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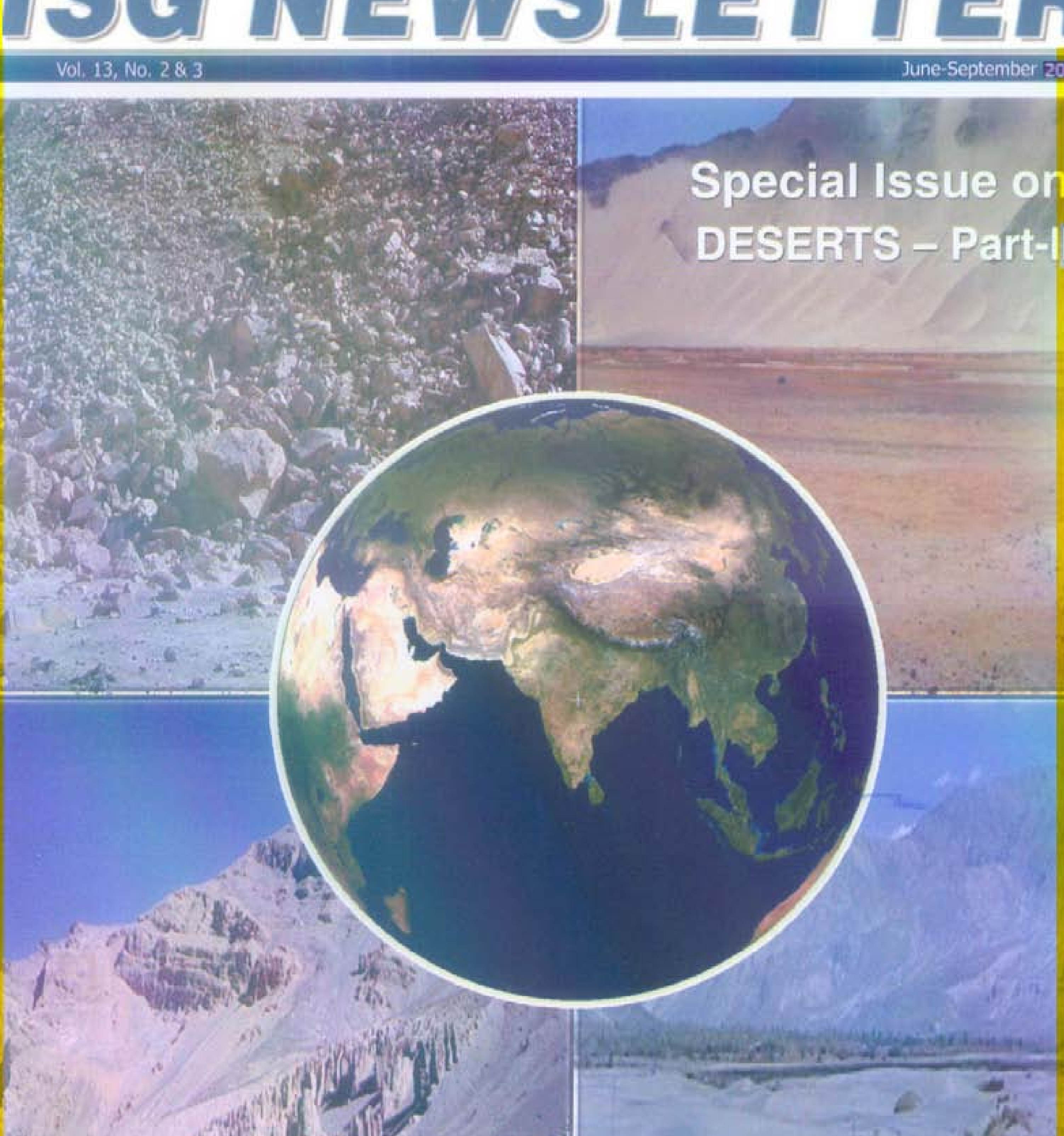

INDIAN SOCIETY OF GEOMATICS

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In this Issue

ISG Executive Council 2005-2008

Editorial

This issue forms part 2 of the special issue on DESERTS. Part -1 was published as Vol. 13, No. 1 (March 2007). Deserts occupy a significant area of the country. The Thar Desert, which spreads over both India and Pakistan, is amongst the 10 largest deserts of the world and covers a major part of the state of Rajasthan. Cold desert in India occupies parts of the States of Jammu and Kashmir and Himachal Pradesh. Therefore, the resource management and development of these areas are challenging tasks and cannot be overemphasized. The lead paper on Thar Desert by renowned experts was published in the first issue. Five out of the ten papers published in these two issues are based on the work carried out under the aegis of Thematic Programme Network (TPN-1) on Desertification Monitoring and Assessment, a part of the Regional Action Programme formulated by UN convention to combat desertification. Space Applications Centre, Ahmedabad was identified as the national focal institution to co-ordinate TPN-1 activities in India... Ministry of Environment and Forests, Government of India has been funding this pilot programme. Papers published here form only a sample of the work carried out using Geomatics technology towards standardization of procedures for desertification status mapping as well as monitoring in arid/semi-arid areas, both in Rajasthan and Ladakh (Jammu & Kashmir). These studies assist and lead to formulation of plans for combating desertification... The other set of papers are from Regional Remote Sensing Service Centre (RRSSC), Jodhpur, which by its unique location in the Thar Desert area, has been doing pioneering work on various facets of the desert. Whereas one paper reports on rapid urbanization of Jodhpur, a major town in Rajasthan desert, and the concomitant problems, the other paper addresses the problems arising due to water supply to Jodhpur through Rajiv Gandhi Link Canal from Indira Gandhi Nahar Pariyojana . This has led to rapid rise in ground water levels which, if not controlled, could lead to serious problems. Another paper has reported use of geo-informatics technology in assisting formulation of rapid action plan for disaster management in areas subjected to flash floods as a result of torrential rains. Such a disaster was reported again in August 2007 in Rajasthan as a result of cloud burst. The preparation of a catchment atlas for Rajasthan, reported in the first issue, would go a long way in disaster management.

Indian Society of Geomatics has been publishing such special issues for last 5-6 years on a variety of themes. Members have always expressed their appreciation and contributed towards present status of the Newsletter. The Society has now launched a peer-reviewed journal – Journal of Geomatics. Sustaining both these activities would be rather taxing on the financial resources of the Society. We would like to hear from members on the desirability of continuing with the ISG Newsletter as a separate entity or its merging with the Journal. Feedback from members on the issue would help the Society in taking a balanced view and taking a decision accordingly.

Baldev Sahai

RAPID URBANIZATION IN DESERT TOWNS - A CASE STUDY OF SUN CITY JODHPUR USING GEO-INFORMATICS

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Abstract

The paper presents the results of changing urban expansion scenario carried out for Jodhpur (Sun city of India), the second largest city of Rajasthan and the gateway to Thar desert. The city has experienced tremendous growth after Rao Jodha founded it in 1459. Un-planned growth and increasing population due to changing scenario in desert has put pressure on Jodhpur. The pattern of urban sprawl was mapped using remote sensing data of last 15 years. It was studied in its physical expansion and also quantified. Sprawl of city was mapped over a period of 125 years from 1880 onwards using old maps and remote sensing data with the help of GIS techniques. IRS LISS III and PAN and SPOT PLA and MLA data were used to identify urban expansion scenario over the years.

Population growth analysis was done with population data from 1891. Ward wise occupancy analysis was done for all the 60 wards in which city is divided. Quantification of urban expansion was done based on spatial extent of urbanization, density analysis, Shannon's entropy values and Jaggedness degree. Impact of distance from the city center was considered on density and entropy. City is not developing in concentric manner but it is spreading linearly in leapfrog pattern and in the direction which offers better opportunities in terms of industrial location and residential developments.

1. Introduction

Rapid urbanization is taking place in desert towns due to peripheral development and increase in population in recent times. Changing resources, availability of drinking water, development in infrastructure facilities etc are the causes of migration of people to desert towns. Jodhpur, the sun city is one of the desert towns experiencing population explosion and rapid urbanization in recent times. Jodhpur city, the gateway to desert was developed around a fort built on hill by Rao Jodha in 1459. To begin with, population of the city was limited to a few thousands and the entry and exit to the city was confined to the four gates. Increasing population and increased activity in Thar desert has put tremendous pressure on Jodhpur. As the population and importance of Jodhpur grew, then King constructed six gates around Jodhpur fort for movement and expansion. Jodhpur has been the centre of arts and culture from Mughal period and from seventeenth century onwards rapid growth in population was observed. Post independence period saw tremendous population inflow to jodhpur and a large number of industries have come up during that period. Due to its proximity to the international border, Jodhpur also became an important center of the armed forces of India. During last two decades the expansion in Jodhpur has increased manifolds due to inflow of tourists / personnel to Jodhpur and Thar desert. Expansion has taken place along major roads, all around the city or in satellite townships. The city has developed in haphazard manner. This unplanned development poses serious implications on the resource base of the region. Urban expansion or sprawl changes the landuse / landcover of the area. The ability to service and develop land affects the environmental and economic quality of life. Identification of pattern along with spatial and temporal changes in sprawl is necessary for understanding the city.

Physical expansion, pattern of sprawl and analysis of spatial and temporal changes can be effectively done using remote sensing data in GIS environment coupled with collateral data in the form of Survey of India sheets. Mapping urban sprawl provides an idea where growth is taking place. It helps to identify the environmental and natural resources, which are affected by sprawl.

Over the years, satellite-based remote sensing data have been successfully utilized for mapping, monitoring, planning and development of urban sprawl, urban land use and urban environment (Ewing 2000, Longley 2000, Hung 2002, Wilson 2002). High resolution data of IRS-IC PAN, SPOT PLA and IKONOS help in mapping of urban sprawl. Multi-spectral data, like IRS LISS III, SPOT MLA, which are available at lower resolution, are often combined with high resolution data to get merged product for interpretation using digital image processing techniques(Bothale 1994, 1995). Resolution, repetivity and swath of satellite data help in getting different data coverage for the study area. Spatial and temporal nature of data help in mapping the sprawl and identifying its growth pattern.

Mapping of urban area can be carried out using visual interpretation or digital image processing techniques. Sudhira et al. (2003) classified the satellite data for urban area mapping. Saxena (2003) mapped extent of Bhopal city using visual techniques. Jothimani (1997) used visual interpretation techniques to monitor urban sprawl of Ahmedabad city. Sudhira et al. (2003) used Shannon's entropy to measure and differentiate different types of sprawl for their study area. Madhavi Lata et.al. (2003) have also used entropy for the study of Hyderabad. Geographical Information System in recent past is being widely used wherever multiple datasets are being used for the analysis and management of resources. Multi criteria decision making ability of GIS has helped planners in analysis. It is used as a decision support system. Sprawl can be quantified with the help of many indices. Galster et.al. (2001) have quantified sprawl by eight indicators, viz., density, continuity, concentration, clustering, centrality, nuclearity, mixed uses and proximity.

2. The study area

Jodhpur city is located at a latitude of 26^0 18' North and longitude of 73^0 1' East and is located in the middle of the Thar Desert tract of western Rajasthan about 250 km from the Pakistan border. Its general topography is characterized by the hills located in the North and North-west. The hill ranges start within the walled city and extend up to Mandore and Jaisalmer road. There are extensive stone quarries to the Northwest of the city. Jodhpur city is located at an average altitude of 241 m above Mean Sea Level (MSL) at railway station with fort and old city being much higher at 367.83 m and between 277.21m to 245.50 m respectively. The city has a natural drainage slope from North-North East to South-South East towards Jojari River. The type of soil found in the region is predominantly sandy except the rocky strata in the part of fort and walled city, which is totally impervious. The climate of the city is characterized by extremes of temperature, uncertain rainfall and dryness. The average annual rainfall is about 386 mm. The average number of rainy days in a year is about 20. About 90% of rainfall is received during the southeast monsoon season from June to September and some times a single storm may give more rain than average. The mean monthly temperature varies from 26^0 C to 41^0 C in summers and 9^0 C to 31^0 C in winter. The relative humidity varies from 45% to 82% in the mornings and from 15% to 50% in the evenings. The prevailing wind directions are from Southwest to Northeast during summer and from Northeast to Southwest in the winter. The mean monthly wind speed varies from 7 to 17 KMPH.

The economy of Jodhpur thrives on industrial goods and cultural heritage. On account of its location and availability of better infrastructural facilities, industrial development in and around Jodhpur is quite noticeable for the last three decades. The greatest asset of Jodhpur is cultural heritage: art, dance, music, architecture, history and above all the people.

3. Dataset used and methodology

To map the spatial extent of city different type of data inputs used are as follows:

- Remote Sensing data: SPOT MLA + PLA (1990), IRS PAN (1997), IRS LISS IV + IRS PAN (2005)
- Survey of India toposheets: Special survey (1880, 1927), SOI sheet (1960)
- Collateral data in the form of master plan, Jodhpur, 2001- 2023, Ward map from Municipal Corporation
- Ward-wise population data from Municipal Department

Methodology includes following major steps:

3.1 Generation of edge enhanced hybrid outputs for mapping

High resolution data sets were georeferenced with respect to Survey of India toposheet after taking Ground Control Points (GCP) on high resolution satellite data and map. Accuracy of registration was kept as low as one pixel for map to image registration. Image to image registration was done to geo-reference low resolution satellite data with already rectified high resolution data with root mean square error less than one pixel. To generate hybrid FCC, band replacement method was used where high resolution data replaces one band from low resolution dataset. High resolution (PAN) data was filtered with a high pass filter with following kernel:

-0.25	-0.25	-0.25
-0.25	+2.0	-0.25
-0.25	-0.25	-0.25

The filtered PAN was added to PAN data in such a way that the resultant dataset has 70% input from PAN and 30% input from filtered PAN. This PANfPAN data then replaces one band in band triplet of multi-spectral data. The hybrid output thus generated highlighted the linear features to maximum extent.

3.2 Generation of base maps

Different base layers were generated for Jodhpur city and surrounding areas. The maps were scanned and then edited to get maps like ward map, municipal area map, road map, rail map etc.

3.3 Urban sprawl mapping

Urban sprawl mapping was done with heads up digitization. Satellite images and scanned maps were loaded on system and polygons were marked to show the extent of urbanized area on particular image/map. Sprawl was mapped over a period of 125 years from 1880 onwards. Special survey maps available for the years 1880 and 1927 were used for mapping. Survey of India toposheet surveyed in 1960 was used as third dataset. SPOT PLA + MLA data of 1990, IRS PAN data of 1997 and IRS LISS IV + PAN of 2005 were also used for mapping.

3.4 Quantification of urban sprawl

To measure and differentiate different type of sprawl various techniques were used. Urban spread area was analysed to understand nature of sprawl. Change in population density as a function of distance from city centre was calculated to quantify sprawl. Ward wise urban occupancy was also calculated as indicator of sprawl. Shannon's entropy was calculated based on wards as well as centre orientation and Jaggedness degree, which tells about shape variation of sprawl in comparison to standard shape of circle or square was also calculated.

Shannon's entropy, which reflects the concentration of dispersion of spatial variable in a specified area, was used for analysis of Jodhpur city. This measure is based on the

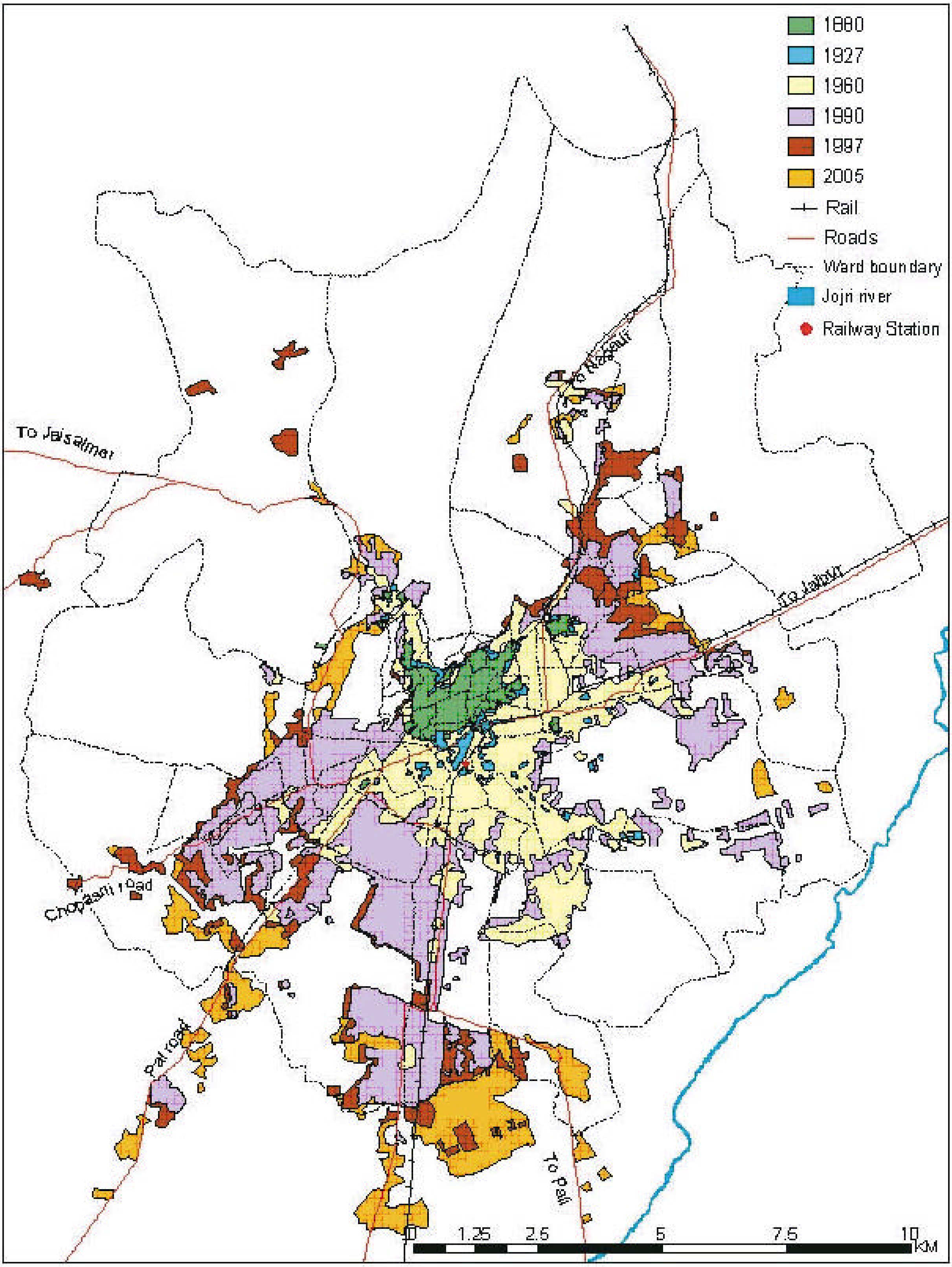

Fig. 1 Urban sprawl map of Jodhpur city between 1880-2005

notion that landscape entropy or disorganization increases with sprawl. The urban land uses are viewed as interrupted and fragmented previously homogenous rural landscapes, thereby increasing landscape disorganization. The Shannon's entropy, Hn is given by,

Hn = - S Pi log (Pi) 1

where; Pi = Proportion of the variable in the ith zone

n = Total number of zones

The value of entropy ranges from 0 to log n. If the distribution is very compact then the entropy value would be closer to 0 and when the distribution is very dispersed the value will be closer to log n. Large value of entropy indicates the occurrence of urban sprawl.

Current literature in geography and landscape ecology defines usually the compactness of any object as a numerical representation describing how far an object deviates from a standard shape, a circle or square. Jaggedness can be defined as

Jaggedness degree $= P / 2\sqrt{(\pi A)}$ where P is perimeter and A is area. The value is 1 for circular shape and increases with unevenness.

4. Analysis and results

4.1 Urban spread

Mapping of spread of urban area was done using data pertaining to six-time period. Table 1 shows the spatial extent of urban area over the years.

Table 1. Spatial extent of urban area over the years

Year of analysis	Urban area in sq km	% increase in urban area	Urban area change in sq km/ year between years
1880	2.903	-	-
1927	3.841	32.27	0.02
1960	21.032	447.71	0.52
1990	44.682	112.45	0.79
1997	51.096	16.17	1.03
2005	65.297	25.79	1.67

sq km. The population was residing within walled city. By the year 1927 as clear from Figure 1, few pockets were developed beyond walled city. An area of 3.841 sq km was mapped in the year 1927. Between 1927 to 1960, Jodhpur experienced phenomenal growth having 21.032 sq km area under urbanization with 447.71% increase in urbanized area from 1927. In another three decades from 1960 to 1990 the urban area was doubled with respect to 1960. Rate of urban area change is shown in Table 1. The rate of urban area change which was 0.02 sq km / year in 1927 is 1.67 sq km / year now.

4.2 Population density

Population wise, Jodhpur is the second biggest city of Rajasthan with population as per 2001 census as 856034. In last ten decades, there is ten-fold increase in population. Population up to year 2001 is from Census Department and that from 2011 up to 2031 is projected population. Table 2 and Fig. 2 show the population and its growth over period of time.

During the decade 1911 to 1921 a negative growth rate is observed due to natural calamities. Jodhpur experienced phenomenal growth in the decade 1971-1981 with growth

Table 2: Population Details, 1891 - 2001

Year	Population	Decadal change	Growth rate (in%)
1891	61756	-	-
1901	79109	17353	28.10
1911	79754	645	0.82
1921	73480	-6274	-7.87
1931	94736	21256	28.93
1941	126842	32106	33.89
1951	190717	63875	50.36
1961	224760	34043	17.85
1971	317612	92852	41.31
1981	506345	188733	59.42
1991	666279	159934	31.59
2001	856034	189755	28.48
2011	1120583	264549	35.90
2021	1402713	282130	25.18
2031	1671875	334375	25.00

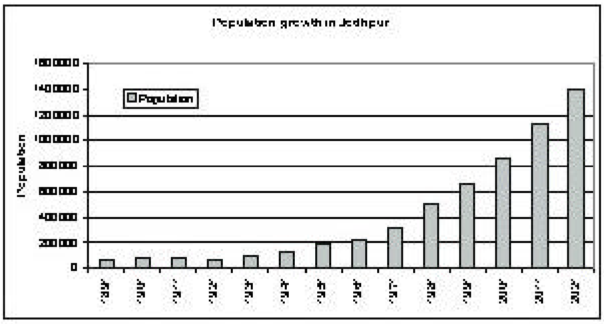

Fig. 2: Population growth in Jodhpur over the years

rate as high as 59.42%. Jodhpur has a tendency of population increase due to its being district and division HQ, employment opportunities in sand stone mining, dyeing industries and handicraft industries, high birth rate, low mortality, increased drinking water facility etc.

