including fertile flood plains of rivers Mahi and Vishvamitri. Being an educational, industrial and commercial center hosting the M.S. University, giant

industrial complexes and public undertakings like Gujarat Refinery, IPCL, GSFC, and Heavy Water Project of the Atomic Energy Commission. The city is on the major rail and road arteries joining Mumbai with Delhi and Mumbai with Ahmedabad. It is known as a 'Gateway to the Golden Corridor'. National Highway No. 8 passing through the city is also connected with Ahmedabad through National Expressway No. 1, a stretch of 97 km superhighway completed in year 2004. The Baroda Railway Station is a major station on the Mumbai-Delhi route. (Figure 2)

Figure 2 : Base Map of Vadodara Taluka

A closely knitted grid of highways railways and canals are established in planes attracting better agriculture, industries and urbanization. Increasing population demands even better facilities. India holds the second largest population in the world. The increased demand of sanitation, transportation and water supply is satisfied by well planned network of sewers rail-road and canals. These infrastructures are taken care by independent government agencies namely City municipal corporation to control and regulate development, water supply, local transportation, road network and sanitation in the city; Ministry of railways takes care of entire rail route infrastructure of country; National Highways Authority responsible for development, maintenance and management of National Highways; National Water Development Agency (NWDA) carry out water balance studies for optimum Water Resources utilisation whereas further development, management, of water works is carried out by state irrigation department or the board set for the particular water development scheme. The Highways and Railways are planned in embankments to have an unobstructed way throughout the year also the canals are planned as contour canals to supply water by gravity over a long distance without pumping. Here all the four agencies involved in creating this infrastructure for road, rain, canal and urban development are totally independent of the other.

Water resources

Major water bodies of the region are the River Mahi, a perennial river that flows at about 15 km west of the city. Other major water body is the Vishvamitri river, a seasonal river flowing east to west, bisecting the city in two half. Ajwa dam is built on the river Vishvamitri in upstream of Baroda city located at about 23 km east. The Sayaji Sarovar lake created by this 5 km long earthen dam has ability to attend water requirements of about 300,000 residents in eastern parts of the city. Pratap Pura lake near Bodeli village is another major water body located in nearest vicinity at upstream of Baroda city, the check dam-cum-reservoir stores water for district's irrigation and drinking water needs.

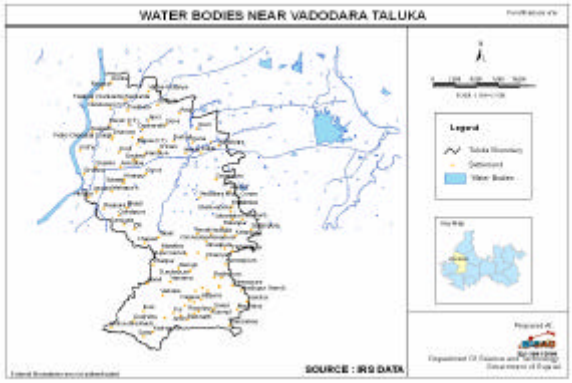

Figure 3 : Major water bodies of Vadodara Taluka

Year 2005 Flood at Baroda City

Rainfall in this region occurs in mid-June to mid-September annual average rainfall is about 931.9 mm. Due to cyclonic circulation of upper air from 25 June to 3 July 2005, the otherwise moderate rain regions of Central and South Gujarat received unprecedented rainfall of 110 cm in 9 days. The floodwaters washed away villages, damaged/destroyed houses causing loss of life and extensive damage to property. The heavy rains has left many of the major dams full while the medium and small dams are overflowing, the worst being the case of Pratap Pura lake in Vadodara district where nearly 100-feet long breach developed in check dam-cum-reservoir as it overflowed and water gushed out towards the villages downstream. Much of the overflowing water was been drained into the Vishwamitri river flowing through the Baroda city. The situation has eased for the villages as the water level has stabilised after the rains have stopped, but the water released from reservoir made river flowing near danger mark.

