Mobile GIS application in planning and monitoring of MGNREGA work

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Abstract: Majority of governance functions of village resources and development planning require location / spatial information. Planning of road connectivity, health and education infrastructure, drinking water and irrigation facilities etc. uses integrated spatial and non-spatial information facilitated by GIS environment. GIS is also used by Panchayat Raj Institutions for the preparation of natural resources management (NRM) plan. Many more GIS based rural applications can be realized by integrating in-situ mobile GIS and management information system (MIS) data with backend GIS databases. At Space Applications Centre, an application has been developed by integrating in-situ mobile GIS observations, MIS and GIS data for planning and monitoring of MGNREGA work for Khavda village resource centre (VRC) cluster. Mobile GIS software QPad was developed for in-situ GIS data collection and desktop VRC GIS software has been developed for integrating in-situ, GIS and MIS data. Two tier approach was followed in planning and monitoring of MGNREGA work. Macro level analysis has been carried out using online public domain data for selecting area of interest. The major work permitted under MGNREGA are pertaining to land development, water conservation and harvesting, drought proofing, flood control and protection, rural road connectivity and micro irrigation. Micro level analysis has been carried out for predominantly drought prone Khavda cluster for suggesting suitable MGNREGA work based on GIS analysis using integrated in-situ mobile GIS observations, MIS and GIS data. Physical, social, economic and composite drought vulnerability modules have been developed for micro level GIS analysis. The details about various GIS functions, in-situ, GIS and MIS data are described in the paper. The GIS analysis results and maps generated for planning of MGNREGA work are presented in the paper. The approach followed for the validation of derived results is included in the paper.

Keywords: Mobile GIS, QPad, VRC GIS, MGNREGA, In-Situ and MIS data

1. Introduction

Rural governance is aimed at development of land and water resources, rural infrastructure planning, economic betterment of people and social transformation by involving participation of rural population in the rural development programs. The majority of governance decision requires location / spatial information. Geographic Information System (GIS) facilitates spatial and non spatial data integration from different sources and helps in rural development and resources planning process. It is possible to realize many more GIS based rural development and planning applications by integrating in-situ data and management information system (MIS) data with GIS databases (Udani, 2005). It is possible to demonstrate application of integrated GIS, MIS and in-situ data for the planning and monitoring of Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) work. Two tier approach was followed in MGNREGA application development. The macro level analysis was carried out for selection of area of interest using available maps and reports of public domain. The micro level analysis were carried out using integrated GIS, MIS and in-situ databases for planning and monitoring of MGNREGA work for 18 villages of Khavda Village Resource Center (VRC) cluster. VRC GIS software was developed for the micro level analysis.

2. MGNREGA

MGNREGA aims at enhancing the livelihood security of the people in rural areas by guaranteeing hundred days of wage employment in a financial year, to a rural household whose members volunteer to do unskilled manual work. The objective of the Act is to create durable assets and strengthen the livelihood resource base of the rural poor. The choice of work suggested in the Act is decided to mitigate the adverse impacts of drought, deforestation, soil erosion etc. and provide employment on a sustainable basis. A majority of the poor in rural areas of the country depend mainly on the wages they earn through unskilled, casual, manual labour. MGNREGA scheme has been an important intervention for providing unskilled manual workers with short-term employment on public work such as irrigation infrastructure, reforestation, soil conservation and road construction. Panchayat Raj Institutions (PRIs) have a principal role in planning and implementation of MGNREGA work. The different categories of permissible work for MGNREGA are:

- Water conservation
- Drought proofing
- Flood protection
- Drainage channel for water logged areas
- Land development
- Minor irrigation
- Rural connectivity

MGNREGA scheme is not a supply driven but a demand driven and work should ordinarily be provided within 5 km radius of the project site. The violation of this distance criteria calls for payment of 10 % extra wage. These conditions calls for GIS based planning and monitoring of MGNREGA work.

3. Village Resource Center (VRC)

VRC program is an initiative of ISRO for rural development and it is aimed at disseminating a variety of societal services emanating from the space systems and other IT tools for meeting the critical needs of rural communities. VRC has primarily two major components – satellite based communication system (SATCOM) and Earth Observation (EO) using satellite data. SATCOM system, providing audio / video linkage between two locations, is used for providing services in various disciplines like health, education, disaster, agriculture and animal husbandry etc. on a regular basis. The EO data is used for creating natural resources management (NRM) databases under GIS environment for each VRC cluster. The NRM data created for the Khavda VRC cluster has been used for the planning of MGNREGA work.