The present Jodhpur service area covers an approximate area of 80 sq. km under Jodhpur Municipal Corporation. Earlier the area was divided into 45 wards, but in 1991 the area was reorganized into 60 wards (Figure 1). The city is densely populated within the walled city limits. As these areas have reached saturation levels, development has started on the outskirts of the walled city. Ward wise population density was calculated for the years 1990 and 2005. The density values vary from 359 to 120060 persons/sq km in different wards for the year 1991 and from 375 to 129670 persons/sq km in the year 2005. To see the effect of distance on density of population, graph was plotted between ward wise distance in kilometer vs population density for the years 1990 and 2005. From Figure 3 it is clear that population density decreases with distance from city center.

4.3 Urban sprawl

Different quantitative as well as qualitative indicators were used for identification of urban sprawl of Jodhpur city.

4.3.1 Physical expansion. From Table 1 it is very clear that urban area has increased over the years with area under this category changing from 2.903 sq km in 1880 to 65.297 sq km in the year 2005. To know if this spatial change is attributed to sprawl, fragmentation analysis was carried out. Area vs perimeter ratio was calculated for all the study years. Table 3 gives the ratio values.

For the same area this ratio decreases with fragmentation but in our case urban area is increasing from year to year. From 1880 to 1927 urban areas were developed in patches, which resulted in more perimeter in comparison to increase in area, and hence lowering in the value of ratio is observed. Similar situation was observed during 1880 to 1927. City experienced growth in North - East and South and South-West directions. Industrial areas were developed during this period. Many residential colonies came on Chopasni road which runs in North-North-West of city. Areal

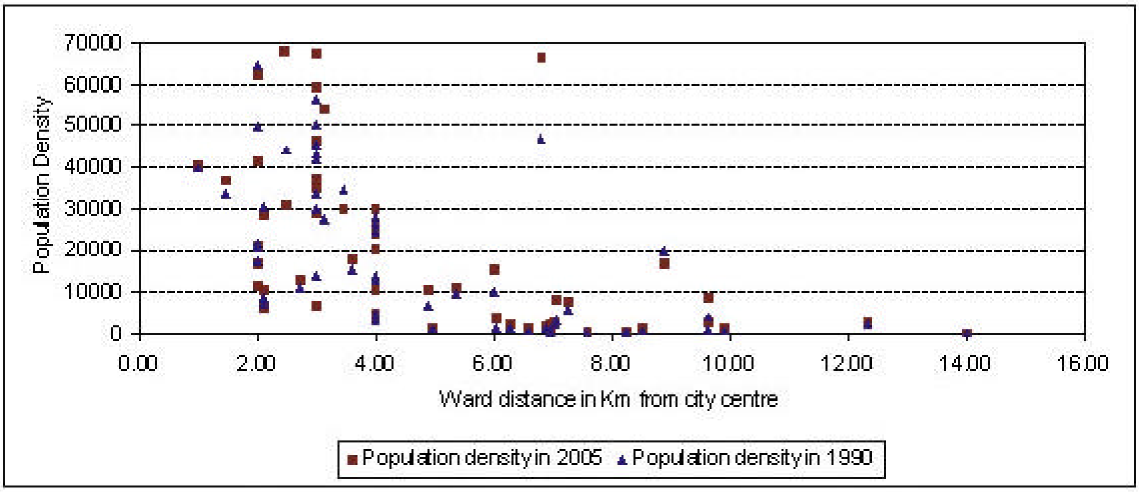

Fig. 3 : Effect of distance on population density

Table 3: Fragmentation ratio for different years

Parameter / year	1880	1927	1960	1990	1997	2005
Fragmentation ratio	0.107	0.091	0.239	0.224	0.249	0.246

spread did not increase much between 1990 and 1997 but the density of construction in already acquired areas increased. During 1997 to 2005 Jodhpur experienced further development in South and South-East direction. Sprawl development in Jodhpur was initially in the form of low density continuous sprawl. Now it has taken two forms. In the North East it is ribbon sprawl and in the South it is ribbon along with leap frog development.

4.3.2 Change in density.

As explained earlier, city was limited to walled area and density of population was very high in those wards. If we compare

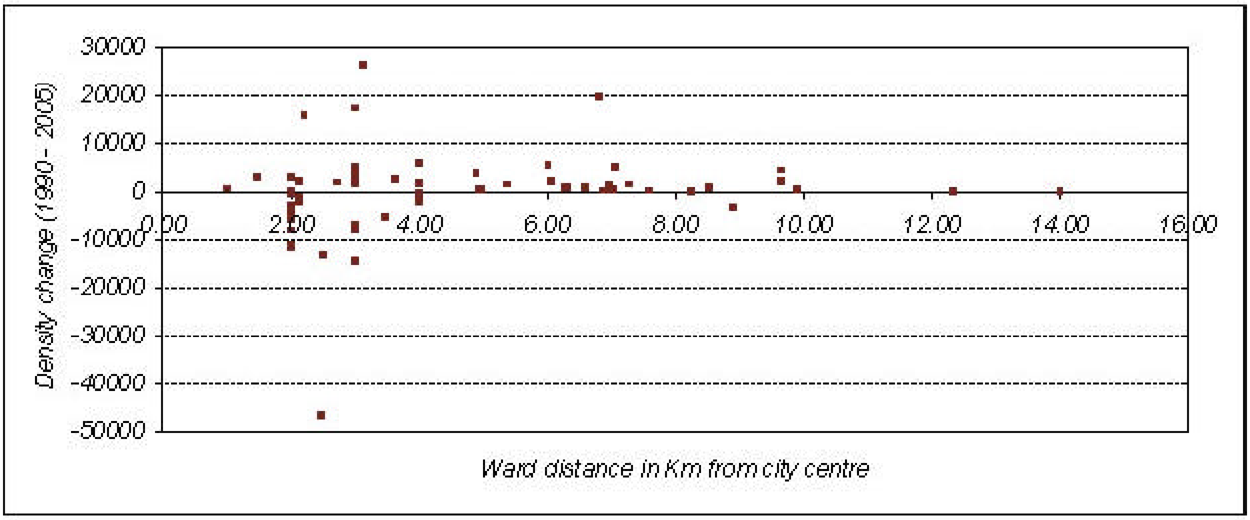

Fig. 4 : Change in ward wise population density between 1990 and 2005.

the change in ward density between 1990 and 2005 then it can be seen from Figure 4 that there is negative change in density in wards within walled city. This also is indicative of urban sprawl. There is positive change in density in wards away from city center.

4.3.3 Ward-wise urban land occupancy.

Analysis was carried out to see the ward wise occupancy of urban areas. Ward map was combined with urban growth map for the years 1990 and 2005. Table 4 shows the ward wise percent occupancy.

Table 4: Ward wise percent urban occupancy

S. No	Percent urban occupancy	Number of wards	
		Year 1990	Year 2005
1	0 to 10 %	8	5
2	10 to 20 %	4	6
3	20 to 50 %	10	7
4	50 to 70 %	4	8
5	70 to 80 %	3	2
6	80 to 90 %	2	1
7	90 to 100 %	5	2
8	100 %	24	9

4.3.4 Entropy and Jaggedness degree as indicator of sprawl.

To capture the effect of density and the distance from city centre, centre oriented entropy was calculated. Equivalent circles are created from city centre using buffer option in GIS. Total 16 zones were created as the city has gone up to 16 km in one direction from city centre as per analysis of year 2005. Area under urban development under each distance buffer is calculated for different years. Entropy values are given in Table 5.

From Table 5 it is clear that there is change is entropy over the years indicative of sprawl. Not much change was observed between 1990 and 1997 due to increase in density of urbanisation during that period. Entropy calculation was also done based on the development in different wards in the city (Table 6).

From Table 6 it can be observed that the city followed a regular trend in increase from 1880 to 1997 but the year 2005 saw a change. This is mainly attributed to the fact that some of the development which took place in 2005 is

Table 5: Entropy values for distance buffer for different years

Parameter / Year	1880	1927	1960	1990	1997	2005	Maximum
Entropy	0.4475	0.5192	0.6684	0.8359	0.8849	0.975	1.2041

Table 6: Wards wise entropy values for different years

Parameter / Year	1880	1927	1960	1990	1997	2005	Maximum
Entropy	1.28	1.38	1.54	1.55	1.56	1.55	1.78

Table 7: Jaggedness degree for urban expansion

Parameter / Year	1880	1927	1960	1990	1997	2005	Optimum
Jaggedness	4.49	6.09	6.41	8.34	8.13	9.267	1

outside ward areas. It falls in the new urban limits fixed by Town Planning Department of Jodhpur. Leap frog development has taken place which is responsible for slightly lowering of entropy values. Table 7 shows the Jaggedness degree for urban expansion in Jodhpur over the years.

From the spatial distribution of urban sprawl also it is clear that city is not developing uniformly in all the directions.

5. Conclusion

Urban sprawl over a period of 125 years was quantified in terms of urban area change, density change and quanitative index like Shannon's entropy and Jaggedness degree for sun city Jodhpur. Percent change in population was found to be 1895% over 125 years where as the percent change value for urban area was 2149% which is higher than population growth rate. From various spatial and quantitative analysis it is concluded that there is a definite sprawl pattern in Jodhpur. City is not developing in concentric manner but it is spreading linearly in leapfrog pattern and in the direction, which offers better opportunities in terms of industrial location and residential developments. Leap frog way can be observed in the South of city and ribbon sprawl in the North-East of the city. Gateway to desert is experiencing haphazard development.

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DESERTIFICATION PROCESSES IN SEMI ARID REGION OF RAJASTHAN : A CASE STUDY OF DAUSA DISTRICT

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INTRODUCTION

Desertification is a term that has been in use since at least 1949 when Aubreville, a perceptive and well-informed botanist and ecologist, published a book on "climate, Forests, et Desertification de 1' Afrique Tropical" (Aubreville, 1949). Aubreville thought of desertification as the changing of productive land into a desert as the result of ruination of land by man-induced soil erosion. He associated it with the humid and subhumid tropics where he worked. Despite the fact that a world conference has been held on the subject, there is no generally accepted definition of desertification. For most people, the word probably evokes a mental picture of a barren forbidding lanscape resembling Death Valley or the Sahara. Fortunately, that grim picture does not apply to most of the land that was undergone desertification. A definition of desertification should recognize that it is a land degradation process that involves a continuum of change, from slight to very servere degradation of plant and resource, and is due to man's activities.

The 1977 UNCOD in Nairobi described disertification as the diminution or destruction of the biological potential of the land. The recent 1992 definition is "Land degradation in arid, semiarid and dry sub-humid areas resulting from various factors including climatic variations and human activities."

Desertification of the arid lands of the world was has been proceeding sometimes rapidly, sometimes slowly for more than a thousand years. It has caused untold misery among those most directly affected, yet environmental destruction continues. Until recently, few if any lessons seemed to have been learned from the past, in part because the problem was an insidious one that went unrecognized in its early stages or was seen as a local one affecting only a small population, and in part because new land was always available to start over again. As long as remedial action could be deferred by moving on to new frontiers, land conservation has little appeal. It was not until the 20th century when easy land expansion came to the end that governments and people finally realized that continued careless degradation of natural resources threatened their future.

Historical Development

Land degradation is by no means a new problem, despite the attention focused upon it in recent years. In some quarters, there is a tendency to blame desertification upon land pressures generated by the population explosion of the middle 20th century. While the rapidly expanding population has greatly exacerbated the situation, desertification is not a new phenomenon. Historical evidence shows that serious and extensive land deterioration occuring several centuries ago in the arid regions had three epicenters: the Mediterranean Sea, the Mesopotamian Valley, and the Loessial Plateau of China. There were other places where destructive changes in soil and plant cover had occurred but they were small in extent or are not well known.

Last one Hundred years Desertification in Africa and elsewhere began long before the 1969-1973 drought struck the Sahel. Stebbing (1937a, 1937b) was the most persistent of those sounding the alarm over the rapid deforestation of the Sahelian and Sudanian vegetative zones. He looked upon desertification in West Africa as forest degradation that leads to erosion and, as a last stage, to barren sand or rock. That process is hastened, he contended, by blown sand from the Sahara being deposited on the deforested land. It was this latter activity that led him to refer to the "encroaching Sahara," a term he later regretted using (Stebbing, 1938). He disclaimed any attempt to give the idea that the Sahara was a vast sand field advancing in great waves like the incoming tide of a sea. The latter concept, however, has proved so attractive to numerous writers on desertification that it now represents a common view on the subject (Cloudsley-Thompson, 1974). There apparently is something fascinating about the idea of an expanding desert threatening mankind. Encorachment of moving sand dunes on desert oases and transportation routes is an aspect of desertification that is of small areal extent but is locally important and highly visible. Warnings similar to those of Stebbing for the Sahel were made by other scientists in southern Africa, North America, South America, Asia, and Australia during the 1920's and 1930's. Research has been undertaken in many countries to develop techniques of grazing management and soil and water conservation that would halt and reverse desertification. As a result, there is now a good understanding of the basic principles of land conservation. Field application of those principles has been slow, unfortunately, and land degradation continues to undermine efforts to improve human well-being.

International Directions

The decade of the 1950's witnessed the first worldwide effort to call attention to the problems and potentials of arid and semi-arid regions. It started when the United Nationals Educational, Scientific, and Cultural Organization (UNESCO) launched its Major Project on Scientific Research on Arid land in 1951. That project led to publication of a newsletter, the provision for funds for establishing and stregthnening arid land research institutes, organization of conferences and symposia, and publication of a series of research reviews and special reports on a wide range of towns. The Major Project was terminated in 1962 and arid land program was merged with the broader UNESCO natural resource program. The impetus generated by the UNESCO project led to expanded interest in, and support of arid lands studies .

Recently, Regional Action Programme (RAP) to combat desertification have been formulated by UN convention to combat desertification (UNCCD) and accordingly RAP for Asian region has been initiated as collective effort by member countries. The aim of RAP is to strengthen the existing capacities of the member countries of the Asian Region to the suitable measures for combating desertification. Under Regional Action Programme, six thematic programme areas were identified. The first one, Thematic Programme Network (TPN-1) is on Desertification Monitoring and Assessment. The overall objective of TPN -1 is to enhance the desertification monitoring and assessment capacities in the region through the establishment of a network and the harmonization of approaches for its conduct in the region. China has been identified as the host country to coordinate TPN-1 activities among the member countries in establishing the Asian Regional Desertification Monitoring and Assessment Network (TPN-1). In India, Space Applications Centre (ISRO), Ahmedabad has been identified as the national focal institution to coordinate TPN-1 activities within the country and establish the national network for desertification monitoring and assessment.

To implement TPN-1 activities in India, a working group has been constituted. The working group consists of the following institutions / organizations from various climatic zones (cold, arid, semi arid and dry sub-humid).

Subsequently a national network for TPN-1 was established in the country. The first meeting of TPN-1 working group was held at Space Applications Centre (ISRO), Ahmedabad on January 25, 2000. The discussion led to the finalisation of indicators, thematic layers, database, design/ standards, network concept and design to be followed for TPN-1 implementation in the country. The working group in its first meeting recommended to initiate a pilot project to evolve and standardize the methodology for Desertification Status Mapping and monitoring using satellite data in arid, semi-arid and dry sub-humid zones for both cold and hot deserts of the country. Accordingly, a proposal for the pilot project was prepared and submitted to Ministry of Environment and Forests, Govt. of India by Space Application Centre, Ahmedabad for funding. A strong need for the pilot project, was also felt during the TPN-1 status workshop held at Tokyo in June 2000. The UNCCD definition of desertification as given in article 1, i.e. ""and degradation in arid, semi arid and dry-sub humid areas resulting from factors including climatic variations and human activities" has been followed in TPN-1 including the preparation of desertification status map.

The pilot project at the behest of Ministry of Environment and Forests, Govt. of India has been taken up by Space Applications Centre. The present study is based on the work carried out in semi arid area in Rajasthan, sponsored by the Space Application Centre, Ahmedabad under TPN-1 activities.

STUDY AREA

Dausa district of semi arid region, Rajasthan has been assigned by Space Application Centre Ahmedabad to Department of Geography, University of Rajasthan, Jaipur for Desertification Status Mapping.

Dausa is located between 26^0 54' to 27^0 15' latitude North and 76^0 38' to 76^0 54' East longitude, covering an area of about 3394 sq km. It is surrounded by Alwar in north, Sawai Madhopur in south, Jaipur in west, Karauli in east and Bharatpur in north-east.

Administratively Dausa district is a part of Jaipur division. This district is divided into 5 tehsils namely – (1) Dausa, (2) Lalsot, (3) Sikrai, (4) Baswa and (5) Mahwa which also forms panchayat samities of the district. (Fig.1)

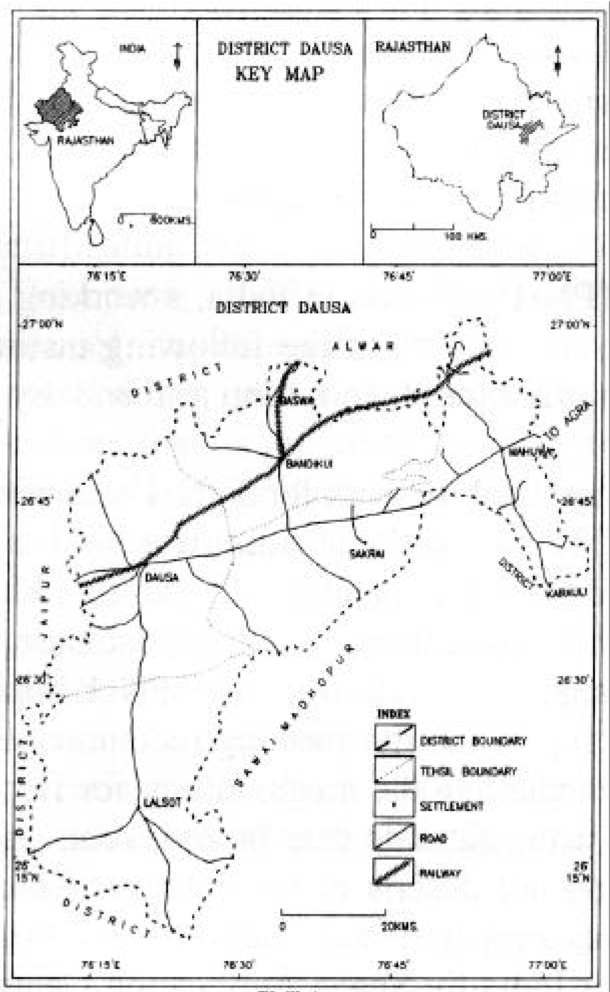

Fig. 1 Dausa district

OBJECTIVES

The main objectives of this study are:

i) To evolve and standardize the procedure for desertification status mapping of

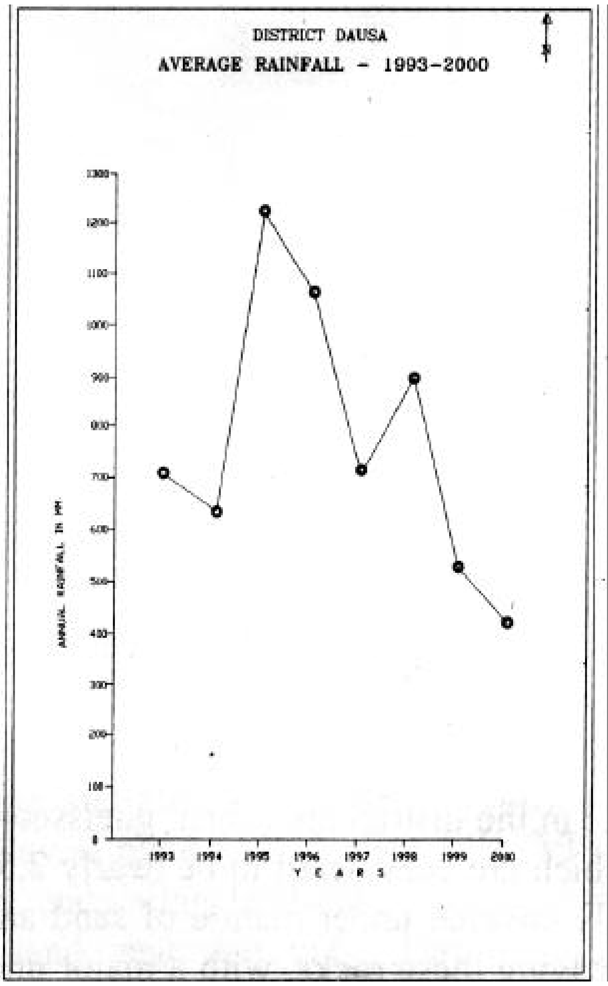

Fig. 2 Average rainfall in Dausa district during 1993-2000

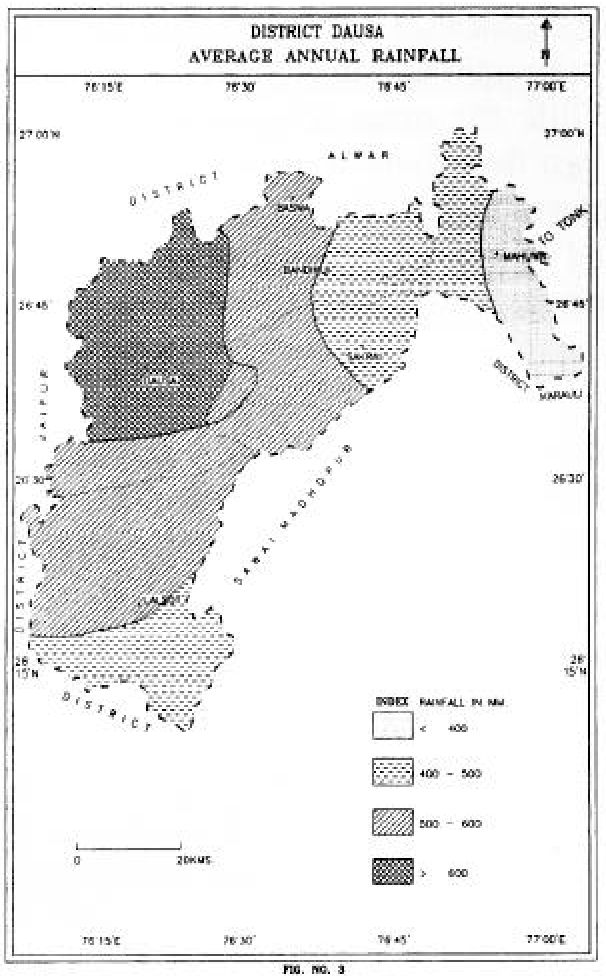

Fig. 3 Average rainfall pattern in Dausa district

Dausa district, Rajasthan and ultimately to harmonise the approach including database.

ii) To study temporal behavior of the land undergoing desertification with respect to the identified indicators vis._a_vis. the severity of degradation.

iii) To suggest an action plan for combating the desertification and monitoring its impact.

