

Final Project Report

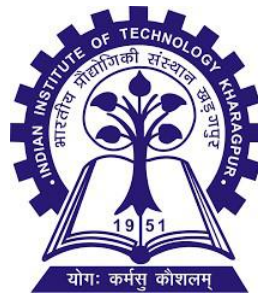
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**Rural Spatial Planning for
Aguibani Gram Panchayat of West Bengal**

Submitted to

**Ministry of Panchayati Raj
Government of India**

Submitted by



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Final Project Report on Rural Spatial Planning for Aguibani Gram Panchayat of West Bengal

by: IIT Kharagpur

Feb 27, 2021



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निदेशक

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Message

The growth of developing nations like India lies in the development of the rural areas, where most of the population resides. IIT Kharagpur has been engaged in rural development in various capacities since its inception. IIT Kharagpur, now recognized as an institute of eminence, has assumed its social responsibility and is helping nearby societies by providing low-cost adaptable technological as well as social solutions for the major issues faced by the rural population, in the area of water, agriculture, transport, energy, health-care, education and skill development, to name a few.

The vision of our honourable Prime Minister Shri Narendra Modi ji to strengthen the rural economy of India and double the income of farmers through various avenues of *Atmanirbhar Bharat* motivates us further to contribute towards rural development. IIT Kharagpur takes immense pleasure in its involvement with the Ministry of Panchayati Raj, Govt. of India along with Panchayats & Rural Development Department, Govt. of West Bengal, National Remote Sensing Centre and Regional Remote Sensing Centre, East for the development of Rural Spatial Plan for identified Aguibani and Mokrapur Gram Panchayats (GP) of West Bengal. The team from IIT Kharagpur has worked, even during the period of COVID-19 restrictions, on the baseline assessment of the GPs, and identifying potential interventions for preparing a comprehensive development plan for the selected GPs.

We have identified a 10-year comprehensive development plan proposed with short-term, mid-term and long-term strategies with regards to water and sanitation, health-care and naturopathy, agriculture and food processing, education and skill-development, rural housing and infrastructure, energy sustainability and natural resources management. The multi-sectoral interventions also aimed convergence with government ambitious schemes like *Har Ghar Nal Ka Jal, Per Drop More Crop, Swachh Bharat Mission, Make in India and Aatmnirbhar Bharat*.

IIT Kharagpur, having a huge volume of work and experience in rural development, is willing to offer technological support for the design, implementation and monitoring of various development schemes suggested for the GPs.

I am confident regarding the outcome of this initiative by the Ministry of Panchayati Raj, and hope that together we may demonstrate the effective implementation of these plans at the GP level. I hope it could become a working model for adoption PAN- India

(V K Tewari)

Acknowledgements

It was harder to work on this field-based project during peak of COVID-19 infections than we thought, but was equally rewarding too. We now take this opportunity to express our profound gratitude and deep regards to the Director IIT Kharagpur Prof. Virendra Kumar Tewari for entrusting this team for the project, and the constant monitoring and encouragement we received throughout the course of this project. We also thank Dean SRIC and IIT Kharagpur administration for facilitation necessary support during the COVID19 restrictions for execution of the activities of the project.

This work would not have been possible without the kind support and help of local stakeholders including Aguibani Gram Pradhan Smt. Rani Hembram Murmu, Panchayat Secretary Mr. Lal Mohan Das, the Village Resource Persons of Aguibani GP, and many villagers and individuals participated in the survey. We would like to extend our sincere thanks to all of them.

We further express our gratitude towards the Ministry of Panchayati Raj, Government of India for funding this project, and Secretary Shri Sunil Kumar, Joint Secretary Shri Khushwant Singh Sethi, and Under Secretary Shri Nirmal Praphul Toppo for all the coordination and support. We also thank the Department of Panchayat and Rural Development, Govt. of West Bengal, and exclusive thanks to Shri Dibyendu Das, Special Secretary, Govt. of West Bengal for extending all the required support for conducting field level studies in the GP.

A special thanks is also due to National Remote Sensing Agency (NRSA), and Regional Remote Sensing Centre (RRSC-East), Kolkata for helping with the necessary remote-sensing data and information about the GP. We specially thank Mr Y K Srivastava from RRSE-EAST for his coordination with our team.

Last but not the least, we would like to express our special gratitude to the project staff engaged in the project, who ventured out for surveys and field visits even during the testing times of COVID19 pandemic. We also thank all other people who directly or indirectly supported this endeavour, and aimed to help us during this work.

Executive Summery

Rural Development is one of the most vital aspect for the country like India, where nearly two-third of the population live in rural areas. The development of rural communities can be richer and more meaningful only if a comprehensive development plan is adopted including education, health-care, employment opportunities, water and sanitation, housing and rural infrastructure, civic amenities and the natural resources management. Further, the success of any development interventions requires participation of all stakeholders, including clientele of development. The Panchayati Raj Institutions assigned with the responsibilities to look after development at gram panchayat (GP) level, plays the most vital role in rural development. However, GPs may not be well equipped with required technical knowledge and skills, and support of relevant expertise and knowledge pool from premier institutions can be harnessed to layout rural development plans in most economical and sustainable ways. Taking an initiative in this direction, the Ministry of Panchayati Raj, Govt of India floated a pilot programme for 32 Gram Panchayats (GPs) across 13 states for the development of the Rural Spatial Plan with the help of a set of premier institutions. IIT Kharagpur participated as Coordinating Institute for 2 GPs, Aguibani and Mokrapur, in the State of West Bengal, and worked with National Remote Sensing Agency (NRSA), Regional Remote Sensing Centre (RRSC-East) Kolkata, and West Bengal Panchayat and Rural Development Department, at conceptualizing Rural Spatial Planning for identified GPs.

Aguibani GP, spread over an area of 20 Km², is located nearly 170 Kms west of Kolkata, on Kolkata Mumbai Highway (NH49). The GP has a population of nearly 11,000 spread over 38 villages. A comprehensive baseline assessment was performed on the socio-economic status of the population, and availability of basic amenities in the GP, based on primary and secondary data. Primary data was collected through the household surveys using a Mobile App, named GPSDP Survey developed by NRSA, as well as paper-based survey in local Bangle language. A total of 315 households, constituting 13.43 % of total households and identified following stratified sampling strategy, were surveyed in Aguibani GP. The secondary data was collected from several sources including the panchayat office, NRSA and RRSE-East, and a few government's web portals.

In the baseline assessment, nearly all development aspects were covered including living standards of population, availability of basic amenities, economic and educational status, natural resources availability, employment status, housing and infrastructure status etc. Aguibani GP was found lacking in several basic amenities like education, health-care,

employment and source of income, water and sanitation etc. The household survey revealed that the average per person monthly expenditure in Aguibani GP is ₹ 1,046 only, which is 27 % less than the average per head expenditure in rural India. Therefore, majority of population lies below poverty line (BPL), and 80% surveyed population was found having BPL card. Over 60 % population in Aguibani GP is still leaving in Kachha houses, and nearly 20% in Semi-Pucca houses, with most of the houses are more than 10 years old. Further, households in the GP do not have piped water supply connections, there are no sewer lines in the GP, and close to 30% households still don't have toilets. There are several primary and middle schools, couple of health centers, one bank and two post-offices in the GP, however most of these amenities are located near the Highway, and interior part of GP is devoid from most of the basic amenities.

For laying out the development plans, and identifying the required interventions that are feasible in Aguibani GP, the SWOT analysis was conducted for the GP. The major strength for the GP included its convenient location having easy approachability, and a rich pool of natural resources (fertile land, forest, and water). On the other hand, poverty and lack of education, skill-development, and employment opportunities were identified as major weaknesses. However, this also indicated that there is huge scope and potential for development in terms of all basic human development aspects. Based on the study, various sector-specific interventions aiming to improve the living standard of the people in the GP, were identified. Development plans considered schemes in all major sector including water supply, sanitation and waste management, agriculture and food security, education and skill development, affordable health-care and naturopathy, employment and income generation, rural housing and road infrastructure, energy self-sustainability, and resource management. The 10-year comprehensive development plan for Aguibani GP was developed incorporating short-term plan for first two years, mid-term plan for following 3 years, and long-term plan for next 5 years.

Technical expertise available at IIT Kharagpur could be utilized for detailed planning and designing, along with implementation and monitoring support for the various identified development scheme for Aguibani GP. As a knowledge resource institution, IIT Kharagpur can integrate the state-of-art technologies and SMART tools and techniques for advancing development schemes in Aguibani GP, and establish the GP as a Model for developed Gram Panchayat.

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1. Project Introduction and Objectives

1.1. Background:

In India, 68.84% of population lives in villages according to 2011 Census. Many of them do not have the access to basic and essential services and amenities including water and sanitation, education, health care, and employment opportunities. This indicates the need and potential for rural development programmes in India, aiming to improve the quality of life and economic well-being of people living in rural areas. In India, the governance of rural development plans at local scales are administrated through gram panchayats under Panchayati Raj Institutions. Therefore, it is essential to develop and promote rural development schemes at panchayat level.

The Ministry of Panchayati Raj, Government of India envisioned a pilot programme for demonstrating rural spatial development plans. The overall pilot programme considered 32 Gram Panchayats (GPs) across 13 states for the development of the Rural Spatial Plan with the help of a set of premier institutions. It was mandated that participating institutes will work in coordination with Panchayat and Rural Development Departments of the states along with the Ministry of Panchayati Raj for preparing Spatial Development Plan for identified GPs. The participating institutes were to coordinate with National Remote Sensing Agency (NRSA), and Regional Remote Sensing Centres (RRSCs) for obtaining remote sensing data for the GPs.

The Ministry of Panchayati Raj communicated with the Director, IIT Kharagpur (via D.O. No. M-11015/166/2020-PESA, Dated June 23, 2020: Annexure A-I) for collaborating with the Ministry in preparation of Gram Panchayat Spatial Development Plan under the aforementioned pilot programme. IIT Kharagpur accepted participation as Coordinating Institute for 2 GPs in the State of West Bengal.

1.2. Team:

For the execution of the rural spatial planning project, a team was constituted by the Director, IIT Kharagpur, and the details of the team members were notified to the Ministry of Panchayati Raj through letter dated July 04, 2020 (copy of the letter attached as Annexure A-II). The team comprised of experts from various domain including Food Engineering, Water Resources and Quality Management, Farm Mechanization, Tribal Development and Rural Infrastructure, Remote sensing and GIS (Table 1).

Table 1: IIT Kharagpur Project Team for Rural Spatial Planning in West Bengal GPs

<i>S. No.</i>	<i>Faculty Name</i>	<i>Department / Center</i>	<i>Area of Expertise</i>
1.	P. P. Srivastav	Agricultural and Food Engineering	Food processing and preservation
2.	P. K. Bhowmick	Center for Rural Development and Innovative Sustainable Technology	Tribal development and anthropology
3.	R. Machavaram	Agricultural and Food Engineering	Farm mechanization
4.	A. Shaw	Civil Engineering	Rural infrastructure
5.	M. K. Tiwari	School of Water Resources	Water resources and water quality management
6.	A. K. Rai	Centre for Oceans, Rivers, Atmosphere and Land Sciences	Remote sensing and GIS

The team collaborated with Ministry of Panchayati Raj, along with West Bengal Panchayat and Rural Development Department, NRSA, and RRSC-East, Kolkata for necessary support and coordination for execution of the project including primary and secondary data collection and filed studies.

1.3. Study Area

The coordinating institute were to select GPs for the project in mutual consultation with Panchayati Raj Department of the State Government. For consultation with stakeholders and guiding on selection of two GPs by the various coordinating institutes, Ministry hosted a Video Conference (VC) on July 01, 2020. During the meeting, following criteria was specified for selection of GPs.

1) Rapid Development Potential: The GPs should be located on or in the vicinity of National or State Highways having good connectivity and high potential for rapid economic development.

2) Proximity: The GPs should be in close distance from the Coordinating Institute.

As per the criteria specified, Aguibani Gram Panchayat from Jhargram District and Mokrapur Gram Panchayat from Paschim Medinipur District were selected in coordination with the Panchayat and Rural Development Department of West Bengal (copy of the letter attached as Annexure A-III).

1.4. Project Objectives

The chief aim of this pilot programme was to prepare Gram Panchayat Spatial Development Plan for rapid economic development of the GPs. For the purpose, a comprehensive baseline assessment was needed, and thereafter integrated rural spatial planning is to be done for the identified pilot GPs. The specific objectives for IIT Kharagpur, as coordinating institute for West Bengal, included:

- 1) To collect relevant field data for the two selected panchayats (Augibani and Mokrapur) through onsite and household surveys.
- 2) To conduct data analysis and a baseline assessment of socio-economic status, and available amenities and infrastructure in the two selected GPs.
- 3) To identify the scope for the spatial development in the GPs.
- 4) To make a suggestive spatial development plan for the selected GPs, and analyze the possible benefits and risks associated with implementation of spatial development plan.

2. Study Area - Aguibani Gram Panchayat

2.1. Socio-Political Status

Located on Kolkata Mumbai Highway (NH49), Aguibani GP is spread over an area of 20 km² and consist of 38 villages accommodating nearly 11 thousand population. The Panchayat is headed by Gram Pradhan *Smt. Rani Hembram Murmu*. Along with Gram Pradhan and other Panchayat Members, Village Resources Persons (VRPs), appointed to represent different villages (or cluster of villages), are responsible to manage and run the panchayat's routine work, in coordination with Panchayat Secretary. The map of Aguibani GP provided by panchayat is shown in Figure 1, whereas the demographic details of the panchayat and available amenities in the Aguibani GP are listed in Table 2.

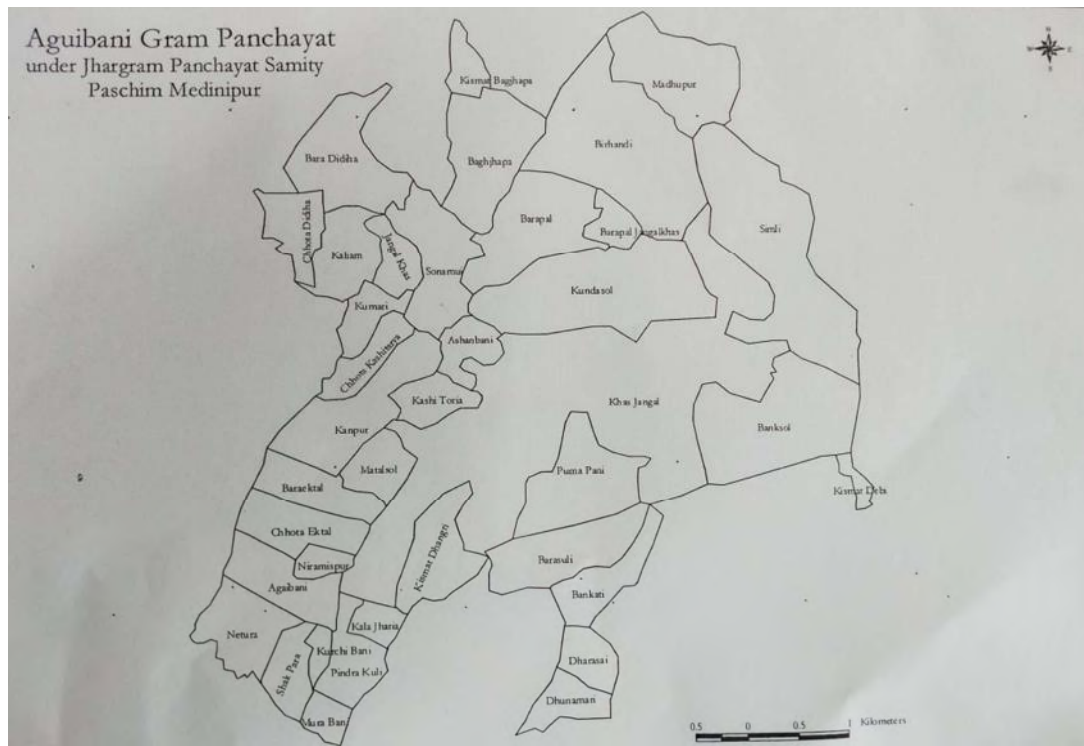


Figure 1: Map of Aguibani GP provided by panchayat, showing villages in the GP

It is apparent from Figure 1(a) that Aguibani GP has villages of varying sizes, and most of smaller villages (in area) are clustered towards western and south-western sides of the GP. The villages towards the northern and eastern parts of Aguibani GP are relatively larger in area, but are sparsely populated.

Table 2: The demographic data and availability of basic amenities in Aguibani GP

<i>S. No.</i>	<i>Parameter</i>	<i>Value / Numbers for Augibani GP</i>
1.	Total Area (km ²)	20
2.	Total Population	10913
3.	Number of Villages	38
4.	Number of Samsads/Booths	08
5.	Number of Households	2345
6.	Female/Male Ratio	0.89
7.	Literacy Rate (%)	69.64
8.	Number of Health Centres	02 (all government)
9.	Number of Primary/Nursery Schools	14 (all government)
10.	Number of Secondary or Middle Schools	03 (all government)
11.	Number of Degree Colleges	Nil
12.	Number of Banks	01
13.	Number of Post Office	02
14.	Number of Industries or MSMEs	Nil
15.	Kuteer Udyag	04 Poultry, Few Shaal Leaf Plate Processing Units
16.	Number of LPG Distributer	01
17.	Number of Sports Play Grounds	04
18.	Number of Public Toilets	Nil
19.	Number of Community Centre	01
20.	Number of Library	Nil
21.	Park	Nil

* *Data provided by Augibani Panchayat*

As shown in Table 2, the GP has couple of health centres, and a number of primary and middle schools, however for the extent of area and population it covers, the basic and general amenities are not sufficient. Further analysis on this is given in Sections 6.3 to 6.5.

2.2. Land Use Land Cover (LULC)

The Land Use Land Cover (LULC) map of Aguibani GP (Fig. 2) is prepared by IIT Kharagpur using RRSE-East and NRSA remote sensing data. The LULC map depicts the population dispersion and human habitations in the GP along with major and minor water streams, road networks, and the green vegetative areas.

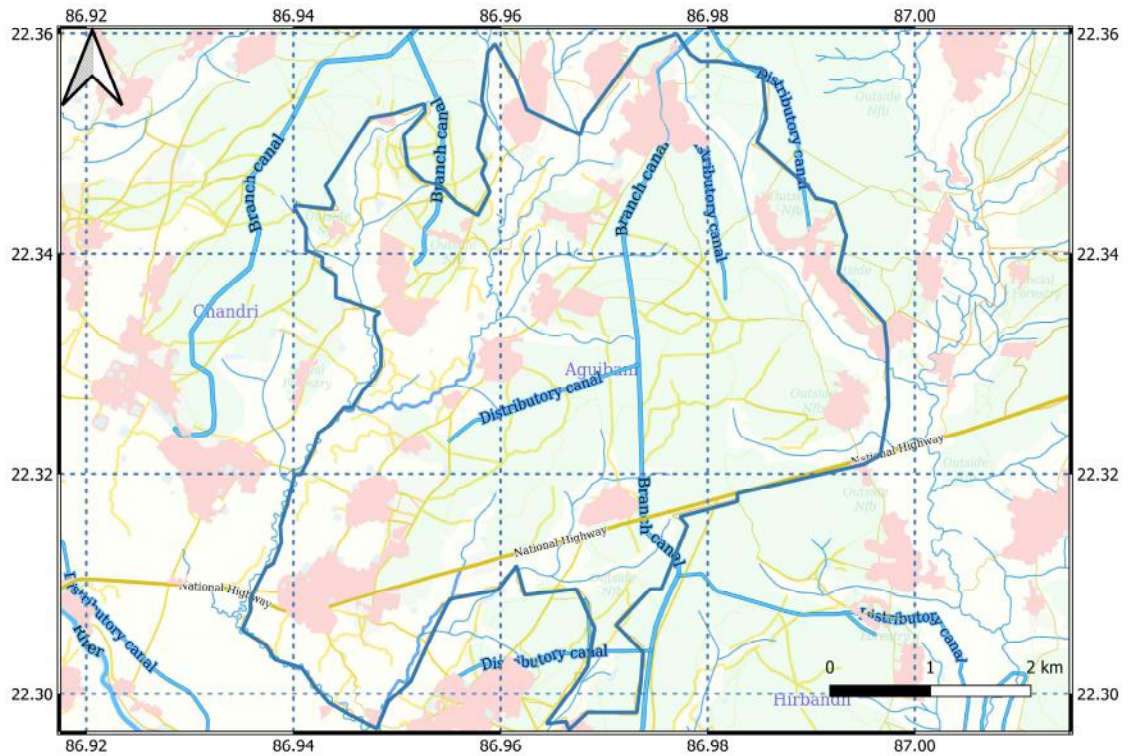


Figure 2: LULC map of Aguibani GP prepared by IIT Kharagpur using RRSE-East and NRSA data. Settlements are shown in pink color, canals and roads are shown in light blue and yellow lines, green areas are agricultural and forested areas.