4. Study area

Khavda VRC cluster comprises of 18 villages of Bhuj taluka of Kachchh district in Gujarat (Figure 1). The geographic extent of Khavda cluster is defined by 23°51′N 69°43′E and 23.85°N 69.72°E.

Figure 1: Location of Khavda

5. Macro level analysis

The macro level analysis has been carried out using vulnerability maps and reports available in public domain (www.terrin.org) for the selection of area of interest (AOI). The rain fall in Khavda cluster is scanty and the region is predominantly drought affected and hence selected as AOI for planning of MGNREGA work.

6. Micro level analysis

Micro level analysis has been carried out for planning of MGNREGA work. The physical vulnerability, social vulnerability and economical vulnerability are useful indicators for village development planning (Das, 2009). The types and number of MGNREGA work to be taken up can be efficiently planned using various vulnerability indices like physical vulnerability, social vulnerability, economical vulnerability and composite vulnerability. For this purpose, VRC GIS software was developed for integrating GIS, MIS and in-situ data and vulnerability analysis. The VRC GIS software was used for planning of MGNREGA work. Major GIS functions supported are query, data browsing, navigation, data preparation and map generation. The vulnerability analysis module of VRC GIS software provides facility for selection of parameters for calculation of physical, social and economical vulnerability. The main user interface of VRC GIS software with ground water prospect map of study area is shown in Figure 2.

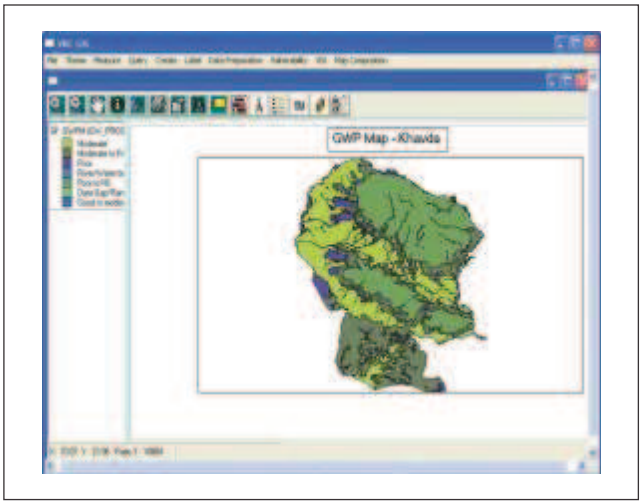

Figure 2: User Interface of VRC GIS Software

6.1 Databases

GIS, MIS and in-situ data for the study area have been collected and integrated for the micro level analysis. The GIS, MIS and in-situ data used are described below.

GIS Data: Land use, ground water prospect, village boundary, drainage, road network etc.

MIS Data: Total population, SC / ST population, number of households, population of landless and population of BPL cardholders etc.

In-situ Data: Education, health, well, water tanks etc.

6.2 Physical vulnerability index (PVI)

Land use, ground water prospect, soil degradation, crop area, irrigated area, irrigation infrastructure, flood and cyclone

prone area, roads network etc. are generally used in determining physical vulnerability. The PVI defines status of natural resources and infrastructure. The physical vulnerability in the present study has been determined using ground water prospect, agriculture land, waste land, grassland, wells and road network. The vulnerability for each parameter has been calculated using the formula:

Parameter_PVI = (Actual value – Min value) / (Max value – Min value).

and vulnerability for each village has been calculated using combined Parameter_PVI.

Village_PVI = GWP(I) + AgriLand(I)
+ (1-WasteLand (I)) + GrssLand(I)
+ (1-Road(I)) + Well(I);

where I is variable for the village. The wasteland and roads are reducing the PVI and their complimentary values with respect to one have been considered. The prepared PVI map of study area is shown in Figure 3.