PHYSICAL AND SOCIAL BACKGROUND OF THE REGION

Climate

The climate of the district is semiarid and is subject to extreme of cold and heat at places. The minimum and maximum temperature recorded is 3^{0}C and 45^{0}C respectively. While the mean temperature is 24^{0}C. In the district the rainy season usually lasts from June to September, the normal annual rainfall is 548.2 mm. The analysis of rainfall data from 1993 to 2000 reveals that there has been a declining trend of rainfall in this district (Fig. 2). The average rainfall pattern in the district increases from west to east (Fig. 3).

Geology

The oldest rocks in the district are schist, gneisses, migmatites and quartzite of Pre-

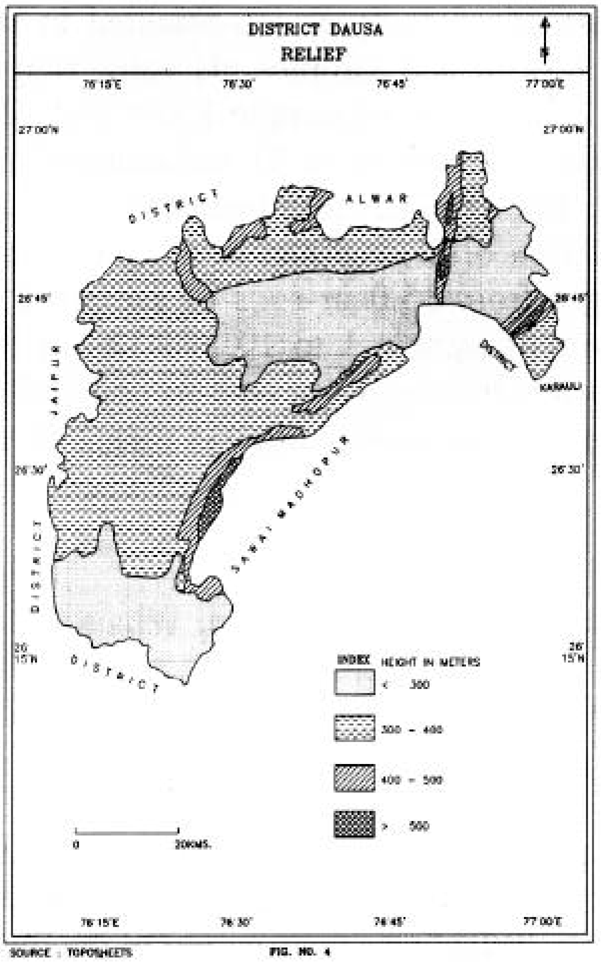

Fig. 4 Relief map of Dausa district

Aravalli, which are considered to be nearly 2,500 million years old. These rocks are usually covered under mantle of sand and alluvium of recent to sub recent age, overlying these rocks, with a major unconfirmity over the rocks of Delhi Super Group, which are made up of Rialo, Alwar and Ajabgarh groups. The rocks of Rialo comprise mainly of dolomite, marble and minor quartzite. The Alwar group consists of conglomeratic quartzite and schist which either lies unconfirmably over Rialo or directly over the metamorphites of Pre-Aravalli. The Ajabgrah group is mainly made up of schists, phyllite, marble and quartzites. These rocks have been intruded by amphibolite, granite, pegmatite and quartzite vein.

Geomorphology

Large part of the district is covered by a thick mantle of soil, blown sand and alluvium. The area is occupied by hill ranges and numerous isolated peaks rising over 200 metres above the surrounding plains (Fig.4). These hills and peaks belong to the Aravalli hills system and are known by different names at different places. In Sikrai, Praswa and Lalsot tehsil, the range is known as Lalsot Todabhim range.

Geomorphologically, the district may be divided into landform units of fluvial origin, denudational origin and hills mainly structural hills. Landform units of fluvial origin include alluvial plain (AP) Valley fills (VF) and ravines (RV). Alluvial plain in mainly undulating landscape formed due to fluvial activity consisting of gravels, sand, selt and clay. Terrain is mainly undulating, produced by extensive deposition of alluvium. Valley fills are formed of fluvial activity usually at lower topographic location, comprising boulders, cobbles, pebbles, gravels, sand, silt and clay. Ravines are confined to major and small tributaries of Moral. These small narrow, deep depressions are generally carved out by running water.

Pediments (P) are broad gently sloping rock flooring, erosional surface of low relief between hill and plain. They are comprised of varied lithology, criss-crossed by fractures and faults. Structural hills (SH) are linear arcuate hills showing definite trend lines with varying lithology with faulting and folding.

Soils

Soils of Dausa district are greyish brown to brown and yellowish brown with wide variations in texture from sandy loam to clay loam having a clear upper boundary of argillic horizon. These soil are generally deep to very deep and at places are affected by salinity-alkalinity. The moderately course-textured soils can be classified as ustifluvents great group of Entisols order.

The soil analysis of 15 samples is presented in table 1. The study of table reveals that in most of soil samples pH value ranges from 8.5 in sample 8 to 10.6 in sample 2. The soils of sample 1 to 5 and 12 to 15 may be classified as saline while soils of sample 8 to 11 are saline/alkaline. The soils of sample 6 and 7 are sodic. The ds/m has also been estimated from 0.17 to 21.0. CEC has been estimated from 0.18 meg/00g. in sample 11 to 19.5 in soils of sample 9 while ESP ranges from 15.0 in soils of sample 2 to 69.2 in sample 13. The alkalinity of soils of sample 1 to 10 and 12 has been estimated as moderate while it has been estimated as severe in soils of sample 11, 13, 14 and 15. Further details of exchangeable cation in meg/100 are given in table 1.

Forest

The total area under forest is 15727 ha. Which is 4.6% of the total area of the district.

Population

The total population of the district as per census 2001 is 1316790 out of which 693438 are males and 623352 females. Out of total population, 1180965 is rural and 135825 urban. Tehsilwise distribution of population is as follow:-

1. Lalsot = 279567
2. Dausa = 333496
3. Baswa = 283275
4. Sikrai = 211631
5. Mahwa= 208821

The density of population (2001) is shown in Fig.5

DATA USED

The Desertification Status Mapping (DSM) aims at recording the latest terrain characteristics with special reference to the processes and

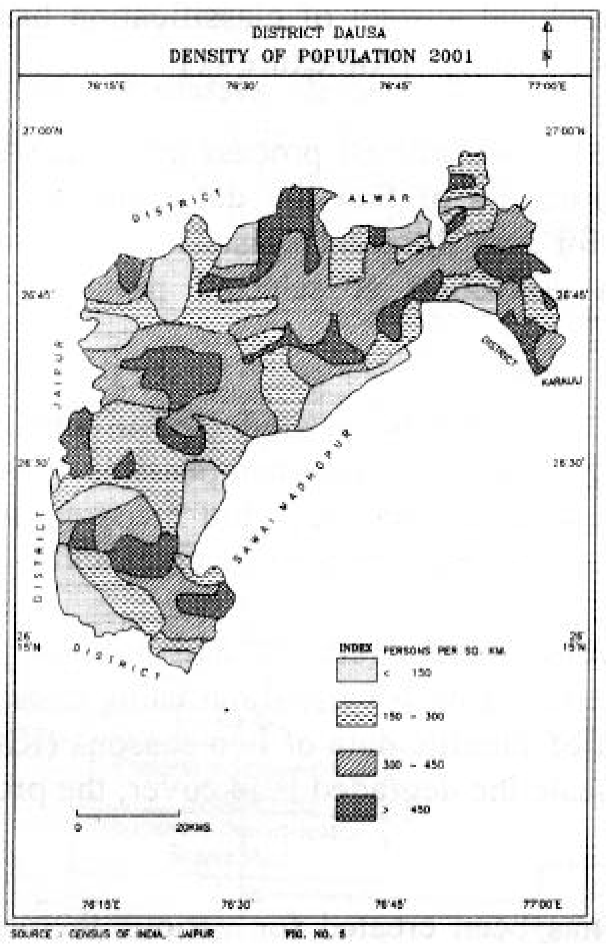

Fig. 5 Density of population (2001)

severity of degradation within each parcel of land under desertification using satellite data. In view of this latest multidate IRS 1D-LISS III data for Kharif (September-October 2001) and Rabi (January 2002) season pertaining to normal monsson/rainfall year have been used.

The following 14 S.O.I. topographical sheet on 1 : 50,000 scale have been used and equivalent number of respective geo-coded paper prints on 1:50,000 have been used.

54A/04, 54A/08, 54A/12, 54A/16, 54B/01, 54B/02, 54B/03, 54B/05, 54B/06, 54B/07, 54B/09, 54B/13, 54E/04 & 54F/01

A lot of collateral data as well as socio-economic profile of the area was collected from the district headquarters/study area in the form of maps, published reports, statistical data etc. Ancillary information in the form of related map and data is also acquired from other concerned organizations/institutions.

METHODOLOGY

The methodology and classification system has been finalized after brainstorming discussion with various collaborating agencies and academia (Fig.6). A three level hierarchical system of classification has been followed for the desertifiction status mapping. (Annexure -1)

Preparation of DSM is an ordered process of certain logical steps carried out using visual interpretation of Satellite data, mainly IRS-LISS III geo-coded FCC paper prints for two different seasons viz. kharif and rabi followed by ground truth data collection at selected points and then finalization of preliminary DSM.

A reconnaissance survey has been conducted in and around the study area to grossly assess the type, extent, cause and possible consequence of the problem with regards to ground conditions. This helps in standardizing the image signatures of various land degradation processes and their varying severity.

Once having collected all the relevant and necessary information about the area, the visual interpretation is carried out using latest

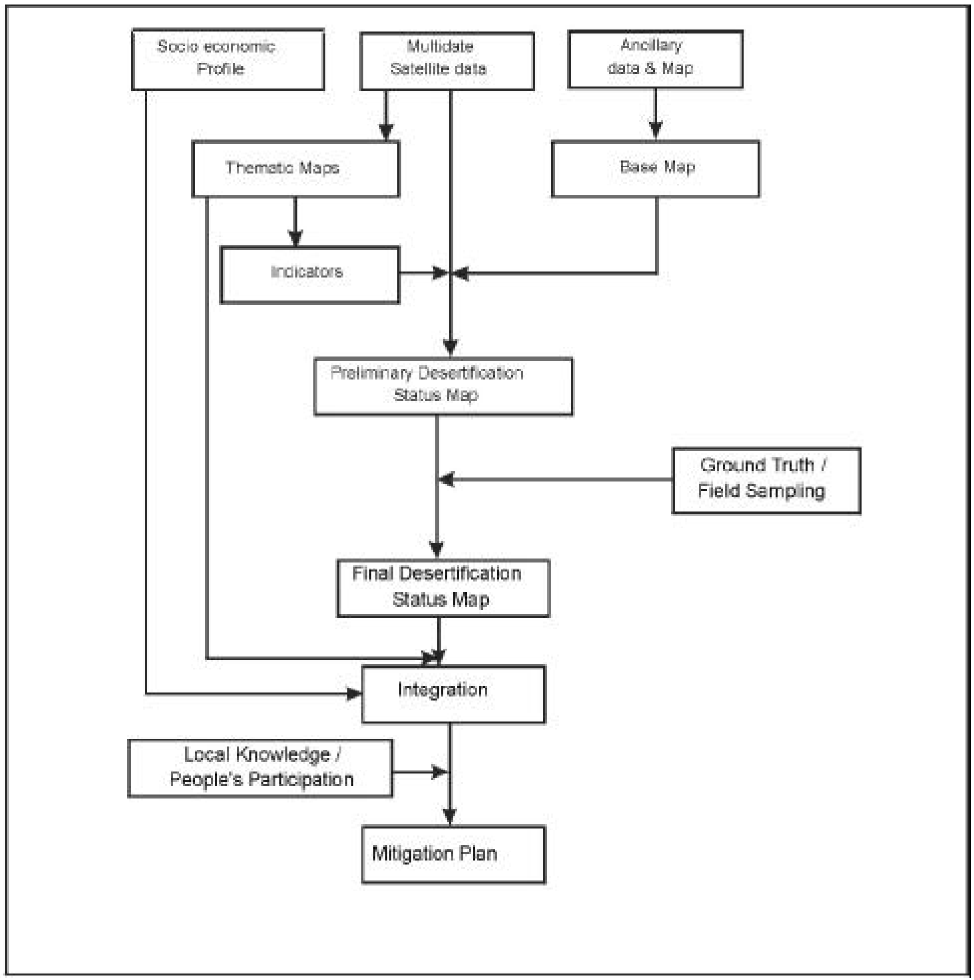

Fig. 6 Methodology for Desertification status mapping / mitigation plan using satellite data

Table-1

Analysis of Representative Soil Samples of Dausa District

L.S.No.	Salinity	Water Extract		Alkalinity	ESP	CEC meg/00g	Exchangeable cation meq/100			Remark
		pH	ds/m				(Ca+mg)+2	Na	K	
1.	-	8.55	0.32	Moderate	15.7	10.2	8.4	1.6	0.16	a2
2.	-	8.5	0.25	Moderate	15.0	2.4	1.8	0.36	0.22	a2
3.	-	8.6	0.25	Moderate	19.2	7.6	5.9	1.46	0.20	a2
4.	-	8.75	0.24	Moderate	18.2	4.4	3.3	0.8	0.26	a2
5.	-	8.5	0.17	Moderate	23.0	2.0	1.1	0.46	0.38	a2
6		9.2	0.60	Moderate	25.25	8.0	5.9	2.02	0.10	a2
7.	Sodic	8.85	0.14	Moderate	26.4	9.6	7.5	1.98	0.08	a2
8.	Saline/Alkelin	10.6	4.60	Moderate	38.9	18.0	10.8	7.0	0.16	s1a2
9.	-	8.53	1.37	Moderate	21.5	19.5	15.2	4.2	0.10	sa2
10.	Saline/Alkelin	8.95	21.0	Moderate	27.6	17.0	12.2	4.7	0.08	s2a2
11.	Saline/Alkelin	10.35	6.0	Severe	57.7	0.18	7.5	10.4	0.08	s1a3
12.	-	9.4	0.39	Moderate	33.3	1.8	1.1	0.6	0.04	s-a2
13.	Saline	10.2	12.5	Severe	69.2	14.6	4.4	10.1	0.06	s2a2
14.	-	9.5	2.0	Severe	50.0	13.2	6.2	6.6	0.44	s-a3
15.	-	9.2	2.2	Severe	42.3	8.5	4.8	3.6	0.08	s-a3

multi temporal satellite data. Interpretation of satellite data of two seasons (Kharif and Rabi) has been carried out to delineate the degraded land cover, the process of degradation and its severity.

Spatial data base has been created for various thematic layers, viz. landuse/ land cover using ARC /INFO GIS Software. The analysis of thematic layers has been carried out in GIS environments.

The soil samples have been selected randomly from 15 sites and subsequent soil sample analysis has been carried out. Different kinds of land use classes, desertification processes and severity as seen on satellite images are given in Table 2.

DATA ANALYSIS AND RESULTS

The data related to landuse/land cover, process of desertification with their severity have been tabulated in table 2. The table give details of various categories of land use/land cover & desertification processes of each scene studied and overall status of desertification of Dausa district.

Land use / land cover

In the region under study, agriculture unirrigated, agriculture irrigated, forests, grazing land, land with scrub, rocky, sandy areas, water bodies and settlements have been identified. The areas under rocky and sandy areas and dunes are not very significant in Dausa district. There are foothills obstacle dunes in which water erosion is taking place resulting into gullies and ravines. The land under agriculture unirrigated and agriculture irrigated is widely

Table -2

Desertification Status Mapping of Dausa District

Category Wise Area in Sq. Km. With Percentage

Category	Area	%%
Bs1	0.06	0.01
Bv1	0.29	0.03
Bv3	0.43	0.05
Bw2	0.11	0.01
Ee1	7.49	0.82
Ee2	0.37	0.04
Ee3	0.18	0.02
Ew1	0.16	0.02
Ew2	1.91	0.21
Ew3	1.70	0.19
Fv1	80.25	8.73
Fv2	58.54	6.37
Fv3	42.79	4.66
Fw1	2.52	0.27
Fw2	4.72	0.51
Fw3	26.54	2.89
Sal	7.94	0.86
Sa2	11.50	1.25
Sa3	12.35	1.34
Sals1	15.48	1.69
Sa2s1	1.95	0.21
Sa2s2	3.01	0.33
Sa3s2	0.61	0.07
SI3	0.24	0.03
Ss1	6.83	0.74
Ss2	2.84	0.31
Sv1	94.47	10.28
Sv2	100.97	10.99
Sv3	32.18	3.50
Sw1	118.62	12.91
Sw2	148.89	16.21
Sw3	132.84	14.46
TOTAL		**100.00**
Desertification Status	918.76	26.97
Water-bodies	5.88	0.17
River	97.25	2.86
Settlement	31.76	0.93
NAD	2352.49	69.07
Out area		
TOTAL	3406.14	100.00

distributed. Nearly 69.07 percent or 2352.49 square kilometers of area of the total area of the district is under this category. This area is generally unaffected by the processes of desertification. 31.76 square kilometers of area is under settlements which is 0.93 percent the total area of the district.

Forest Area : The forests are confined to the hills running from south east to north east. The area is under serious threat to vegetal degradation and water erosion of various stages of severity.

Land with scrub: The area under this category are confined to foothills, particularly pediment zones and isolated patches near river sides.

Desertification Processes

In Dausa district the following disertification processes are significantly marked on maps :

1. Water erosion
2. Salinization and alkalinisation
3. Vegetal / Forest degradation.

Water erosion resulting into gullies and ravines is very significant in the district. The tributaries of the Banganga, foothill slopes and piedmont zones are under threat of water erosion. More than 400 square kilometers of area or nearly 42% of the degraded areas of the district is under the process of water erosion.

The saline/alkaline areas/processes are widely distributed in the district. The southern and western-central areas are prone to salinization / alkalinization. Few patches are found in the north eastern part. The saline patches are generally confined to those areas where the top soils of sandy areas have been removed by erosion.

Vegetal degradation is confined to hill zones and plain areas near water courses.

CONCLUSIONS & RECOMMENDATIONS

The multidate satellite data reveals that desertification is a land degradation problem of great importance in the region under study. Degradation in soil and plant cover have adversely affected nearly 918.76 sq.km. area or 26.97% of the land areas as a result of human mismanagement of cultivated land on marginal areas. Water erosion in the form of ravines and gullies, salinization, vegetal degradation and water erosion on dunal areas are main desertification processes in Dausa district. The problem of salinization and alkalinisation are very acute which further accelerated gulleying and ravination in such soils. The region has been under the grip of consecutive droughts during last three decades which has further exaggerated the effects of desertification.

Solutions to desertification in region under study can be implemented readily if resources are available to do so. An exploding population will continue to build pressure on land resources. This would further hasten the destruction of vegetal degradation by the ever increasing demand for fine wood and other requirements. The future droughts will have greater damaging effects on all walk of life.

Combating desertification can be done successfully using technology already known if financial resources are available and the political will to act is present.

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Annexure -I

Classification System

A three level hierarchical system of classification has been followed for the desertifiction status mapping. This is explained as below :

LEVEL 1 : Land Use/Land cover

The following categories have been identified as below –

Agriculture – Unirrigated	(D)
Agriculture – Irrigated	(I)
Forest	(F)*
Grassland/Grazing land	(G)
Land with Scrub	(S)**
Barren / Rocky Area	(B/R)#
Dune/Sandy Area	(E)
Water body/Drainage	(W)
Others (Urban, Glacial, Peri-glacial, Manmade etc.	(T)

(*Rocky areas within forest can be annoted as only R in the map)

(**Vegetal degradation in Land with Scrub around periphery of notified forests can be delineated as SV_)

(Encroachment in forest area esp. agricultural practices, is FV3)

(#Barren and Rocky areas to be delineated separately us B or R and shown in others category of the legend)

(All settlements should be hatched)

LEVEL 2 : Processes of Degradation –

Types of morphological processes resulting in degradation :

Vegetation Degradation	(V)
Water Erosion	(W)*
Wind Erosion	(e)
Water Logging	(l)
Salinization Alkalinization	(s/a)**
Man made (Mining/Quarrying, Brick Kiln, Industrial Effluents, City Waste, Urban Agg etc.)	(m)
Mass Movement	(g)
Weathering	(h) – [in cold areas]

(*Gully/ravines should be shown as Xw3, where x is the Land use/cover class of surrounding area.)