The LULC map of Aguibani GP shown in Figure 2, displays:

- The population dispersion and human habitations in the GP → Pink Colour Regions
- The national highway passing through the GP → Thick Yellow Line
- The network of village roads in the GP → Thinner Yellow Lines
- The branch and distributory canals passing through the GP → Thicker Blue Lines
- Smaller drains (mostly stormwater drains) in the GP → Thinner Blue Lines
- Forest, agricultural land and vegetative areas in the GP → Green Colour Regions

The major part of the Aguibani GP is situated towards north of the Kolkata Mumbai Highway (NH49). It is apparent that majority of human settlement is towards south-western part of the GP, which is alongside the national highway. The central region of the Aguibani GP is mostly covered with forest or agricultural land. There are couple of branch canals (one towards north-west side, while other in north-south direction passing through the middle of the GP), and a few distributory canals in the GP for the supply of water for irrigation purpose. The road network also appears to be denser towards the southern and western side of the GP.

3. Data Collection Methodology

3.1 Data Type and Sources

For developing any rural development plan, the understanding of the existing physical as well as socio-economic status is important. However, this requires all relevant data and information. The data for Aguibani GP was collected from primary as well as various secondary sources. The primary data was collected through site visits and household surveys, while secondary data was collected from the records of various local and regional offices, and web portals. The details of the data collected from various sources are listed in Table 3.

Table 3: The sources of data collected for Aguibani GP

<i>S. No.</i>	<i>Primary / Secondary</i>	<i>Type of Data</i>	<i>Data Source / Collection Approach</i>
1.	Primary	Basic information of households	Household Survey
2.	Primary	GPS location, type and status of common amenities	Site visit and physical surveys
3.	Secondary	High-resolution remote sensing imagery, LULC data	RRSE-East and NRSA
4.	Secondary	Basic information about GP, villages and amenities	Aguibani Panchayat Office
5.	Secondary	Social and natural resources maps	Aguibani Panchayat Office
6.	Secondary	Other relevant information about GP	Open-source information on Government Web Portals

3.2 Primary Data Collection

3.2.1. Survey Form and Mobile App

For collection of representative data related to socio-economic status of the population in the selected GPs, a household survey was conducted in all of the pilot GPs across the country. In order to maintain uniformity in the survey data, the Ministry of Panchayati Raj recommended a standard format for household survey in all GPs. The survey questionnaire aimed collecting data related to the social, educational, economic and health status of the families.

Later, NRSA developed a Mobile App, named *GPSDP Survey*, to conduct survey facilitating easy collection and storage of geo-tagged data at common platform. The survey questionnaire in App were identical to that in the Survey Form. The screen capture of *GPSDP Survey* App is shown in Figure 3(a).

3.2.2. Survey Form in Bangla Language

The questions in the Survey Form as well as in the *GPSDP Survey* Mobile App were in English Language. It was observed that the villagers in the two GPs selected in West Bengal were not well-versed with the questionnaire in English, as it's not a common language in the area. Therefore, the survey form was translated to local language (Bangla) so that villagers could easily understand the questions. The screen capture of the front page of the translated survey form is shown in Figure 3(b).

3.2.3. Selection of Households for Survey

The survey for household data collection is aimed to capture statistically sizable number of households representing all the socio-economic classes present in the GP, following stratified sampling strategies. A total of around 15% representative households (covering various socio-economic classes) from the Aguibani GP were selected for household survey. The selection of the households was made with the help of Village Resources Persons (VRPs) from the various villages of the GP. Finally, a total of 315 household (13.43 % of total households in Aguibani GP) were surveyed.

3.2.3. Household Survey Methodology

For conducting the household surveys, following steps were followed:

- IIT Kharagpur personnel visited the village, and approached a selected household in the village along with VRP.
- The image of the house was captured and location was geo-tagged in the *GPSDP Survey* App.
- The paper copy of survey form in Bangla was given to the head of the household.
- The head of the house was requested to fill in the survey form in local language (Bangla), and alongside IIT Kharagpur personnel made entries in the *GPSDP Survey* App.
- The team moved to the next identified household for survey in similar fashion.

The couple of images of the IIT Kharagpur Team conducting household survey in the Aguibani GP are shown below in the Figure 4.



Figure 4: Images of the IIT Kharagpur Team conducting household surveys in the selected GPs.

3.2.4. Survey of Public Amenities

IIT Kharagpur Survey team along with VRPs visited all accessible villages in the Aguibani GP and captured details including images and geo-locations of all the common and public amenities, such as health centres, schools, bank and post offices, market and ration shops, water pump houses etc.

3.3 Secondary Data Collection

The secondary data required for the baseline assessment of the Aguibani GP was collected from several sources as mentioned in Table 3. The panchayat office was the most prominent sources for secondary data. The Aguibani GP provided all the basic information about GP including socio-political status of various villages, the availability and distribution of natural resources, the availability of basic amenities in the villages, social maps for all the samsads, and resource maps for all the samsads.

The NRSA and RRSE-East facilitated high resolution remote imageries for the Aguibani GP. This helped IIT Kharagpur to develop LULC map for the GP, which is shown in Figure 2. The other freely available remote sensing data like SRTM data were also used. This also helped in understanding the distribution of natural and man-made resources across the villages in the GP. In addition, various web-portals from the state and central government were used to extract the relevant information about the GP. The past population data of the villages were extracted from census data, whereas amenities available, budget and expenditure etc. were also collected using government's web portals.

4. Project Inception Meeting and Coordination with Local Team

4.1 Meeting with Gram Pradhan and VRPs

IIT Kharagpur project team visited Aguibani GP for inception meeting on September 02, 2020. The visits were done in coordination with the West Bengal Panchayat and Rural Development Department and district authorities.

The IIT Kharagpur team met with local stakeholders including Gram Pradhan, Panchayat Secretary, VRPs and some villagers. The panchayat representatives including VRPs were explained about the objective and advantages of the rural spatial planning project. Also, they were made to understand their role and responsibilities in conducting field data collection and assessment. The local resources at Aguibani were excited about the project and expressed their willingness to offer all possible support. Some images capturing IIT Kharagpur Team meeting with the panchayat representatives including Gram Pradhan and VRPs at Aguibani GP Office is shown in Figure 5.



Meeting with Gram Pradhan at Augibani GP



Meeting with VRPs at Augibani GP

Figure 5: IIT Kharagpur Team meeting with Gram Pradhan and Panchayat Representatives in Aguibani GP.

4.2 Visit to Villages in the GP

The team also visited various villages and public areas in Aguiboni in order to observe the field conditions in the GP. Some of the images captured during filed visits are shown in Figure 6.



Gram Panchayat Office at Augibani



High School at Aguibani



Ration Distribution Shop



Village Market



Drinking Water Supply Project



Highway Crossing Through Aguibani GP

Figure 6: Images captured during site visits in Aguibani GP.

5. Primary Data Analysis

5.1. Household Survey Data

A total of 315 household data were collected using household survey conducted as specified in Section 3.2.3. The number of households surveyed (315) were 13.43 % of total households in Aguibani GP. The village-wise number of households surveyed in the Aguibani GP is Shown in Figure 7.

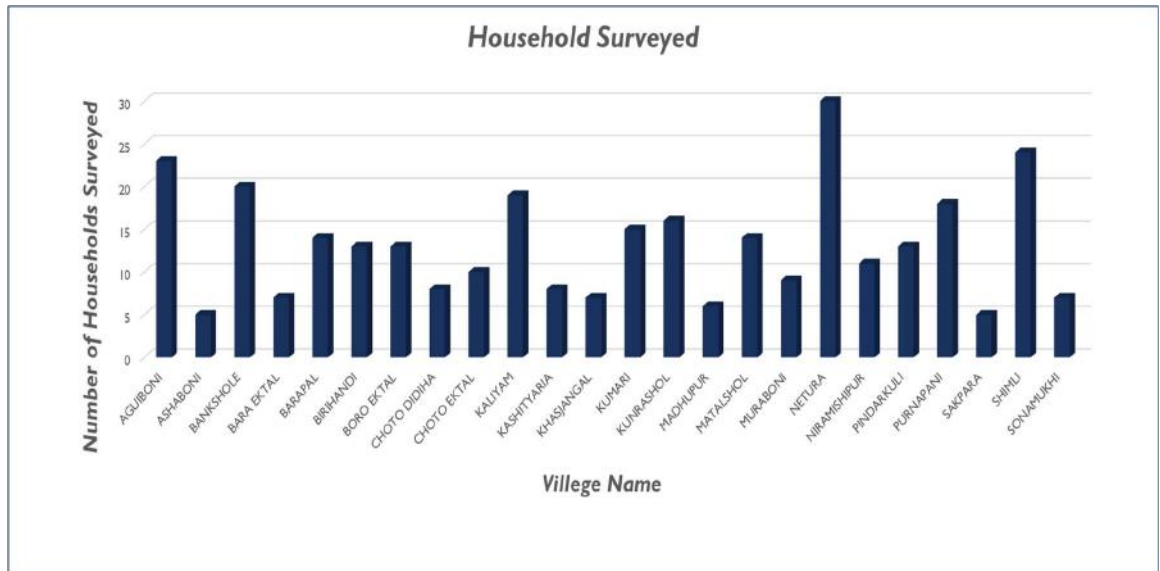


Figure 7: Number of households surveyed across different villages of Augibani GP.

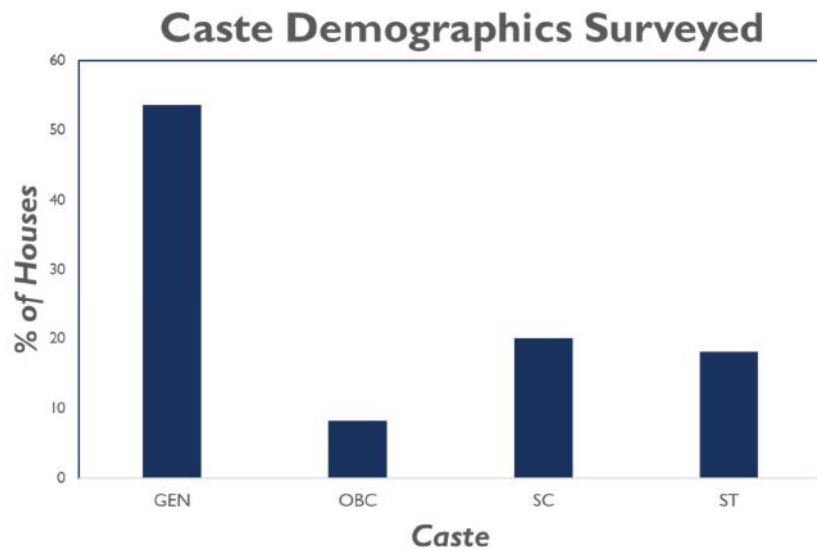


Figure 8: Percentage of households surveyed from different castes in Augibani GP.

The survey attempted to cover the various socio-economic classes of people through stratified sampling strategies. Alongside, different economic classes, population from different caste and social backgrounds were surveyed. Figure 8 shows the percentage of households from different castes that were included in the survey. However, economic status of the could not be analysed as most of the households were reluctant to reveal their monthly or annual household income.

5.2. Type and Age of the House

Through the survey, the type and age of houses were investigated in the Aguibani GP. The house types were classified under the following three categories:

- **Pucca:** House made up of cement and brick or stone with RCC roof
- **Semi-Pucca:** House partially made up of brick and cement, however roof is made up of the material other than RCC
- **Kuchha:** House made up of mud, grass, straw etc

The types of houses as observed through survey are shown in Figure 9. Nearly two-third (63.2%) of the houses were of Kuchha type, while Pucca and Semi-Pucca types house were only 18.4%, each. As expected, houses were not constructed in any planned way.

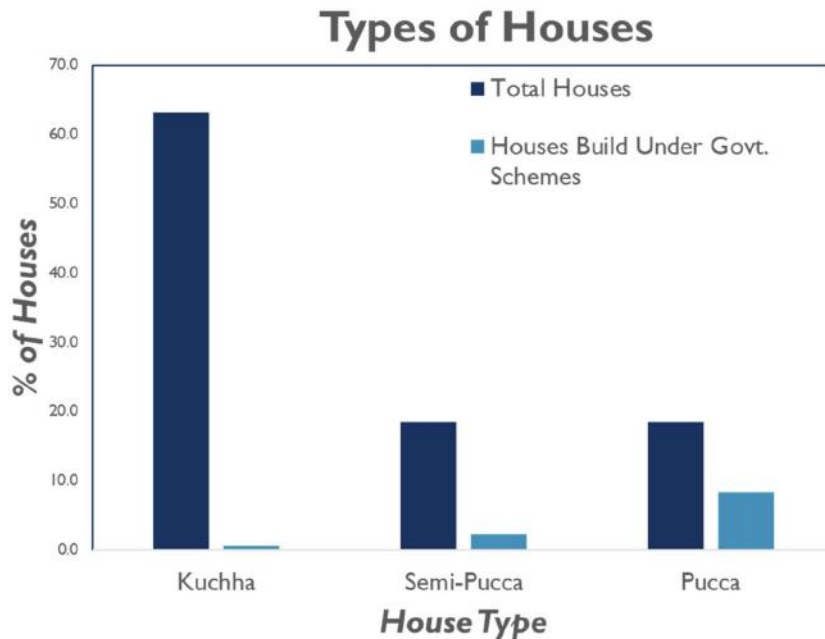


Figure 9: Percentage of Kuchha, Pucca, and Semi-Pucca houses in Augibani GP.

Further, there are schemes from central and state government to financially support house building. Figure 9 also shows percentage of houses built with financial support from government for all three categories. Nearly half of the Pucca type houses were reported to be built with the support from such government schemes. Whereas, the percentage of house built under government schemes were very little for Semi-Pucca houses, and almost negligible for Kuchha houses (Figure 9).

Along with house type, the age of house was also enquired during the survey. The age of houses (categorized under four groups as <10 years; 10-20 years; 20-50 years; and >50 years) for different house types across surveyed households in Aguibani GP is given in Figure 10.

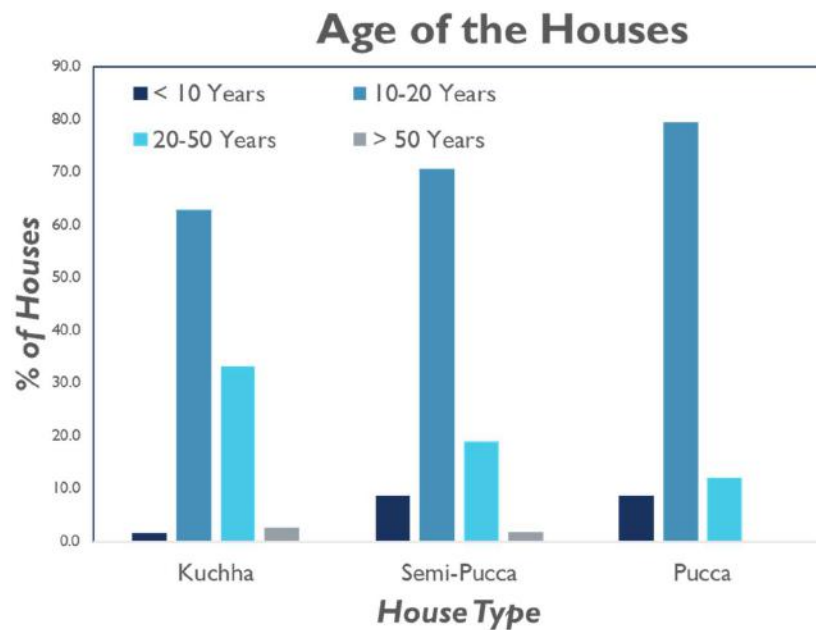


Figure 10: Age of different types of houses surveyed in Augibani GP.

Most of the houses under all three categories (Pucca, Semi-Pucca and Kuchha) were older than 10 years. Only, a little less than 10% of Pucca and Semi-Pucca houses recently concentrated (<10 years), while there has been only 3 Kuchha houses (1.5 % of total) built over the last decade. Most of the houses were of age 10-20 years, followed by 20-50 years range. There was no Pucca house of age >50 years, while only 1 Semi-Pucca and 5 Kuchha houses (among the surveyed households) were found to be of age >50 years. Among Pucca house nearly 80% were of 10-20 years age, whereas for Semi-Pucca, nearly 70% of houses were of 10-20 years age. The trends indicated that recent constructions are more of Pucca or Semi-Pucca houses than the Kuchha houses in the Aguibani GP.

5.3. Family Sizes

The average and standard deviation of the family size of the households surveyed is shown in Figure 11. The mean (\pm standard deviation) family size was found to 4.8 ± 2.3 across all the surveyed households. Among the surveyed households, the largest family size observed was consisting of 15 members, while the smallest family was with just one member. Apparently, there was no statistically significant difference in the family sizes across different classes.

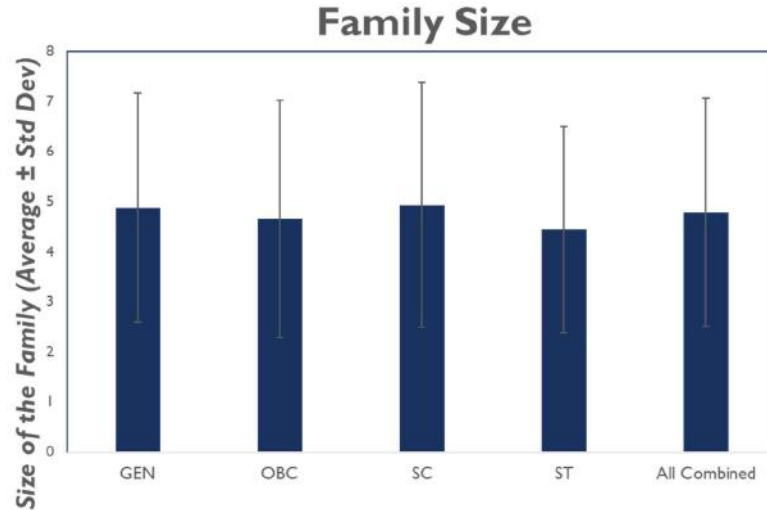


Figure 11: Percentage of households surveyed from different castes in Augibani GP.

5.4. Monthly Expenditure

The average monthly expenditure per household, enquired through household survey in Aguibani GP, is shown in Figure 12. The average monthly expenditure was estimated as ₹ 5,022, and for the most houses, the expenditure ranges between ₹ 1,000 - ₹ 6,000 per month. With the average family size of 4.8 (Section 5.3), the per person average monthly expenditure comes to nearly ₹ 1,046 in Aguibani GP.

As per the Consumer Expenditure Survey 2017-18, by the National Statistical Office, an average rural Indian family spent ₹ 1,430 per person per month. Therefore, the average per person monthly expenditure in Aguibani GP is nearly 27 % less than the average per person monthly expenditure for rural India. This indicated that the society in the Aguibani GP is relatively poor, at large. Only, less than 20 % population in the GP reported to have monthly expenditure more than the average monthly expenditure for rural India.

