CLIMATE CHANGE TRENDS AND ASSOCIATED ENVIRONMENT IMPACT IN UDAIPUR BASIN OF RAJASTHAN, INDIA

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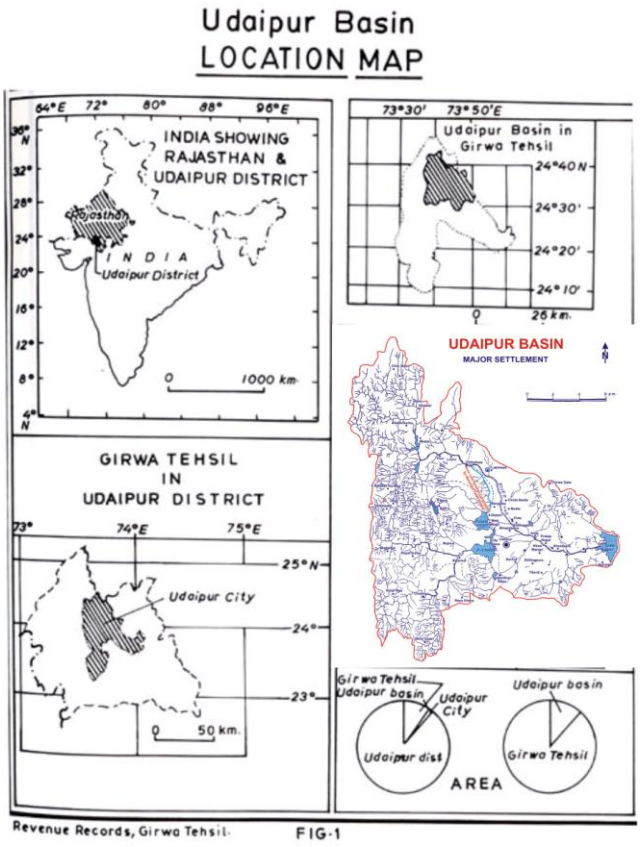
ABSTRACT: The present study is focused on the environmental impacts of changing climatic variables of Udaipur basin. Rapid growth of population, increased urbanization, massive deforestation, unplanned mining activities, over exploitation of underground water, encroachment of river beds etc have resulted in marked deterioration of the environment in the basin.

STUDY AREA

The study area Udaipur Basin lies between $73^0$36'51"East to $73^0$49'46"E longitude and $24^0$28'49" to $24^0$42'56" North latitude (Fig-1). It is a saucer shaped basin 22 kms wide from East to West and 24 kms long from North to South. It is wider in the South and tapers northwards. Its average height is 577 meters above the mean sea level. The tropic of cancer lies 122 kms to the South of the study area. Udaipur City popularly known, as the city of Lakes or Venice of the East is a picturesque city located to the south of the North-Western state of Rajasthan in India. Founded by Maharana Udai Singh of Mewar in 1559 A.D. Udaipur is one of the most majestic and historical city with rich cultural heritage and diversity.



PROBLEM UNDER STUDY

Udaipur Basin is the recent years, (past six years since 1999) has been facing an acute problem of drought. There is a severe water crisis. Both the surface and underground water sources have depleted considerably. The lakes have completely dried up causing a severe set back to the tourism, agriculture and other economic activities. The present paper is an attempt to make an in-depth study of the underlying causes of this critical situation and make constructive suggestions for future. Remotely Sensed data has been used for making this study.

MATERIALS AND METHODS

The present study has been undertaken with the help of Survey of India Toposheets of scale 1:25000 and 1:50000 surveyed in 1959-60, 1967-72 and 1973 respectively. Satellite images of varying resolutions for different years viz. Land sat MSS data of 3rd March, 1975 with 80 meters resolution, IRS data of LISS I of 18th February, 1996 with 72.5 meters resolution, IRS data of LISS III of 8th February 2004 with 23.5 meters resolution and IRS data of LISS-IV of 7th June, 2004 with 5.6 meters resolution have been used. Besides this Geological Survey of India Map 1997 depicting lithological formation of the region has also been used. Ground truths have been verified through field survey. Secondary data pertaining to rainfall, irrigation, land use, population, lake water storage capacity, forest cover etc. have also been acquired from various Govt. institutions.