Picture 1 : Vishwamitri River flowing near danger mark at heart of Baroda.

The situation turned menacing when heavy rainfall in the catchments areas of Ajwa Dam necessitated opening of spillway gates to release water. With this river Vishwamitri overflowed, canals of Mahi and Narmada irrigation breached resulting floods in large and most unexpected areas. HEAVY rain and the release of water in the Vishwamitri caused havoc in Vadodara. With the flood water even number of crocodiles from Ajwa dam and city Zoo entered in Baroda city and the flooded river cut off

eastern and western parts from each other. With State Government and Baroda Municipal Corporation along with the Non Government Agencies and Indian army working round the clock to get citizens out of trauma, water from most part of the city resided in less than 12 hours. Well-planned drainage network of the entire city worked very well after rain. However, the situation was far from normal in north-west part of the city, area of about 25 - 30 km^2 (Nizampura, Sama, Chani) still inundated in knee deep waters. These areas remained waterlogged despite Vadodara not receiving any rain for next 48 hours. The floodwater in this region was not stagnant as observed in most flood-affected areas but there has been water flowing with a heavy current.

Picture 2 : Flooded Baroda City

Major reason of this as said by local people and news agencies is the Bhukhi drain that was flowing from this part of the city. Commissioner Rajesh Topno announced that all illegal landfill of the natural drainages, slopes and nalahs which played major role obstructing water flows in the recent havoc caused by the unusual rains will be removed and the authorities have reportedly began the surveys of such illegal landfill obstructing the water flow causing flooding of residential areas around them. A satellite survey was also ordered to assess the situation and for removal of obstructions is gaining ground.

DATA COLLECTION

The data used for the study can be grouped in two major groups as follows

1. Ground truth data
2. Satellite data

Topographic maps constructed by geometric measurement, in scale of 1: 50,000 were used as a baseline data source in the study because of their precision. Apart from the available topographical data, additional Landuse or Landcover information is needed to fill gaps in the available data and to update terrain information due to new developments in last few years. Other necessary data for instance Rainfall, flood depth and extent and flood risk perception needed in flood impact assessment are collected from district authorities. Flood history of study area suffering from prolonged flash flood is collected form the local residents.

Indian Remote sensing satellite (IRS-1C) Linear Imaging Self-Scanning Sensor 3 (LISS-3) four bands 23.7 m spatial resolution image and Panchrometic image with 5.8 m resolution of the year 2003 is taken to map the drainage pattern and observe extent of urbanization in the city. Also the Landsat Thematic Mapper (TM) imagery of the year 1987 with 30 m resolution is taken to observe the drainage pattern before the city development. Flooding of the city is observed by taking Radarset images of the area over time period of 2 - 3 days.

DATA ANALYSIS AND METHODOLOGY

The study is divided into 3 main phases, namely,

1. Change detection of small drains and its analysis,
2. Flood impact assessment,
3. Observation of urban blockages to natural drains.

The first phase focuses on data preparation, analysis and integration. The two images IRS 2003 and TM 1987 covering the whole area of Baroda district and parts of neighboring were taken. The images have been found to be of suitable quality, with no cloud amount and fairly close to represent the older and developed localities of the Baroda city. To establish relationship between the image coordinate system and the geographic coordinate system, the satellite imagery was georeferenced and registered to the geographic space using topographic maps. Several ground control points (GCPs) were selected from points easily identified on both the satellite images and on topographic map of the area. Geometric corrections were carried out until root-man square errors were less than one pixel. After the geometric correction mapping of water bodies present at the time of data acquisition was done by visual interpretation using a vector layer. Geological divisions, administrative boundaries and population data were prepared in a common coordinate system. Finally, all digital data were incorporated with geometrically corrected satellite data within a GIS approach.