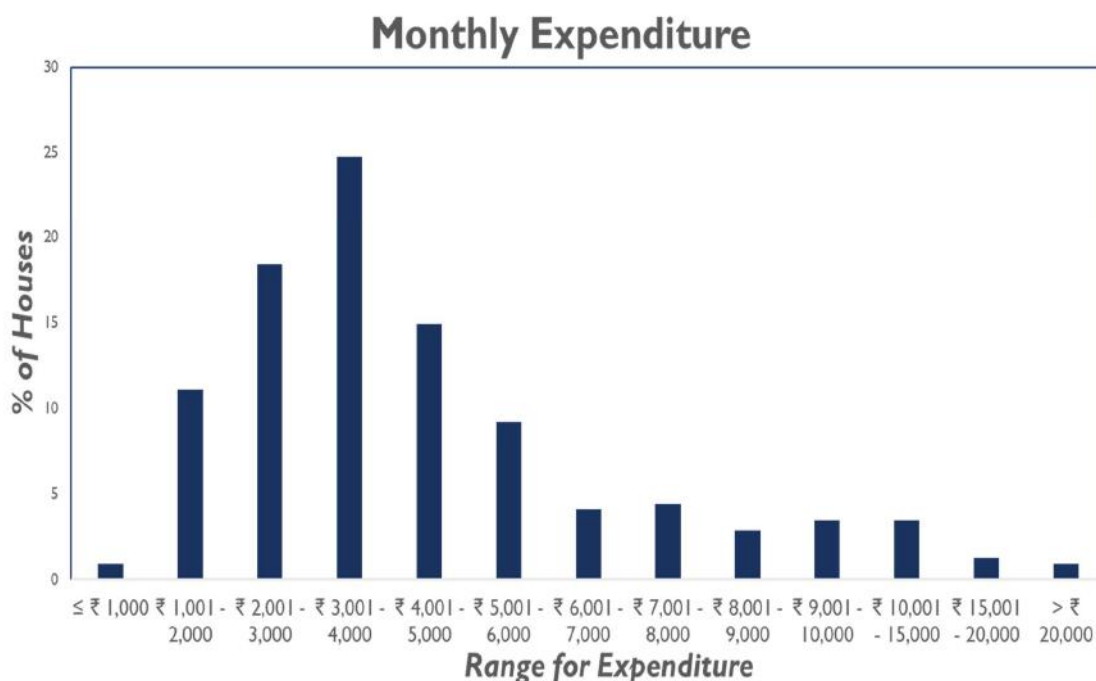


Figure 12: The range of monthly expenditure for the households surveyed in Augibani GP.

The financial status of the Aguibani GP in terms of monthly expenditure coincided with the poverty conditions of the society. Nearly 80 % households surveyed had Below Poverty Line (BPL) Card, as shown in Figure 13.

5.5. BPL, Ration, Electricity and LPG Connections

The status of BPL Cards and Ration Cards possessed by the households, and the status of electricity connections and LPG connections to the households in the Aguibani GP are shown in Figure 13. Almost all (>99%) the houses surveyed had Ration Cards, while nearly 80 % population possessed BPL Card. Further, nearly 92% household have electricity connection through grid, and currently electricity supply in the GP is for about 20 hours per day.

Only less than half of the household surveyed (~ 44%) had LPG connection. Rest of the population in the GP mostly relied on cowdung, firewood, or kerosene oil for cooking purpose.

5.6. Occupation for Living

The occupation for living for the surveyed population in Aguibani GP is shown in Figure 14. For the household surveyed in Aguibani GP, the major occupation for living were agriculture

and labour, at 44% 35%, respectively. Only 7% households were had earning from business, while just about 4% were engaged in service. Nearly 10% of the households surveyed were either unresponsive, while only one household admitted unemployed status.

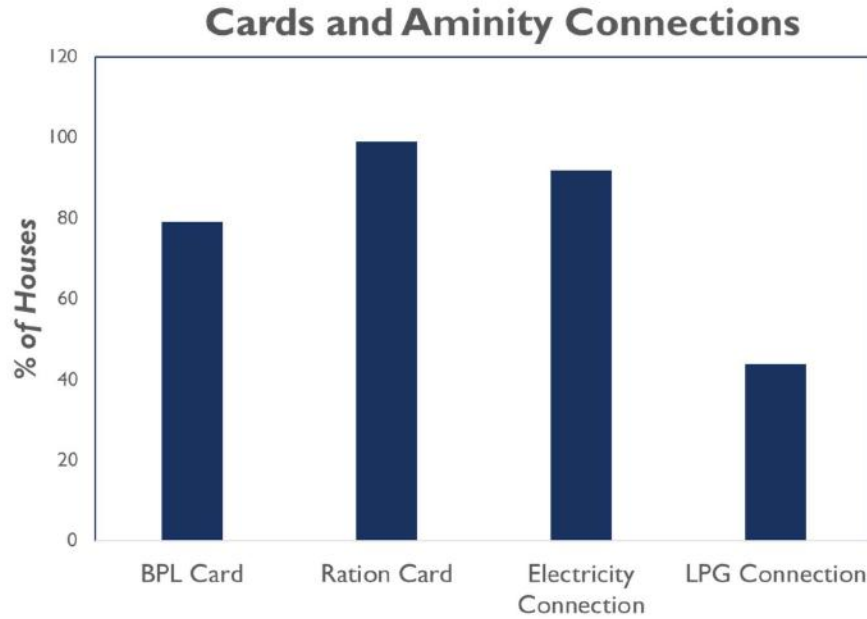


Figure 13: The percentage of households possessing BPL Card, Ration Card, Electricity and LPG connections in Augibani GP.



Figure 14: Occupation for living for the households surveyed in Augibani GP.

5.7. Status of Toilets

Status of toilets for the households surveyed in Augibani GP is shown in Figure 15. Nearly 70% houses reported have toilets, indicating close to 30% population still adopting open defecation practices, as there is no public toilet in Aguibani GP. Over 45% households have availed government schemes for building toilets, and thus more than half of the households having toilets have got their toilets build with the government support through Swachh Bharat Mission or Nirmal Bangla Mission.



Figure 15: Status of Toilets for the households surveyed in Augibani GP.

5.8. Vehicles and Means for Local Commute

Out of surveyed households, only 10 houses constituting just 3.2 % were having 4-wheeler, whereas nearly 26% of surveyed households have owned motorbikes (2-wheeler), as shown in the Figure 16, depicting vehicles owned and means for local transport in Aguibani GP. More than half of the surveyed households (53%) owned bicycles and used it for local commute. Twenty percent population among the surveyed households admitted to either use public transport even for local commute, or did not provide an answer on their ways for local transport. Overall, only 28% houses have ownership of any form of motor vehicle (2-wheeler or 4-wheeler), whereas rest were believed to use either bicycle (for smaller distances) or commute through the public transport.

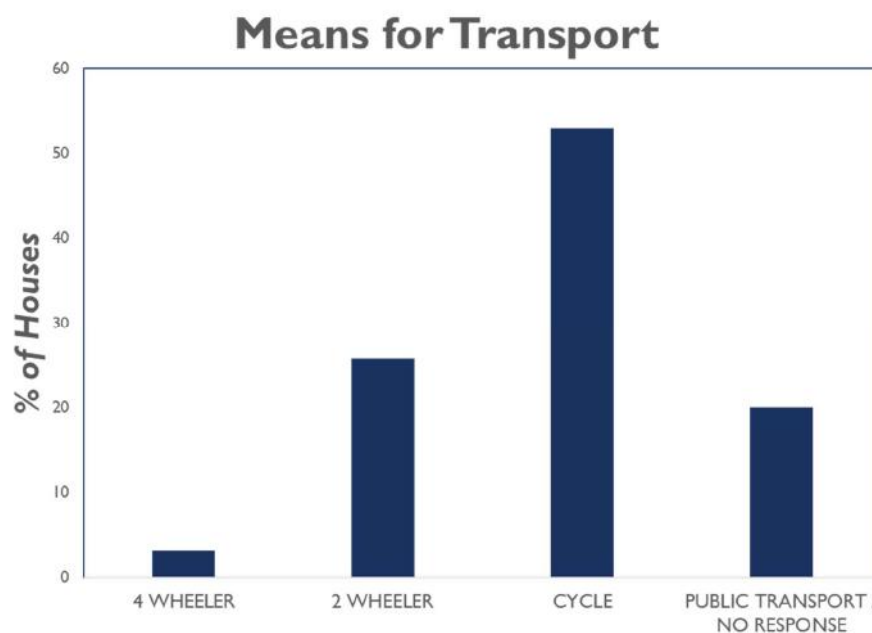


Figure 16: Means of local transport for the surveyed population in Augibani GP.

5.9. Water Sources

There is no piped water supply to households through water supply network in Augibani GP, and all the households rely on either private water sources or public taps and handpumps. Various sources for meeting the domestic water need among the surveyed households are shown in Figure 17.

It was observed that more than half of the population (53.7 % of the surveyed households) do not have any direct means for household water supply and rely on either public taps or public hand-pumps for meeting their domestic water demand. The West Bengal's Public Health Engineering Department (PHED) have arranged for several public taps through their water supply project, and water is supplied through these taps intermittently. Nearly 45 % of surveyed households mostly rely on these public taps and line-up to fetch the water from these taps for their domestic water needs. In addition, 8.7 % of surveyed households said to mostly rely on public handpumps. On the other hand, a little under half of the respondent claimed to have private means for water supply through either personal hand-pump, private borings, or open wells. Nearly one fourth of the houses (23.5 %) claimed to have private taps connected through borings, while dependency of private handpumps and private wells were 14 % and 8.9 %, respectively.

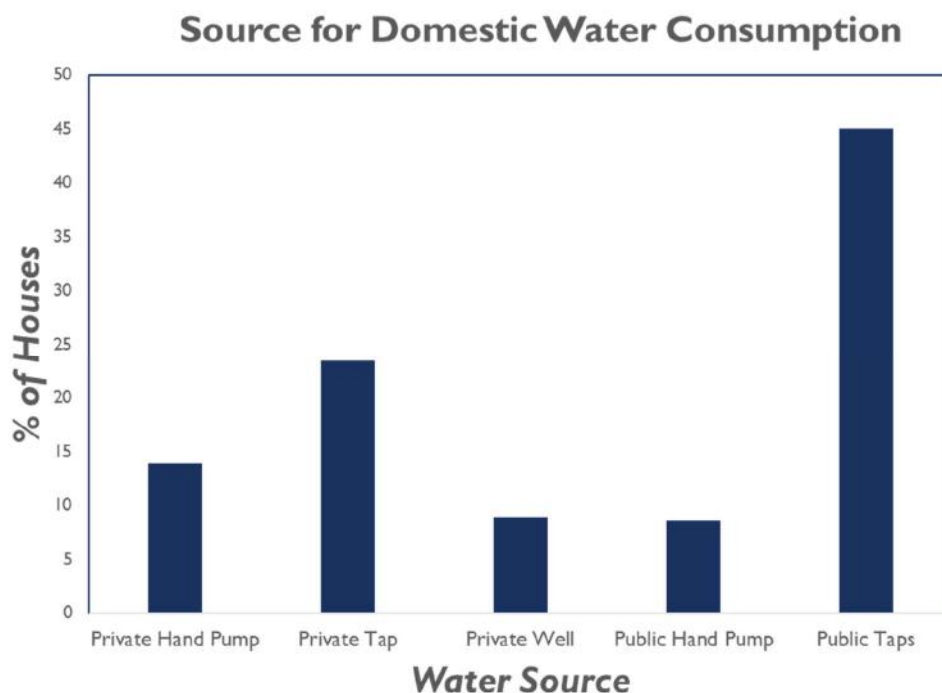


Figure 17: Domestic water sources for the surveyed population in Augibani GP.

5.10. Livestock Details

Livestock plays an integral and important role in rural economy in India, and is regarded as a significant contributor for the livelihood of the rural population. Like rest of rural communities, Cow, Ox, Goat and Chicken were the major livestock possessed by houses in Auguibani GP. The percentage of houses owning different types of livestock, and the total number of livestock owned by the surveyed households are shown in Figure 18.

Nearly half of the households in Auguibani GP had some sort of livestock. Among the houses surveyed, Cow and Chicken livestock were found to be more common followed by Goat livestock. Over 38 % houses had Cows, whereas nearly 28 % houses were found to have Chicken livestock, though the total number of Chicken livestock (559) were more than twice than the total number of Cows (266) in the surveyed households in Auguibani GP. A total of 155 Goats were also possessed by 50 houses, constituting a total of 15.9 % of the surveyed households. Oxen were 7 in numbers owned by 6 of the households surveyed. In addition, there were 107 other livestock owned by 21 houses among the households surveyed.

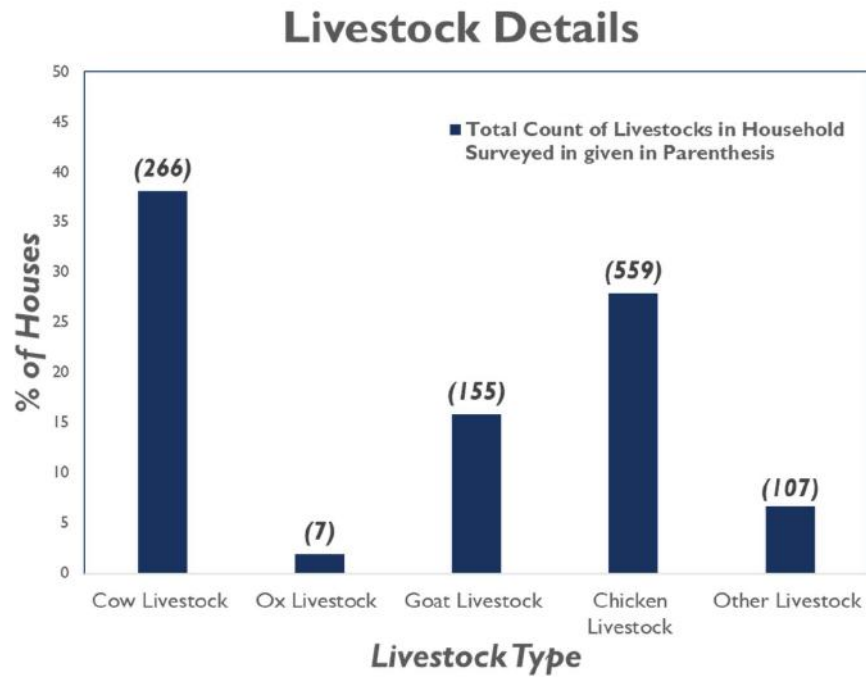


Figure 18: Livestock details for the households surveyed in Augibani GP.

5.11. Other Information

There were many other information sought from the households under the survey conducted, however, respondents were reluctant to reveal some of the information, especially on earnings, government support received, loans etc. Few other important information that came out of the survey are as under:

- There is no proper guideline adopted for solid waste management in the villages of Augibani GP. The current practice for the solid waste management is unregulated open dumping.
- Most people have not had even the generic vaccination, especially adult and aged population. However, in several households polio vaccine has been given to children under polio vaccination drive.
- Few people reported to have suffered with prominent diseases, and people were disappointed with the lack of good and affordable medical facilities nearby.
- Several respondents informed that they have had bank loans, mostly for agriculture.
- Most of the households had cell phones, and large number of households had televisions. On the other hand, computers/laptops were not present in most of the households surveyed.
- Solar equipment was also largely absent in the surveyed households.

6. Secondary Data Analysis

6.1. Population Density

The population the Aguibani GP is dispersed over 38 villages (Table 2), however there is substantial variations in the population of different villages. A map showing population clusters and qualitative population densities in Aguibani GP is shown in Figure 19. The map was prepared by IIT Kharagpur using freely available satellite data on thermal imageries of the area.

It was interesting to note that, most of the population clusters are located towards south-west and north-west regions. The Aguibani village (under Aguibani GP), shown in the extreme south-west corner in Figure 19, had the highest population density. The Aguibani village is located beside Mumbai-Kolkata National Highway and thus have attracted relatively more human settlement as well as more development in comparison to the other villages in Aguibani GP. The population density in several other villages in the GP was comparatively very low, and eastern part of the GP appeared to have fewer human habitations. The observations were in line to the village map (Figure 1) received from the GP.

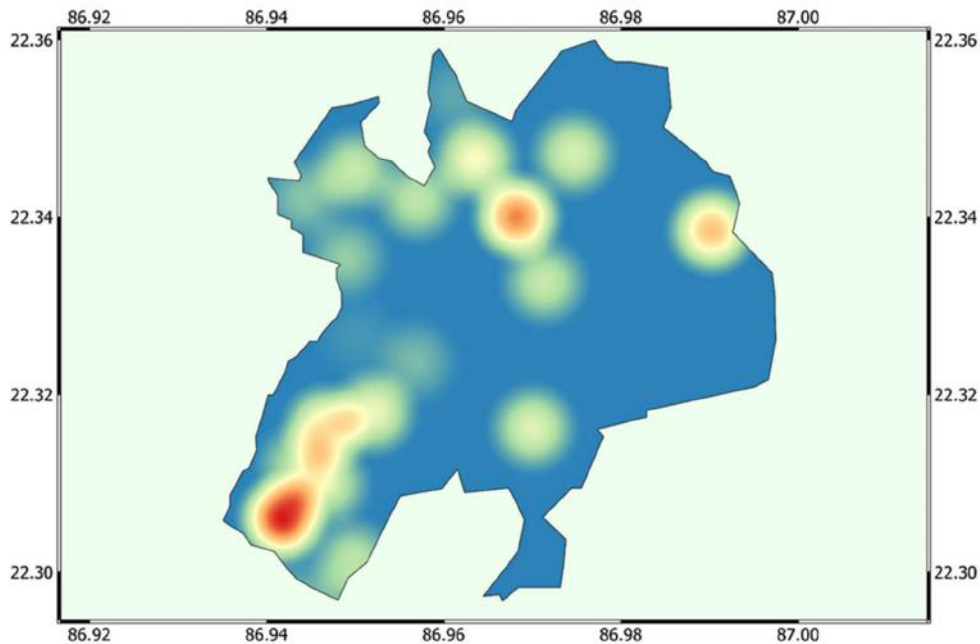


Figure 19: Population Density Map of Aguibani GP. Red areas are high population density areas.

6.2. Geo-profile and Elevation Map

Aguibani GP under Jhargram District is located in the flat plain regions of the south-west Bengal, and the elevation from the mean sea level is below 100 meters, even for the regions at the highest altitude. Remotely captured Shuttle Radar Topography Mission (SRTM) data was used by IIT Kharagpur to prepare the Elevation Map of Aguibani GP, which is shown in the Figure 20.

The Elevation Map of the GP indicated that the eastern side, and especially north-eastern part of the GP is at relatively higher elevations (~ 70 to 90 meters), whereas the south-western regions of the GP are at relatively lower elevations (~ 44 to 70 meters). The difference between the lowest and the highest altitude points were only 50 meters, indicating a reasonably flat terrain in the Aguibani GP.