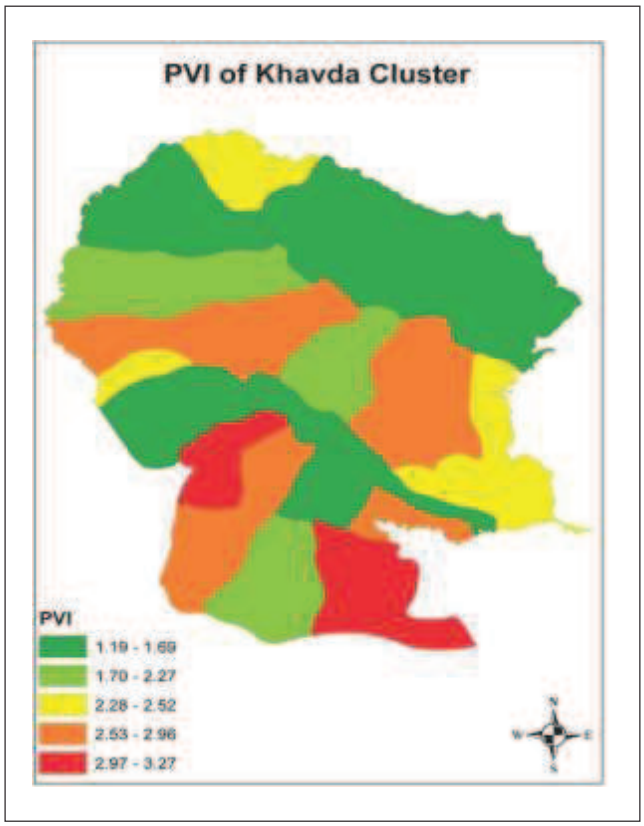

Figure 3: PVI map of Khavda cluster

6.3 Social vulnerability index (SVI)

Total population, population of SC/ ST, landless workers, agriculture workers, other workers, marginal farmers, (< 1 ha), small farmers (< 1-2 ha), social infrastructure, literacy ratio, access to health, education and electricity facility, seasonal migration, crop insurance, etc. are generally used in determining social vulnerability. The social vulnerability for the study area has been determined using population of SC / ST, population of women, literacy ratio, health and education facility. The vulnerability for each parameter has been calculated using the formula:

Parameter_SVI = (Actual value – Min value) / (Max value – Min value).

and vulnerability for each village has been calculated using combined Parameter_SVI.

Village_SVI = SC(I) + ST(I) + Woman(I)
+ (1-Literacy(I)) + (1-Helth(I))
+ (1-Education(I)).

The prepared SVI map of study area is shown in Figure 4.

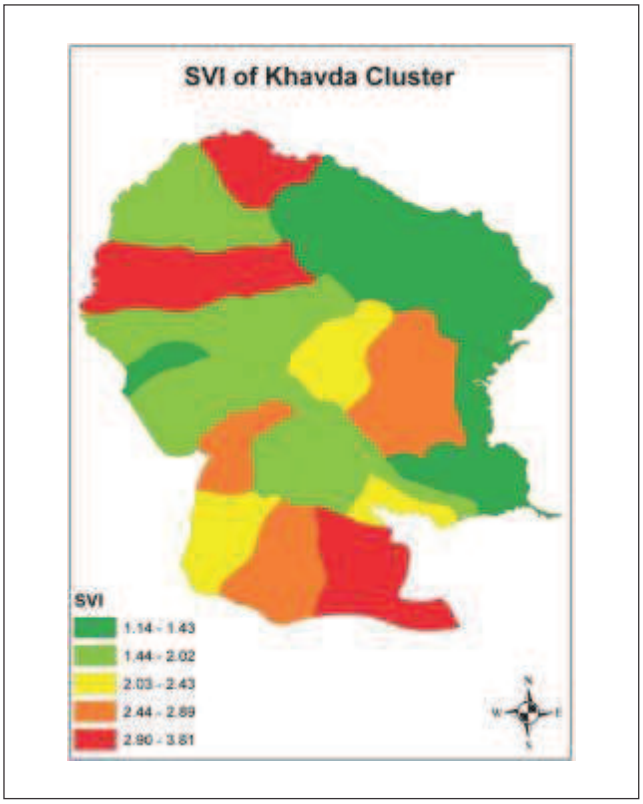

Figure 4: SVI map of Khavda cluster

6.4 Economical vulnerability index (EVI)

Agriculture dependency, income, commercial crop, food crop, transportation, no of pumps set holders, no of earning members in family, population of BPL card holders etc. are generally used in determining economic vulnerability. The economic vulnerability has been determined using no of SC/ ST workers, BPL card holders, MGNREGA card holders, number of house hold workers and total workers. EVI for each parameter is calculated the using the formula:

Parameter_EVI = (Actual value – Min value) / (Max value – Min value) and vulnerability for each village has been calculated using combined Parameter_EVI.

Village_EVI =SCEmp(I) + STEmp(I)

+ BPLCard(I) + ACHolder(I)

+ (1-HHWorker(I))

+ (1-TotWorker(I))

The prepared EVI map of study area is shown in Figure 5.