In the second phase the Radar images taken over time were subjected to various corrections and registered to the geographic space. These images were overlapped on chronological order that shows how the inundation changes over time.

For the third phase Panchrometic imagery of the year 2004 is merged with the LISS image of the same year to give better resolution for confirming obstructions to the smaller natural drains.

RESULTS AND DISCUSSIONS

Analysis of Radar images show overflowing water bodies, flooding of the Baroda city, nearby areas and stagnation of water in the urban outskirts of the city. Validity of these flood affected areas against actual conditions is verified by conducting site investigations. Results derived from satellite data analysis were compared to previous traditional studies and they showed a similar result. The pre and post flood Radar images clearly shows stagnation of flood water in the western parts of the city. (Figure 4)

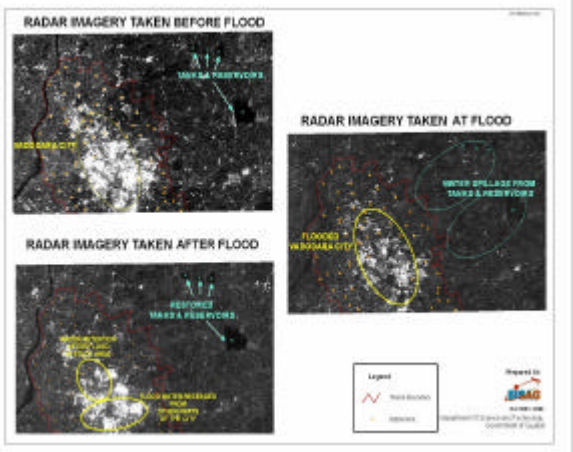

Figure 4 : Radar images showing flood severity

Results of analysis and interpretation of time series satellite data were compared indicating spatial changes of drainage

network mainly to the second and third order drains in the north western part of the city suffering with prolonged flood. There are two main parts of changes as the following. Blockage of drains mainly occurred in the Bukhi drain from Sama area to lower stream the phenomenon was less severe in old city area. The obstructed areas are not large, about 100 to 1,000 meter in length and 20 to 30 m in width extending from 1.5 to 2.5 sq. km. Narrow river segments were blocked as North-West part became dense in population straight because of the major industries located at nearby villages. Many small drains vanished in this area by illegal land fills and the accretion in both sides of riverbank, made the channel shifted leftward. (Figure 5) The Blockage of natural drains in this part of the city can be best seen tin the merged imagery of year 2004 as shown in Figure 6.