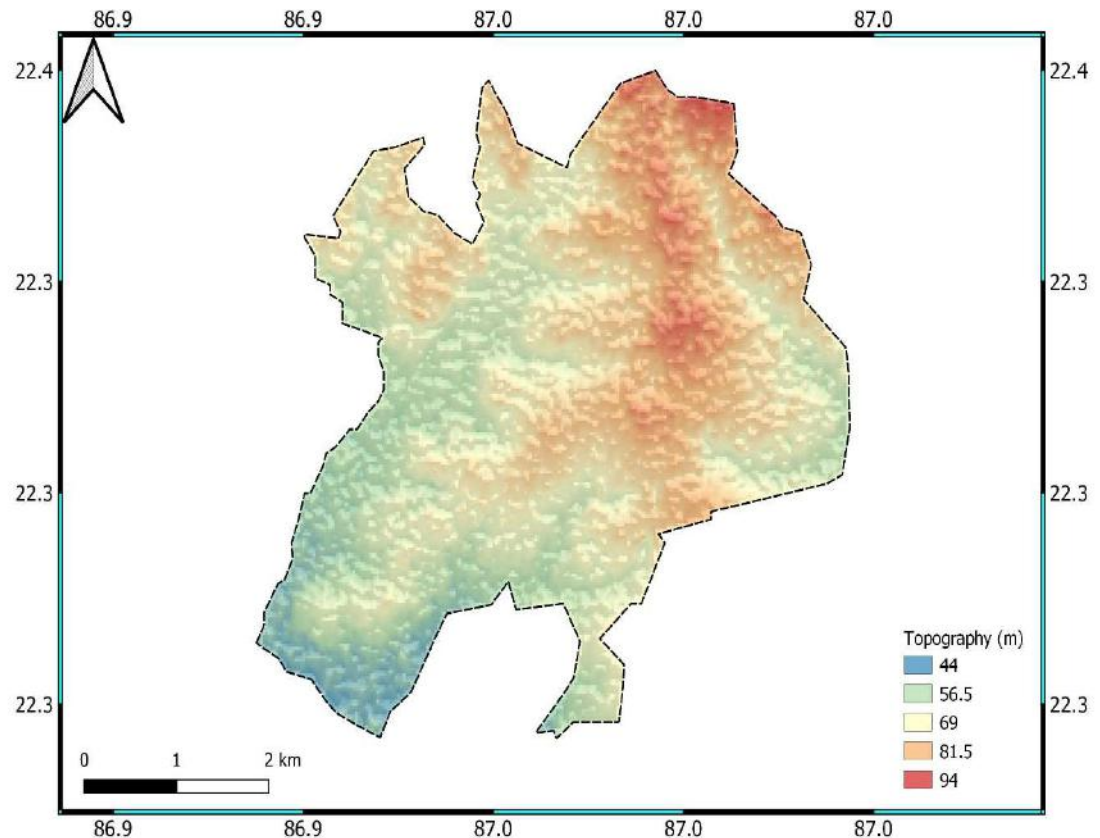


Figure 20: Regional Elevation Map of Aguibani GP (derived from SRTM data).

6.3. Availability of Public Amenities

As stated in Section 3.1, the secondary data on public amenities were collected from Aguibani Panchayat Office, as well as few other sources. The details of public amenities as per data panchayat data is listed in Table 2. Few important observations are as under:

- There are just two health centres in the GP, and healthcare facilities are not adequate.
- There are quite a few primary and nursery schools (14 government schools), and few secondary/middle schools (3 numbers), however the schools infrastructure and conditions are not very good. There is no degree college in the Aguibani GP.
- There is no major or mid-size industry, and no MSME in the GP. However, there are a few Kuteer Udyog in the form of poultry (4 numbers), agriculture or forest produce processing.
- There is just one bank, one LPG distributor, and only couple of post offices in the GP, which appeared insufficient for the population of the GP.
- While there is one community centre and a few sports play grounds, there is no public toilets, parks or library in Aguibani GP.

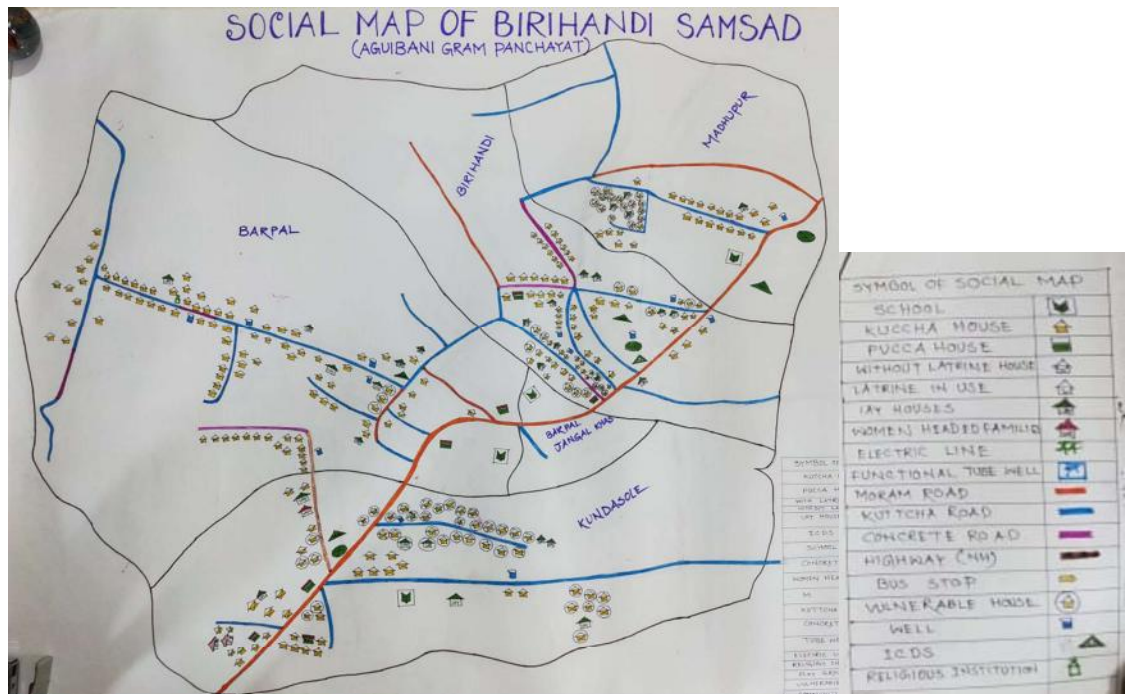
6.4. Social Data and Resources Maps

The information and data regarding social status of the GP was also collected. Female to Male ratio in the GP is 0.89, which is less than the sex ratio for the state of West Bengal (0.95). Literacy rate in the GP is 69.64%, which is also less than 76.26%, the average literacy rate in the state of West Bengal.

The maps available with Panchayat representing social data (Social Maps) and resource data (Resource Maps) for various Samsads were also collected.

- The Social Maps portrayed the location of houses, schools, roads and other community structures in a samsad
- The Resource Maps portrayed the location of various available resources in the region including pond, river, canal, forest, fallow land, paddy fields, and roads etc. for a samsad.

These maps were utilized for obtaining the distribution of population and resources in the GP. Example of social and resource maps obtained for Birihandi Samsad from Aguibani is shown in Figure 21.



(a)



(b)

Figure 21: Images of (a) Social, and (b) Resource maps of Birihandi Samsad of Augibani.

The detail inventory of natural resources based on spatial analysis using geospatial technologies conducted by RRSE and NRSC is given in detail in Annexure B.

6.5. Spatial Distribution of Public Amenities (Based on Field Survey)

The latitude and longitude of various public amenities were recorded during field surveys, and based on these recorded geo-locations, the public amenities were located on the map of the Aguibani GP. The spatial distribution of various public amenities surveyed in Augibani GP, implanted over the google map of the GP, is shown in Figure 22.

The analysis of spatial distribution of amenities, revealed the followings:

- Most of the public amenities are centred near the national highway in the southern and south-western part of the GP. The most populated village, Aguibani, in the GP is also in the south-western region, and majority of the public amenities is in and around Aguibani village.
- The two health centres in the GP are located in the closed proximity in Aguibani village, and several other villages do not any healthcare facility nearby.
- The interiors of the GP are mostly devoid of common and even essential public amenities like health centre, bank and ration shops.

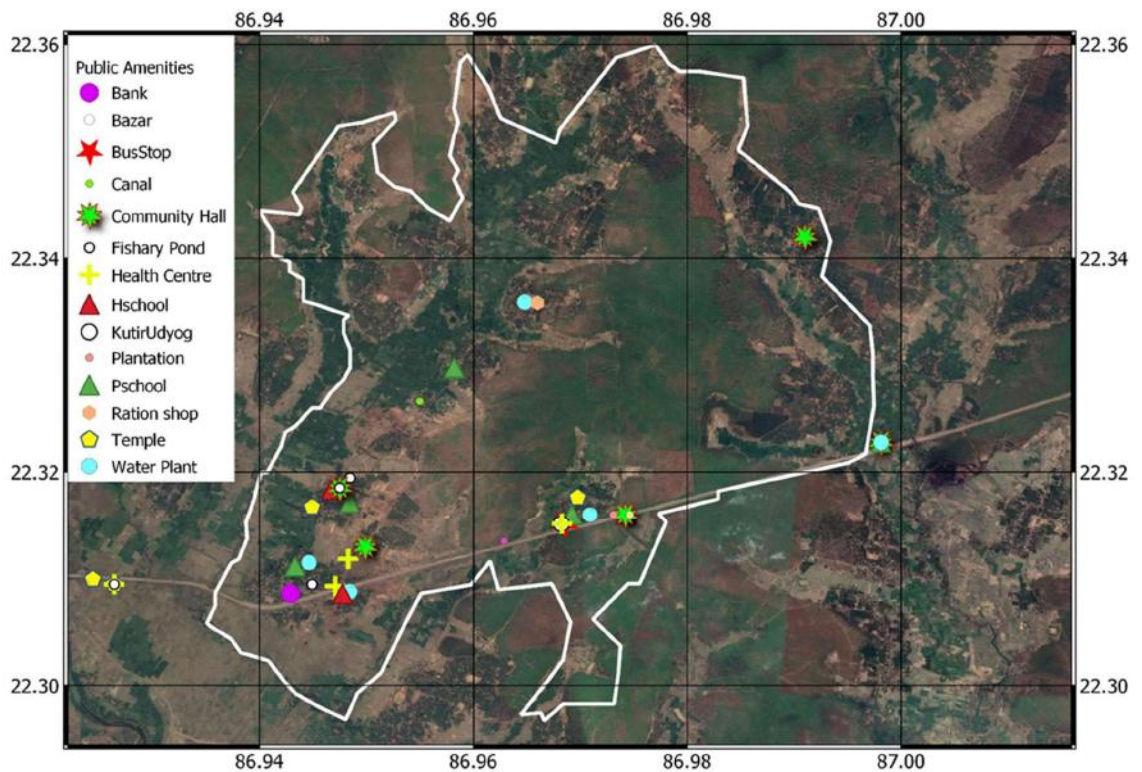


Figure 22: Spatial distribution of various public amenities surveyed in Augibani GP, shown over google map.

6.6. Future Population Projections

The development plans are usually laid for future, and therefore, it is important to predict the future population before laying out any development plan. There are several standard population forecasting methods which are used for predicting future population of a city, town or village. These methods rely on statistical analysis using the past population data. Unfortunately, past population records for Aguibani GP were not available, therefore, as a proxy, the past census population records for Jhargram was collected from the census website for years 1991, 2001, and 2011. Thereafter, the population forecasting for Jhargram was done for years 2021, 2031, and 2041, adopting arithmetic increase method and geometric increase method. The future population of Jhargram was finally estimated as the mean of the forecasted population obtained through the arithmetic increase method and the geometric increase method. Further, the future population of Aguibani GP was predicted following the ratio method using the forecasted population of Jhargram, and assuming mean of the ratio of populations of Aguibani to that of Jhargram remains constant. The final population forecasted for Jhargram and Aguibani GP are given in Table 4.

The population density was also estimated based on the predicted population. The population density in Aguibani GP as per 2011 census data was 509.7 persons/Sq. Km, which is presently expected to be nearly 600 persons/Sq. Km. The population density in the GP was higher by rural standards, as the National Sample Survey Organisation (NSSO) defines 'rural' as an area with a population density of up to 400 per square kilometer.

Table 4: Forecasted population for Jhargram, and forecasted population, and population density for Aguibani GP

<i>Year</i>	<i>Past, and forecasted Population of Jhargram</i>	<i>Forecasted Population of Aguibani GP</i>	
		<i>Population (Numbers)</i>	<i>Population Density (persons/Sq. Km)</i>
1991	42094	--	--
2001	53145	--	--
2011	61712	10193	509.7
2021*	72964	12051	602.6
2031*	85522	14126	706.3
2041*	99654	16460	823

7. SWOT Analysis for Aguibani GP

Based on the data and information collected from primary and secondary sources, the SWOT (Strengths, Weaknesses, Opportunities, and Threats) Analysis was done for Aguibani GP. Some of the major strengths, weaknesses, opportunities, and threats identified for Aguibani GP are presented below.

7.1. Strengths

- ***Good connectivity and approachability:*** Aguibani GP is located on Kolkata Mumbai Highway NH49, and the nearest railway station is within 10 Kms. This facilitates easy accessibility to the GP through rail/road transport. It's nearly 170 Kms from Kolkata, 110 Kms from Tatanagar, 36 Kms from Kharagpur, and only 25 Kms from district headquarter Jhargram.
- ***Adequate fertile-land, forest and water resources:*** The land in the GP is fertile, and area has healthy forest cover. The groundwater table goes not below 10 m below ground level even during the pre-monsoon dry seasons. Also, there are a number of distributary and branch canals as surface water sources for irrigation.
- ***Low-risk of flood and droughts:*** The area is not in the disaster-prone zone, and the region has low-risk of flood or drought.
- ***Under newly created Jhargram District:*** Aguibani GP was earlier in Paschim Midnapore District, however, a separate district Jhargram was created in 2017. The GP now comes under this newly created Jhargram district administration. The newer administrative set-up mostly has better financial resources to layout various social and regional development schemes.

7.2. Weaknesses

- ***Large extent poverty:*** The majority of the population in Aguibani GP lacks in financial resources, and nearly 8% of the population is below poverty line (BPL) category.
- ***Lack of education, skill-development, and employment opportunities:*** Unemployment was one of the major issues in the region, and only few are engaged in service or business. Also, there is lack of opportunities for higher education, vocational training or skills development.

- ***Non-uniform growth and development:*** Aguibani village in the GP, which is near the highway, has the highest population density, and houses the most of the public amenities present in the GP. On the other hand, the interior areas have not seen much of the development, and lacks even in the basic amenities.
- ***Relatively lower literacy rate:*** The literacy rate in Aguibani GP is close to 70 %. Although it's not too low, but lower than the average literacy rate for the state of West Bengal.
- ***Legacy of naxal history:*** The entire GP area have been in the naxalite affected region in the past, and, still some parts in the GP has naxal influence.

7.3. Opportunities

- ***Huge potential for green-field development:*** As the major part of the GP has not seen any of the development, there is huge potential for green-field development projects in the GP.
- ***Utilization of local resources:*** As the GP has adequate reserve of natural resources including, land, forest and water, there is scope for the utilization of the local resources for development and economic growth of the region.
- ***Social Integration:*** The GP has a sizable population of deprived and backward communities. There is opportunity to integrate these deprived and tribal population with the main-stream development projects in the GP.
- ***Proximity to major industrial, commercial and educational hubs:*** The GP is in the reasonably close distance to several major industrial, commercial and education centres like Kharagpur, Tatanagar and Kolkata.

7.4. Threats

- ***Preventing migration:*** Retaining skilled workforce in the villages for execution of development project is a major challenge.
- ***Safety and security of public assets:*** Preventing thefts and ensuring safety and security of public infrastructure assets
- ***Managing naxal influence:*** The integration of stakeholders from the naxal influenced regions is a challenge.
- ***Protection of crop-fields:*** The wild elephants roam around in the region, and, at time, destroy the crop fields.

8. Proposed Developmental Activities

The baseline assessment and SWOT analysis for Aguibani GP suggested that the GP lacks in almost all development aspects, but has adequate resources and huge potential to be developed as a model GP. The project team at IIT Kharagpur identified several developmental activities which could be adopted or implanted in order to enhance the living standard and quality of life for the people of Aguibani GP. The development activities envisioned aim to bring out interventions which would facilitate multi-dimensional growth in all sectors including education and skill development, healthcare, employment, agriculture, housing and infrastructure, water and sanitation etc. A brief description of sector-wise proposed developmental activities for Aguibani GP is given below:

8.1. Housing and Road Infrastructure

- **Low-cost Rural Housing:** As appeared through surveys, nearly two-third of the population still resides in Kuchha houses. A planned housing scheme must be brought in the GP where low-cost residential houses must be constructed in a planned way. A housing colony pattern may be adopted for residences, with outdoor areas for keeping cattle and livestock. Low-cost housing solutions such as bamboo-reinforced concrete buildings could be adopted which uses easily available and renewable raw material as bamboo, and results in lesser cost and carbon footprint.



Figure 23: A concept image of planned residential colony for rural sector
(Image Credit: <https://worldarchitecture.org/>)

- **Rural Roads:** Although the GP has connectivity through national highway, several of the interior roads are not of good quality. In order to ensure well connectivity, the interior rural roads should be made or upgraded with better quality sustainable roads. For example, IIT Kharagpur developed cell-filled concrete road, which are cost-effective and maintenance-free, could be adopted for upgrading road infrastructure in Aguibani GP. A picture of laying of such road is given in Figure 24.



Figure 24: A typical image of cell-filled concrete road for rural areas

8.2. Water, Sanitation and Waste Management

- **Rainwater Harvesting:** The government is promoting nation-wide programme for rainwater harvesting and efficient utilization through its ‘*Catch the Rain*’ campaign. With the average annual rainfall of about 1400 mm, 20 Km² of the GP area potentially receives 28 million m³ of rainwater per year. Considering forecasted population of Aguibani GP in 2041 (Table 4) as 16460, and per capita water requirement as 135 liters/day (Indian standard for water demand, for cities/towns with sewerage network) the total annual domestic water demand for the GP comes out to be only 0.81 million m³/year, which is under 3% of annual rainwater received at the GP. Therefore, even if 10-20% of available rainwater is harvested, it will not only meet the entire domestic demand of the GP, but could facilitate supporting other uses in livestock management, small irrigation, and groundwater recharge. Fig. 20 shows the regional topography which can be used to identify the low-lying areas. In-addition, a detailed topographic survey and contouring can also help in pin-pointing the potential zones for rainwater harvesting, and groundwater recharge. Based on this rainwater harvesting and utilization schemes could

be designed for the GP. Some low-cost rainwater harvesting models are shown in the Figure 25.



Figure 25: Some low-cost rainwater harvesting models for villages
(Image Credit: Google Images)

- **Piped Water Supply of Potable Quality Water:** Through the flagship programme of ‘*Har Ghar Nal Se Jal*’ the government envisions providing drinking water connections to every rural household by 2024. Presently, household level piped water connections are non-existent in Aguibani GP. Therefore, there is a pressing need to set-up a piped water supply project for the GP. A harvested rainwater based (with provision of canal or groundwater for emergency uses) potable water supply schemes for the cluster of villages in the GP is recommended. The capacity and coverage of these schemes could be worked out, using cost optimization and feasibility analysis. These piped water supply schemes must integrate water intake, water treatment units, treated water storage, and water supply network. Further, it must have provision for water quality monitoring and display for quality assurance.
- **ODF Status:** As came out through the household surveys, nearly 30% population still don’t have toilets and home, and adopting open defecation practices. Further, there is no public toilet in the GP. Building toilets for households with no toilets should be promoted

and a few public toilet complexes must be set-up especially in market area. This would facilitate the GP to acquire Open Defecation Free (ODF) status.

- ***Sewage Treatment and Recycling:*** There is no proper sewer line in any of the villages in Aguibani GP. In order to ensure sustainable management of wastewater, decentralized sewage collection, treatment and recycling system should be provided for clusters of the optimum number of households depending on the house size and spread. For sewage treatment, low-cost and low-maintenance natural processes like wetlands (as shown in Figure 26) can be developed, and treated effluent can be reused in agriculture.



Figure 26: A typical constructed wetland-based sewage treatment system
(Image Credit: <https://www.mdpi.com/2073-4441/12/6/1665/htm>)

- ***Solid Waste Management:*** At present, solid waste is usually dumped in open. The majority of the solid waste from the households in rural areas are of organic nature, and can easily be converted to bio-manure through composting. Therefore, it is recommended that a proper solid waste management system should be set-up in the villages, involving segregation (at dumping level) of organic waste and recyclable waste, and thereafter setting up the optimum scale composting system for organic waste, and recycling system for non-degradable waste, in line to Swachh Bharat Mission.