For this study three broad methods have been used. Visual interpretation of Remotely Sensed data, mathematical analysis and field survey for verification of ground truth. The satellite data have been geo referenced. Digital Imaging Processing Techniques have been used for the demarcation of cropped area for 1975, 1996 and 2004. Catchment boundaries have been overlaid. Geological Map has been referred for lithological composition of the entire basin and a composite picture has been arrived at for analysis including lineaments, drainage, settlements and roads.

PHYSIOGRAPHY, GEOLOGY, DRAINAGE AND CLIMATE

. Structurally Udaipur basin is a triangular basin in form of a deep valley surrounded by the Aravalli hill ranges which gridle it from all sides. Locally it is called Girwa meaning a range of hills (Fig-2)

Udaipur basin is largely dominated by Aravalli and post Aravalli geological systems with phylite and schist as dominant rock types. The main city area lies on soft and cleaved metamorphic rocks of phyllite, schist and metagraywacke. The satellite image (IRS P6) of February 2004 depicts three prominent set of lineaments, trending NE-SW, NW-SE and EW directions around Udaipur City. These lineaments represent fracture zones in the area.

The region is drained by river Ahar and its tributaries. This is the only major river that flows through this region. It originates from the hills of Gogunda lying in the North West of Udaipur City, flows for a distance of 30 kms and joins Udaisagar in the East. It is joined by numerous tributaries and subtributaries. Sisarma River with its tributaries Amarjok and Kotra is one such important tributary that merges into the Picchola Lake in

Udaipur City. The Ahar River and its tributaries are seasonal in nature, they flow only during the rainy season and remain dry for the rest of the period. The basin is characterized by typical pinnate drainage pattern. Ahar River lies at the centre and its tributary form in dendritic pattern. The western boundary of Udaipur basin is demarcated by Great Indian Water Divide line.

Climatically Udaipur basin is transitional between semi-arid region in the north and sub-humid region in the south. It receives an annual rainfall of 65 cms, bulk of it is received during the summer season from the South West monsoons. Winters are dry with mild temperature and occasional cold waves. The nature of rainfall in the basin is highly erratic and uncertain. There is high variability in the amount of rainfall received. Consequently occurrences of droughts coupled with rainfall are a characteristic feature of the basin.

Keeping in view the above climatic conditions and limited natural water resources the erstwhile rulers ' Maharanas' of Mewar constructed several lakes in the Udaipur basin to overcome the problems of availability of water for the local population. These lakes are the principal lifelines of the residents of the basin. The Udaipur Lake region is divided into six major catchments (Table-1)

Table-1 Udaipur Catchment of Lake Region (in Hectares)

Lake Region	Catchment Area
Bada Madar	8780.48
Chhota Madar	2987.23
Fatehsagar	4325.35
Bari Ka Talab	1906.55
Pichhola	14610.63
Goverdhan Sagar	814.63

Source : Based on Indian Topograhical Maps& Satellite data, RRSSC, Jodhpur

DISCUSSION

Udaipur Basin has been suffering from recurring problem of droughts. In the past three decades there have been six spells of severe drought. The average rainfall during these years has remained below normal to the extent of more then 30%. This has severely affected the availability of water in the basin. Both the surface water and underground water resources got depleted. The lakes became dry, large proportions of the basin have turned into a dark zone. The main causes of which are discussed below: -

