

Case Study

Application of GIS in Panchayati Raj System in India: A Case Study of Naugaon Village, Uttarakhand, India (An Initiative of G-governance)

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Abstract Panchayati Raj system is autonomous body of self-governance which deals with all aspect of village. Villages are the basic unit of administration, it is necessary to provide adequate power to villagers so that they have real sense of “Swaraj”. In this Present study Geographical Information Systems (GIS) technique has been used as problem solving tool to solve a real world problem which can influence villagers life’s directly. For the fulfillment of this objective filed survey has been carried out at Naugaon village, then long discussion with Sarpanch of village helps to identify problem of the village which can be solved with GIS technique. Shortage of water supply in some agriculture field has been treated as research problem. To solve this problem site suitability of water tank and canal has been done using GIS to provide adequate water supply to agricultural field. So in this way GIS can be used for scientific planning and decision making at village level.

Keywords *Geo-spatial Technology; Site Suitability and G-Governance*

1. Introduction

Panchyati Raj system has been in existence since long in India. Village panchayat consisting of village elders were autonomous local self-governance bodies which deal with all aspects of village. Considering villages as the basic unit of administration, it was necessary to provide adequate power to villagers so that they have real sense of “Swaraj”. In India the panchayat raj now functions as a system of governance in which gram panchayat are the basic unit of local decentralization. The system has three levels: gram panchayat (village level), Mandal parishad, or block samiti or panchayat samiti (block level), and zilaparishad (district level), it was formalized in 1992 by the 73rd amendment to the Indian constitution.

Government of India in 2006 with an intention to transform the governance landscape by ensuring participation of citizens in policy making and providing ease of access to information to the citizens, introduced the National e-Governance Plan (NeGP) in 2006. E-Government is not about ‘e’ but about ‘government’; it is not about computers and websites, but about services to citizens and businesses (Second Administrative Reforms Commission Report, Government of India, 2008). Now this era is shifting from e-governance to g-governance to bring wide range of benefits. GIS (Geographic Information System) is computer based system or tool in which we store, analyze, Retrieve and extract information out of Geospatial data.

The governance process, which involves the use of geo-information and communication technologies (Singh, 2009). G-governance is initiative to enable better planning processes, delivery systems, and increasing transparency and efficiency in the national-level decision-making and reaching developmental benefits to citizens in a unique manner. The application of Geographic information system could serve the needs of natural resources management, public distribution policy and other planning activities as spatial decision support systems. Participatory, decentralized and transparent governance could be efficiently achieved with G-governance or GIS based governance.

1.1. Role of Remote Sensing and GIS in Panchayati Raj System

Remote sensing (RS) is a science of obtaining information with distance. RS can be used to derive accurate information with high spatial and temporal resolution (Adham et al., 2016). A GIS is a tool for collecting, storing, and analyzing spatial and non-spatial data (Mati et al., 2016). In simplest term GIS is problem solving tool which solve real world problem and give alternative solution. This study is pioneer in order to implement GIS on village level to solve problem faced by villager in daily life with the help GIS technique.

Role of GIS in Panchayati System

Geographic information system could be used to support decision making at village level and national level. Scientific planning and monitoring of Natural resource could be efficiently achieved with this emerging technology. Integration of information and efficient management of data in digital form can provide basis for planning, resource management and public distribution. This technology is capable of giving voice to local people, to the extent of putting local people on a more equal footing with external experts and decision-makers, such as claimed for P-GIS used in land reform in South Africa (Michael, 2003)

Challenges in Implementing GIS Based Technology

- Majority of communities are illiterate/semi-literate living in adverse conditions. With the scarcity of resources and basic needs, using GIS and IT for database generation may seem luxurious
- Political resistance to local empowerment
- Participation in training programmes could be negligible because of overlap with their occupational calendar

Nowadays Government of India has started initiative of Digital India which aims at improved online structure to provide government services to citizens. Nationwide projects namely Village information system and Empowerment of Panchayati Raj Institution system aims at creation of digital data base (Land record, population data, Economic record) and asset mapping. Digital Database (spatial and non-spatial) can improve scientific planning and decision making. GIS has to play vital role in maintenance and creation of Digital Database of every city, Village, public and private organization. In this present study GIS has been applied on the village level therefore study attempts to give irrigation facility through site suitability of canal and water tank. Majority of population of village is engaged in agricultural activities, so increase in agricultural productivity will eventually help in overall economic perspective. This study is an example how GIS could be used for betterment of society and its efficiency in resource management and public distribution policy.