Figure 27: Typical images for rural-scale composting (*Image Credit: Google Images*)

8.3. Education and Skill Development

- **Upgrading Schools:** The existing government schools lack in good laboratories and library. These school's infrastructure must be upgraded, and the schools must be equipped with good laboratories, library, and other facilities. Further, the pedagogy training must be given to teachers for infusing art and skills for effective teaching at various levels.
- **Tele-Learning Centres:** Tele-learning is an emerging concept for education and training from remote locations. Modern tele-learning centres could be established especially at middle and secondary schools in Aguibani GP, to connect students seeking academic support with the best of expertise.
- **NDLI Access:** National Digital Library of India (NDLI) developed and moderated by IIT Kharagpur ensures wider access to academic resources from anywhere in the country. Local youths and students from the GP could be trained on NDLI access and operations, connecting them to vast pool of academic resources.
- **Skill Development Centre:** Skill development and vocational trainings helps in promoting self-employment and small business. Currently, there is no such facility in Aguibani GP. A vocational training and skill development centre should be established in the GP for providing the youth opportunity to develop/refine their skills and use it for professional growth and development.

8.4. Affordable Health-Care and Naturopathy

- **Ayurveda, Natural Care and Yoga Centre:** Naturopathy is progressively getting more and more attention for promoting good-health and immunity against diseases. A Yoga and Physical Fitness Centre should be established. In addition, a Ayurveda and Naturopathy centre should also be opened for Ayurvedic consultation.

- **Tele-medicine:** Tele-medicine practices relying on e-consultation with expert doctors from remote location is deemed to be a path-changing solution in healthcare. A number of telemedicine points could be arranged in the GP to facilitate expert medical advisory from distant locations.
- **Emergency Response System and Mobile Medical Units:** As it's not feasible to have multi-speciality hospital like services in village level, the emergency response system should be strengthened by ensuring rapid ambulance facility, first-aid training, and CPR training. Provisions for arranging mobile medical units on demand should also be made.

8.5. Agriculture and Food Security

- **Enhancing Agricultural Production:** In order to enhance agricultural production, following steps/interventions could be taken:
 - Training farmers about sustainable and effective cropping practices
 - Setting up mobile testing facilities for testing of soil fertility and water quality at farmers' fields
 - Planning of crops suitable for seasonal cultivation and marketing
 - Promoting water efficient cropping with setting up micro-irrigation systems, and canal and drainage planning
 - Promotion for advance techniques such as plastic mulching, greenhouse cultivation, bee-keeping, vermicomposting etc. Some of these techniques adopted at PFDC, IIT Kharagpur are shown in Figure 28.



Figure 28: Organic farming and protected cultivation technologies developed at PFDC IIT Kharagpur

- ***Agri-mechanization:*** Use of agricultural machines could help in performing farming activities in more efficient and rapid ways. Following interventions could be adopted:
 - Setting up custom hiring centre for Agri-Machines from where can hire the machine for their specific works
 - Training of youth for operation and self-servicing of Agri-Machines
 - Training and guiding manual for ensuring safety measures during machine operation and spray applications
 - Promoting women friendly tools to reduce drudgery operation
- ***Food Processing, Storage and Supply:*** The storage and processing of agricultural produce is very important for food security. Following steps could be undertaken in this regard:
 - Setting up proper crop storage facility for long-term storage of food grains and vegetables for minimization of crop loss. Cold-storage facility for storing vegetables, fruits and milk should also be created in the GP.
 - Setting up primary processing of food grains and vegetables for increasing quality and selling price for agri-products
 - Establishing a food processing centres for processing locally available food grains and vegetables in order to convert them to good quality commercial food products fetching higher demands, and resulting in more economic return on the investments. For example, there is huge tomato production in the GP, which can be processed to tomato sauce for retailing, or tomato puree for supplying to bulk users of such products (Figure 29).
 - Arranging regular training programmes for villagers and specially women, for setting-up of small-scale food processing units
 - Creation of packaging facility in the GP for raw and processed agri-products, and setting up a supply-chain mechanism for distribution of the agri-products from the GP for retailing through traditional markets, larger market chains, as well as through e-commerce.



Figure 29: Some of the suggestive food processing techniques for Aguibani GP

8.6. Employment and Income Generation

- ***Promoting Industries and Small Business Enterprises:*** Based on the available skills and local resources, several small-scale industries and business enterprises could be promoted in Aguibani GP. Some of the identified potential opportunities are as under:
 - *Cottage Industries:* Milk processing units, Primary/secondary processing of crops, Muri making, Local art and craft
 - *Mini- /Micro-Industries:* Rice parboiling, Rice milling, Cash-crop farming, Wood machinery, Farm machinery, Supply-chain industry
 - *Small Business Enterprises:* Carpentry, Automobile repair, Mobile repair, Cold storages and warehouses
- ***Infrastructure/Assets Management:*** Capital intensive development schemes are likely to enhance the level of infrastructure in the GP. Skilled manpower would be needed for operation & maintenance of water, energy, health-care etc. infrastructures. This could be potentially developed as an employment opportunity for local youth.
- ***Attracting Investments:*** There are out-side funding avenues which provide funds for development schemes as well as employment creations. Such government and private supported schemes could be explored on a regular basis for attracting investments for employment creation in the GP.



Figure 30: Some small-scale industry and business ideas for Aguibani GP.
(Image Credit: Google Images)

8.7. Energy Self-Sustainability

Although the villages in Aguibani GP are connected to electricity grid, the electricity is supplied intermittently, and villagers had to rely on power through grid. Further, the cost of electricity for non-subsidized consumers are a point of concern due to low income. Renewable energy sources could help in villages turning to energy self-sufficient. Generally, rural areas with adequate land resources have enough potential to generate solar energy, which could make them energy self-sufficient. In this regard, following measures could be adopted at the village or panchayat level:

- **Renewable Energy Resources:**
 - Adopting solar energy systems for energy-intensive applications like power at schools, water pumping, street lightings etc.
 - Producing bio-gas from natural waste materials and cow-dung, and using the biogas for cooking etc.
- **Energy Efficient Utilities:**
 - Switching to energy efficient lights and devices like LEDs.
 - Promoting energy conservation at household levels through user awareness campaigns and programmes.

8.8. Resources Management

Aguibani GP is rich in natural resources include land, forest and water. However, uncontrolled and unregulated use of these will lead to adverse effects on quantity as well as quality of these resources. In order to ensure sustainable development of the GP, the utilization of resources must be done on controlled way, and efforts must be made to preservation and sustainable management of these resources. Following steps could be adopted for resource management at Aguibani GP:

- ***Forest Preservation:*** Vigilant supervisory system to watch and control illegal deforestation in the area.
- ***Canal/Ponds Management:*** Restoring and reviving canal, ponds, and wells in the villages, and use them effectively with water conservation/harvesting plans
- ***Groundwater Recharge:*** Monitoring groundwater levels and setting up groundwater recharge stations for harvested rainwater

9. Time-line of Development Plans

Previous Section has discussed several possible developmental activities which could be taken up at Aguibani GP. However, obviously, all of the developmental activities can't be taken up simultaneously. Therefore, a prioritization should be done and time-line for the development plans could be conceived.

Based on the expertise of the team, and consultation with the local stakeholders, the set of identified development plans were laid for next 10 years, in three different time-phase, as Short-term Plan (1-2 Years), Mid-Term Plans (3-5 Years), and Long-term Plan (6-10 Years). A summary of the envisioned 10-year development plan is shown in the Figure 31, and prioritizing of development schemes in the 10-year development plan are discussed as under:

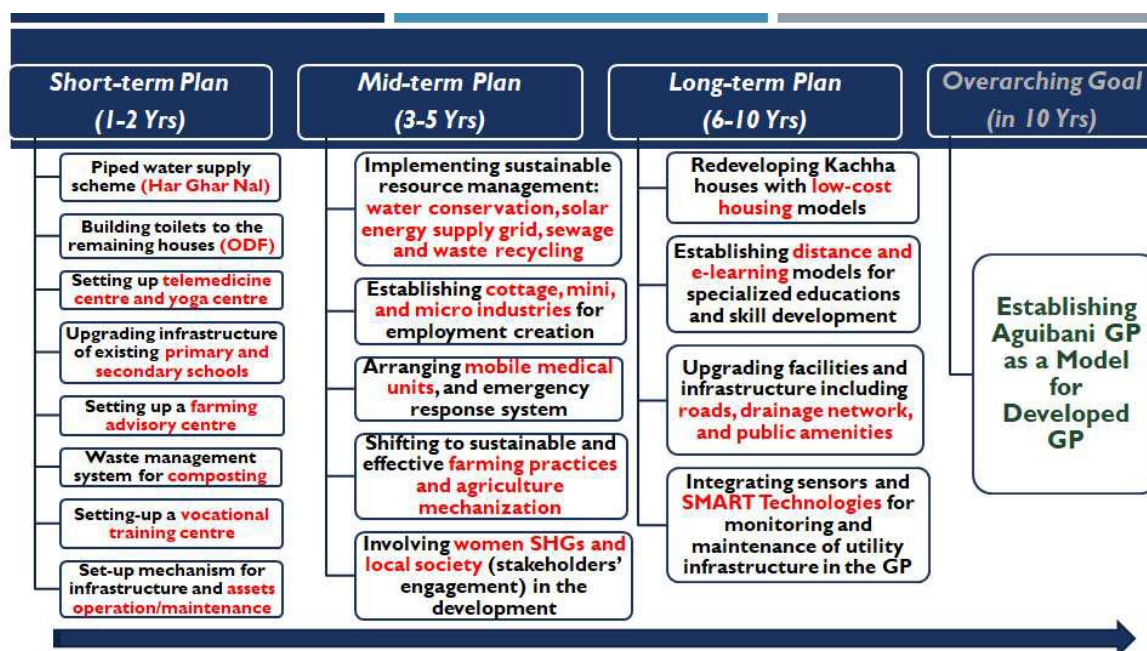


Figure 31: Proposed 10-Year Development plans/activities for Aguibani GP

9.1. Short-term Plans

Short-term development plans were envisioned for first two years, and mainly focused on areas needing immediate attentions, or initiation of activities for subsequent upgradation and development. The major activities considered under Short-term Plans include:

- **Water Supply:** Setting up piped water supply scheme to meet ambitious aim of Har Ghar Nal se Jal under Jal Jeevan Mission
- **Swachh Bharat:** Acquiring ODF status by building toilets to the remaining houses

- **Health-care:** Setting up telemedicine centre, and yoga and naturopathy centre
- **Education:** Upgrading infrastructure of existing primary and secondary schools
- **Agriculture:** Setting up a farming advisory centre
- **Waste Management:** Setting up composting systems for waste management
- **Employment:** Setting-up a vocational training centre
- **Infrastructure:** Set-up mechanism for infrastructure and assets operation/maintenance

9.2. Mid-term Plans

Mid-term development plans focused on advancing development schemes proposed under Short-term Plan, and initiate other developmental activities that requires larger preparatory time and/or budget for implementation. The major activities under Mid-term Plans include:

- **Resource Management:** Implementing sustainable resource management plans as water conservation, solar energy supply grid, sewage and waste recycling
- **Employment:** Establishing cottage, mini, and micro industries suitable to local conditions and resources
- **Health-care:** Arranging mobile medical units, and emergency response system
- **Agriculture:** Shifting to sustainable farming practices and agriculture mechanization
- **Stakeholders Engagement:** Involving women SHGs and local society (stakeholders' engagement) in the development

9.3. Long-term Plans

Long-term plans aimed at taking forward the earlier initiated schemes and with the use of advanced tools and SMART technologies, establishing Aguibani GP as a Model for developed GP. The infrastructure intensive activities were considered under this phase. The major activities considered under Long-term Plans include:

- **Rural Housing:** Redeveloping Kachha houses with low-cost housing models
- **Rural Infrastructure:** Upgrading facilities and infrastructure including roads, drainage network, and public amenities
- **Education and Skill Development:** Establishing distance and e-learning models for specialized educations and skill development
- **SMART Technologies:** Integrating sensors and SMART Technologies for monitoring and maintenance of utility infrastructure in the GP

10. Possible Role of IIT Kharagpur

Being an institute of national importance, IIT Kharagpur has been working towards bringing out technological as well as techno-social solutions for urban as well as rural regions since its inception. Being awarded with the Institute of Eminence status, it's now has grater responsibilities towards nation building. IIT Kharagpur has been working in rural development since last several decades, and have dedicated units like *Department of Agricultural and Food Engineering*, and *Center for Rural Development & Innovative Sustainable Technology*. In addition, through National Service Scheme (NSS) programme, IIT Kharagpur is working along with several nearby villages for various developmental activities.

In the proposed development plan for Aguibani GP, IIT Kharagpur can extend technical support on several fronts. Some of those possible avenues where IIT Kharagpur can help with the development of Aguibani GP, include:

Water, Sanitation and Waste Management Sector:

- IIT Kharagpur can help with planning, detailed designing, and overseeing implementation and maintenance of water supply scheme including water treatment, sewer line scheme, wastewater treatment and recycling in the villages
- IIT Kharagpur can provide the technology, design and implementation support for rainwater harvesting, storage and utilization schemes.
- The scheme for waste collection, segregation and processing (composting and recycling) can be designed by IIT Kharagpur

Agriculture Sector:

- IIT Kharagpur have done extensive work on agri-mechanisation, and can support GP with guiding on uses of agri-machines and can provide on-field training for that.
- Precision Farming development Centre (PFDC) at IIT Kharagpur is one of the pioneers in precision farming including drip irrigation, mulching, and greenhouse technologies. IIT Kharagpur can help the GP by providing knowledge and training of field adaption of these technologies.
- IIT Kharagpur has developed several technologies for food processing and marketing. A comprehensive plan for local-scale food processing, with agri-business model including storage, and supply-chain facilities could be developed for the GP.

Education and Skill Development Sector

- IIT Kharagpur can help setting up modern teaching laboratories & other required infrastructure in the schools.
- NSS volunteers at IIT Kharagpur can help in organizing pedagogy trainings. Also, IIT Kharagpur offers several pedagogy training sessions from time to time.
- IIT Kharagpur can organize specific training and skill development program at IIT Kharagpur campus or other centres
- IIT Kharagpur students can volunteer to help PG students seeking academic support
- IIT Kharagpur is leading NDLI project, and can train local youth on its access and uses

Infrastructure Sector

- IIT Kharagpur has developed bamboo-reinforced concrete buildings technology which are regarded as a feasible solution for low-cost rural housing. IIT Kharagpur has also developed cell-filled concrete roads as suitable pavement technology for rural roads. IIT Kharagpur can offer design and supervisory support for these technologies (shown in Figure 32) to be adopted in Aguibani GP.

Other Sectors (Health Care/ Employment/Energy)

- IIT Kharagpur has developed and demonstrated telemedicine system for affordable healthcare, and can facilitate village-scale adaptation of the system.
- IIT Kharagpur can facilitate in training and skill development, machineries designs, development of business models etc. for various small-scale industry and business proposed for the GP.
- IIT Kharagpur can help in planning and execution of solar power projects in the GP



Figure 32: Bamboo-reinforced concrete building technology, and cell-filled concrete technology developed by IIT Kharagpur (which could be adopted at Aguibani GP)

11. Summery and Way Forward

Aguibani GP lacks in several basic amenities (especially for villages located in the interior parts), and the majority of population is poor (below poverty line). The household survey revealed that over 60 % population still leaving in Kachha houses, and the average per person monthly expenditure in Aguibani GP is ₹ 1,046 only, 27 % less than the average per head expenditure in rural India. There is no piped water supply for households in the GP, no sewer lines, and even the GP doesn't have ODF status, as close to 30% households still don't have toilets.

The SWOT analysis was conducted to identify the opportunities and challenges for implementing development plans in the villages. The GP is rich in natural resources (fertile land, forest, and water), conveniently located and have huge scope and potential for development in terms of all basic human development aspects. Through this short-term study, IIT Kharagpur identified the possible sector-specific interventions, which could improve the overall standard of living of the people in the GP. The proposed developmental activities identified actions/interventions needed in various sectors including water, sanitation and waste management, agriculture and food security, education and skill development, affordable health-care and naturopathy, employment and income generation, rural housing and road infrastructure, energy self-sustainability, and resource management. The various identified interventions were prioritized on the time-scale for a 10-year comprehensive development plan for Aguibani GP. The activities were categorized under short-term plan for first two years, mid-term plan for following 3 years (3-5 years), and long-term plan for next 5 years (6-10 years). Short-term plans focused on areas needing immediate attentions in different sectors, whereas mid-term and long-term plans focused on advancing development schemes with the use of advanced tools and SMART technologies.

IIT Kharagpur, having vast technical expertise in all of the aforementioned domains, can help as a knowledge resource institution, with the detailed planning, design and supervisory support for the various identified development scheme, with an overarching goal of establishing Aguibani GP as a Model for developed Gram Panchayat.

Annexure A-I

सुनील कुमार, आई.ए.एस.
SUNIL KUMAR, IAS



सचिव
भारत सरकार
पंचायती राज मंत्रालय
SECRETARY
GOVERNMENT OF INDIA
MINISTRY OF PANCHAYATI RAJ
Dated: 23rd June, 2020

D.O. No: M-11015/166/2020-PESA

Dear Prof. Tewari,

The interdependency of villages, cities, industrial townships, urban centers call for spatial planning of villages for services and infrastructure. The unplanned development in Rural, Peri-urban areas and that in the vicinity of National & State highways, besides being inefficient in the use of resources, also has adverse social, environmental and health hazards.

2. The urban areas already have a system in place in terms of Master Plan for large cities / towns. However, at present there is no such perspective spatial planning process for rural areas.

3. I am happy to note that your esteemed institution has responded enthusiastically and agreed to collaborate with this Ministry in preparation of Gram Panchayat Spatial Development Plan. Gram Panchayats for the pilot are to be selected through mutual consultation with the respective Institutes and the Panchayati Raj Department of the State Government, wherein priority is to be accorded to Panchayats located on or in the vicinity of the National or State Highways, having high potential for rapid economic development. This task must be completed by 30th June, 2020 at the latest. Further details are in the enclosed Concept Note on the Need for Spatial Planning in Rural Areas. Altogether, Master Plans for 32 GPs spread across 13 States will be prepared in the next four months. The Final Reports are to be made available to the Ministry latest by October 2020.

4. Keeping in view the strict time lines for completion of the exercise, a **Video Conference (VC) meeting has been scheduled on 01st July, 2020** wherein consultation with all stakeholders will be held. The details of the VC may be seen in annexure. This will provide all of us an opportunity to discuss and understand the nuances and the modalities involved with the rollout of this project. It is important that all of us are on the same page since this project could lay the foundation for new 'drivers' of economic growth and social change in the country.

5. I look forward to your active participation in taking this unique initiative to its intended goals and objectives. I believe that this exercise will be a very good learning experience for all stakeholders.

With best wishes,

Yours sincerely,

Encl: As Above

Prof. Virendra Kumar Tewari,
Director
IIT, Kharagpur

Prof. P.P. Srivastava
Prof. P.K. Bhowmik

Pl. Choose two
gram panchayats as
desired and participate in
1st July thro VC.
23.6.20
(Sunil Kumar)
24/06/20

Annexure A-II



भारतीय प्रौद्योगिकी संस्थान खड़गपुर
Indian Institute of Technology Kharagpur
खड़गपुर Kharagpur - 721 302

प्रोफेसर वीरेन्द्र कुमार तिवारी
निदेशक
Professor Virendra Kumar Tewari
Director

04 July 2020

To
Sri K. S. Sethi
Joint Secretary
Ministry of Panchayati Raj
Govt of India
New Delhi - 110001

Subject: Approval of the Group Members and Seed Money Advance

Dear Sri Sethi Ji,

As per your advice we have selected following Gram Panchayats from the State of West Bengal, which meets the requirements of the present proposal, in consultation with you and which you have already approved.