(i) **Population Explosion**

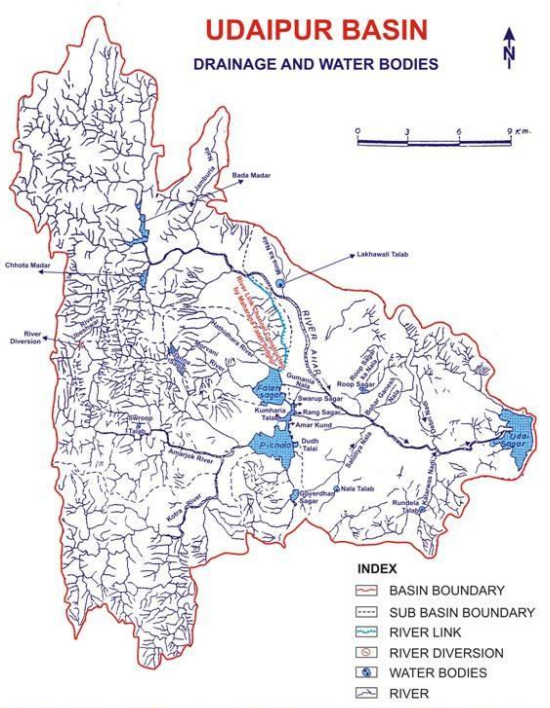


Fig. 2

At the outset there has been an explosive population growth in the Udaipur basin (Table-2). An analysis of the population growth of the past 80 years (1921-2001) shows that population increased from 34,798 in 1921 to 490142 in 2001, the year in which last census was held. Thus population has increased by 1308% over 1921. The decenial growth rate of population also shows an unprecedented growth trend. For example between 1921-1951 the decenial growth increased from +4.69 to +50.25%. Thereafter it declined to 24.01% and again increased to +45.11% between 1961-71. According to the latest census of 2011 it increased by 40.37% between 2001-2011.

Table –2 Decennial Growth of Population in Udaipur City (1921-2011)

Year	Population	variation during 1921-2001 in	
		Persons	Percentage
1921	34789	+1560	+4.69
1931	44035	+9246	+26.58
1941	59648	+15613	+35.46
1951	89621	+29973	+50.25
1961	111139	+21518	+24.01
1971	161278	+50139	+45.11
1981	232588	+71310	+44.21
1991	307682	+75094	+32.28
2001	490142	+182460	+59.30
2011	688019	+197877	+40.37

Source: Collectorate, Statistical section, Udaipur census, 2011.

This explosive growth of population has increased the demand for water causing severe depletion of both surface and underground water resources. From the statistics of water consumption requirement it is inferred that per capita water requirement for domestic purposes is 135 liters per day currently. At this rate the total water required for domestic purposes would be 27.10 million cubic meters in 2005. Another 9 million cubic meters would be required for industrial purposes totaling to 36 cubic million meters or 1271 million cubic feet water. As against it only 997 million cubic feet of water is available from all sources thus causing a deficiency of water.

(ii) **Depletion of forests**

Another reason for the prolonged drought is the depletion of the environment of Udaipur basin. Forests have been recklessly destroyed from the catchment area of the lakes. In the past 45 years between 1960-2004 almost 60% forest cover has been removed from the surrounding Aravalli hill ranges which now bear a deserted look. This is clearly visible from the visual interpretation of the satellite image of 1975, 1996 and 2010. This has resulted in the decline of the rate of evapotranspiration and increased soil erosion.

(iii) **Urbanization**

Rapid growth of population in the last 50 years has led to a rapid expansion of urbanization in the basin (Fig-3). The extent of urbanization can be gauged from the fact that the municipal limit of Udaipur city has been revised six times between 1948 and 2001. The area has increased from 17.75 km^2 in 1948 to 61.10 km^2 in 1991, an increase by 248%. It has further increased to 91.52 km^2 in 2001 an increase by another 50% in mere 10 years. The expansion of urban area is clearly reflected in the IRS P6 LISS satellite image of February 2004. This has led to a severe encroachment of the catchment and lake bed region. Excessive dumping of the urban waste has converted River Ahar into a dirty ditch at many places along its course prominent examples of such encroachment are at Roopsagar Tank, Naila Talab, Fateh Sagar, Pichhola, Kalaliya Talab, Titardi, Madar Basin etc.

