GEOSPATIAL TECHNOLOGY IN HUMANITARIMAPPING – A CASE STUDY OF KOSI RIVER FLOODS: 2008, INDIA

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Introduction:

Land use is a complex and dynamic system which keep changing with time through human intervention and natural forces. Land use changes have varied detrimental effects on the quality of landscape and environment (Audsley et. al. 2006). Introduction of canal irrigation through Indira Gandhi Nahar (IGNP) system brought green and granary in so called 'Thar' or 'Great Indian Desert'. However improving the environmental performance of irrigation agriculture is also important for its long term sustainability (Stockle, 1998). The present study attempts to assess land use changes in Jaisalmer district of arid Rajasthan occupying 38,401 km ^{2} area. Using IRS P6 LISS-III data of 2005-06 supported with field check the land use map of the district has been prepared on 1:250, 000 scale and changes are worked out by comparing with the land use map of 1980. The trend in different land use systems and their impact on human life and physical environment were find out through analysis of historical data on land use and other parameters from 1980-81 to 2005-06 and appraisal of biophysical resources. The negative impacts of such developments are also discussed. Measures are suggested for appropriate use and efficient management of land, water and human resources for sustainable regional development.

Location and Environment:

Jaisalmer, the largest district of Rajasthan State forms the core of the 'Thar' or the Great Indian Desert. With a total geographical area of 38,401 Km^2 it is located between 26º 01' 00" N and 28º 02' 12" N latitudes and between 69º 30' 00" E to 72º 21' 30" E longitudes. It is bounded by 471 km international boundary with Pakistan towards north and west; Barmer district towards south; and Jodhpur and Bikaner districts towards east. The climate is hot arid. The average annual rainfall varies from 200 mm Pokaran in the east to less than 100 mm towards extreme west. The

coefficient variability of annual rainfall varies from 49-91% and crop growing period 4-7 weeks. Drought years are 53%. The maximum temperature during summer month often goes to 47^0 C while daily minimum temperature during winter month goes down to freezing point.

The region is characterized by large tract of sand dunes and interdunal plains, exposed rocky/gravelly pediments and buried pediments and few saline depressions. There are only few small ephemeral streams. Geological formation ranges from Pre-Cambrian sandstone and limestone to Quaternary alluvium and wind blown sand. Nearly 74% district is occupied by coarse textured fine sand to loamy fine sandy soils, 11% by sand to loamy sand and rest by shallow misc. soils (Chatterjee and Kar, 1992). Natural vegetation is sparse and consists mainly of xerophytic grasses and shrubs. Important grasses are *Lasiurus sindicus* (Sewan) and *Cenchrus ciliaris* (Dhaman). Shrubs and trees are *Calligonum poligonoides* (Phog), *Leptadenia* pyrotechnica (Khemp), *Capparis decidua* (Kair), *Calotropis procera* (Akra), *Ziziphus nummularia* (Bordi), *Prosopis juliflora* (Vilayti babool), *Prosopis cineraria* (khejri) and *Salvadora oleoides* (Jal). The population of district was 5,08,247 in 2001 and livestock 17,73,143 in 2003 (Anon. 2007).The district has 6,52,000 ha culturable command area under IGNP Stage-II.

Method and materials:

Topographical maps on 1;50,000 scale, land use map of 1980 on 1:250,000 scale and IRS P6 LISS-3 digital data of August, 2005 and Jan –March, 2006 were used as basic material. Arc GIS 9.3 software was used for image analysis on 1:50,000 scale, creation of spatial data base, map composition and generation of final land use map on 1:250,000 scale and area statistics. Land use map of 1980 was digitized and statistics were generated. The results were compared and changes were worked out. Historical data from 1980-81 to 2005-06 on land use, cropping pattern, crop production and other relational aspects were analyzed to assess the trend Socio-economic data were correlated to assess the impact of land use change. Land use report of the district prepared at CAZRI (Sen and Gheesalal, 1980), Land use/land cover report (CAZRI, 1990) and integrated natural resources survey report (Chatterji and Kar, 1992) were consulted to find out characteristics, potentials and spatial distribution of natural of resources.

Results and Discussion:

Present land use: Results of land use mapping of the district (Fig 1) reveal 26.19% district area under agriculture and 67.61% under different category of wasteland. Irrigated cropland constitutes 5.01% and rainfed 21.18%. Irrigated area is mainly concentrated in command area of IGNP Stage-II system. Out of the gross irrigated area 82% is served with 2073 km network of canals and 18% by ground water through 2,283 tube wells and pumping sets. Ground water irrigated area is mainly concentrated between Chandan-Sodakor-Lathi and Rajmathai-Bandewa villages. Rainfed area is concentrated mainly in southern part and canal command zone. Cultivation on the conserved

moisture though *'Khadin'* is another important land use system of this region. There are about 500 *khadins* in the district. Forest plantation, permanent pasture and '*oran*' and grasslands constitute 0.31%, 1.90% and 3.16% respectively. Amongst wastelands sandy waste constitute 11.35%, sandy waste with scrub 33.26%, saline waste 0.05%, salt rann 0.28%, barren rocky/stony waste 0.97%, stony/gravelly waste 15.11%, stony/gravelly waste with scrub 6.6% and waterlogged area 0.04% respectively. Waterlogging has developed near Ghantiyali, Madasar and Nedai villages. Mining area (mainly limestone and gypsum) occupy 0.24%. Limestone occurs mainly around Sanu, Khinya, Parewar, Pithla and Khuri. Gypsum occurs around Mohangarh, Falsoond, Nokh, Chinnu and Nachna. Settlement and water bodies constitute 0.48% and 0.04% area.