S. No.	Gram Panchayat	District
1.	Kultikri	Jhargram
2.	Makrampur	PaschimMedinipur

After participating the VC meeting on 01 July 2020 we have formed a group consisting of *the* following members, details of the members along with their expertise is appended below –

S. No.	Name	Department	Specialisation
1.	Prof. P. P. Srivastav	Agril & Food Engg.	Food processing and preservation
2.	Prof. P. K. Bhowmick	Rural Development Centre	Tribal development & Anthropology
3.	Prof. R. Machavaram	Agril & Food Engg.	Farm mechanization
4.	Prof. Amit Shaw	Civil Engineering	Rural road construction
5.	Prof. Manoj K. Tiwari	School of Water Resources	Surface water conservation
6.	Prof. Abhishek K. Rai	CORAL	Ground water hydrology

You are requested to kindly approve the group and to sanction and release the seed grant as an advance so that the preliminary study in the catchment area could be started at the earliest.

With regards,

Yours sincerely,

(V. K. Tewari)

Annexure A-III



Government of West Bengal
Department of Panchayats & Rural Development
Joint Administrative Building (6th to 10th Floors), HC-7, Sector-III
Bidhannagar, Kolkata-700106

No. 381/SS/DD/2020

Dated: 07.07.2020

From : Shri Dibyendu Das
Special Secretary to the Govt. of West Bengal

To : Prof P.P. Srivastav,
Agriculture and Food Engineering Department,
Indian Institute of Technology,
Kharagpur- 721302

Sub: - List of Gram Panchayats identified in the State of West Bengal for Spatial Planning in Rural Areas.


Sir,

I have been directed to inform you that in regards to the letter from the Secretary Ministry of Panchayat Raj vide memo no. M -11015/166/2020-PESA regarding Spatial Planning in Rural Areas, the following Gram Panchayats have been finalised by this Department for the said initiative:

Sl No.	District	Block	Gram Panchayat	Pradhan	Contact No.
1	Paschim Medinipur	Narayangarh	Mokrapur	Jogendranath Doi	9732700317
2	Jhargram	Jhargram	Agulboni	Rani Hembram Murmu	8016058650

This is for your information and necessary action.

Yours faithfully,

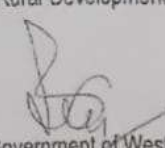

Special Secretary to the Government of West Bengal
Panchayats & Rural Development Department

Dated: 07.07.2020

No. 381/1(1)/SS/DD/2020

Copy forwarded for necessary information and action to:

1. Sri Soumyajit Dutta, Officer on Special Duty to the Panchayats and Rural Development Department & Administrative Officer of STARPARD.


Special Secretary to the Government of West Bengal
Panchayats & Rural Development Department

Annexure B: Natural Resources Inventory and Spatial Analysis using Geospatial Technologies

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Team

Mr. Y K Srivastava, RRSC-East

Ms. Khushboo Mirza, RRSC-North

Dr Vinod Kr Sharma, RRSC-North

Mr. Shankar Ram N R, RRSC-North

Overall Technical Guidance

Dr C S Jha, Outstanding Scientist & CGM, RCs, NRSC

Dr D Dutta, GM, RRSC-East, NRSC

Dr V M Chowdary, RRSC-North

Dr K Chandrasekar, NRSC

Natural Resources Inventory and Spatial Analysis using Geospatial Technologies

1. Introduction

Developmental planning is a complex process of decision making based on the information about the status of resources, socio-economic conditions and institutional constraints. Reliability of the databases, both the spatial and non-spatial, is therefore crucial to the success of the developmental planning. Hence, it is necessary to understand various elements of Gram Panchayat and their interrelationship for ecological planning. The ability of space technology for obtaining systematic, synoptic, rapid and repetitive coverage in different windows of the electromagnetic spectrum, and over large areas from its vantage point in space, has made this technology unique and powerful. Indian Remote Sensing (IRS) satellites are providing timely information from regional level studies to farm level studies through multi sensor resolutions. Thus, Remote sensing and GIS are playing a rapidly increasing role in the field of land and water resources management and also becoming more and more important for environmental applications. There is a strong synergy between remote sensing and GIS, as remote sensing data are a major source of spatial information in GIS analysis and GIS data can be used as an ancillary information to support remote sensing data interpolation. The synergy between these two technologies is a major advantage in the use of an integrated approach. Over the last two decades remote sensing and GIS have been widely used for the preparation of different types of thematic layers and integrating them for different applications that include land and water resources planning, agricultural applications, water resource management, disaster management, forestry applications, watershed management and urban applications etc. The present study focuses on the inventory and analysis of natural resources for Aguiboni Gram Panchayat, Jhargram district, West Bengal with specific objectives as given below.

2. Objectives

1. Inventory and spatial analysis of natural resources that include thematic layers viz., infrastructure layers, LU/LC, slope, drainage network & water bodies, contours, soil etc.
2. Long term analysis of Rainfall.
3. Long term assessment of surface water potential
4. Generation of Land and Water resource development plans

3. Inventory of Natural Resources using High Resolution Satellite Data

Potential tools such as remote sensing and GIS techniques are utilized for generation of various thematic resource maps in conjunction with collateral data. Data integration and generation of development plans are carried out in Geographic Information System environment.

3.1. Information sources for developmental planning

Satellite data IRS -1D LISS III data, Cartosat and IRS P6 LISS IV data and other collateral

data form major source for preparation of various thematic maps as spatial database. The data acquired from the multi-spectral sensors LISS IV (5.6 m resolution) and CARTOSAT (2.5 m resolution) of the Indian Remote Sensing Satellite (IRS) series are extensively used for generating spatial databases. Very high-resolution satellite data (Cartosat 2S & Komsat 3A), is analyzed at finer resolutions to update the spatial layers needed for generating the value-added Land resource and water resource development plans. The data needed for this study is studied in detail and the collected primary maps have been grouped into hydro-geomorphological, topographical, land use/land cover, hydrology and socio-economic parameters (Table 1). Subsequently, these primary maps are used to produce utilitarian types of maps to serve planning decisions. They are derived, in some cases, by direct translation of single thematic map and in others by combination of two or more thematic maps or chosen parameters of the different themes (Table 2). Natural resources data representing environmental status of the study area that were generated under various national level projects at 1:50000 scale was considered for the present study and are presented below. The database was standardized for integrated analysis under GIS environment.

Table 1. Information sources for development planning

Data/map	Source	Spatial/Non-spatial	Scale
Digital Elevation Model	Cartosat Stereo data	Spatial	10 m
Contour	CARTODEM	Spatial	5m
Geological map	Rajiv Gandhi National	Spatial	1:50K
Geomorphological map	Drinking Water Mission	Spatial	1:50K
Structures/Lineaments		Spatial	1:50K
Soil	NBSS & LUP	Spatial	1:50K
Land use/cover	Very high-resolution data	Spatial	1:4K/10K
Drainage map	High resolution satellite data	Spatial	1:4K/10K
Surface water bodies		Spatial	1:4K/10K
Meteorological data	IMD	Spatial	25 km grid
Settlement		Spatial	1:4K/10K
Infrastructure	High resolution satellite data	Spatial	1:4K/10K
Village boundaries		Spatial	1:50K
Population	Census Directorate, NIC,	Non-spatial	
Demography	NRSC	Non-spatial	

Table 2. Derived spatial databases required for planning

Derived map	Theme map	Remarks
Contour/Slope	Topographical map/IRS PAN stereo data	Derived from DEM
Groundwater potential	Geology, Geomorphology, borewell, Lithology and yield data	Integration of thematic maps and point database
Surface water potential	Slope, soil map, land use, rainfall and micro-watershed boundary	SCS-CN technique through integration of layers

Water Resource Development Plan	Slope, soil map, land use, drainage order, lineament, Runoff Potential	Multi Criteria analysis
Land Resource Development Plan	Slope, soil map, land use, Ground Water Potential, Geomorphology	Multi Criteria analysis

4. Satellite Data used

4.1. High Resolution Satellite Data

Resourcesat LISS 4 satellite data acquired during 2018 was used for GPSDP planning. The LISS-4 multispectral high-resolution sensor is the prime instrument of ResourceSat-2 satellite.

4.2. Very High-Resolution Satellite Data

Resource mapping at 1:4000 scale was carried out using VHRS data at sub meter resolution acquired using Komsat 3 sensor. KOMPSAT-3A will provide panchromatic resolution of 0.55m and multispectral resolution of 2.2 m and also has an infrared sensor at 5.5m resolution. The merged product is generated with spatial resolution of 0.7m (Figure 1).

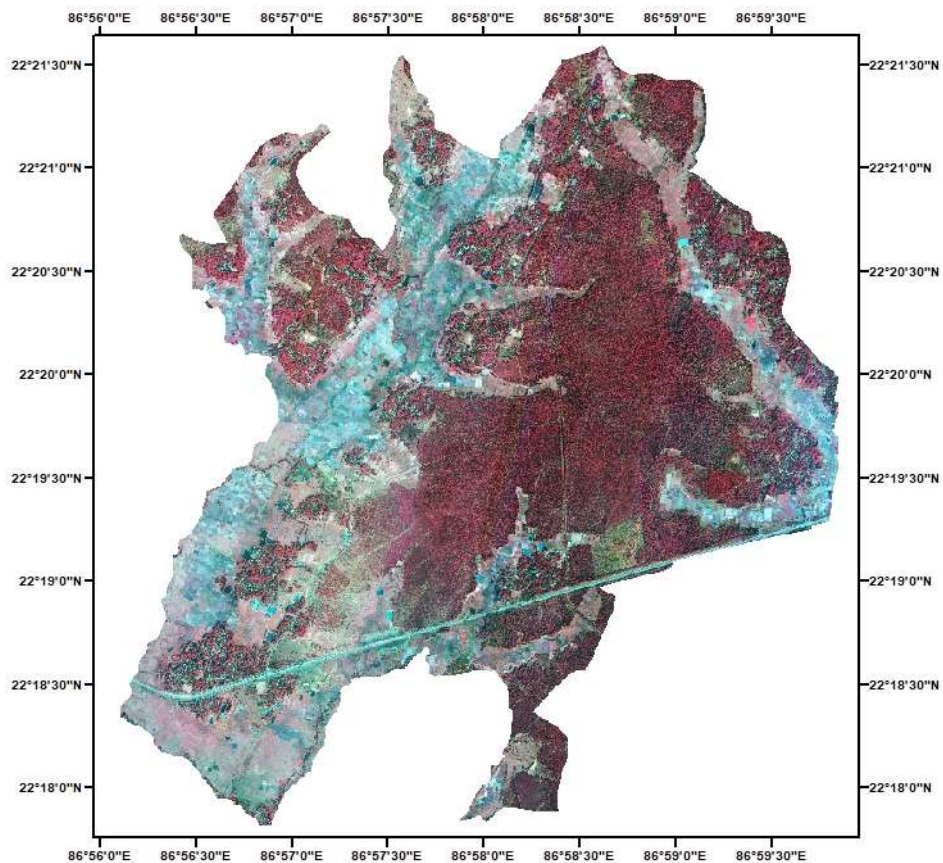


Figure 1. Aguiboni GP as seen through Very High-Resolution Satellite data (0.7m)

4.3. Digital Elevation model

DEM is one of the important parameters for developmental activities and was derived from CARTOSAT stereo data. The elevation data is very much essential for generation of slope and contour maps, which are essential requisites for spatial planning purposes. DEM of the study area is shown as Figure 2.

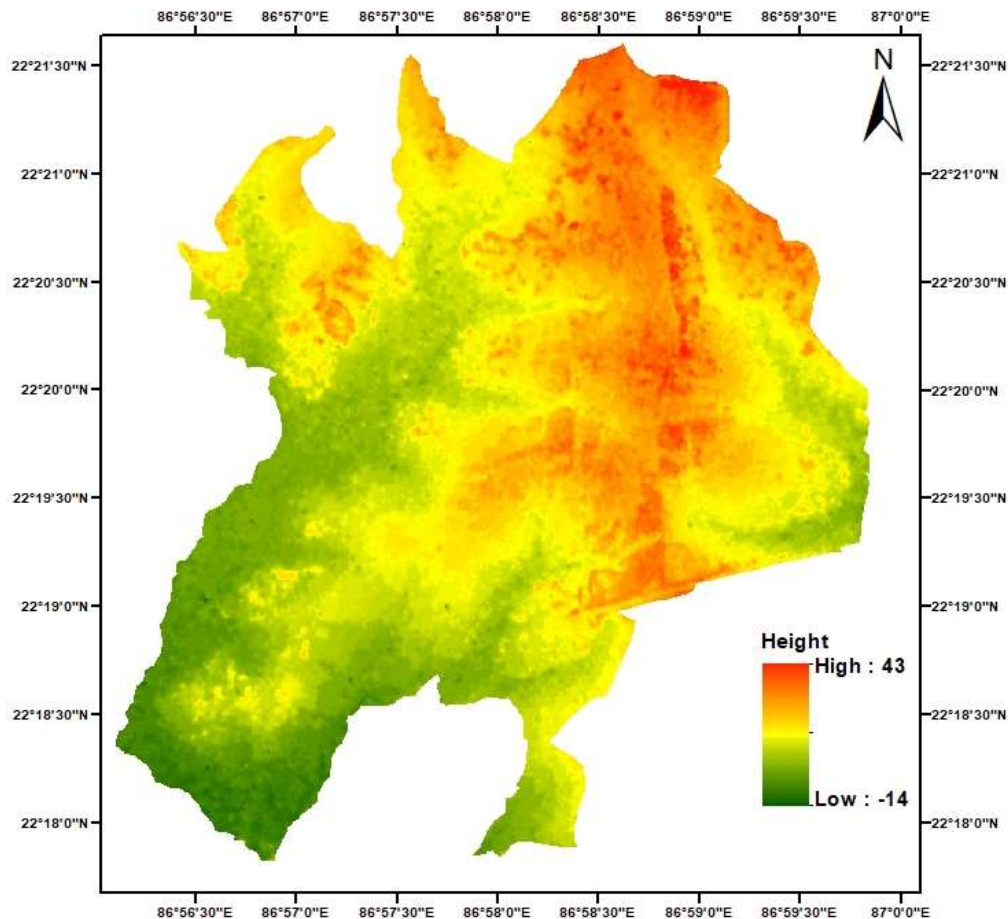


Figure 2. Digital Elevation Model (DEM)

5. Spatial Layers

Spatial layers representing the synoptic view of GP were generated at 1:10000 and 1:4000 scales.

5.1. Infrastructure Layer

Road and rail network delineated from very high-resolution satellite data is shown as Figure 3. Further, the road network was overlaid with zoning map (5KM,10KM,20KM) in order to analyze the nearness of the towns to GP shown in Figure 3.

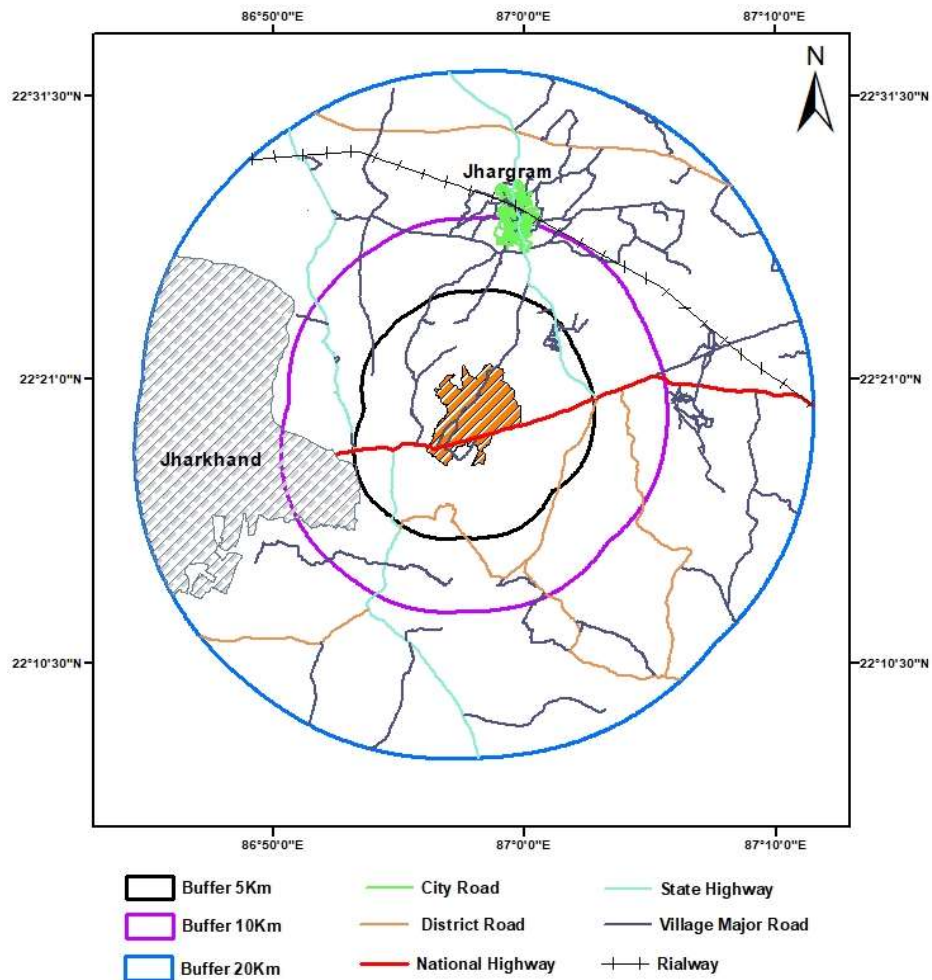


Figure 3. Infrastructure & Proximity of Auiboni GP to nearest town Jhargram

5.2. Settlement layer

Growth of settlement in a particular direction can be analyzed using satellite data more explicitly. The settlement layer was generated using VHRS data (Figure 4).

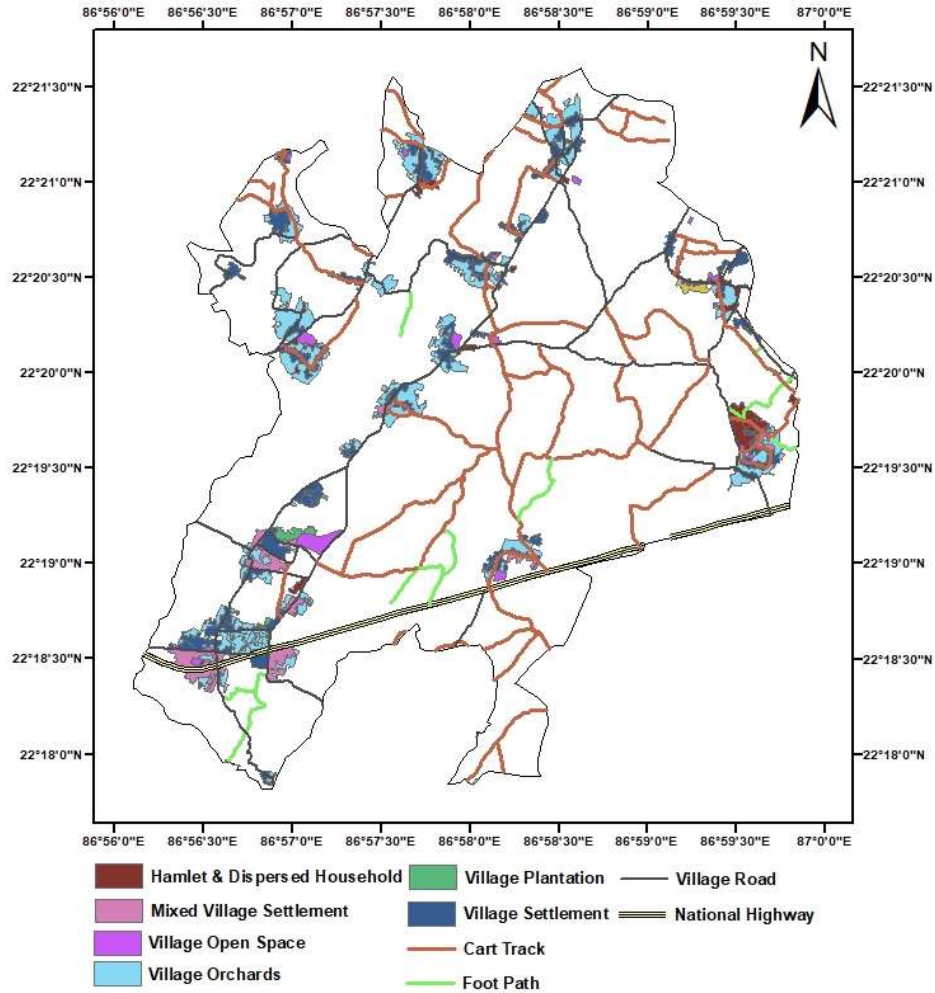


Figure 4. Settlement map.