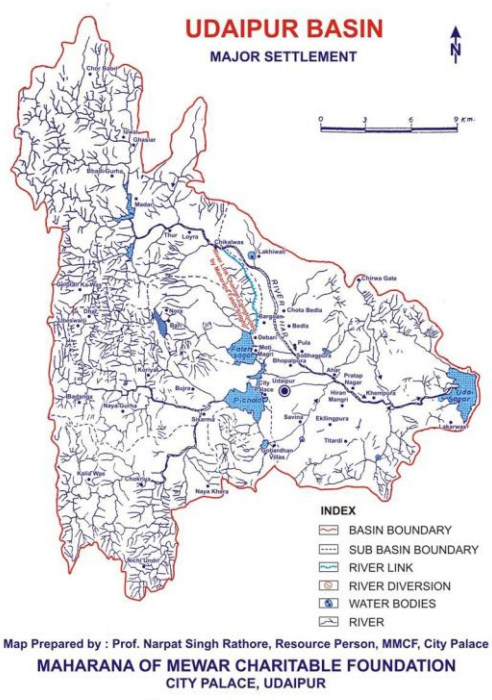


Fig. 3

(iv) **Erratic Rainfall**

Udaipur basin lies in the semi arid zone. It receives moderate rainfall averaging 65 cms annually. Bulk of it (95%) is received from the southwest monsoons from June to September. Some rainfall is also received during winters under the impact of western disturbances, however the amount received is negligible. Rainfall here is characterized by high variability and erratic occurrence. If we analyse the annual rainfall data for the past 90 years from 1921 to 2010. It will be seen that 58 years recorded below normal rainfall and only 37 years recorded normal or above rainfall. Within these 58 years of deficient rainfall continuos drought for 3-year period has been a common feature. It has occurred 8 times in the past 90 years, besides there have been two 4- year period droughts and the last six years from 1999-2004 has been the longest period of drought in the last 90 years. In six years between 1999-2004 rainfall had been abnormally low, it was 36.61%, 31.07% and 40.61% below normal rainfall in the years 1999, 2000and 2002 respectively (table-3). This caused severe drought in the Udaipur Basin. In the last 20 years between 1991-2010 aridity in the region has increased. The percentage of rainfall deficient years has increased by 2% from 60% to 62% and the rainfall surplus years has declined by 2% from 40% to 38% .

(v) **Expansion of Agricultural Area**

Agriculture is an important activity in the Udaipur Basin. There are many valleys and some flat areas in the lakes catchment area which are being intensively used for

cultivation. Over the years there has been a rapid expansion in the cultivated area in the catchment area. The total cropped area in the lake catchment region in 1959-60 was 2881.20 hectares, which was 8.6% of the total catchment area. It increased to 2887.79 hectares in 1975, 3981.08 hectares in February, 1996 but declined to 3134.36 hectares in February, 2004 as revealed by the satellite data. Thus in a period of 36 years the cropped area increased to peak a level of 3981.08 hectares, an increase by 38.17 percent in 1996 over 1959-60, but declined to 3134.36 hectares in February, 2004 which was however still 8.7 percent higher then the cropped area in 1959-60.

An important feature of the cultivation has been the rapid expansion of cultivated area in the lake bed region as revealed by the satellite imageries of the cropped area in the catchment of Fatehsagar and Pichhola, the two principal lakes of Udaipur city in the year 2002, 2003 and 2010. The dry beds of the lakes and rivers have been used for intense cultivation that exhibits an excellent example of dry land farming rapid. This expansion of seasonal farming in and around the lake bed regions has however also caused adverse impact on the underground water and has also disturbed the surface symmetry.

CONCLUSION

From the above discussion it is amply clear that there is considerable degradation of the environment in Udaipur Basin. Steps need to be taken to conserve and protect the environment in the study area.

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