Cropping pattern and crop production: Out of the total cropped are 89.5% is put under kharif crops and 10.5% under rabi crops. Guar and bajra are dominant rainfed crops produced in 42.85% and 24.29% of the gross cropped area. Amongst irrigated crops mustard constitute 16.53%, gram 8.2%, wheat 2.25%, cumin 1.68%, isabgol 1.36% and groundnut 1.0%. Other crops of lesser significance are moth, moong, sesame, castor, jowar, taramira and cotton. The total production comes to 2,06,040 tones. The production of rainfed crops is highly variable depending on quantum and distribution pattern of rainfall.

Land use changes:

Based on area statistics of land use maps of 1980 and 2006 the changes are worked out. The irrigated area has increased from just 54 ha to 1,92,439 ha, rainfed cropland by 332.1%. Forest plantation in form of sand dune stabilization, pasture development, block plantation, fodder and fuel wood plantation and canal and road side plantation has increased by 887.8%. Area under permanent pastures has increased by 105.52%, mining area by 251.01%, and settlement and water bodies 51.18%. Area from rainfed cropland, sandy undulating older alluvial plains and grassland has gone to irrigated farming while the area from sandy undulating interdunal plains and shallow gravelly land has gone to rainfed agriculture. The area under wastelands has reduced by 26.95%. This has gone to agriculture, plantation and mining. The land records data (1980-81 to 2005-06) also show 5.79% decline in culturable wasteland. Vegetation cover over the wastelands has significantly increased. This has given more stability to the desertic terrain. The net irrigated area has increased form 111 ha to 1,46,246 ha, gross irrigated area from 119 ha to 2,00,446 ha and net sown area by113.32%. For expansion of irrigated cropland the grasslands were cleared. This has caused nearly 60% reductions in *Lasiurus sindicus* (Sewan) grasslands. The trend in gross irrigated area and gross cropped area is shown in figure 2. Development of waterlogging/salinization, invasion of weeds and increase in sand drift are the negative impacts of canal irrigation.

The major drivers of land use change are introduction of canal irrigation along with command area development programme, increased human and livestock populations and infrastructure development. Size of land holdings is reduced from 25.14 ha to 16.7 ha and numbers of operational holdings are increased by 145.07%. 114 colonized villages were created and agriculture land was allotted to settle down the population in the canal command area (IGNB, 2001).

Change in cropping pattern and crop production:

Introduction of canal irrigation led to shift in pearl millet based rainfed farming system to mustard-gram-wheat-groundnut based irrigated farming system. During the period from 1979-80 to 2005-06 (Anon.1982-2007) the acreage of bajra has declined by 38.95% while the acreage of wheat has increased by 44.46%, guar by 24 times and kharif pulses by 875.13%. There has been absolute increase in gram, mustard, groundnut, castor, cumin and isabgol crops. The trend in area and production of principal crops is shown in figure 3. The average production in the district has increased by more than 20 times. The productivity of rainfed crops has also increased due to availability of moisture and adoption of improved varieties. In 1900 km^2 area Desert National Park is being developed. Mineral production has increased from 0.06 million tones to 2.31 million tons.

Impact on socio-economic life:

Infrastructure facilities were also created along with the irrigation development. During 1980-81 to 2005-06 the number of revenue villages are increased from 515 to 688, irrigation wells from 37 to 2283, length of roads from 1976 to 5767 km, electrified villages from 13 to 390, co-operative societies from 64 to 283, tractors from 42 to 2988, motor vehicles from 852 to 12404, schools and colleges form 275 to 1354, veterinary hospital and dispensaries from 10 to 42, medical hospitals and dispensaries from 22 to 170, communication facilities in 163 to 545 villages.

Strategies for sustainable land use:

In order to maintain the sustainability of irrigated farming as well as rational use and efficient management of natural resources, there is need to improve water use efficiency, minimize transit loss, regulate proper and timely water supply; growing of less water requiring crops, use of drip and sprinkler system, adoption of improved agronomic practices; rodent, insect and pest management; development of livestock based integrated farming system; regeneration and development of pastures/grasslands, establishment of fodder bank, dairy development and livestock production; development of silvi-pasture; rehabilitation and development of waterlogged and mine spoil areas; drought proofing and management; provide adequate infrastructure facilities, linkage and coordination between all agencies working in the region, involvement of local people in all development works and formulation of long term land use policy.

Conclusion:

Expansion of irrigated and rainfed farming, diversification in cropping system, increase in production and productivity of crops; increase in soil moisture, afforestation, vegetation cover; improvement of living conditions including availability of drinking water and employment opportunities; and infrastructure development are the major changes and impacts observed in the district.

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