(**Salinization or Alkalinization should be shown as ‘s, or ‘a’ separately. Where both occur, they should be shown together i.e. $s_x a_y$, where x and y are respective degree of severities)

LEVEL 3 : Severity of Degradation –

This level represents the degree and severity of the degradation.

Slight	1
Moderate	2
Severe	3

The details on the severity classes for different desertification process are given as under.

a) Vegetative Degradation

Status criteria	Desertification classes: Slight	Moderate	Severe
Plant community	Climax or slightly changed	Long lasting secondary	Ephemeral secondary
Percentage of climax species	>75	75-25	< 25
Decrease of total plant cover, %	< 25	25-75	> 75
Loss of forage, %	< 25	25-75	> 75
Loss of current increment of wood, %	< 25	25-75	> 75

b) Water Erosion

Status criteria	Desertification classes		
	Slight	Moderate	Severe
Non-arable land			
Type of erosion (Depth and Width is in Meters)	Sheet erosion or Single rills – (Depth < =0.5m and Width = 0.4-0.9m)	Rill erosion, or Formation of gullies- (Depth-0.6-3.0m and Width-1.0-3.5m)	Network of gullies- (Depth 3m-10m and Width 3.5-20.0m) or Wide deep gullies/ Ravines (Depth >10 m, width 20-40m)
Density of channels, linear km per sq. km	< 0.5	0.5-1.5	1.5-3.0
Removal of top soil horizon, %	< 0.5	0.5-1.5	1.5-3.0
Removal of top soil horizon, % Arable land	< 25	25-50	> 50
Removal of top soul horizon	< 25	25-50	> 50
Loss of yield of main crop, %	< 25	25-50	> 50

C) Wind Erosion

Status criteria	Desertification classes		
	Slight	Moderate	Severe
Non-arable land Sand Sheet in Cms	<30 cm per hummock Upto 100 cm over plains	<50-150 cm/ stable dune and sandy hummock (East of 300mm Isohyet) <90-300 cm/ reactivated sand/ plant roots upto 40-100 cm (West of 300mm Isohyet)	<1-4m dunes/ 100-300 interdunal sand/ Barchans 2-4 cm (mostly west of 300 mm Isohyte) 2-5 m active/ drifting dunes-Very Severe
Percentage of area covered with sand dunes	< 30	30-70	> 70
Percentage of area covered with sod forming plants	50-30	30-10	< 10
Arable land			
Removal of top horizon. %	< 25	25-50	> 50
Blow-outs, percentage of area	< 5	5-10	> 10
Loss of yield of main crops, %	< 25	25-50	> 50

d) Salinity/ Alkalinity

Status criteria	Desertification classes		
	Slight	Moderate	Severe
Soil salinity and Alakanity			
Ref : NRSA and AISLUS	4-8 ds/m	8-30 ds/m	> 30
	< 15	15-40	>40
Soil salinization, solid residue, %	0.20-0.40	0.40-0.60	> 0.60
Salinity of ground water, g/litre	3-6	6-10	10-30
Salinity of irrigation water, g/litre	05.-1.0	1.0-1.5	> 1.5
Seasonal salt accumulation, ton/ha	16-30	30-45	45-90
Loss of yield of main crop, %	< 15	15-40	> 40

e) Water logging

Status criteria	Desertification classes		
	Slight	Moderate	Severe
Water logging Ref. AIS&LUS and NRSA	Seasonal (Affecting one crop) 4-6 months	Affective two crops >6 Months of submergence	Inland Marshes

Annexure - III

Desertification Status Mapping:
Parameters amenable to Remote Sensing and Conventional Survey

Process of Degradation	Desertification Indicators	Degree of Severity		
		Slight	Moderate	Severe
Vegetal Degradation	% of Crown Cover*	40 -20	20 7 10	< 10
	Plant Community @	Clima X	Long Lasting Secondary	Ephemeral Secondary
	% of climax species @	> 75	75 -25	<25
	Decrease of total plant cover, % @	< 25	25-75	> 75
	Loss of forage (grasses) % @	< 25	25 - 75	> 75
Salinization	Crops Supported*	Two Crops	One Crop (Kharif)	No Crops
	pH@	< 8.5	8.5	> 8.5
	Soil Salinity	4- 8	8 - 30	> 30
	Ecenin ds/m @ Salinity of ground water g/litre @	3 - 6	6 - 10	10 -30
	Loss of yield of main crop @	< 25	25 - 50	< 50
	Soil residue, % @	0. 20- 0.40	0.40-0.60	> 0.60
	Salinity of Irrigated water g/litre @	0.5 - 1.0	1.0 - 1.5	> 1.5

***Amenable to Remote Sensing @ Amenable to Conventional Survey**

USE OF GEO-INFORMATICS FOR PREPARATION OF A DESERTIFICATION STATUS MAP OF STOD VALLEY (1F4C2), PADAM (ZANSKAR), DISTRICT KARGIL, J & K STATE

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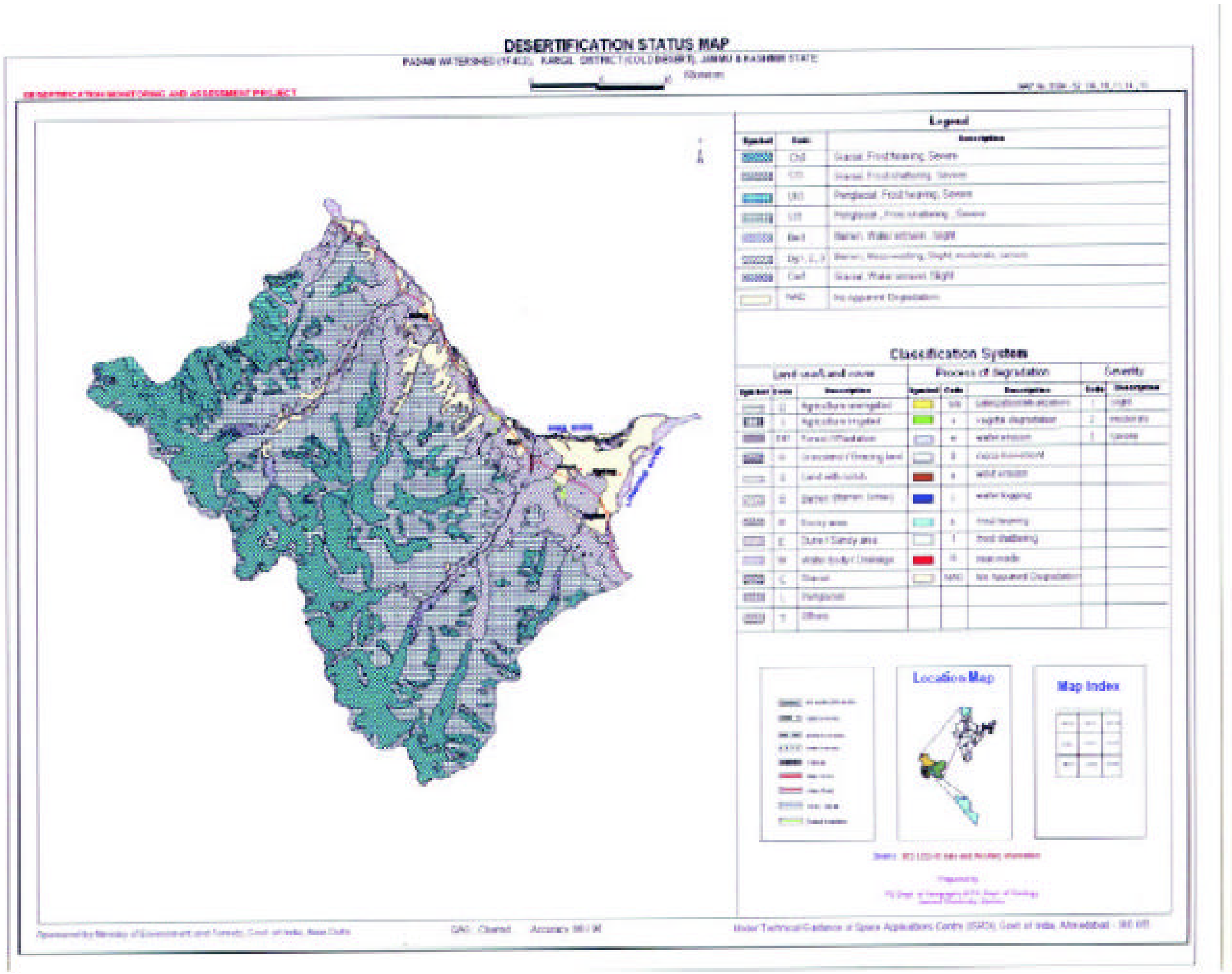
Abstract

The paper deals with the desertification status mapping of Stod valley of Zanskar region, District Kargil, Jammu & Kashmir State (India), located in the altitudinal belt of 3450m to 6200m asl. The valley, located in the rain shadow region of Tethys Himalaya is studded with eight major glaciers and experiences permafrost conditions for nearly eight months of the year. The temperature in the valley fluctuates between -48°C to -20°C in winters at different altitude levels qualifying it to semi-arid to arid climate designated as Bc . The permafrost conditions lead to solifluctuation and gelifluction process producing immature soils and cause for the triggering of natural geomorphic hazards, such as snow and rock avalanches, landslides and fluvio-glacial erosion. The hazards have been responsible in the mass movement and other catastrophic activities that result in high morpho-dynamic activity of erosion, breaking of ice and damming and bursting of lakes causing desertification of the region. Maps of geomorphic features, soils, slope, drainage and meteorology on the scale of 1:50,000 prepared on the basis of the IRS data supplemented by field work is for better understanding of desertification status of the area. Besides the IRS and field data, collateral data from Indian Meteorological Department, J & K State desert Development Authority and other state government agencies and NGOs have been consulted to authenticate the thematic maps. The field and satellite data complement each other in understanding the degradation of land cover and its processes and further categorize the land degradation into slight, moderate and severe. Different layers of data are digitized and later synthesized for the entire valley (711.78 km^2). Three zones of high morpho-dynamic activities, namely glacial-periglacial (533.13 km^2), barren (125.92 km^2) and agriculture, grassland and water body (52.73 km^2) are identified. The limited and restricted agriculture, based on monoculture with a very low yield, compels the male population to migrate and make handsome earning from outside the region. A combat map, based on the data generated by field work and study of IRS data to mitigate and check the further spread of cold desert, is under way.

INTRODUCTION

Cold deserts of India are situated in the rain shadow zones of Himalaya and Ladakh plateau, above an altitude of 3500m asl. Himalaya acts as a barrier to prevent the monsoons from entering the region as a consequence the summer precipitation is sparse and mostly in the form of snow. The winter temperature dips as low as -30° C (average) that leads to the operation of permafrost and peri-glacial conditions in the region.

The Ladakh Plateau, in general, and Zanskar region (Fig. 1), in particular, are subjected to strong seasonal pattern of energy and moisture regime consisting of dry summers and wet



winters. Radiation, temperature, humidity, precipitation and atmospheric pressure change rapidly with gain in altitude. Ambient temperature, density of atmosphere, concentration of water vapor and carbon dioxide decreases with gain in the altitude. The Green House effect of atmosphere drops the temperature sharply and ground surface heats and cools rapidly resulting in high diurnal temperature variations. The orientation of slope to or away from the sun determines the local heating character, a microclimatic variation within the region.

The intense climatic conditions are largely responsible for the degradation of landscape in Zanskar region. The growing population has further worsened the situation in the region.

OBJECTIVE

The major objective of undertaking the study at Stod valley, Padam, Zanskar is to prepare land-use policy map in the background of the deteriorated landscape due to intense climate conditions, and propose measures to mitigate the natural hazards, such as slope failure, snow avalanche, etc. , on a short and long term basis

STUDY AREA

Stod valley (Padam) is the largest valley of Zanskar region. The altitude of study area ranges from 3450m to 6270m asl and is studded with eight glaciers, namely Haptal, Yaranchu, Shimling, Mulung, Kanthang, Gompe, Chabber and Denya. The largest of all these is Haptal glacier with an approximate area of 53.85 km^2. The Stod valley is enclosed on three sides by lofty ridges, Pensi La pass and Durung Drung glacier in the northwest; Mulung, Haptal, Shimling glaciers and Umasila Pass in the west, south and southwest; and Tanglangla Pass in the east and Stod river in the north. Umasila Pass along the Great Himalaya in the west connects Zanskar region with Padar valley of Kisthwar.

Stod (Padam) valley contains some of the highest and steepest mountain slopes. The relative relief of main valley is rarely less than 2500m, even the tributaries have an elevation difference of 2000m in a horizontal distance of 2 to 4 kms. Valley walls are covered with rills, gullies and mud channels. Massive debris slope covered with scree gradually merge with fans, low terraces, valley fills and channel gravels on the floor of valley. The magnitude of relief, steepness of slopes and debris accumulation causes the instability of slope, mass movement and thus trigger catastrophic events that are accentuated by the arid environment of the region.

Stod (Padam) valley is represented by the rocks of Central Crystalline, Phe Formation and Purple Formation. Most of the south, southwest and west part of Stod is represented by Central Crystalline rocks consisting of crystalline schist, stratified migmatites, porphyritic granites, gneisses and feldspathic quartz-muscovite-biotite schist often garnetiferous. The rocks are intricately folded into flextures, flexture slips, recumbent and disharmonic folds. The rocks of Phe Formation, exposed in north and northwest of Stod consist of phyllites, slate, quartzite, greywacke, grey-green micaceous sandy slates, brown ferruginous sandstones and limestone. In north and northwest parts of study area, overlying Phe formation is thick sequence of conglomerates, quartzites and slates characterized by purple colouration and designated as Purple Formation.

METHODOLOGY

The study area is covered by IRS 1C/D-LISS III satellite image covering paths 76.15-77.0 and rows 33.15-33.45 for the months of May and October 2001. Topographic sheet nos. 52C/6, 52C/10, 52C/11, 52C/14 and 52C/15 of Survey of India on the scale of 1:50,000 of the year 1965-66 (surveyed in 1962-63) were consulted for field study during the field season of the year 2002-2003. The basic approach was to have a comparative analysis of the study area during last 40 years to evaluate geo-ecological and geomorphic damages during the said period as a result of extreme cold arid conditions. The study involves (i) traditional field work to study and generate data on geomorphology, geology, climate/weather and landuse of the region. Studies are planned to augment the understanding of dynamic geomorphic processes and interviews were conducted of local people and decision makers to determine the human perception of hazardous situation as well as responses they provoked, (ii) preparation of base maps, such as drainage map, slope map, natural vegetation map, land-use map, etc., and (iii) assimilate the data generated to prepare hazard map and suggest necessary plans to combat the hazards on the basis of geomorphological evidences based on geomorphic processes and field checkup of draft map to determine limits of accuracy.

GEO-ENVIRONMENTAL ANALYSIS

a) Climate : Climate plays an important role in causing and controlling desertification of the region. The Stod (Padam) valley is under the influence of Western Disturbance (WD) and as such receives heavy snowfall during winter season. The WD causes widespread changes in the weather, including distribution of moisture in the form of snow as well as effects the temperature and hygrometric conditions. Abrupt fall in temperature is peculiar phenomena of WD disturbance in the region. The variation in minimum diurnal temperature is very large and the temperature dips as low as -4 5° C resulting in the freezing conditions. The analysis of weather data for past fifty years (1950-2000) shows no seasonality pattern as major part of the year (almost eight months) experiences cold weather. The summers are weak and last for four to five months only. The average daily temperature during summer season is 13° C with highest reaching to 26° C. The diurnal variation in summer temperature is 10°C. The atmospheric temperature begins to decline from September and dips to its lowest during nights of January-February at an altitude of 4000m (-30° C to -40° C). The annual average precipitation is 573mm of which 90% is received in the form of snowfall between the months of November and March. The average snowfall received is 2 to 10m. However, floor of Stod (Padam) valley receives less snowfall and frost action serves as primary weathering agent. The intensity of frost rises with elevation that leads to severe weathering in the form of frost shattering. The area of study has arid to semi-arid type of cold climate with 90% of precipitation concentrated in winter months, moisture regime of 30, moisture index -65 and thermal efficiency of 40%, designating the valley as E type of climate zone (Thornwaite) and H type of climate zone (Oliver and Hidore 2003).

b) Geomorphological Processes : The exogenic processes powered principally by solar and gravitational energy modify the Stod valley from outside. The solar and gravitational energy are responsible to major exogenic processes related to glacier sliding, processes of permafrost and mass movement, fluvial, glacio-nival processes. The processes occur at varying rate at various level of spatial resolution. On account of this, much of the present character of the topography is polygenetic composed of elements produced by glacial, periglacial and glacio-fluvial in geological past. A study of currently operative glacial and periglacial activities throw light on the landforms that were created by similar agents in the geological past. The glacial and periglacial agencies produce frost shattering and frost heaving processes that supply the raw material to glacier for erosion and subsequent deposition. Nival processes play a major role in shaping the landscape by way of generating certain micro-climatic processes leading to the weathering. Frost shattering and frost heaving in the higher altitudes leads to solifluction and nivalfluction resulting in major mass movement processes.

The five major glaciers, namely Haptal, Mulung, Yaranchu, Kanthang, Chabber, of the eight major glaciers of the region, are confined in high Himalayan ice field commencing at an altitude of 5600m along south western margin. Three major glaciers, namely Shimilng, Denya and Gompe, are confined in Zanskar upland. There neve fields coalesces with each other and join the main ice field of Zanskar upland at an altitude of 5300m along southern margin. Present day glaciers are the relics of their mighty predecessors of Pleistocene period when they extended to Padam basin. The High Himalayan glaciers are comparatively longer in length (18 to 12 km) than the Zanskar upland glaciers (12 to 6 km). The glaciers are primarily cold dry type as major portion are confined to protracted cirque valleys of higher altitude. Normal temperature gradient does not permit upward escape of geothermal and frictional heat, so that cold glaciers are normally frozen to the bed. The lower portion of the glacier particularly in the vicinity of the ablation zone (snout) is mainly confined in the lower altitudes where conditions during the summer are slightly milder and the glacier behaves as a warm wet type. In this part melting occurs in short summer ablation season which results in the formation of marginal and supra glacier streams temporarily along with the runoff which contribute to the discharge of Doda and Lungnak rivers.

Majority of high altitude zone along with the valley slopes are subjected to extreme low temperature for the major part of the year. The water freezes in the cracks and also within the soils of valley walls and are subjected to intense stress due to high diurnal temperature. This results in cryostatic pressure that increases as temperature falls below -25^{0}C. Further the ground ice trapped below the surface of the earth results in the formation of sheet wedges and frost thrusting. These features lead to formation of differential heaving processes. In the higher reaches, particularly in the cirque basin vacated by glaciers, thawing during summer season produce more water than retained in the voids of soil. It leads to the thermokarst conditions resulting in collapse of basin valleys and sometimes mountain foot and results in slumping and creeping of debris as well as scree.

Stod (Padam) valley has well developed drainage system. The antecedent drainage has distinctive characters and flows through various geological and structural set up. The rivers originate from an altitude of 4400m and traverse a distance of nearly 10 km to join Doda/Stod river, the trunk stream. The drainage system has developed trellis pattern in upland regions and dendritic in the region below the altitude of 5500m. The rivers originating from High Himalaya are of 5th order whereas rivers originating from other areas are of 4th order. The bifurcation ratio ranges between 3.5 and 8.1 reflecting the high rate of erosion in the valley.

A large flood plain, about 7km wide, is formed at the foot of Padam village where Lungnak and Doda river meet. Two levels of terrace surface are formed along the Doda river with an escarpment of 5m. the older terrace (T-1) stretches from Ating village to Padam covering a length of almost 25km and width of 3km. the terrace surface is fertile and supports the agriculture activity. The younger terrace surface (T-2) is about 900m in width and stretches from Sani village to Padam, a distance of about 11km. The terrace surface is not good for agricultural purposes as it is covered with boulders and sand.

The flowing/ running water on the ground surface has resulted in four types of water erosion- (i) rill and gully erosion, (ii) mass movement along rivers, (iii) mass movement on open slopes, and (iv) other elements of erosion.

The active medium of rill and gully erosion is the rain water. Less cover of vegetation/forest further accelerates the process of rill and gully formation. The river causes lateral erosion initiating mass movement along the river. The high gradient of river beds, shallow sediment in the river, and less or negligible vegetation along the banks of river are some of the factors that accentuate the mass movement. The nature of rock material (schist, phyllites, sandstone) and steep slopes are further responsible for rapid movement of material in the form of debris flow causing mass movement on open slopes. The debris flow is stabilized and is reworked, though rare, as landslide due to rainfall.

c) Vegetation & Livestock : The Stod valley has sparse vegetation with Rhizoweeds scattered sparsely in higher altitudes in the vicinity of permafrost areas. In the lower reaches there are meadows and pasture lands adapted to moderate heat and ranges between 3600m to 3800m. In this zone good loamy and fine grainy soil is available. Above 3800m there are few bush/scrub with various species of Hydrophilous plants. In the lower reaches particularly in foothills of the river basins plantation has been taken on large scale by NGOs and government machinery to stabilize the slopes and retrieve the area for afforestation.