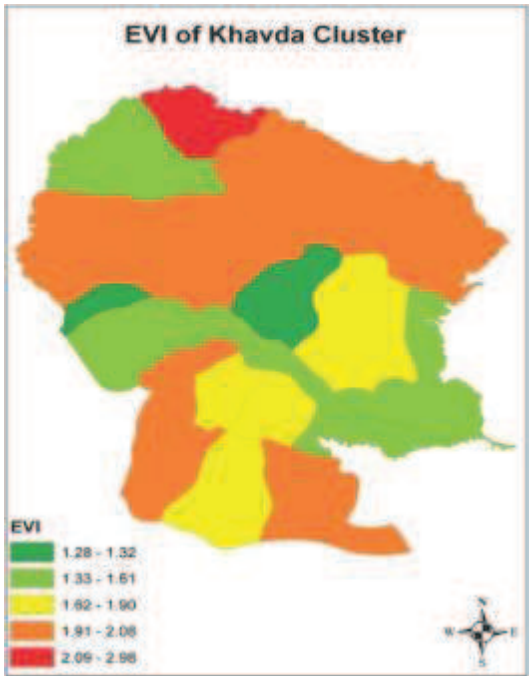

Figure 5: EVI map of Khavda cluster

6.5 Composite vulnerability index (CVI)

The composite vulnerability has been calculated using formula CVI=(PVI+SVI+EVI). The CVI has been determined for each village for need assessment of MGNREGA work. The CVI value for Daddhar moti is highest and it is considered highly vulnerable. The CVI value for Mnt is smallest and it is considered least vulnerable village. The bar chart showing PVI, SVI, EVI and CVI values for all villages of Khavda cluster is shown in Figure 6.

The results of CVI analysis and maps generated were ported to mobile GIS system for field verification. The reference data about the MGNREGA work reported and used as per the MoRD site (www.rural.nic.in) is presented in table 1. The mobile GIS system was used for in-situ data collection for ongoing MGNREGA work. The in-situ mobile GIS observations taken for MGNREGA work pertaining to water conservation and harvesting (WCH) and road connectivity (RC) are shown in Figures 7 and 8. The complete information about village wise MGNREGA work is provided in table 2.

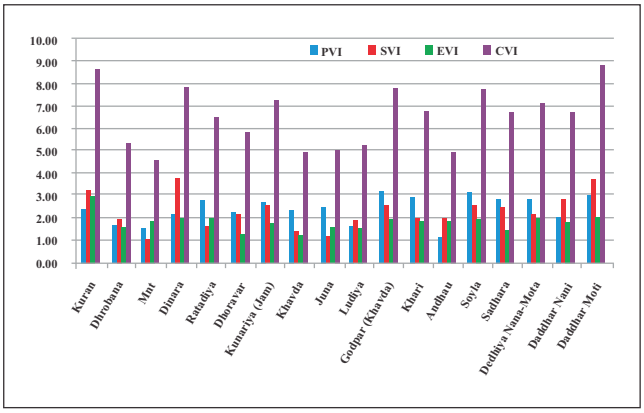

Figure 6: Bar chart of study area for PVI, SVI, EVI and CVI

The construction of retaining wall shown above in Figure 9 was not considered much useful and it may be contributed to the constraint of work allocation within 5 km distance.

Figure 7: Mapping of Roads connectivity, wall repairing and desilting of pond

Table 1: MGNREGA Work (Source: Ministry of Rural Development, August 2011)

Village Name	Work
ANDHO	plantation, ID GAH PASE TALAV, jangal vistarma teres talavadi, MAIYARA TALAV
DADHADHAR	dadhar moti to kharivav road work, South side talav (MOTI), vandha vas talav (sadhara), halavas talav (moti), zil talav (Nani), chhervas talav (Nani), SIM TALAV - DADHDHAR - SADHARA , gam thi kabrastan sudhi rasta nu kam
DHORAVAR	kunthan talav, harijnavas bavdiyo talav, katar varo talav, vighasar talav, bavariyo tobho talav, kundhan talav
DHROBANA	husenivandh adabanda, ishanivandh adabandh, sumrapor adabandh DHROBANA-SUMARPOL SIMTALAV, aadbandh 1 - 4, dafaivado tadav