5.3 LULC data

Land use/land cover was carried out using high resolution data at multiple scales i.e. both at 1:10000 (2010-2011) and 1:4000 (2018-19) for periodic monitoring of natural resources. Spatial distribution of land use land cover classes at 1:4K in the GP is shown as Figure 5. Land use land cover statistics in the study area is given in Table 3.

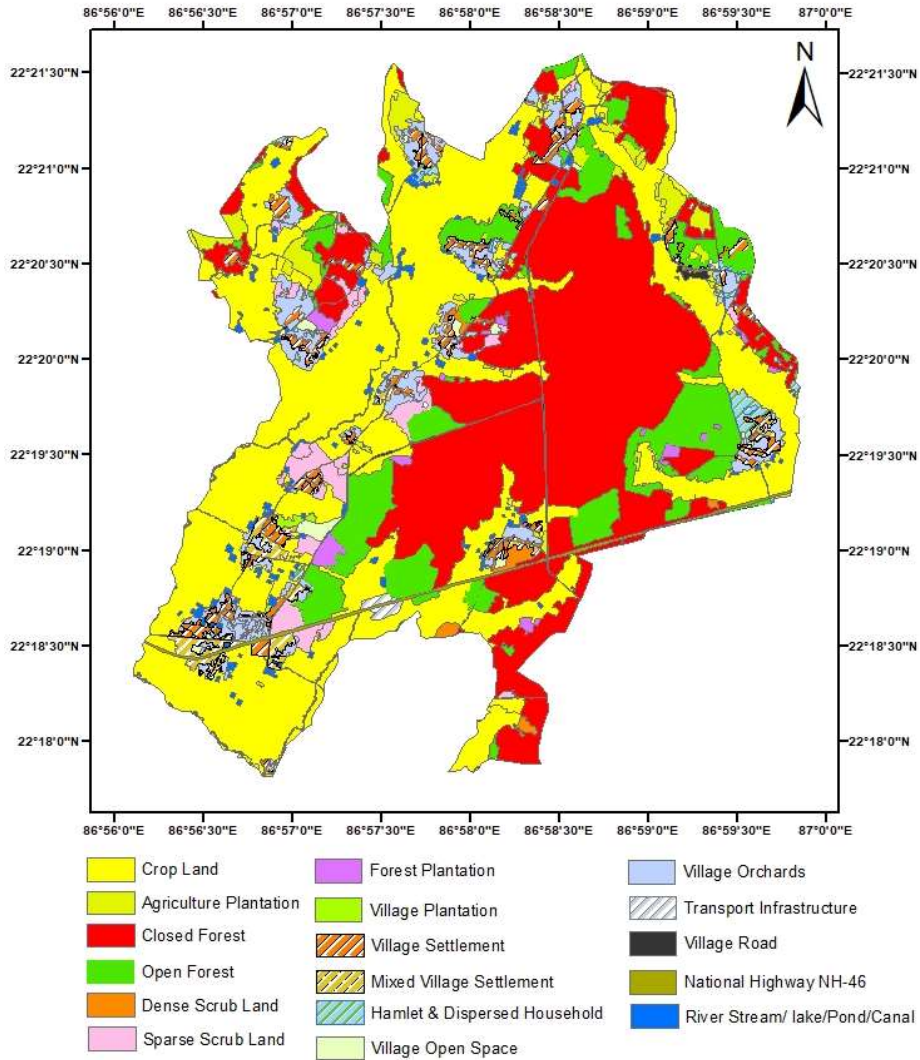


Figure 5. Land use/ land cover map

Table 3. Land use / Land cover area statistics

Sl. No.	Land use / Land cover Class	Area (ha)
1.	Agriculture Crop land	977.88
2.	Agriculture Plantation	65.63
3.	Closed Forest	817.04
4.	Open Forest	275.85
5.	Forest Plantation	19.39
6.	Village Settlement	85.38
7.	Mixed Village Settlement	29.10
8.	Hamlet & Dispersed Household	19.46
9.	Village Plantation	3.81
10.	Village Orchards	113.91
11.	Village Open Space	14.42

12.	Dense Scrub Land	11.94
13.	Sparse Scrub Land	60.79
14.	Canal	4.64
15.	River Stream	6.34
16.	Lake/Pond	36.93
17.	Village Roads (Polygon)	19.43
18.	National Highway NH-46 (Polygon)	16.36
19.	Transport Infrastructure	5.70

5.4. Area under Cultivation

Agricultural areas under Gram Panchayat were delineated from LULC layer at 1:4000 scale (Figure 6)

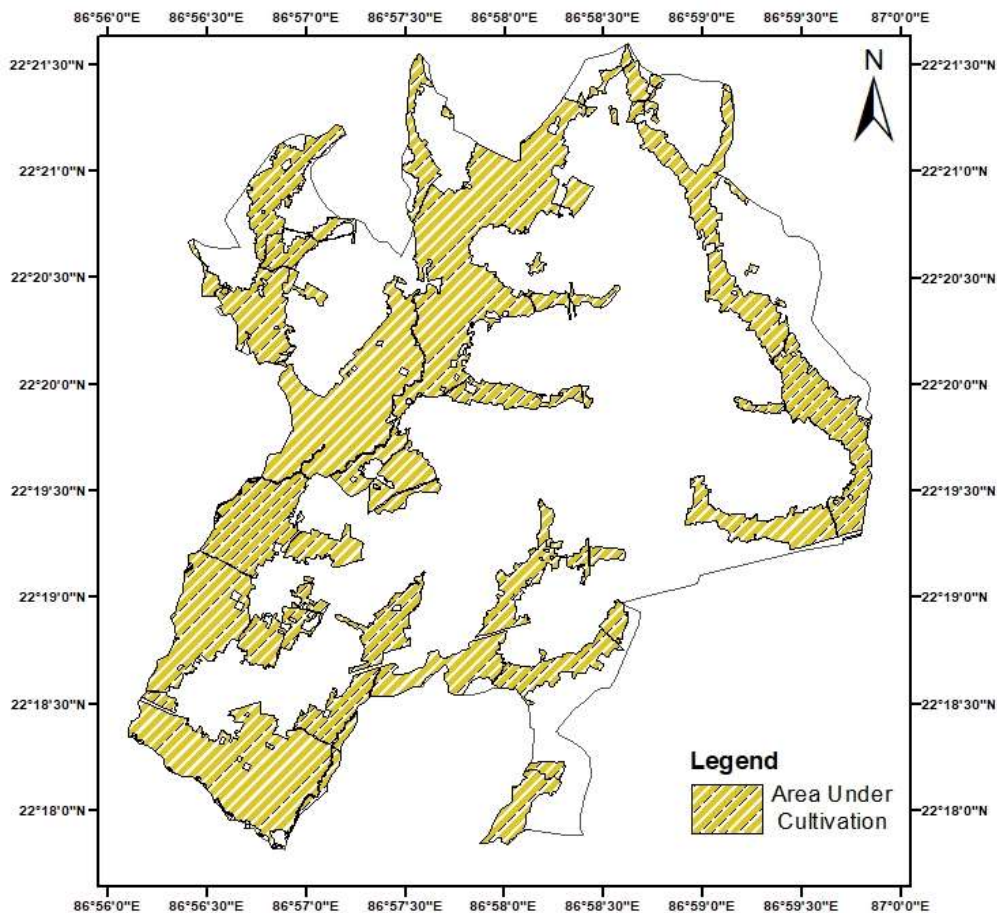


Figure 6. Area under Cultivation

5.5. Drainage Network & Waterbodies

Rivers/streams are natural course of water flowing on the land surface along a definite channel and its spatial distribution in the GP is shown as Figure 7.

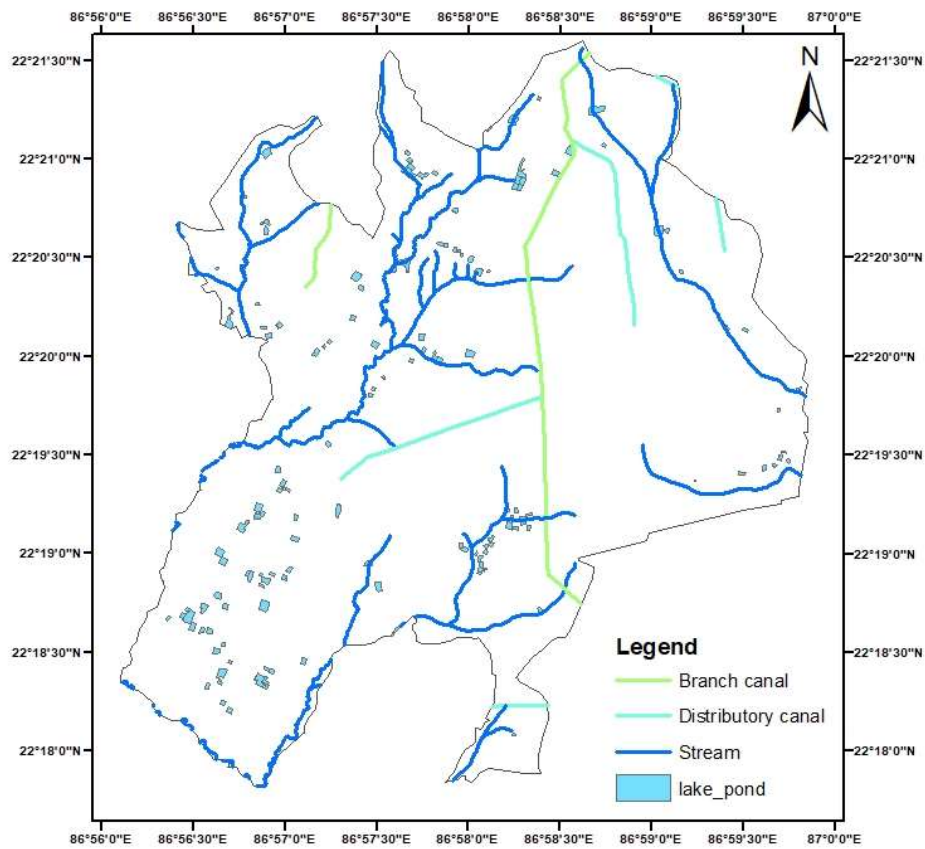


Figure 7. Drainage Network and Waterbody map

5.6. Soil and Soil Texture

Spatial distribution of soil textural information in the GP is shown as Figure 8.

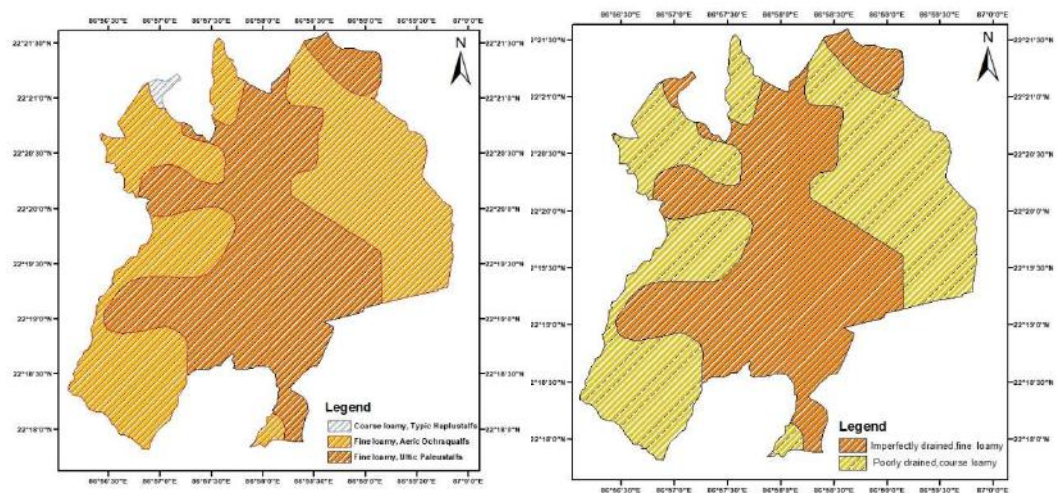
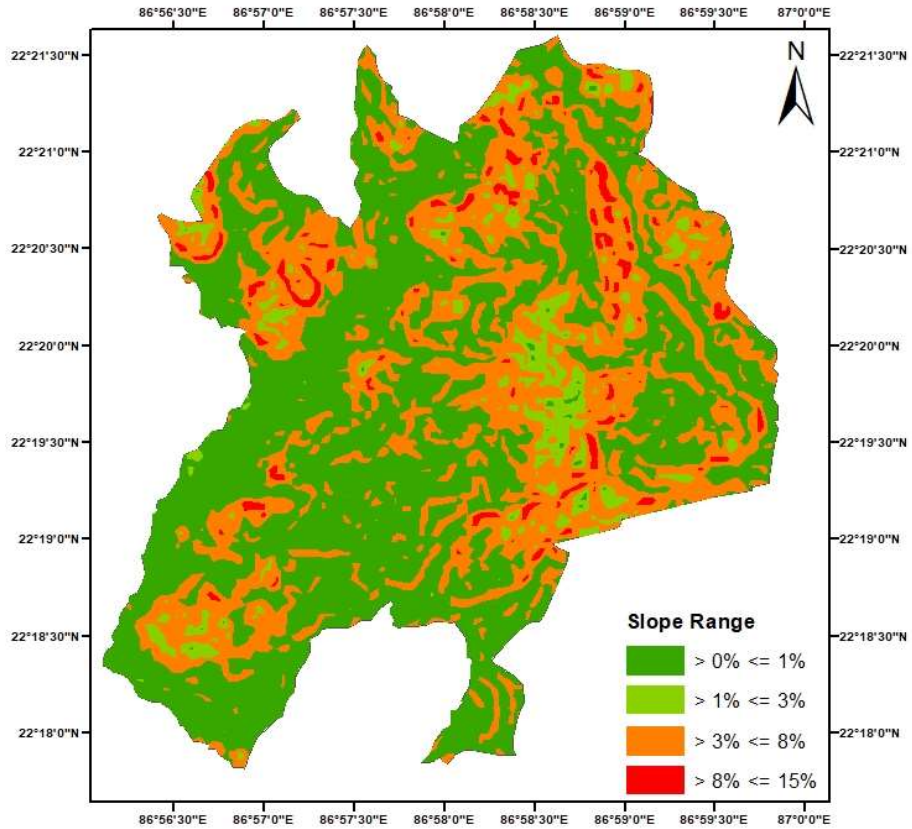


Figure 8. Soil and Soil Texture map

5.7. Slope map

Carto-DEM is used for generation of the slope layer and plays an important role in developing the Water Resource Development Plan (Figure 9).



9. Slope map (Percentage)

Figure

5.8. Geomorphology

Hydro-geomorphological maps depict major geomorphic units, landforms and provide an understanding of the processes relating to groundwater occurrence as well as groundwater prospects. Based on the morphological expressions in the satellite data, geomorphological map prepared at 1:50000 scale is presented in Figure 10.

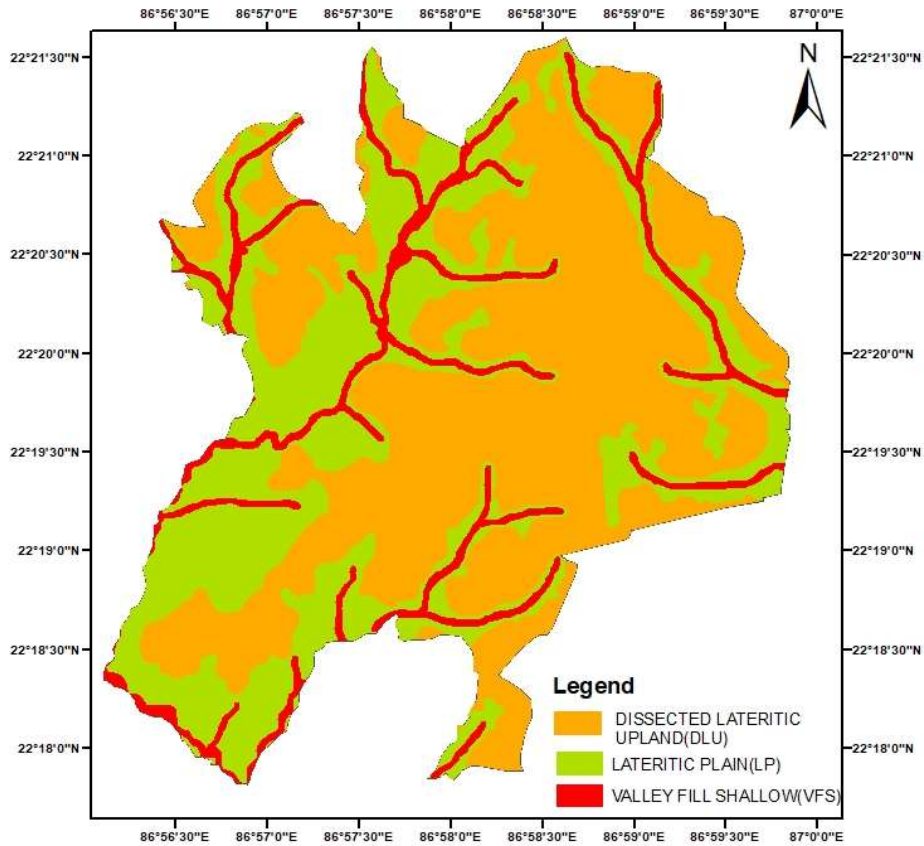


Figure 10. Geomorphology map

5.9. Lithology

The general physical characteristics of a rock or the rocks in a GP is derived from satellite data in form of lithology layer (Figure 11). The information about the rock type is very important in generation of water resource development plans.