Study Area and Data

The study area of this project is Naugaon village which situated in Bageshwar district of state Uttarakhand. Bageshwar district is a hilly region-amidst Shiwalik range and high Himalaya (Figure 2). Bageshwar district characterized by average annual temperature of 20.4°C and evenly distributed rainfall. Most of the rainfall is convectional and occurs in summer season. According to Koppen climate classification this region comes under Cfa category. The areal extent of study area is 79°33'28" E and 79°33'46" E longitude and 29° 33' 28" N and 29° 53' 50" N latitude (Figure 1).

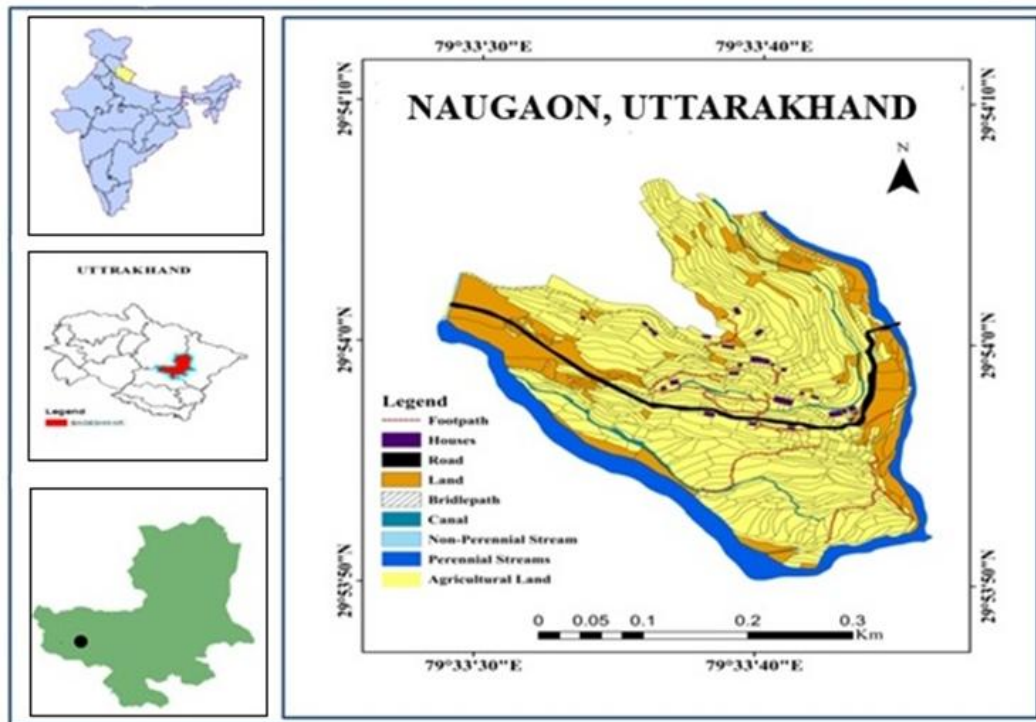


Figure 1: Overview of study area

The village is present at altitude of around 1315 meters above mean sea level. Economic condition of that region is low, majority of population engaged in primary activities such as agriculture, animal husband ring, cattle rearing etc.



Figure 2: Physiography of study area

Figure 2 is showing overall physiography of study area. Terrace farming has been practiced there and major crops are Barley, Ragi, Rice, and wheat which is mainly consumed within family of farmer, Development in agriculture activities could lead to overall development of region.

Data Used

The following data has been used for study (Table 1).

Primary Data: This data has been collected during field survey which includes GPS point of various entities which can't be identified on Google earth imagery. Population data of village has been collected to create digital Database of village.

Secondary Data: The secondary data include shape file and Base map of village provided by NRDMS Uttarakhand. Other than this Google earth and SRTM DEM has been used for updating village map.