Pastoral animal husbandry is important occupation of farmers of Stod valley. In all three are 25,919 animals, out of which sheep alone are 18,382 followed by goat (3291) and buffalo (2131). Nearly 3000 sheep and 54 goat are herd by each studied village. These two animals are herd by every household to supplement with cultivation. Literally whole life of people is revolved around the animals in carrying them to pastures in higher reaches during the summers. During last two decades, 1981-2001, livestock population has increased by 18.8%. Major increase has been found in sheep and goat population that has resulted in a lot of pressure on grassland as well as bushy land leading to land degradation and thereby increasing the rill erosion.

d) Agriculture : Agriculture is the mainstay of people. Out of the cultivable area of 1957.7 hectares, only 48.6% is cropped due to near availability of river water for irrigation. The agriculture activity is only for four to five months of the year as for the rest of year the fields are under thick cover of snow. In last two decades the agriculture practices have changed considerably and use of fertilizer and mechanization has increased the cropping from 860 hectares to 952.42 hectares, an increase by 10.7%. Wheat, barley, gram and peas are cultivated as food crop and fodder for animals. Almost 35% of cultivable land is devoted to wheat production.

e) People : Six villages inhibit the valley and are linearly located along the Doda river. The data with regard to the size of village and agriculture land is retrieved from satellite imagery, topographic sheets and ground checks. The correlation between the number of households and village size is found to be between 0.8 and 0.9. The villages - Ating, Padam, Salapi, Sani, Pipting and Rugrug - cover an area of 1957.7 hectares. The area of village has increased by 28% since 1981. About 4200 people of the region confine to 1.5% of the total area. The population of the region has increased by 54.5% since 1981. The density of population of region is 2.6 person/ km^2. The study further reveals that 52% of population is male and 48% is female of which 20.7% fall in age group 0 – 15 years, 18% in the age group of 15-30 years, 28% in the age group of 30-45 years, 19% in the age group of 45-60 years and 14% in the age group above 60 years. The total literacy rate is 18.78% with literacy rate as high as 75.5% in male and 24.5% in female.

DESERTIFICATION STATUS

The Desertification Status Map of the area has been prepared on the basis of satellite imageries, topographical maps and the data related to geomorphological studies retrieved from the field (process and form). The map has been evolved by overlapping the Level 1- landuse and land cover, Level 2- process of degradation related to vegetation, water erosion and mass movement processes, and Level 3- on the severity of degradation (slight, moderate and severe) layers with the help of GIS technique(Fig.1).

The glacier area is presently confined to 8 major glaciers (5 located in high Himalayan flank and 3 in Zanskar upland). They cover an area of 193.55 km^2 (Survey of India Topographical sheets 1963). The area has shrunk to 188.47 km^2 as per the satellite imageries and field study (2003). During last four decades there has been net reduction of 5.08 km^2 of area because of persistent arid conditions. This clearly reveals that the glaciers during last four decades have been retreating at a very slow rate of 1 to 2 m per annum. This is a usual phenomenon with the Zanskar glaciers. The landuse category of glaciers has a slope of 8° to 40°. Out of the total area, 86% has a moderate slope (8^0-30^0) and rest has a steep slope (32^0 to 40^0).

The glacier landuse category has further divided it into three categories: frost heaving, frost shattering and glacier melt water erosion on the basis of geomorphological degradation processes.

Glacial frost heaving landscape is mainly confined to higher reaches of Himalaya and Zanskar uplands. The region is experiencing extreme cold arid climate and the temperature during major part of the year is below freezing (-30^{0}C to -45^0 C) leading to permafrost conditions along the glacier (ice) margin. The low temperature has lead to freezing of super saturated ice margins to permafrost conditions causing hydrostatic pressure leading to the production of ice wedge and rock glaciers. This landscape category covered an area of 177.58 km^2 as per the Survey of India topographical sheet (1963) and 172.50 km^2 as per field survey (2003). During last four decades the area under this category has shrunk by 5.08 km^2, indicating the vacation of land due to the melting of the glaciers.

The glacial frost shattering category is mainly confined along valley walls of the glaciers. In the frost shattering process the rocks are subjected to repeated cycles of freezing and thawing. Rocks have a different thermal conductivity and rapid freezing favors the break down by wedging. This process of degradation covers an area of (16.11 km^2) whereas in 1963 it covers only 12.26km^2. As such, in last four decades an addition of 3.85km^2 to this category is because the area vacated by frost heaving has been replaced by frost shattering. Major frost shattering is confined between the altitude of 4500m to 5800m particularly along narrow valley walls of the Stod valley. In these areas diurnal variability in temperature is maximum that causes frost shattering by freeze and thaw activity. It leads to widening of cracks followed lateral displacement of rock material.

The landuse category under glacier water erosion is prevalent in the vicinity of snout from glacier melt water originate and flow down the valley. Presently the category covers 4.94km^2, whereas in 1965 the category covered the area of 3.71km^2 revealing marginal retreating of snout and increase in area of glacier melt water erosion.

Periglacial

Periglacial area is mainly confined to parts of Higher Himalayan flank and Zanskar uplands that are devoid of ice bodies. These areas have precipitous slopes. During winter season the snowfall on the bare slopes is sometimes drifted to the interior areas otherwise subjected to extreme freezing due to very low (-45°C) temperature for long duration of the year. The freezing leads to large pressure and stress conditions on the valley walls and solifluction and nival fluction in inter mountain basin floor and valleys. The solifluction and nival fluction leads the ground snow/ice below the surface to super saturate the upper ground surface. It leads to the process of ground freezing resulting in the formation of cracks and hummocks. During summer thawing produces more water than retained and lateral planation and frequent freezing develops thermo planation and frost thrusting along the valley walls due to differential heaving. Along the valley walls there is a mass wasting caused by super saturated permafrost frozen walls that moves down slopes and produce scree cones and rock glaciers. In the basin floor patterned ground is produced. The periglacial area covers 339.58km^2. Out of which 290.63km^2 is produced by shattering and 48.95km^2 by heaving processes.

The periglacial frost heaving is mostly confined to the foot hill of the mountains along the valley margin covering an area of 48.95 km^2 out of which 88% lies in Zanskar upland having a slope of 32°. In these areas ice wedge and solifluction is observed upto the depth of 3m between the rocks and within the thermokarst basins. The process of thawing in these areas leads to the mass movement processes.

Periglacial frost shattering is confined to High Himalaya and Zanskar upland slopes having an average slope of 16° to 40°. This landscape category covers an area of 290.63 km^2. In these areas in initial stages small polygons 4m to 5m length, 2m to 5m width and depth of 70cm to 80cm occur on the slope where cracks are produced and later block rings are shaped which facilitates movement of water in the cracks. These cracks freezes and increases in volume thus causing hydrostatic pressure on crack walls, followed by lateral displacement along the slope.

Barren water erosion This landscape category is confined to altitude of 4200m to 5000m and having a slope of 16° to 40° mainly confined in Zanskar upland with large Ist order channel leading to sheet erosion on barren rock surfaces.

Barren mass wasting

This category of landscape covers an area of 115.77 km^2. Majority of the category is confined in the vicinity of 5500m to 5800m where average slope ranges 16° to 32°. The second mass wasting is confined near the foot hills of Zanskar upland on the rocks of phyllites, schists and quartzites. The barren mass wasting category is of three intensities slight, moderate and severe.

Slight mass wasting covers an area of 22.41 km^2 that is confined to Zanskar foothills having a slope of 8° to 16°. Rest of the area is confined to upper Zanskar uplands.

Moderate mass wasting covers an area of 41.82 km^2 confined in entire basin except the High Himalayan flank along the slope of 8° to 24°. The moderate mass movement has produced scree slopes of varying dimensions and shapes.

Severe mass wasting is confined to High Himalayan and upland slopes of Zanskar. It covers an area of 51.54 km^2. In this category severe sliding of rock debris is produced by freeze and thaw due to large diurnal thermal variation.

Barren This category is found mainly on steep slopes which are very susceptible to sliding. This is mainly produced along the road construction, slope cuttings and diversion of collected waters. Some of the barren area is also produced in over grazed grasslands leading to rill wash erosion.

Not Apparent Degradation In the Stod valley, the least affected by degradation processes covers an area of 47.57 km^2. It includes agriculture land, grassland and water bodies. The agriculture land covers an area of 14.99 km^2 out of which 0.43 km^2 is under social forestry. Most of the agriculture land is confined along the terraces in the vicinity of Stod/Doda river. The grassland is widely scattered and is confined along the valley bottom particularly in the vicinity of water logged areas. Some grassland area is found in foot hills where shrubs are found. The total grassland area covers 19.91km^2.

The water body covers an area of 12.24 km^2 and includes trunk river Doda and its tributaries, fed by melt water of glaciers.

MEASURES TO COMBAT DESERTIFICATION

Mass wasting is the major degradation category found along the valley slopes. It is primarily an outcome of slope failure and slope gullies. The mass wasting move rapidly to river channels as mud flow and debris flow that contribute to siltation problem. The reclamation of failed slopes particularly of scree slopes is very difficult but mud flow and other debris flow slopes can be stabilized by constructing embankments and terraces. Further, these areas can be stabilized by planting saplings of Willow and Popular trees. NGOs and J&K Forest Department have already initiated reclamation of large number of slopes in the vicinity of Padam by social forestry. Further, check dams can be constructed in the upstream of the Doda river at different altitudes to store water and canalize it to the nearby lands for raising grasslands.

DISCUSSION AND CONCLUSIONS

The entire Stod (Padam) valley has been divided into four major geo-ecological zones-basin floor, mountain rim, Zanskar uplands, and High Himalayan flank (Fig. 1). These divisions are based on the characters of drainage pattern, nature of slope, predominance of geomorphic agency, climatic characteristic and vegetation. The altitude variation is explanatory variable of vegetation and climate as later are indicators of former. Further the utilization of land for cultivation and other kinds (forest, grazing land, barren and other types of landuse) depend on climate, soil and slope which themselves are functionally related to altitude. Basin floor comprises alluvial plain and river terraces produced by Doda river in north-northwest and Lungnak river in the east that confluences at Padam. At their confluence they have produced old and new alluvial plains. The basin floor covers an area of 91.8km^2 and extends in altitude 3500m to 3800m and has drainage density 1.65/km^2. Mountain rim extends between 3800m to 4600m and covers an area of 111.71km^2. The region has bushes and dry grasses along with scree slopes and fans on valley walls. It has a high drainage index of 6.6/km^2. Zanskar upland extends between 4600m and 5800m, and comprises denuded mountains of Phe Formation. The region covers an area of 238.54km^2. It houses number of glaciers and has moderate drainage density of 2.52/km^2. Large grazing grounds and pasture are located at lower altitude in the vicinity of 4600m to 4800m. High Himalayan flank lies between 5800m to 6100m altitude, and covers an area of 26.73km^2. It houses number of glaciers. The region has overall permafrost topography produced by periglacial activity.

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Journal of Geomatics

Indian Society of Geomatics launched the first issue of a peer-reviewed six-monthly publication, Journal of Geomatics, in May 2007. The guidelines for authors were published in the same issue of the Journal and are also put on ISG website: www.isgindia.org. All members are requested to use the opportunity of submitting articles for publication in the Journal.

Interested readers can view the abstracts of articles published in April 2007 issue at the following

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TORRENTIAL RAINS AND FLASH FLOODS IN RAJASTHAN DESERT - ROLE OF GEO-INFORMATICS FOR RAPID ACTION PLAN AND DISASTER MANAGEMENT

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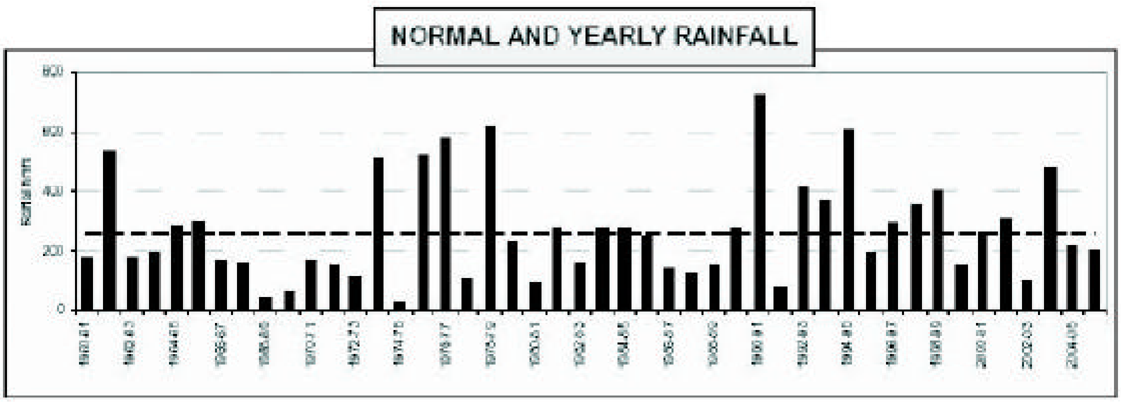
1. INTRODUCTION

In the month of August 2006, Barmer and Jaisalmer districts received heavy, widespread and continuous torrential rains for nearly one week, particularly during August 20th to 23rd amounting to nearly 400 mm of rainfall in 4 days. Because of such heavy rains all water bodies got filled and ephemeral streams drained heavy run-off to the lower areas. As a result, the settlements, which were in lower areas (interdunal flats & depressions) got submerged resulting in heavy damage to human, livestock, property and infrastructure, particularly Kawas/Sar ka Par (with population of 1225), Malwa (515) and Uttarlai (4188) as per 2001 census. The analysis was carried out by Regional Remote Sensing Service Centre (RRSSC), Jodhpur to investigate the scenario and provide relief solution on war footing by understanding the gravity of situation under the ISRO's societal mission for disaster management support.

2. STUDY AREA

Study area comprises of Barmer district of Rajasthan, situated in South-West of Rajasthan. It is bounded by latitude 24° 44' & 26° 26' and longitude 70° 01' & 72° 57'. Total area of the district is 28387 km^2 making it second largest district in Rajasthan. The district is divided in 8 sub-districts and 8 panchayat samities. Total number of villages are 1625. Population of district as per census 2001 is 1,964,835 with population density as 69 persons / km^2. Extreme temperature and erratic rainfall characterize the district. Temperature varies from 0° to 49° C. The average annual rainfall is 260 mm. Small offshoots of Aravalli can be seen in the east of district. Area is dry and forms a part of the Thar desert. Luni is significant river in the district, which enters from east of district and after flowing west, drains towards south. Sandy plains, dune complex, alluvial sandy plains and interdunal flats are major landforms.

Extreme events of rainfall were observed in Barmer district over a period of time. In a span of last 107 years, Barmer has received rainfall more than 150% of normal value during the years 1907, 1908, 1909, 1913, 1916, 1917, 1921, 1926, 1927, 1931, 1944, 1978, 1990,



1991, 1994, 1998 and 2003 apart from heavy rains of 2006. The years when less than 50% of normal rainfall (Severe droughts) occurred were 1901, 1904, 1905, 1918, 1925, 1930, 1968, 1969, 1972, 1974, 1977, 1980, 1987 and 2002. Figure 1 shows the actual and normal rainfall for Barmer district over the years.

3. DATA USED

To analyse the flood situation and provide rapid action plan, following data sets were used in the analysis:

1. IRS LISS III, IRS AWiFS
2. Radarsat SAR
3. SRTM Digital Elevation
4. Landsat ETM
5. IKONOS
6. Topomaps (Surveyed in 1928 - 30), published by US Army (1955)
7. SOI Toposheets surveyed in 1958-59 and 1983-84
8. Climate records
9. Digital archive data of RRSSC-J.

4. ROLE OF GEO-INFORMATICS

The occurrence of flood in Barmer is a historic event as this area has not witnessed such loss of property, infrastructure, human and livestock population in recent past as gathered from different departments and media. Satellite Remote Sensing is the only available tool as on today to understand the entire flood phenomenon in near real time by viewing multi-date images (pre, during and post) for understanding and mapping of water spread areas, progress of water recession, stream & channels of flood water flow, demarcation of catchment's area, elevation, gradient, slope, depression areas, submerged settlements, damage assessment of infrastructure and agriculture lands, identification of safer sites for rehabilitations, optimal routes for draining out flood water from submerged villages, obstructing dunes along the drain path and destination of the drained flood water and finally the Environmental Impact Assessment. The analysis was a challenge due to desertic nature of the terrain and non-availability of well-demarcated drainage network and catchments with most of the organizations approached for database and outputs on current floods.

5. ANALYSIS AND RESULTS

5.1 Water spread area analysis

Water spread area were analyzed using data of 24th August 2006 and 5th September 2006 for immediate rapid action plan generation. Total water spread in entire Barmer district was 244.51 km^2, on 24th August, which reduced to 171.91 km^2 on 5th September 2006. Size wise distribution of water bodies as on 5th September 2006 is given in table 1.

Table 1 : Size and number of water bodies in Barmer district as on September 5, 2006.

S.No.	Size	Number
1	< 2 ha	887
2	2 - 5 ha	218
3	5 - 10 ha	136
4	> 10 ha	240
	TOTAL	1481

Change analysis was carried out for Kawas, Malwa and Uttarlai water spread areas. Following table shows the status of water spread on two dates.

Table 2: Water spread on 24th August and 5th September 2006

Places	Water spread (km^2) As on 24th Aug. 2006	Water spread (km^2) As on 5th Sept. 2006	Change (km^2)
Barmer district	244.51	171.91	72.60
Kawas	18.07	17.25	0.82
Malwa	5.64	4.66	0.98
Uttarlai	21.03	19.64	1.39

From the Table 2 it is clear that there is marginal change in water spread areas at three most affected sites.

Analysis was continued even after submission of rapid action plan and Table 3 shows the status of water spread at later dates also. Figure 2 shows the water spread at Kawas on different dates.

5.2 Slope, drainage and catchment analysis

Slope, drainage and catchment analysis was done based on interpretation of Digital Elevation Model (DEM) data from Shuttle Radar Topographic Mission (SRTM). Hydrologic interpretation of DEM is based on the fact that it views DEM as a surface that naturally allows flow of water and directs its flow towards channels located at relatively lower elevations in the topography. DEMs are useful for interpretation of flow paths and delineation of catchments and channel network. Analysis was carried out separately for Kawas, Malwa and Uttarlai villages.

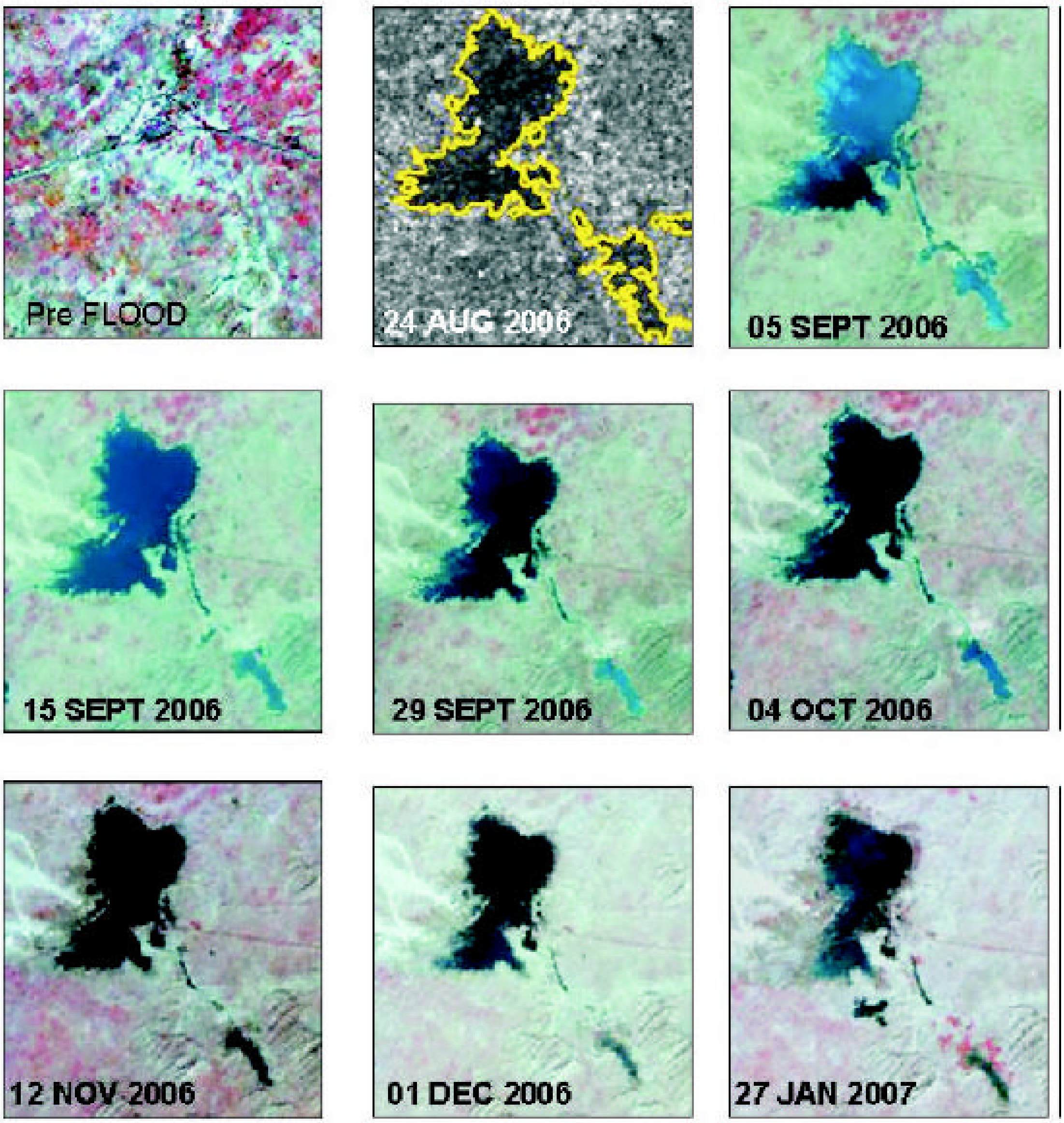
5.2.1 Analysis for Kawas: The Kawas area is located on a natural depression where all the drainages from upper catchment areas meet and converge, resulting in excessive runoff accumulation and flooding in the event of such high and continuous rainfall. Kawas area has a catchment area of 2354 km^2. The width of the channels in this catchment area after this flood event ranges from 158 meter to 1244 meter. Water in this region has flown through three distinct channels passing through following villages:

1. Matikagol - Khural - Balai - Joranada - Motinada - Pragniyoki Dhani - Chokla - Khanji ka Tala - Chhitar ka Par - Kawas (Distance 186.7 km).
2. Juneji ki basti - Jalela ki Dhani - Agoriya - Nimbla - Kanji ka Tala - Kawas (Distance 115.4 km).
3. Vishala, Sonar, Kumbharon ki Dhani, Sar ka Par, Kawas (Distance 109.4 km).