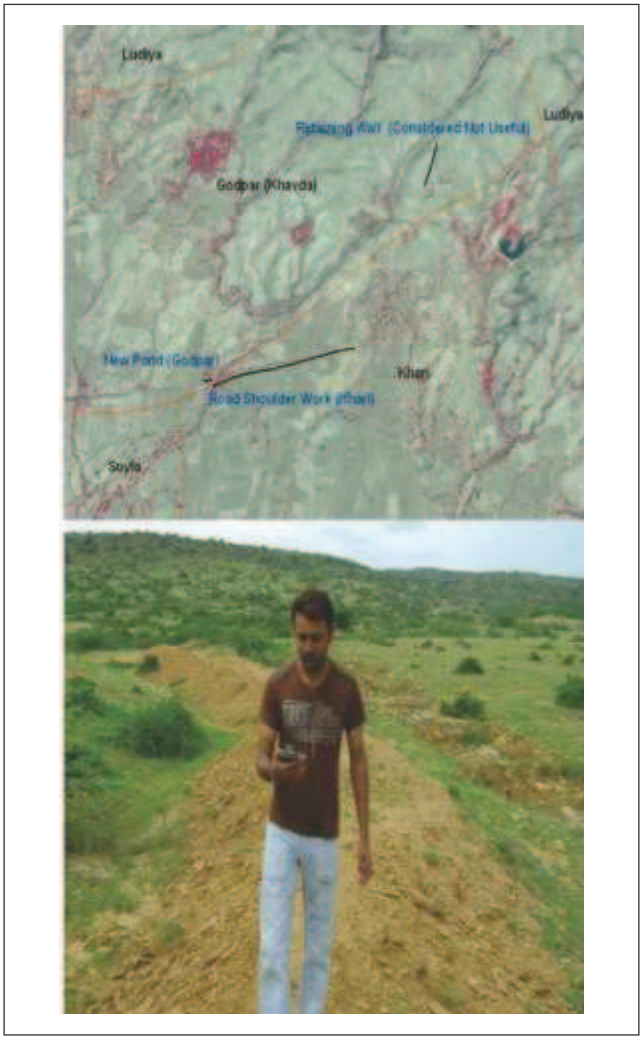

Figure 8: Mapping of retaining wall

Table 2: CVI and water conservation / harvesting and road connectivity work

VNAME	CVI	WCH	RC	VNAME	CVI	WCH	RC
Kuran	8.74	0	0	Ludiya	5.32	11	8
Dhrobana	5.32	20	0	Godpar (Khavda)	7.92	2	0
Mnt	4.66	2	0	Khari	6.84	8	6
Dinara	7.95	25	1	Andhau	5.07	9	4
Ratadiya	6.62	38	0	Soyla	7.82	0	0
Dhoravar	5.84	25	2	Sadhara	6.77	7	6
Kunariya (Jam)	7.27	4	6	Dedhiya Nana-Mota	7.20	0	0
Khavda	5.06	23	3	Daddhar Nani	6.81	12	0
Juna	5.31	30	2	Daddhar Moti	8.90	0	8

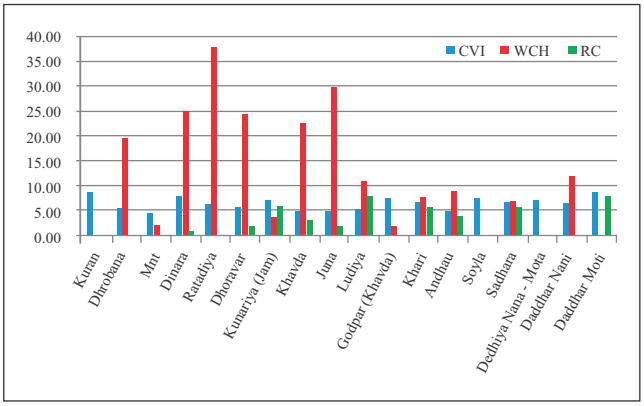

Figure 9: Comparison of CVI and ongoing MGNREGA work

7. Results and discussion

The Khavda cluster is highly drought prone and rainfall in study area is scanty. The priority work planned for MGNERGA were water conservation and harvesting (nala bunding, farm pond, digging of pond and storage tank, percolation tank) and road connectivity. The CVI values were compared with ongoing MGNREGA work and findings are shown in Figure 8. It has been found that CVI is useful in planning of MGNREGA work. No MGNREGA work reported for Kuran, Soyla and Dedhiya Nana-Mota may be attributed to their location and characteristics of the surrounding region. It can be observed from the graph that ongoing WCH work are not adequate for Mnt, Kunaria and Khavda. Village location, total population and distance criteria are also found influential in planning of MGNREGA work. This case study has demonstrated application of Mobile GIS technology in monitoring of MGNREGA work. Adapting such participatory GIS approach in planning and monitoring of MGNREGA work is desired for drought proofing and ensuring food, fodder and water security for drought prone region.

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