Table 1: Data used in study

Data	Source	Specification
Base map	Revenue department	Every minute information is available
Shape files	COE NRDMS	Information of study area in different layer of 1959
Field data	Field survey	Primary data about house owner and number of family member
Google earth image	Hybrid	High resolution satellite image
Digital elevation Model	Bhuvan portal	30meter resolution DEM

2. Methodology

The methodology of present study has following phase:

2.1. Meeting with Ministry of Panchayati Raj and Rural Development on Role of GIS in Rural Development

This study primarily concerned with application of GIS technique at village level which can influence villager's life directly, Moreover to use GIS as a problem solving tool to solve a given problem. First of all meeting with ministry of Panchayati raj members has been conducted by Natural Resource Data Management System (NRDMS) Uttarakhand, to discuss work of ministry on rural development using GIS. After long discussion with representatives of ministry they reveal that till date no one has done GIS implementation at village level to solve their daily life problem. So this study could be beginning or pioneer of GIS implementation as tool which can solve daily life problem and capable of giving alternative solution of problem. So this study is pioneer with objective of solving village level problem with use of GIS.

2.2. Field Survey, KII and Problem Identification

Map of Naugaon village has been provided by NRDMS Uttarakhand. This map of Naugaon village has been prepared by the NRDMS in 2000, so with the help of Google earth and field survey final map as LULC of village has been prepared. Most stimulating and challenging part of this study is to find out the problem of village which can be solved with GIS. Field survey has been carried out in order to identify difficulty which can be sorted with means of geo-spatial technology. Personal observation and discussion with "Sarpanch" of village on each aspect helps to identify the problem. Naugaon village

has facilities such as school, Hospital, Post office and Police station in defined range as stated in government rule, however in some Agriculture field there's a shortage of water (Figure 3). This shortage of water has great significance because majority of village population is engaged in agricultural activities. To get rid of this problem construction of water tank and canal indeed this could be capable of providing water to agriculture field. The site suitability of canal and water tank has been considered as a research problem. As this research problem shows application of GIS at village level and problem solving tool for real life problem.



Figure 3: *Water shortage in Canal*

2.3. Site Suitability of Water Tank and Canal

First of all land use and land cover has been prepared with data provided by NRDMS Uttarakhand and data collected during field survey has been used to update feature of map. Land cover land use map show how much of land is cover by what type of natural phenomena or how it is used by man. LU/LC is prerequisite in many project of Remote sensing and GIS because it give us broad idea of what type of activities is running in that region, or if we took LU/LC map of different year we can easily identify what changes has occur in certain period of time. Site suitability analysis in GIS is used to find best place or location for something. The approach behind site suitability is rule based mapping in which we define certain condition of it and then if they will meet we have result of most suitable site. In site suitability Analysis we can have result in two form one is based on Boolean logic and another one is based on heuristic approach (knowledge based). Boolean logic gives result in form of 0 or 1 but in the heuristic approach we rank all the factors responsible for site suitability and give suitability to every location in form of high, medium, low suitable. In this study both approach has been adopted for comparative analysis of results.

2.4. Heuristic Approach for Site Suitability

This approach is also known as knowledge based approach because in this approach analyst rank all those factor which play significant role in influencing site suitability of that entity. The most important factor is Land use land cover map which has several layers such as canal, river, barren land, houses, bridlepath, agriculture land and road. Suitable weights have been assigned to each thematic feature after considering their characteristics (Kumar et al., 2008) as shown in (Table 2). In this method weightage has been given to barren and location nearest to river. As LULC map shows (Figure 4.1) barren land present on North West direction at high elevation of study area. Advantage of constructing water tank on this side could be understood in two ways, Firstly barren land has no use, or may be with water availability it would become fertile after some time. Another advantage is that location is that it is nearest to river which will result in less expenditure in construction of water tank and supply of water.

Table 2: Ranks given to LULC layers

FID	Name	Rank
0	Road	2
1	Canal	3
2	River	4
3	House	2
4	Bridle path	2
5	agriculture	3
6	barren	5