Figure 3 shows the delineated catchments.

Table 3: status of water spread on 9 date of passes for Kawas, Malwa and Uttarlai

Places	Water spread area in km^2 as on								
	Year 2006							Year 2007	
	24 Aug	05 Sep	15 Sep	29 Sep	04 Oct	12 Nov	01 Dec	27 Jan	19 Apr
Kawas	18.07	17.25	14.83	14.77	14.71	12.87	11.79	8.93	2.29
Malwa	05.64	04.66	3.95	3.85	3.71	3.33	3.17	2.65	2.25
Uttarlai	21.03	19.64	19.53	14.32	13.62	12.93	9.30	6.91	1.18



Water-spread area in sq km

1	2	3	4	5	6	7	8	9
18.07	17.2	14.8	14.8	14.7	12.07	11.79	8.93	2.29

Fig. 2: Status of waterspread areas on different dates

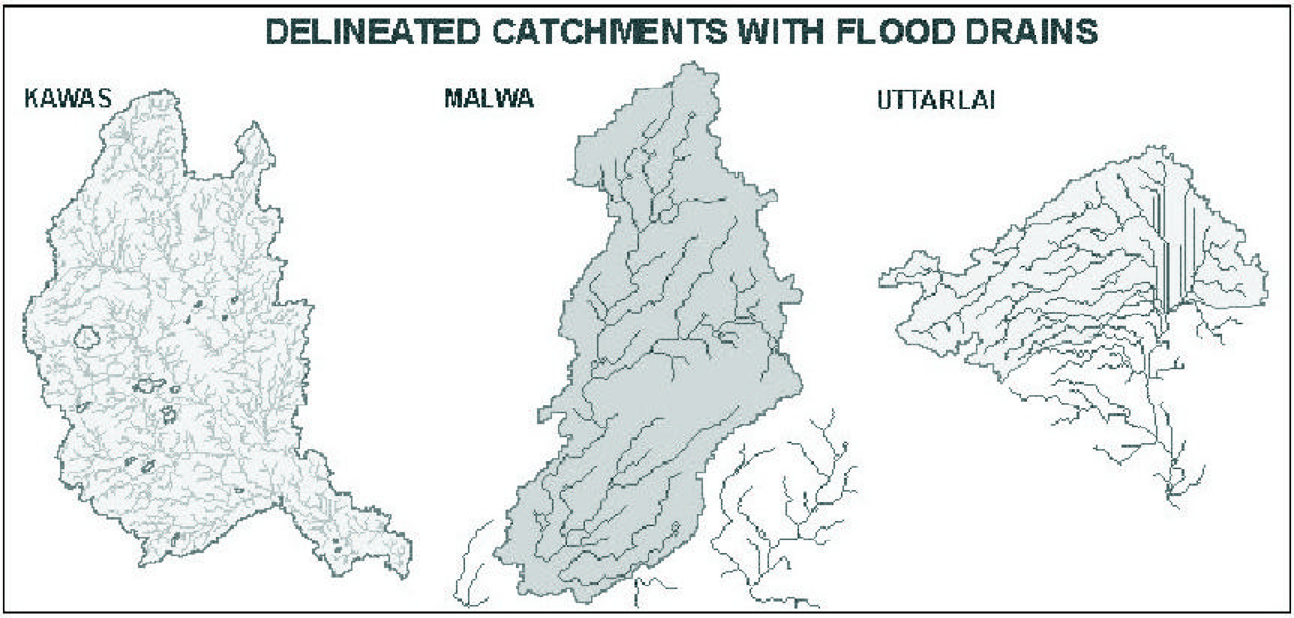


Figure 3: Delineated catchments for Kawas, Malwa and Uttarlai

5.2.2 Analysis for Malwa: It has a catchment area of 142.17 km^2. The length of the two channels contributing for floods at this site is 27.47 km and 11.00 km respectively. The elevation between highest and lowest point is 290 m and 225 m for the first channel and for the second channel it is 264 m and 248 m. The water depth at Malwa is up to 15 ft as per 5th September 2006 data.

5.2.3 Analysis for Uttarlai: It has a catchment area of 250 km^2. The length of the two major channels contributing for flooding at this site is 35.50 km and 21.00 km respectively. The relief between highest and lowest point is 261 m and 155 m respectively for the first channel and for the second channel it is 235 m and 155 m. The water depth at Uttarlai is about 3 ft.

5.3 Rapid action plan

Based on the analysis carried out using near real time satellite data and field data following action plan was suggested.

- Draining the water through the suggested path up to Luni river in case of Kawas. The water will have to be taken out through a channel to be constructed for this purpose and put to natural drain, which runs for 16.57 km un-interrupted out of a total distance of 66.37 km up to river Luni. Further, there are obstructions due to dunes at four places. The average available gradient between Kawas and Luni is 1:745 with elevation being 155 m and 89 m near Kawas and Luni respectively. The obstruction are at the distances of 16.57 km, 20.40 km, 23.69 km and 31.35 km, respectively from Kawas and extend for 2.26 km, 1.44 km, 0.75 km and 0.13 km, totaling to 4.58 km.
- Draining out water through the suggested path and releasing water in Jaldu Rann in case of Malwa village. The possible route for draining of water is by cutting dune towards south east of Malwa and joining the flow path leading to Jaldu Rann. The length of channel is 8.14 km with available gradient as 1: 301 with elevation being 233m and 206m near Malwa and Jaldu Rann respectively

- Rehabilitating the people to alternate safer sites of both the villages.
- Looking at the size of the channels formed during this year's flood, water is going to accumulate at these sites even in normal rains (though in lesser quantity) and hence these sites must be declared as unsuitable for retaining as human settlements.

Figure 4 shows the proposed flood water removal path from Kawas and Uttarlai.

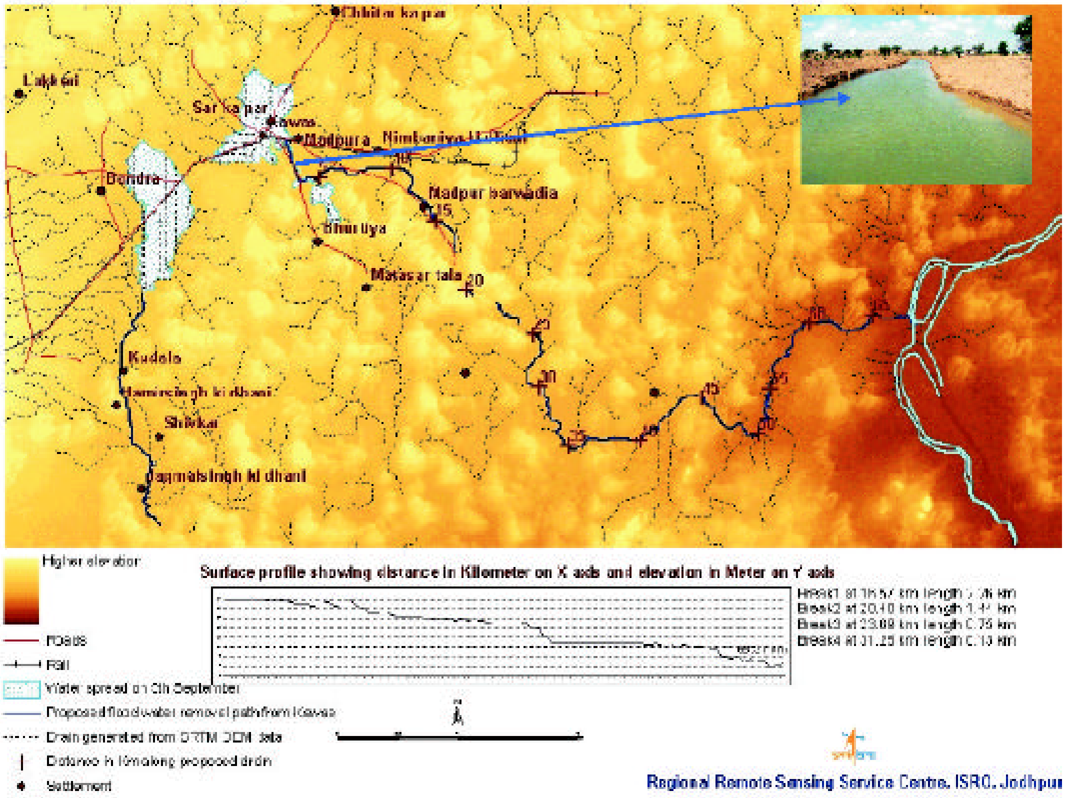


Figure 4 : Proposed flood water removal drain from Kawas to Luni with surface profile.

6. CONCLUSION

The analysis carried out for disaster management support proved to be beneficial to administrators / NGOs and other departments for deciding the action plan for removal of water from affected sites. The flood water drain as proposed after the analysis was constructed to remove the water (Fig. 4).

ACKNOWLEDGEMENTS

Authors wish to acknowledge with thanks the help and support received from Ground Water Department, Jodhpur, Sambhaav, Ahmedabad, School of Desert Sciences, Jodhpur and entire staff of RRSSC Jodhpur.

JODHPUR THE GATEWAY OF INDIAN DESERT - STUDY ON RISING GROUND WATER LEVELS IN THE CITY

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*RRSSC/ISRO, CAZRI Campus, Jodhpur
**Ground Water Department, GOR, Jodhpur

Abstract

Jodhpur has been experiencing the problem of rising ground water levels in different parts of the city for the last 10 years since the commissioning of the Rajiv Gandhi Link Canal (RGLC) and storage of water in the naturally existing Kaylana-Takht Sagar reservoirs. Normally a minimum of about 27 days of water supply to city is stored in these reservoirs at any given time. The problem has taken serious turn as water levels are rising in more and more city areas. In many of the areas the water level has reached as high as 1 to 2m bgl (below Ground Level) which include Tripolia, Ghantaghar, Nai Sarak, Polo, Chandpole, Sojati Gate, Shivanchi Gate, Laxmi Nagar, Fateh Sagar, Gulab Sagar and areas surrounding the Meharangarh Fort etc. Water is flooding the basements in the busy market area damaging buildings and forcing businessmen to abandon the basements and keep pumping water out of the buildings. Regular pumping of water from basements has resulted in dissolution of cementing materials in the flushed out waters and further weakening of the constructions. Remote sensing studies (using high resolution IRS PAN data along with LISS-III data) and also GIS and GPS based studies have been carried out by the Regional Remote Sensing Service Center (RRSSC/ ISRO), Jodhpur on the behest of the district administration. Apart RRSSC also carried out several other scientific/ support studies based on data inputs on water levels of Reservoirs and borewells in the city area from state Govt. Departments viz. PHED and GWD to draw the inferences regarding source of seepage, possible causes of the water table rise and to work out remedial measures. The paper provides a brief detail of the studies carried out, the findings of the studies and scientific solutions/ recommendations to ameliorate the problem.

1.0 Introduction

Study area comprise of area within about 10 kilometers radius around Jodhpur city (Fig.1).

The studies carried out to understand the source for water level rise and various technical parameters include a) Remote Sensing and GIS based studies; b) GPS Measurements for relative heights determination of source & seepage areas; c) Geophysical surveys and drillings to locate the existence of image identified lineaments on the ground (By GWD), d) Analysis of water levels from existing bore wells in the city to observe water table behavior (GWD data), e) Analysis of water level data of Kaylana and Takth Sagar reservoirs to study changes in reservoir levels (PHED Data), f) Generation of DEM to measure topographic variations around the city, g) Study of Geology and structures present in the rocks occurring in the area, and h) Study of water consumption rates in the city (PHED Data).

2.0 Observations

Image interpretation and analysis : Digitally merged LISS-III (23.5 m resolution) and PAN data (5.8 m resolution) from the Indian Remote Sensing Satellite were used in the study and FCC prints generated on 1:20,000 scale. A number of prominent lineament sets traversing NNE-SSW are seen on the image derived Lineament map (Fig.2). The prominent water

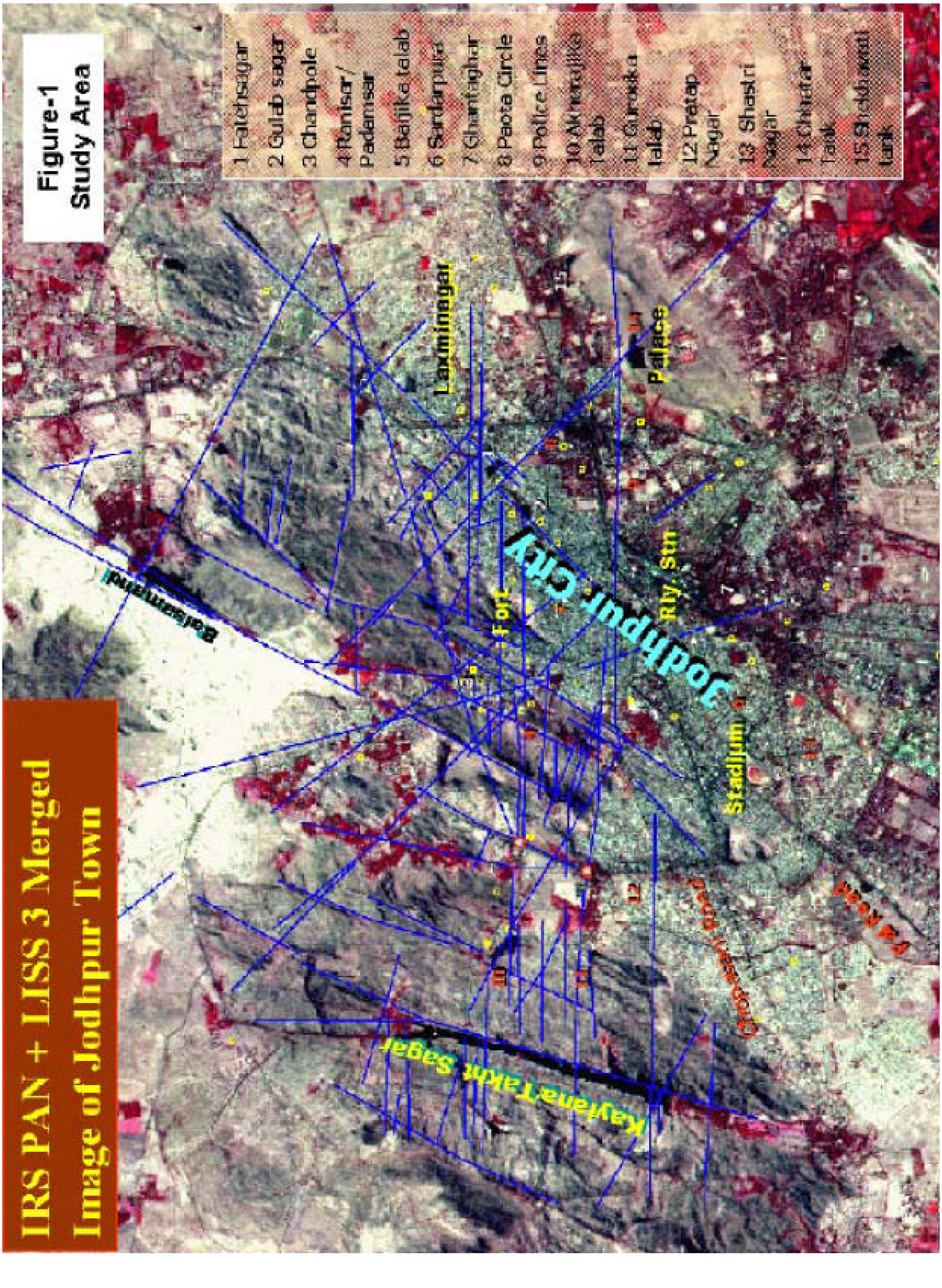

Fig.-1: Study area

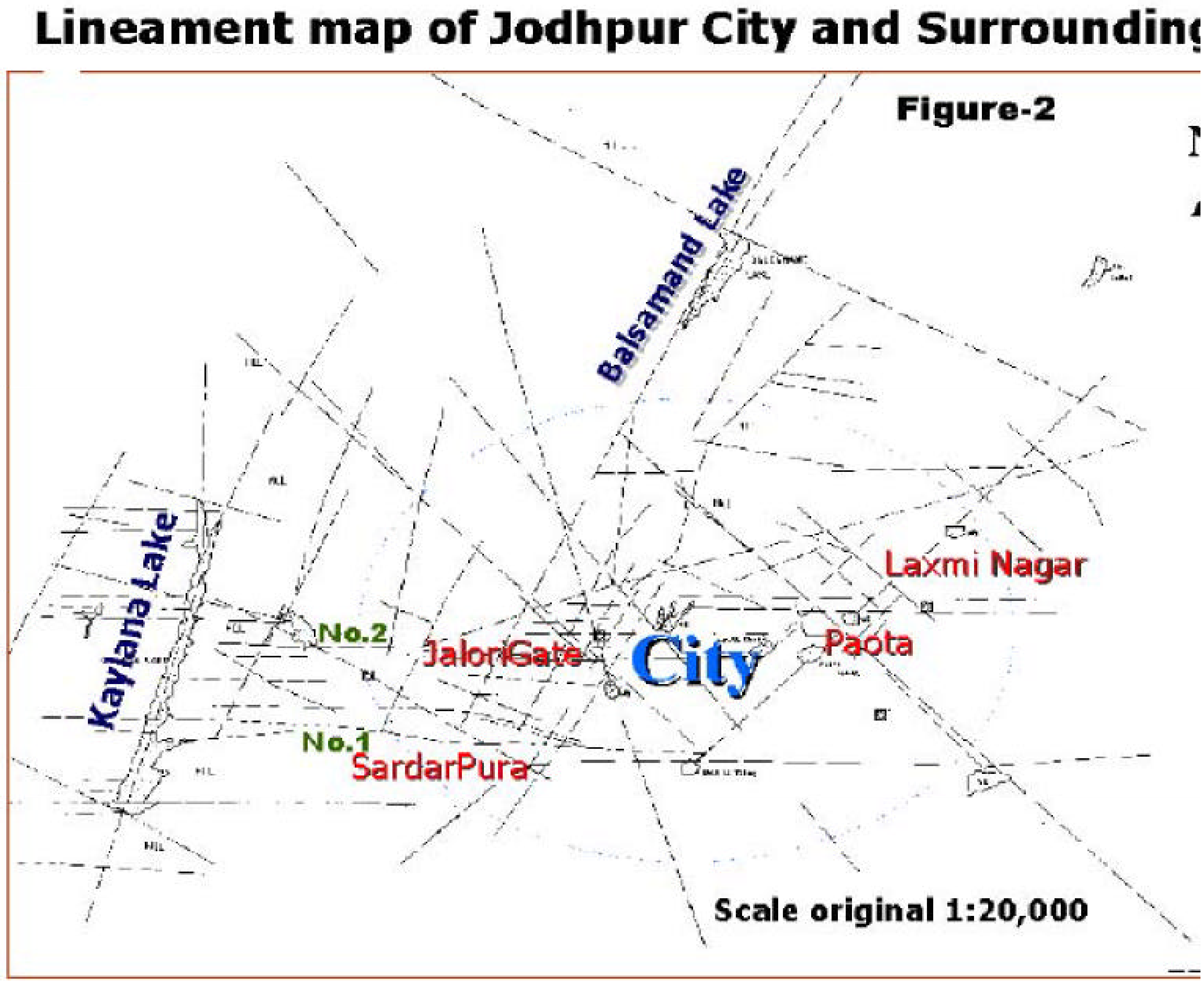

Fig.-2: Satellite imagery with lineament map bodies viz. Kailana/ Takht Sagar, Balsamand lakes and many of the ridges and hills lie along these lineament sets. RS&GIS studies reveal the presence of several closely spaced east-west trending sets of lineaments (joints/fracture sets) cutting across the reservoirs and the rhyolites present around it and their continuation upto the city area. Apart from E-W direction traversing lineaments other sets in NW-SE, WNW-ESE and NNW-SSE directions are also clearly visible on the imagery. Together these lineaments form a dense fracture network, and provide an easy conduit for movement of Reservoir waters to the city area. Due to dense urbanization in the city these lineament sets are not clearly visible in the city area. Two major E-W trending lineaments No. 1 and No. 2 noticed in the satellite imagery (Fig.1), originate near Kaylana lake and continue for quite long distance eastward and are observed to pass through Bai-ji-ka Talab and Chittar Tank. Along lineament no. 2, the water bodies of Akhay Raj Ji Ka Talab, Gulab Sagar, Fatehsagar and Shakhavati Tank are aligned.

Geology Jodhpur city in the western side is surrounded by the hills comprising of the Jodhpur Group of rocks belonging to Marwar Super Group. The rocks are mostly rhyolites and sandstones. Sandstones are compact and overlay over rhyolites. The reservoir is located on rhyolites, which are major rock types of the area, having highly porous and fractured flows.

GPS Studies, using single frequency Leika SR 9400 model GPS equipment, have been carried out for about 50 locations including existing observation-well sites to ascertain relative heights of the water bodies and of the effected areas in the city. It has been observed that the average height of Kailana Lake is approx. RL 251.8 m. (Ellipsoidal heights in WGS-84datum), Takht Sagar 245.7, Balasamand Lake 236.2 m., Gulabsagar 226.9 m. and of city areas ranging from 226-200 m . A RL/ Head difference of about 20-50 meters from Kaylana /Takht Sagar water level to different city areas was observed during the GPS surveys. This provide sufficient head difference for reservoir waters to leak to the city.

Water levels in Kailana and Takht Sagar : Graphs indicate that the water levels in Kailana and Takht Sagar have risen considerably after 1997 after commissioning of IG Canal waters to Jodhpur and 1999 onwards are regularly maintained at about 50-55 ft. levels. Since commissioning of RGLC to Jodhpur, the water head in Kaylana has risen by 25 feet and in Takhat Sagar by 20 feet (Fig. 3).