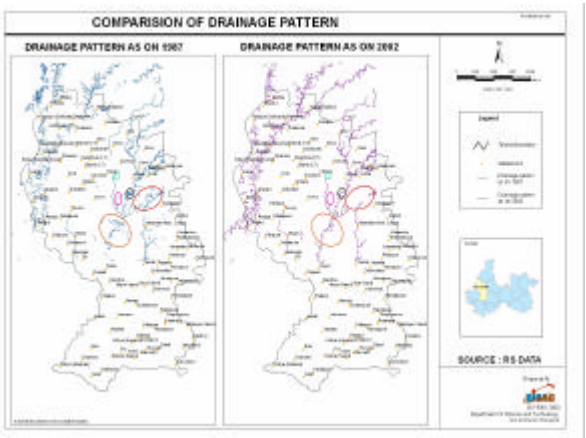

Figure 5 : Comparison of the drainage pattern

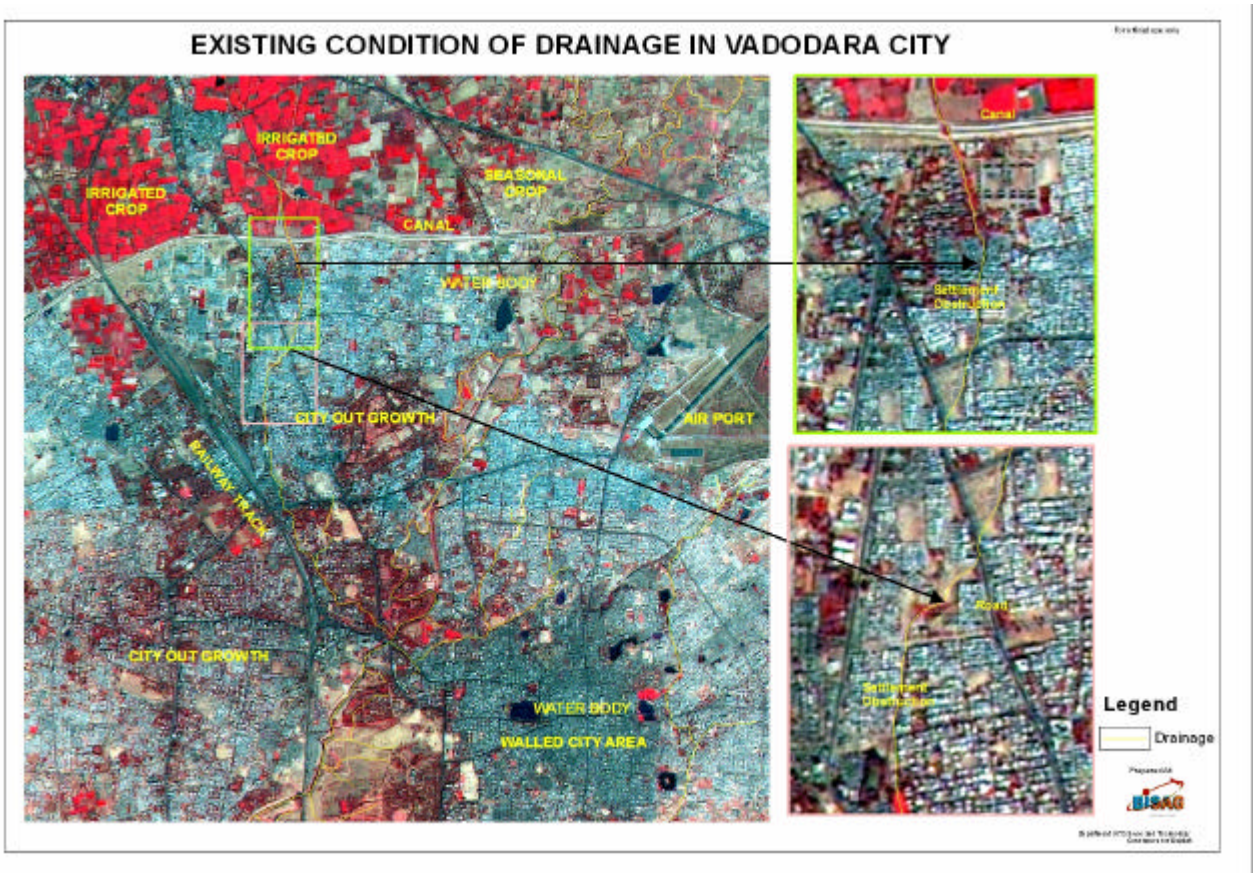

Figure 6 : blockage of natural drains due to urbanization in Baroda city

CONCLUSION

From the above study it may be concluded that in areas experiencing flash flood at Baroda city new localities were built encroaching drainage channel. The flash flood may damage most of the structures built on illegal land fills. Taking this fact in to consideration the urban planner has to monitor the areas for checking the growth and expansion of the city, proper planning and management is required to mitigate the flood risk vulnerability in these areas. Satellite data gives an objective view allowing a synoptic viewing to predict changes in the region, use of time-series satellite data shows a continuous change, which is useful to resource management. In addition, combination of traditional methods with modern technologies like high resolution satellite data with frequent dates of acquisition can help for long term planning of land and water resources, they may also prove excellent for detailed prediction at local scale for disaster management to prevent could-be-avoided damages.

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