Table 3: Ranks given to distance from river

FID	Distance (m)	Rank
0	10	5
1	20	4
2	30	3

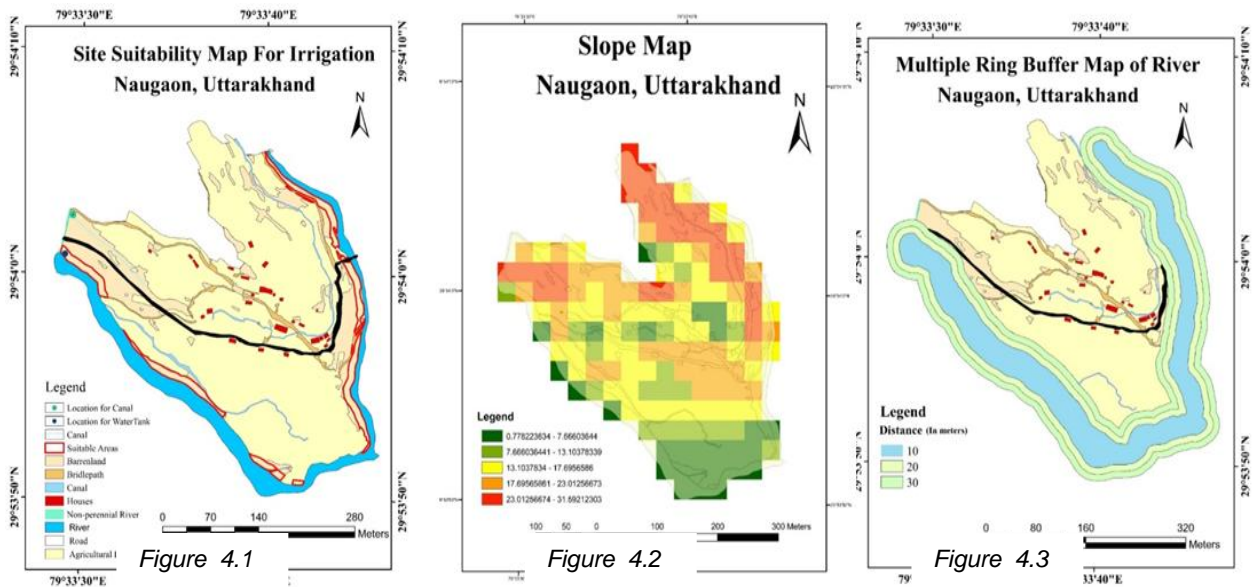


Figure 4: 4.1: Site suitability map for irrigation Naugaon, Uttarakhand; 4.2: Slope map Naugaon, Uttarakhand; 4.3: Multiple ring buffer map of river Naugaon, Uttarakhand

Another significant parameter which influence suitable site for water tank and canal are slope and distance from river. Buffer map as shown (Figure 4.3) on both side of river has been generated on both side of river using Arc GIS and weightage has been given to its nearest location. Slope map as shown in (Figure 4.2) has been generated in Arc GIS to analyze slope factor for suitable site of water tank and canal. Then union of these factors create new polygon where condition meet, for this first of all addition of both ranks required in new field (Rank final) with the help of field calculator then again new field (suitability) is added, finally area of high, medium and low suitability can be identified through query operation in which we state that final rank ≥ 8 IS Highly suitable for water storage tank and final rank ≥ 5 And final rank < 8 is moderately suitable and remaining ones come under category of low suitable. We have result in form of every area has some sort degree for suitability of water storage tank but objective of site suitability analysis is to give particular location for that third factor of slope is used and put a point to particular location which has moderate slope or capable of serving water to barren land.

For suitability of canal as we can see in LULC map we need to locate canal at highest elevation point of barren which is capable of serving whole barren region, if location of canal would at highest point no power required to supply water it will flow to whole region due to gravitational force.

2.5. Boolean Logic (Method) for Site Suitability

Boolean logic gives output in form of 0 and 1, same factors are responsible for site suitability of water tank and canal but here analyst doesn't need to each factor, output can be generated by query operation such as river distance =10 and name = barren Result is generated as we can see in the map suitable site for water tank in form of polygon, same as in heuristic approach we could find particular location using third factor of slope where slope is moderate that site is much suitable for water storage tank.

3. Results and Discussion

The site suitability map for irrigation facilities with Boolean approach as shown (Figure 5.2) is showing best location for water tank and canal which is including three factors namely LULC, distance from river and slope of area.