Water levels in wells & piezometrs: Analysis of the water level data collected by GWD/PHED from various bore wells located in the city indicate that water levels in the wells, tube wells, piezometers and water bodies in the city have risen considerably and constantly since 1997 after commissioning of the RGLC, have now reached to a maximum saturation levels and almost stabilized within a few meters from the ground level in most part of the old city areas. In newly formed extensions away from the city on either side the effect of water seepage is much less. As observed from the graphs (Fig. 4) clear impact of Kailana water on water level rise has been noticed in the areas around Nehru Park, Siwanchi Gate, Chandpole, Ganwa (Pratap Nagar), Mohalla Laykan, Vyas Park, Dev Nagar, Sardarpura, Ratanada, Jalara (Kiriyoka), Fateh Sagar, Sindhibhatoo Ki Masjid, and Ghantaghar areas.

Water Bodies in the city : Water bodies (Akhay Raj Ji Ka Talab, Rani Sagar, Padam Sagar, Gulab Sagar, Fatehsagar, Baiji Ka Talab, Chittar Tank etc.) lying over the Lineaments cutting across Kaylana/ Takht Sagar reservoirs are perennial in nature and fill up very quickly when emptied by pumping.

Situation of water levels in the city is shown by the water table contours drawn on the DEM (Digital Elevation Model) Fig. 5.

Figure-3

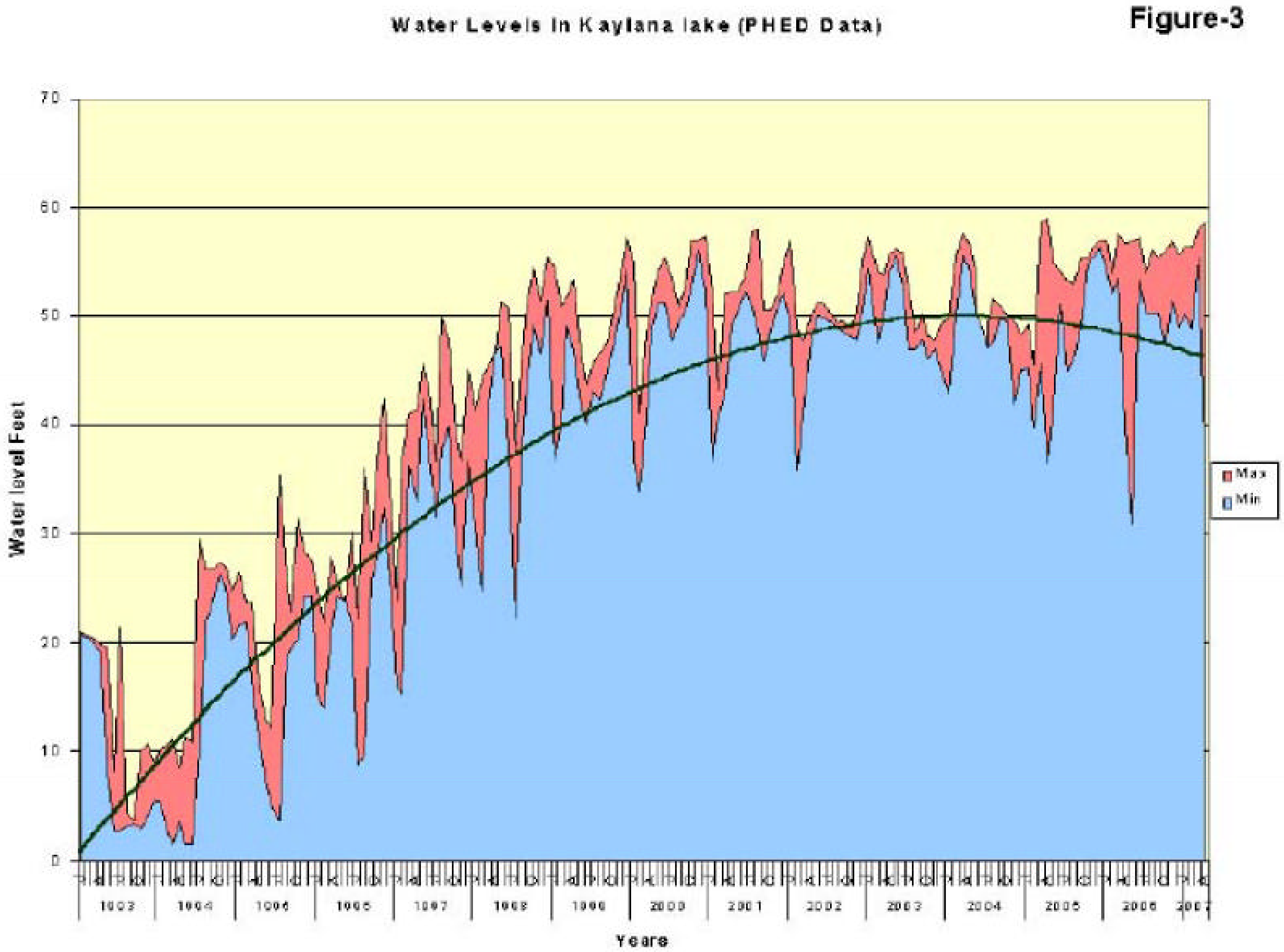

Fig.-3: Analysis of monthly Water levels data from Kaylana reservoir

Figure-4

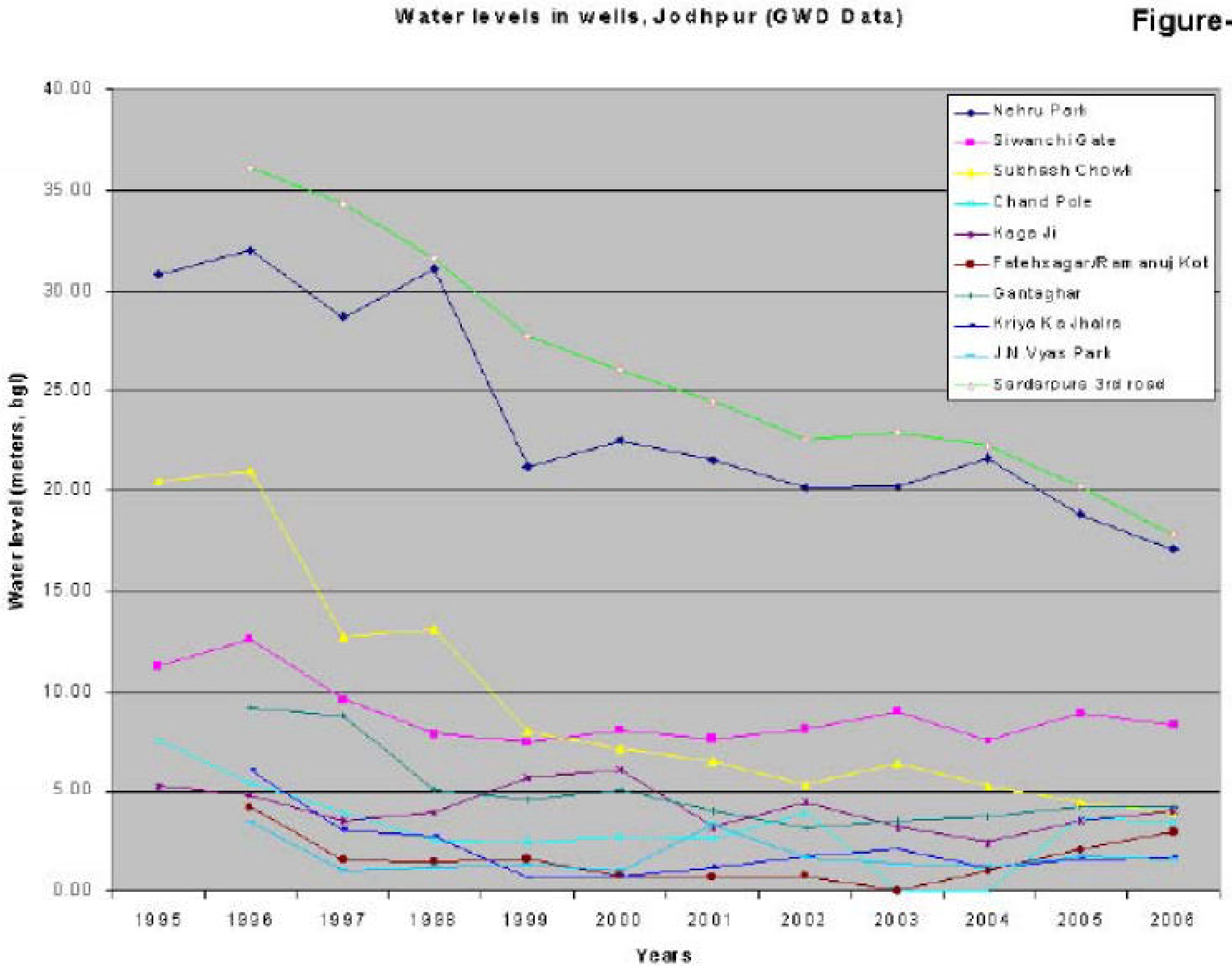

Fig.-4: Analysis of monthly water level data from existing water bodies, handpumps and peizometers in the city

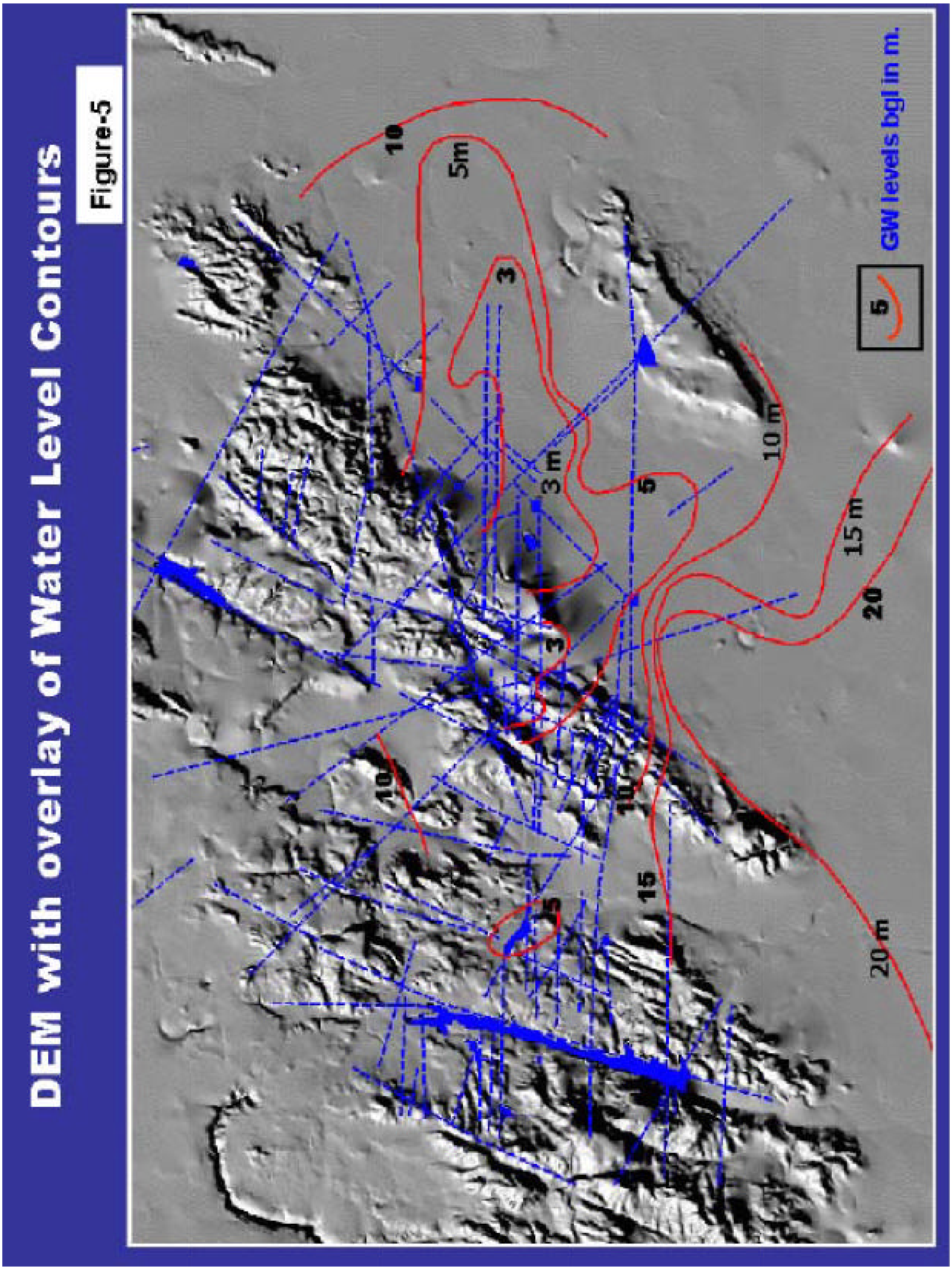

Fig.-5 : Water Level contours in the city

Figure-6

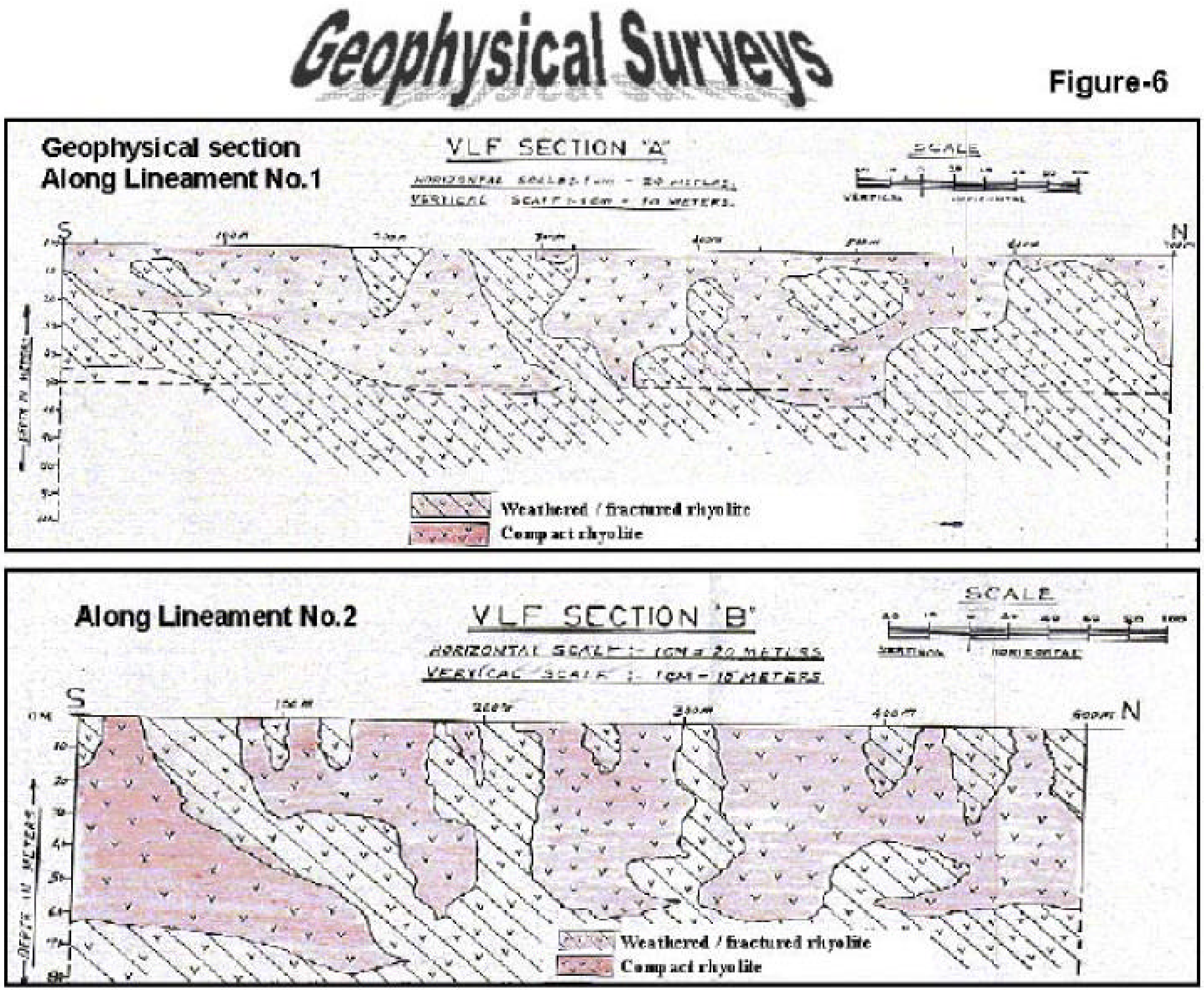

Fig.-6: Geophysical section for the lineaments drilled in the city

Geophysical (Resistivity) surveys conducted over the lineament zone (Fig. 6) and the wells drilled by the GWD over it, in Pratap Nagar area indicated high yields and lake quality ground water (with yields of 3600 & 4100 gph, TDS of 544 & 957 mg/l and recuperation time of 30 minutes, respectively), confirming seepage from the reservoirs.

Isotopic analysis of Oxygen-18 ($\delta^{18}O$) vs Deuterium ($\delta^{2}H$), Oxygen-18 ($\delta^{18}O$) vs Tritium ($\delta^{3}H$) indicate that most of the water samples collected from Kaylana lake, tube wells, open wells and the basements lie on the meteoric water line, indicating seepage of water from Kaylana/ Takht Sagar reservoirs, as against the poor water quality in the city area.

3.0 Findings

- Analysis of water level data from Kaylana / Takht Sagar reservoirs and from the piezometers and WL monitoring wells 1995-2007 in the city clearly indicates the start of the problem since commissioning of the RGLC in year 1997(Fig. 3&4). Similar conclusion that ground water levels in the city rose after 1997, has been drawn based on analysis water levels in the wells from 1995-2006.
- Presence of joints and lineament sets in porous rhyolite aquifer in the city area and the presence of compact sandstone basement below it have been the major contributor to seepage of water from Kaylana/ Takht Sagar reservoirs and rise of ground water levels in the city.
- Large RL/ Head difference of about 20-50 m from Kaylana /Takht Sagar water level to different city areas is also responsible for the continued seepage of reservoir waters to the city area.
- Geophysical (Resistivity) surveys conducted over the lineament and the wells drilled by the GWD over it, in Pratap Nagar area (about a km from Kaylana in the east) indicated high yields and good quality Lake ground water (with yields of 3600 & 4100 gph, TDS of 544 & 957 mg/l and recuperation time of 30 minutes respectively), confirming seepage from the reservoirs.
- Isotopic analysis of Oxygen-18 ($\delta^{18}O$) vs Deuterium ($\delta^{2}H$), Oxygen-18 ($\delta^{18}O$) vs Tritium ($\delta^{3}H$) indicate that most of the water samples collected from Kaylana, tube wells, open wells and the basements lie on the meteoric water line, indicating seepage of water from Kaylana/ Takht Sagar reservoirs. In general the ground water in Jodhpur are not of good quality and in many areas are saline. Ground waters in borewells, water bodies and hand pumps in city show a mixing of ground water with the lake waters.

4.0 Conclusion

The investigations carried out indicate that the source of the water for the water level rise in the city area is from (a) Kaylana-Takht Sagar reservoirs. However, presence of lineaments/ joint sets in the rocks apart from, (b) reduced ground water extraction from existing bore wells and hand pumps after commissioning of RGLC, (c) leakage of used house hold water from unlined drain system, and (d) presence of impervious sandstone basement at shallow depth below the porous rhyolite aquifer in the city area are the other important reasons responsible for the rise of water table in the city area. The path for flushing out the filled up seepage water in the city is shown in Fig. 7.

5.0 Recommendations

Based on the findings a number of short and long term measures have been suggested for overcoming the problem that include (1) Regular pumping/ flushing out of the excess ground water for possible use within or outside the city area, (2) Reducing of water levels in Kaylana / Takhat Sagar lakes to 45 ft level to reduce the water head. This calls for maintaining lower water levels in the reservoirs not acceeding 45 feet in Kaylana and 50 feet in Takht Sagar. This can be done by planning

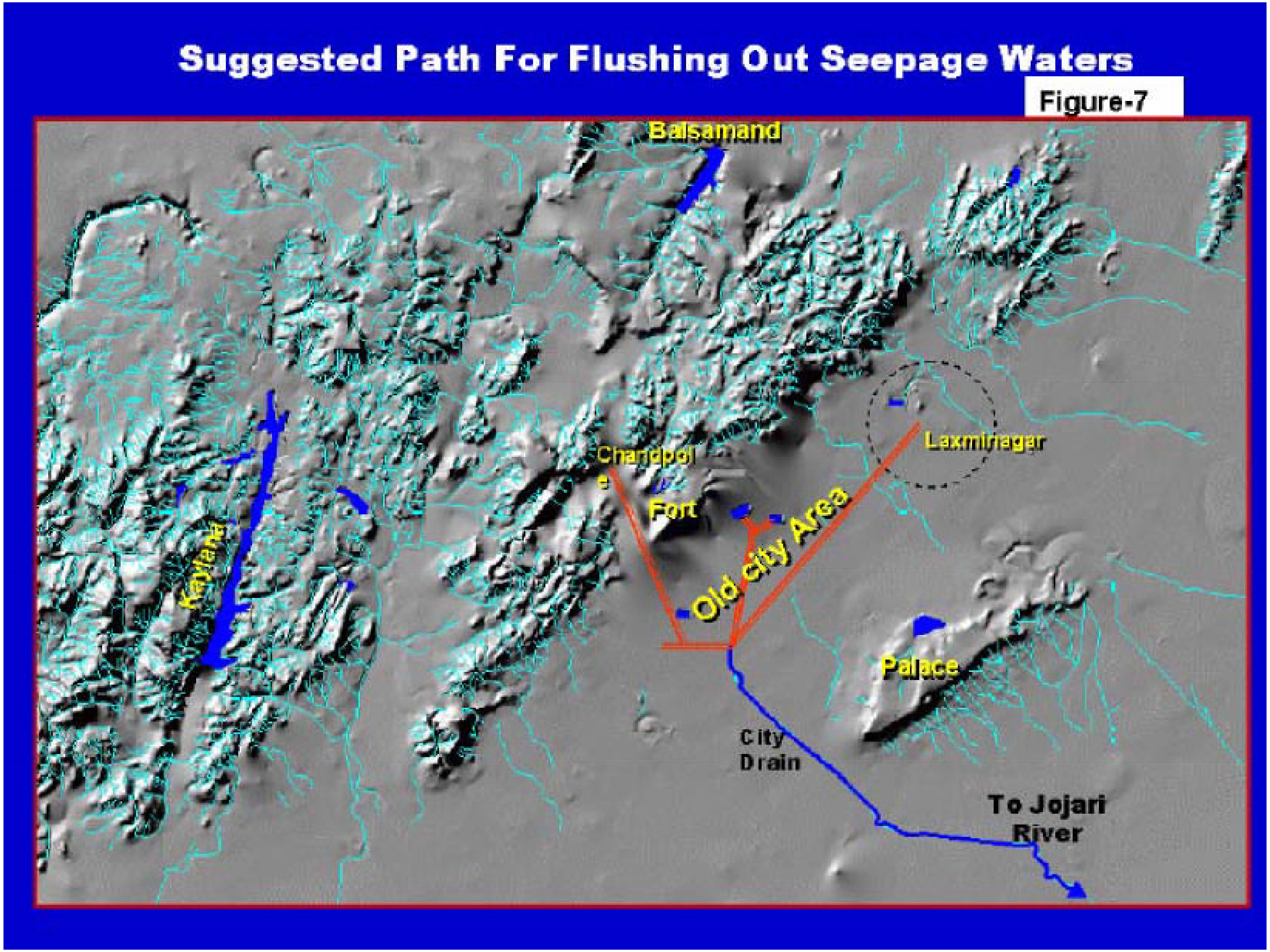

Fig. 7 : Suggested path for evacuating filled up seepage water

alternate water storage structures (reservoirs) in the city through new constructions or using the existing ones like Ummaid Sagar, Balasamand Lake, Mining pits in Soorsagar etc. for which feasibility studies may be necessary by consultants/ PHED etc. (3) Go for alternate storage sites with tank base and walls scientifically grouted and sealed before storage of water into new storage site/ reservoir. (4) Mandatory stoppage of the construction of basements in the seepage effected areas.

Acknowledgement

Authors are thankful to K.M Mathur Additional Chief Engineer, Public Health Engineering Department and Shri VN Mathur, Chief Engineer, Ground Water Department, Government of Rajasthan, for providing the data of reservoir levels and of hand pumps and peizometers existing in the city for water supply /level monitoring.

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Interested readers can view the entire newsletter at the following

ISG Website: http://www.isgindia.org

Journal of Geomatics Launched

The Indian Society of Geomatics (ISG) launched the "**Journal of Geomatics**" at a gala function held at GMDC Auditorium, Ahmedabad on May 8, 2007. Dr. Ranganath Navalgund, Director Space Applications Centre (ISRO), was the chief guest on the occasion. Shri Rajesh C. Mathur, President, ESRI, India, Dr. Baldev Sahai, Dr. A.R. Dasgupta, Shri S.N. Mathur, General Manager, GMDC, Dr. Kiran Kumar, Deputy Director, Space Applications Centre also graced the dais on the occasion. Geomatics professionals, members of the Indian Society of Geomatics and a fairly large number of students made their presence felt by actively participating in the entire proceedings. In releasing the Journal Dr. Navalgund spoke about the importance and scientific value of the journal and said that he is sure that this journal will publish outstanding original research on all aspects of Geomatics. Dr. Baldev Sahai, Chief Editor of the Journal, gave a brief introduction to the persistent demand from the members of the ISG for a peer-reviewed journal and the efforts leading to the launching of the Journal. He mentioned that the journal will provide an international forum for rapid publication of developments in the fields of Geomatics technology and applications. He said that journal would publish full research articles as well as short communications and there will be a particular emphasis on speed of publication and on presentation of the articles in a highly professional, qualitative and intelligent way.

India has a large number of professionals in the field of Geomatics. ISG had made an effort to bring out the first thematic journal - the **Journal of Geomatics -** which aims to address research into all aspects of Geomatics, geodata acquisition, pre-processing analysis and publishing. This includes extensively GIS, GPS, data warehousing and data mining, photogrammetry, cartography, remote sensing, web-enabled dissemination, surveying, spatial data infrastructure and technology including hardware, software, algorithm and modeling and promises to retain the rigour of academic research by publishing high quality peer-reviewed papers. This will provide an excellent forum for emerging scholars to publish ideas alongside papers by established researchers and academics. Journal of Geomatics is backed by eminent Editorial and Advisory Boards which include renowned experts from all over the world

The journal launch was followed by a special lecture on "Future trends in earth observation system" by Dr. Kiran Kumar, Deputy Director, Space Applications Centre (ISRO).

From L – R Dr. Baldev Sahai, Shri Rajesh Mathur, Dr. Ranganath Navalgund, Shri S.N. Mathur and Dr. Kiran Kumar

A view of the audience

FORTHCOMING EVENTS

1. b-GIS@Asia 2007

Dates: December 17-19, 2007

Venue: Technopark, Thiruvananthapuram (Trivandrum)

Organisers: Trans Asiatic GIS Society

Conference Themes:

Enterprise GIS; Enterprise data sharing, publishing, and security; GIS for Police Departments and Homeland security; Implementing metadata services; Implementing GIS Systems in local governments; Implementing GIS Systems in Disaster Management Centers; GIS and business process work flow; GIS for project management and control; ERP-GIS systems; GIS for Resource Management

Abstract submission: October 1, 2007

Full papers for accepted abstracts: November 15, 2007

For details contact: bgisasia.info@tagsasia.org or see the

website: http:// www.tagsasia.org/bgisasia

Journal of Geomatics

(A publication of the Indian Society of Geomatics)
Contents of Vol. 1, No. 1 April 2007

FROM ISG SECRETARIAT

i) Change of Address of Members

Members are kindly requested to inform us about their changed mailing address as well as current email address to update our database.

ii) National Geomatics Awards

The details of these awards are available in ISG Newsletter of March 2007 and present issue as well as in Journal of Geomatics and ISG website. The members are requested to send their applications for awards by August 31, 2008, if they have any outstanding contributions in the field of Geomatics.

iii) Chapter Activities and related issues

a) Active Chapter of Year Award (2005-06)

Each chapter Chairman/Secretary is requested to send the applications for this award in the prescribed format to the President/Secretary, ISG. The prescribed format for this award is available on ISG website.

b) Chapter Reports and Audit Statements

- Chapter Chairman/Secretary are requested to send the report on the activities of the chapter during FY 2006-2007 for publication in the ISG newsletter.
- All the ISG Chapters are requested to get their accounts audited at the earliest and send them to ISG HQ to include in the audited report of the Society. This is a legal requirement

CHAPTER ACTIVITIES

PUNE CHAPTER

ISG General Body Meeting on 21-4-2007 (2000Hr) at Institution of Engineers Pune-

Following items were discussed and decisions taken unanimously:

I. Strengthening of the Executive Committee:

For ensuring more participation from members in the Chapter activities, it has been proposed to expand the executive committee. Accordingly, it has been decided to have restructured executive committee for Pune Chapter as follows:

Chairman	Shri R. K. Suryawanshi,	NWA
Secretary	Shri Sandeep Srivastava,	C-DAC
Joint Secretary	Dr Manoj Khare,	C-DAC
Treasurer	Dr. Gautam Talukdar,	C-DAC
Executive Members	Ms. Sulochana Shekhar,	NDA
	Ms. Deepali Gadkari	UoP
	Shri B K Kakade	BAIF
	Shri Y L P Rao	GOM
	Shri Vinay Kumar	C-DAC

II. The **Account Statement** for the year 2006-2007 was presented by the Secretary. The same was approved by the G.B.

III. **Activities during the Year**

Members were appraised about the **activities during the year**:

- ISG, Pune Chapter organized a popular lecture by Dr S.D. Naik on the topic "Geo-informatics in River Morphology-Case study of Brahmaputra basin" on 12th August, 2006.He also showed many cartoons prepared by him on the subject of Geoinformatics which were appreciated by the audience.
- ISG President, Shri Rajesh Mathur visited Pune for the convocation of Symbiosis Institute of Geo-informatics. Shri R. K. Suryawanshi, Chairman, ISG, Pune Chapter discussed the chapter activities with him.
- ISG along with IE (I) IWRS, organised **Water Resources Day -2007** function on 21th April, 2007. Over 120 eminent people including ISG members participated in the function. Shri R. K. Suryawanshi, Director, National Water Academy & Chairman, ISG Pune Chapter, addressed the audience on role of "Geoinformatics in Water resources planning, development & management".

IV Forthcoming Activities:

Members also discussed the activities to be conducted during next six months.

It was decided to organise following events.

1. Essay competition for college students in & around Pune during Aug-Sept 2007

   Sub : Role of Geoinformatics in Disaster Management

   Activity In charge: Ms. Deepali Gadkari University of Pune

   E-Mail: deepali@dass.unipune.ernet.in

2. Lectures / Brain storming session during June-July 2007

   Sub : Geoinformatics in forest management

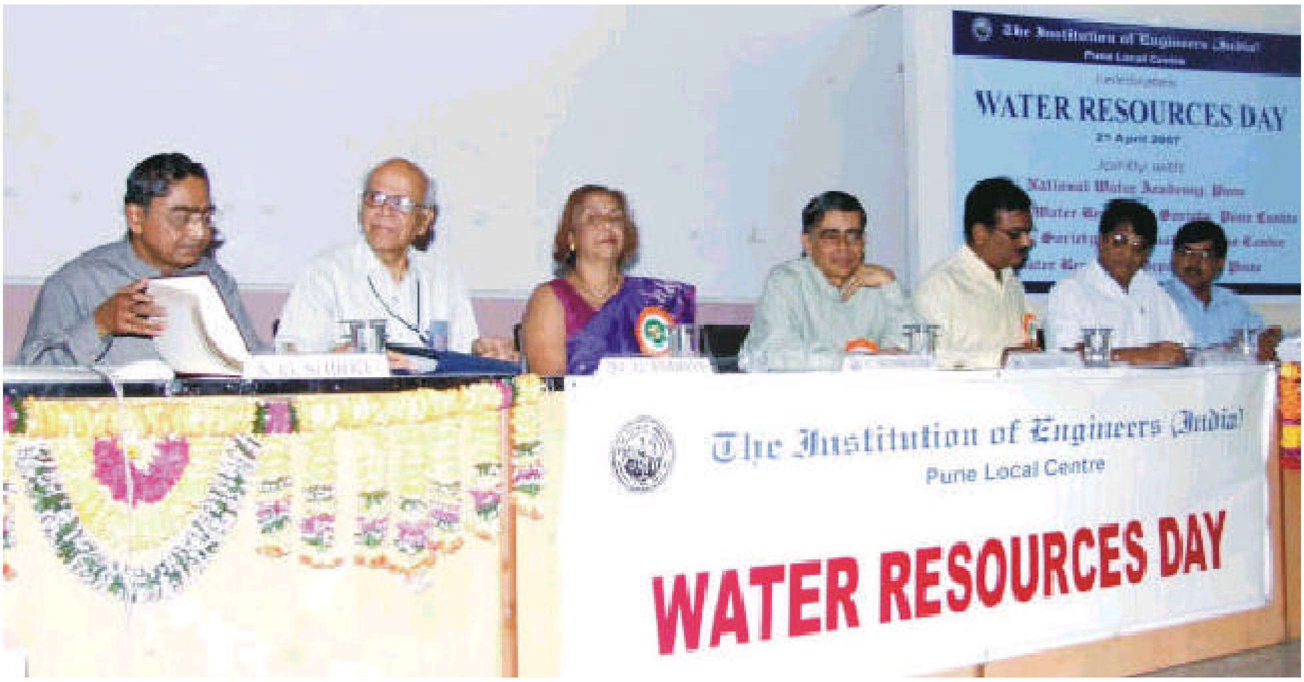
   Activity Incharge: Dr Sandeep Srivastawa, Dr Manoj Khare & Shri Vinay Kumar

   E-Mail: sksrivastava_gkp@yahoo.co.in; E-Mail: manoj-khare@cdac.ernet.in

Following event preceded the General Body Meeting.

WATER RESOURCES DAY-2007 BY ISG, PUNE

Water Resources Day-2007 function was organised by INDIAN SOCIETY OF GEOMATICS, Pune Chapter along with Indian Water Resources Society (IWRS), Water Resources Dept (Govt. of Maharashtra), National Water Academy & Institution of Engineers (I), Pune on 21-4-2007 at Firodia Auditorium. Shri A Sekhar, Member Maharashtra Water Resources Regulatory Authority, Mumbai was the Chief Guest & delivered the theme address on “Peoples participation in conservation of water resources & preservation of water quality”. Shri M. G. Padhye, Secretary (Retd) MoWR, GOI was felicitated by the Chairperson of Institution of Engineers for his contribution to the water sector. During the function, “Suresh Shirke Prize” for the best Under Graduate Project Work in Water Sector instituted by the IWRS Pune Center was awarded to the students of Sinhgad College of Engineering, Pune & their guides at the hands of the Chief Guest. Earlier, Ms J C Deshpande, Chairperson, Institution of Engrs (I) Pune welcomed the guests. Shri R K Suryawanshi, Chairman ISG Pune Chapter, addressed the gathering about the role of “Geoinformatics in Water Sector”. Shri S G Shirke, Chairman IWRS, Pune briefed about the IWRS activities. Shri A V Surve, Convener of the program, briefed about the importance of the Water Resources Day. Prof K K Ghosh proposed vote of thanks. Function was attended by over 100 eminent participants from Pune & nearby area. General body meeting of ISG, Pune followed the function.



NATIONAL GEOMATICS AWARDS

Indian Society of Geomatics has instituted two National Geomatics Awards to be given each year a) for original and significant contribution, b) for innovative application(s) in the field of Geomatics. Each award comprises a medal, a citation and a sum of Rs. 25,000

The guidelines for the award are as under

- **Areas of contribution considered for the award**

1. Geographical Information System
2. Global Positioning System
3. Photogrammetry
4. Digital Cartography

- **Eligibility**

Any citizen of India engaged in scientific work in any of the above-mentioned areas of research is eligible for the award.

  - The awards are to be given for the work largely carried out in India.
  - First award will be given for original contribution in the field of Geomatics supported by publications in a refereed journal of repute.
  - Second award will be given for carrying out innovative application(s)
  - The contribution for the first award should have been accepted by peers through citation of the work.
  - Work based on the applications of existing technologies will not be considered for the first award.
  - The work should have made impact on the overall development of Geomatics

- **How to Send Nomination**

Nominations should be sent in the prescribed format, completed in all aspects to the Secretary, Indian Society of Geomatics, Space Applications Centre Campus, Ahmedabad 380 015 by August 31, 2008.

Nominations should be signed by two Life Members of the Society and sent by Registered / Speed Post.

- **Selection Process**

An expert committee, consisting of at least three members, constituted by the Executive Council of the Indian Society of Geomatics, will scrutinize the nominations and recommend the awardees' names to the Executive Council. The Council will decide on the award based on the recommendations.

FORMAT FO R NOMINATION FOR NATIONAL GEOMATICS AWARDS

1. Name of the Candidate:
2. Present Position:
3. Positions held earlier (chronological order):
4. Academic qualifications (Bachelor's degree onwards):
5. Names of at least three Indian Scientists / Technologist in the area as possible referees*:
6. Brief write up on the work (500 words) for which award is claimed:
7. Publication(s) on the above work (reprint(s) to be enclosed):
8. List of other publications of the candidate:
9. Citation of the work for which award is claimed:
10. Impact of the work (for which award is claimed) on the development in the field of Geomatics (500 words):
11. Whether the work has already won any award? If so, give details:

The Applications in the above format (five copies) should be submitted (by Registered Post or Speed Post) to The Secretary, Indian Society of Geomatics, Space Applications Centre Campus, Ahmedabad 380 015 so as to reach by August 31, 2008.

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* ISG is, however, not bound to accept these names and can refer the nomination to other experts/ peers.

ISG FELLOWS

Shri Pramod P. Kale, Pune

Dr. George Joseph, Dehradun

Dr. A.K.S. Gopalan, Secunderabad

ISG - PATRON MEMBERS

P-1 Director, Space Applications Centre (ISRO), Jodhpur Tekra, AHMEDABAD 380 015

P-2 Settlement Commissioner, Gujarat, Multi-story Building, Lal Darwaja, AHMEDABAD 380 001

P-3 Commissioner, Mumbai Metropolitan Region Development Authority, Bandra-Kurla Complex, Bandra East, MUMBAI 400 051

P-4 Commissioner, land Records & Settlements Office, MP, GWALIOR 474 007

P-5 Director General, Centre for Development of Advanced Computing (C-DAC), 12, Thube Park, Shivajinagar, PUNE 411 005

P-6 Chairman, Indian Space Research Organization (ISRO), Antariksha Bhavan, New BEL Road, BANGALORE 560 094

P-7 Director General, Forest Survey of India, Kaulagarh Road, P.O. I.P.E., DEHRA DUN 248 195

P-8 Commissioner, Vadodara Municipal Corporation, VADODARA 390 001

P-9 Centre for Environmental Planning and Technology (CEPT), Navarangpura, AHMEDABAD 380 009

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P-12 Director, National Atlas & Thematic Mapping Organization (NATMO), Salt Lake, KOLKATA 700 064

P-13 Director of Operations, GIS Services, Genesys International Corporation Ltd., 73 A, SDF-III, SEEPZ, MUMBAI 400 096

P-14 Managing Director, Speck Systems Limited, B-49, Electronics Complex, Kushiaguda, HYDERABAD 500 062

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P-16 Managing Director, Tri-Geo Image Systems Ltd., 813 Nagarjuna Hill, PunjaGutta, HYDERABAD 500 082

P-17 Managing Director, Scanpoint Graphics Ltd., B/h Town Hall, Ashram Road, AHMEDABAD 380 006

P-18 Institute for Sustainable Development Research Studies (ISDRS), 7, Manav Ashram Colony, Goplapura Mod, Tonk Road, JAIPUR 302 018

P-19 Defence institute for GeoSpatial Information & Training (DIGIT), C/O CAMS, Rao Tula Ram Marg, Cantt. NEW DELHI 110 010

P-20 Rolta India Ltd., Rolta Bhavan, 22nd Street, MIDC-Marol, Andheri East, MUMBAI 400 093

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P-23 Senior Manager, Library and Documentation, Larsen & Toubro Limited, P.B. No. 979, Mount Poonamallee Road, Manapakkam, CHENNAI – 600 089. Email: sv@lntecc.com

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New ISG Members who joined during April-August 2007

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Journal of Geomatics

Indian Society of Geomatics launched the first issue of a peer-reviewed six-monthly publication, Journal of Geomatics, in May 2007. The guidelines for authors were published in the same issue of the Journal and are also put on ISG website: www.isgindia.org. All members are requested to use the opportunity of submitting articles for publication in the Journal.

Interested readers can view the abstracts of articles published in April 2007 issue at the following

ISG Website: http://www.isgindia.org

INDIAN SOCIETY OF GEOMATICS (ISG)

(www.isgindia.org)

MEMBERSHIP APPLICATION FORM

To: The Secretary Indian Society of Geomatics
Building No. 40, Room No. 36,
Space Applications Centre (SAC) Campus
Jodhpur Tekra, Ambawadi PO, AHMEDABAD – 380 015

Sir,

I want to become a Life Member/ Sustaining Member/ Patron Member/Annual Member of the Indian Society of Geomatics, Ahmedabad from ——————Month of ———— year.

Membership fee of Rs./US$ _____ /- is being sent to you by Cash/ DD/ Cheque (In case of DD/ Cheque: No.___________, drawn on Bank __________________________________ payable at Ahmedabad. For outstation cheques add clearing charges Rs 65.00/US$ 10.00). I agree to abide by the constitution of the Society.

Date:

Place: Signature

1. Name: ____
2. Address: ______________________________________
   ____
   ____ PIN: _______

   Phone: ___________ Fax: ___________ Email: _____________________
3. Date of Birth: __________
4. Sex (Male/Female): ______
5. Qualification: ___________
6. Specialisation: ___________
7. Designation: _____________
8. Membership in other Societies: __________________________________
   ____
9. Mailing Address: __________________________________
   ____
   __________________________________ PIN: _______

Proposed by:

(Member's Name and No) Signature of Proposer

For Office Use

ISG Membership No: ISG- -

Receipt No.: Date:

MEMBERSHIP SUBSCRIPTION

Sr. No.	Membership Category	Admission Fee Rs. (Indian)	Admission Fee US $ (Foreign)	Annual Subscription Rs. (Indian)
1.	Annual Member	10.00		200.00
2.	Life Member			
	a) Admitted before 45 years of age	1000.00	250.00	
	b) Admitted after 45 years of age	750.00	200.00	
3.	Sustaining Member	—-	——	2000.00
4.	Patron Member	15000.00	2500.00	——
5.	Student Member	10.00	—-	50.00

MEMBERSHIP GUIDELINES

1. Subscription for Life Membership is also accepted in two equal instalments payable within a duration of three months, if so desired by the applicant. In such a case, please specify that payment will be in instalments and also the probable date for the second instalment (within three months of the first instalment).
2. A Member of the Society should countersign application of membership.
3. **Subscription in DD or Cheques should be made out in the name of '**INDIAN SOCIETY OF GEOMATICS' **and payable at Ahmedabad.**
4. Outstation cheques must include bank-clearing charges of Rs. 65.00/US$ 10.00.
5. For further details, contact **Secretary, Indian Society of Geomatics** at the address given above.
6. Financil year of the society is from April 1 to March 31.
7. ISG has chapters already established at the following places: Ahmedabad, Ajmer, Chennai, Hyderabad, Indore, Mangalore, Mumbai, New Delhi, Pune, Tiruchirappalli and Vadodara. Applicants for membership have the option to contact Secretary/Chairman of the local chapter for enrolment. Details can be found at the website of the society: www.isgindia.org
8. Journal of the society will be sent only to Patron Members, Sustaining Members and Life Members.