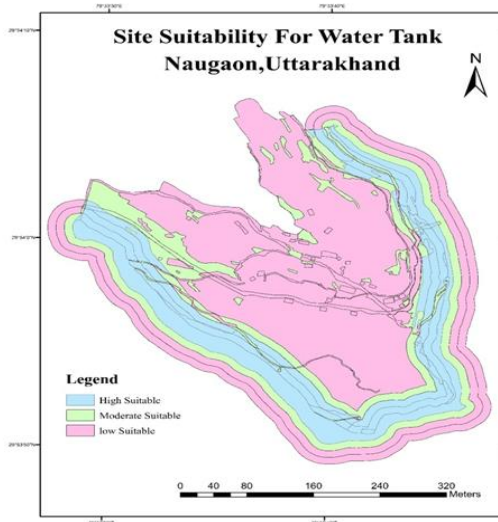


Figure 5.1

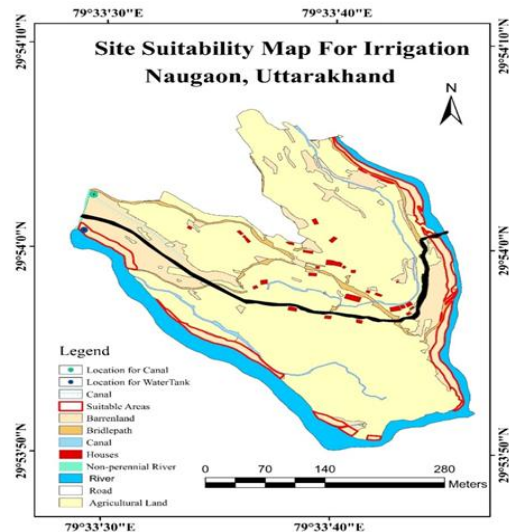


Figure 5.2

Figure 5: 5.1: Site suitability for water tank Naugaon, Uttarakhand; 5.2: Site suitability map for irrigation Naugaon, Uttarakhand

The result is exact up to our expectation because water tank is closet to river and located at barren land which has two advantages. Firstly less expenditure indeed for water supply to water tank and second one is that we are using waste land which has no use right now or with the availability of water there are some chances for conversion of this barren land to agriculture land. Canal is located at highest point of barren land which is capable of serving water to whole barren land with force of gravity no external force is required. Total area under high suitability for water tank with Booleans approach is 6374.49 square meter

In the heuristic approach map as shown (Figure 5.1) degree of suitability for water tank to each location, but location of high suitability in both approach is almost same because we have given weightage to river and barren land then consider slope. Table is showing how much of area is under which category of suitability for water tank.

At present several national wide projects (EPRIS, SISDIP and VIS) are ongoing for application of GIS at village level for decentralizes planning. This present study is also step forward in the same direction. The overall objective of this project is to implement geographic information system technique on grass root level to solve village level problem. As we study this technique as a problem solving technique for real world and through this project we can directly influencing common people through GIS technique. To solve village level problem with GIS, in depth field observation played vital role. GIS can be used as a spatial decision support system for scientific and decentralize planning. With the help of GIS Digital base of each village could be generated which helps in efficient planning and resource management. This present study is attempt in same direction. To Use GIS as tool for rural development present case study is significant example. For fulfillment of objective field survey has been carried out and long

conversation with Sarpanch of that village we found that there is seasonal shortage of water supply to agricultural field so this project is all about providing irrigation facilities to agriculture fields.

As mentioned above result of this study is per expectation. With first interface of prepared updated map of Naugaon the first idea strikes in my mind that there should be some water storage tank near the river. Water from water tank need to be supplied to canal which is located at the highest elevation point of village which can be capable of serving water to all agriculture fields without external force required to supply water. Site suitability analysis for water tank and canal with help of two approaches shows almost same result however the main advantage of heuristic approach is that this approach provide alternative of highly suitable area for water tank. Result in form of polygon of suitability which range from higher to lower suitable site. However there should be particular location for water tank for.

In comparison to heuristic method, Boolean approach gives result for highest suitable site for water tank and canal. With the help of Boolean method exact site could be marked. The discussion part must contain how can we implement this project to real world or there is any economic viability of this project on ground, so know that we must know about total expenditure required for constructions of canal and water tank because this is hilly area of we have to make sustainable solution which is capable of tackling every problem.

At present time application of GIS on village level has great significance. Village information system and Empowerment of panchayati Raj system is nationwide project in India. Their major focus is on creating digital database of village which will play pivotal role in planning and decision making.

4. Conclusion

Geospatial technology or spatial science provides integrated tools for solving real world problem. Geospatial technology could be a very significant tool for efficient and transparent governance. Public distribution or resource management could be another example of Geospatial technology at grass root level. This study is pioneer in respect of GIS implementation at village level. Efficiency of geospatial technology on grass root level could be summarized using following points given below:

- GIS can be used in scientific planning and decision making.
- In this study GIS has been used to solve Real world which can influence villager's life directly.
- This study shows application of GIS at grassroots level.
- This study is an attempt toward decentralize planning using geospatial technology.
- Geospatial technology could be use to develop To develop comprehensive web portal as per PRIs and stakeholders needs for decentralized planning, governance, outreach to the citizens and data dissemination

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