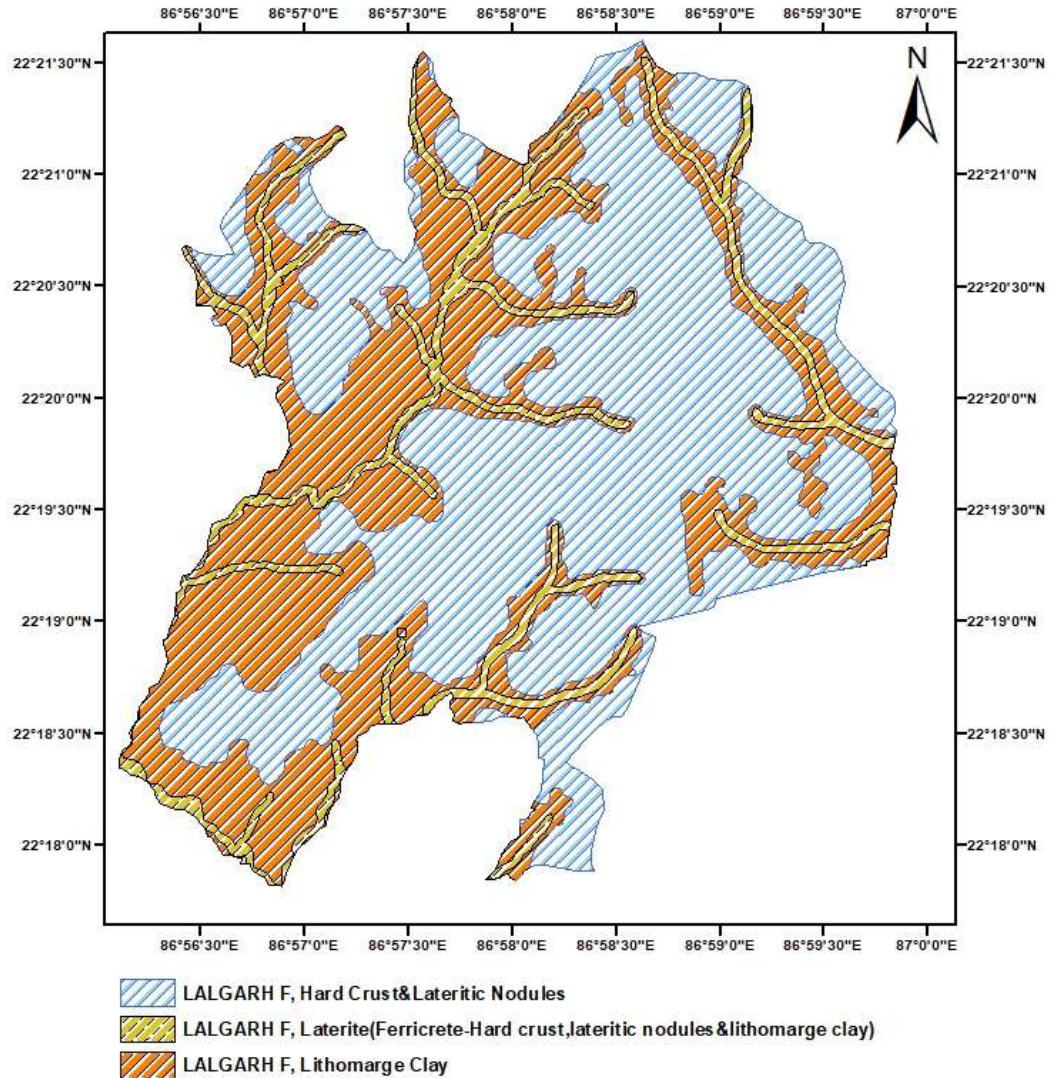


Figure 11. Lithology map

5.10. Hydrogeology

The hydrogeology and recharge condition layers have to be integrated to know the depth to water table and available recharge to the aquifer. It is used to calculate the recharge from continues irrigated water source, temporarily/seasonal water source, less or no recharge sources. Its an important information needed to determine the water condition in the vicinity of Gram Panchayat.

5.11. Contour map

Contours at 10m contour interval generated using carto-DEM are shown in Figure12.

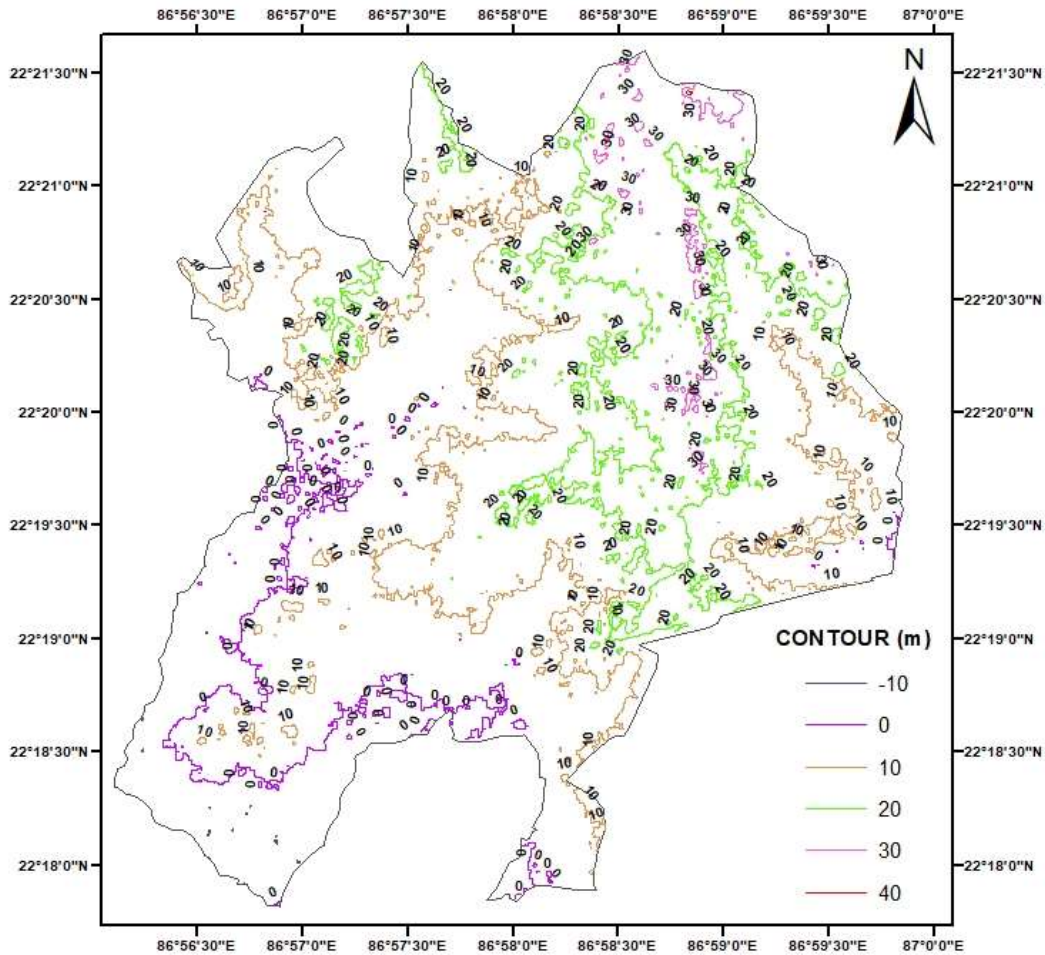


Figure 12. Contour map

6. Long term Rainfall Analysis

Annual rainfall varied between 629 mm -1484mm during the period 1979-2003 indicating high temporal variability (Figures 13 & 14). Further, number of rainy days along with statistics in the GP was computed for different years indicating wet, dry and normal conditions (Table 4).

Meteorological Condition									
	Dry Condition			Wet Condition			Normal Condition		
	Rain fall	Runoff	Rainy days	Rain fall	Runoff	Rainy days	Rain fall	Runoff	Rainy days
Mean	1121.5	269.5	96	2265.3	830.5	115.2	1242.5	406.8	83.5
Std. Deve	90.7	92.9	13.6	169.2	172.6	14.1	728.6	254.9	41.8

Table -4 Rainfall analysis for Dry, Wet and Normal Conditions (1979-2003)

7. Long term Surface Runoff Assessment

Runoff is a general term to indicate the accumulation of excess rainfall, which traverses over surface/sub surface and occurs when rainfall intensity is greater than the rate at which it is able to infiltrate the soil. In this study, one of the most widely used technique USDA Natural Resources Conservation Service (NRCS) Curve Number (CN) method was used for assessment of runoff potential for GP (USDA-SCS, 1985). The spatial distribution of runoff in the study area was computed for three meteorological conditions (wet years, dry years and normal years) and presented in Figure 14. Quantitative assessment of runoff serves as basic information for adopting suitable soil and water conservation measures in a watershed.

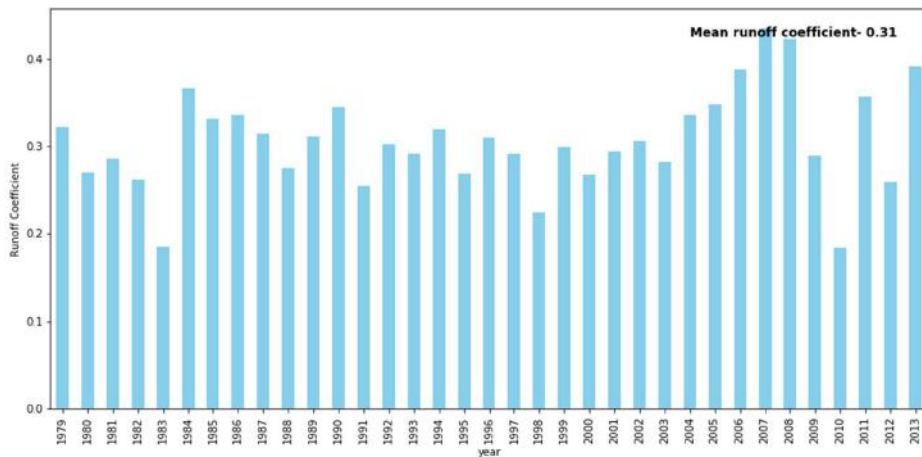


Figure 13. Annual Variation of runoff Coefficient (1979-2013)

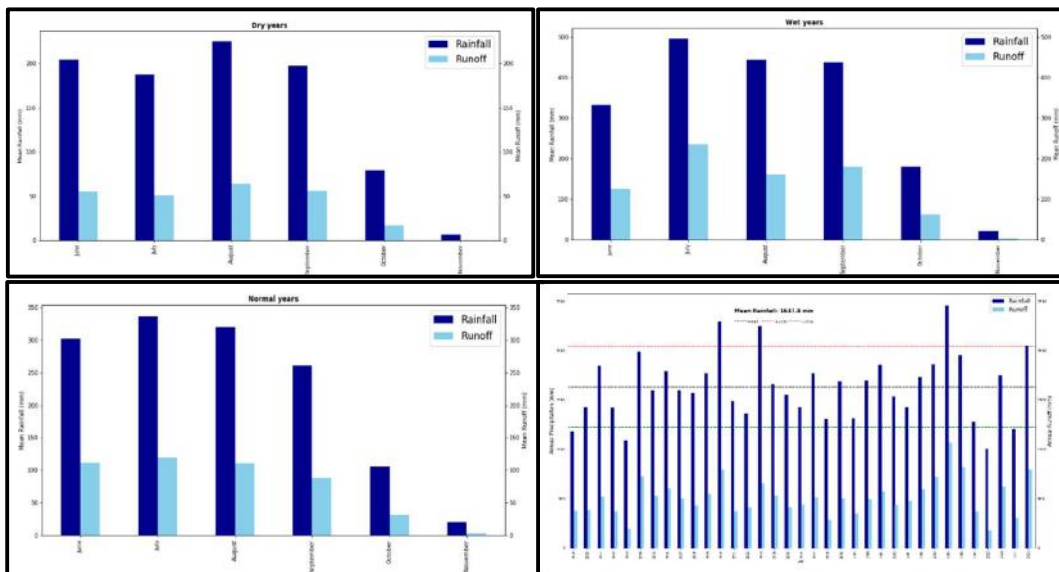


Figure 14 Surface Runoff (a) Dry conditions 1983 (b) Normal conditions-1994 (c) Wet conditions-2007 (d) Annual Runoff (1979-2013)

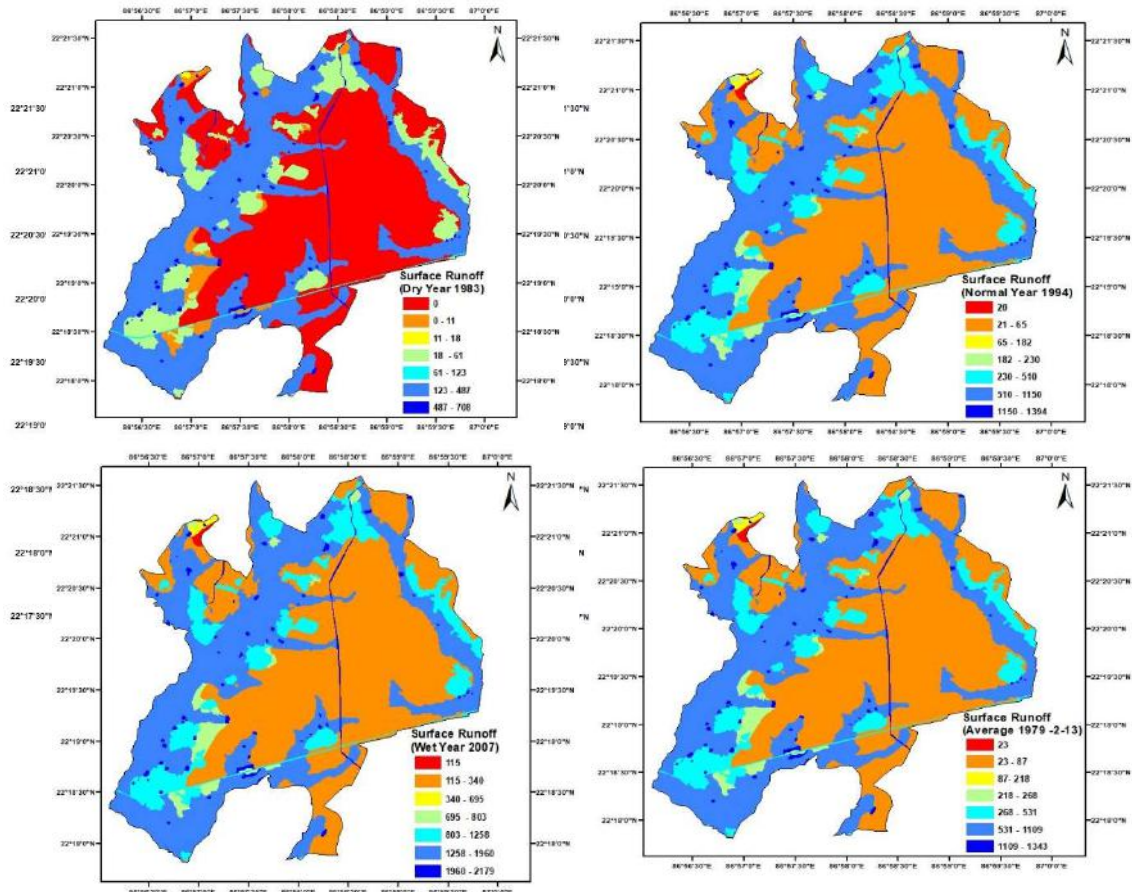


Figure 15. Surface runoff assessment under different meteorological conditions

8. Ground Water Potential

Groundwater cannot be seen directly from remotely sensed data hence its presence must be inferred from manifestation of surface features which act as an indicator of groundwater. Ground water potential map generated under Rajiv Gandhi Drinking Water Mission carried by NRSC was used for planning purpose (Figure 16). Groundwater potential map was categorized according to its recharge characteristics as either (i) Good – Very Good, (ii) Moderate - Good, (iii) Moderate (iv) Poor - Moderate (v) Poor. The lineaments are the surface manifestation of linear features like joints and fractures. They have been demarcated from the imagery as linear features and are ascertained after field traversing. Groundwater potentiality of a higher order is indicated where lineaments run along and across the alluvial zone.

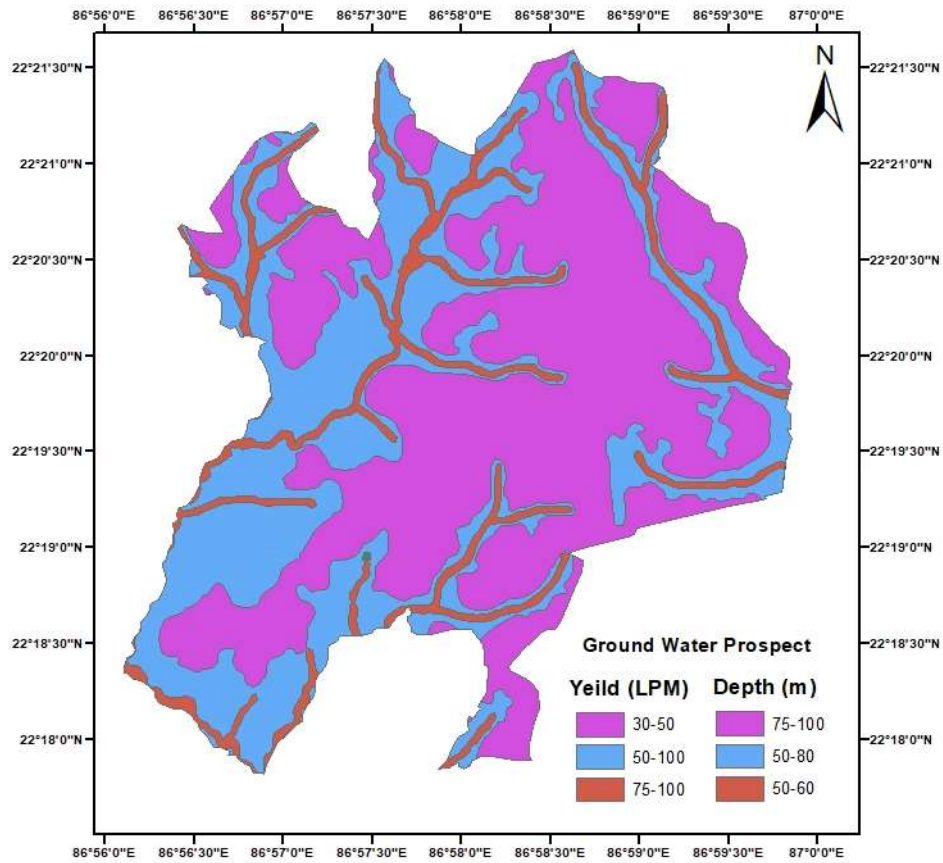
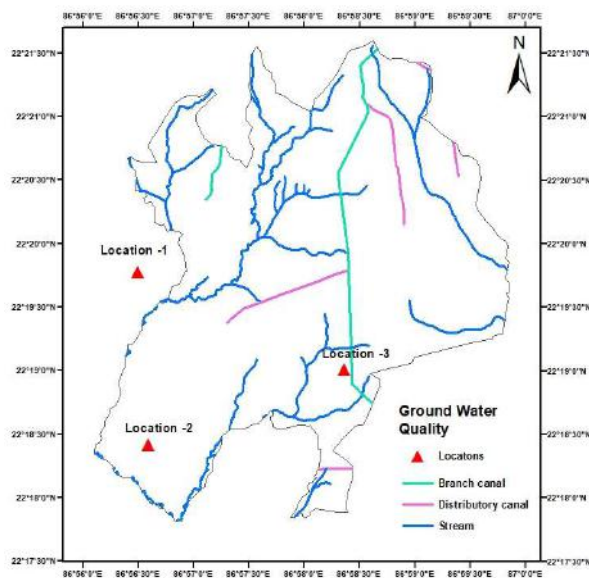


Figure 16. Groundwater Prospects map

(Source: Groundwater potential map generated under Rajiv Gandhi Drinking water Mission project, NRSC)

Groundwater quality map of the study area is shown as Figure 17 and Table 5 .



Parameter	Location 1	Location 2	Location 3
pH	7.99	8.06	8.14
TDS	166	262	448
Hardness	90	160	220
Fluoride	0	0	0
Chloride	0	0	
Iron	4.3	1.5	1.5
Nitrate	0	0	0
Alkalinity	0	0	0
GWQ	Non Potable	Non Potable	Non Potable
Data source	IMIS	IMIS	IMIS
Year	2011	2011	2011

Figure 17 Groundwater Quality Location map Table 5. Water Quality parameters

9. Generation of comprehensive development plan for GP

9.1. Water Resources Development Plan

The water resource development plan generation using GIS includes identification of suitable zones for taking up locale specific activities in the study area. Local area specific activities are generally the areas, where certain type of water resource activity is recommended for implementation. Water conservation measures like check dam, percolation tank, underground barrier etc. fall under location specific activities. In order to identify the suitable zones for location of recharge structures, different thematic layers viz., drainage network with drainage order buffer map, soil, slope and land use/cover and runoff potential were integrated under GIS environment. Subsequently, zones in which the defined conditions of the different thematic layers were fulfilled are identified for location specific activity. The guidelines for the selection of suitable zones for planning location specific activities are adopted from literature (IMSD,1995; Chowdary et al., 2009; Chowdhury et al., 2010; Shankar and Mohan, 2005).

9.2. Land Resources Development Plan

In the present study, a decision model that involves the logical combination of thematic maps resulting from the application of conditional operators was established for evaluating the suitability of a particular land use activity in the study area. For achieving this objective, essential prerequisites such as land use/cover, soil, slope and groundwater potential maps are generated using remote sensing and GIS. Integration of geomorphological, hydrogeological and land use data with geophysical investigations gives groundwater potential. This coupled with surface water potential, helps in the generation of alternate land resource development plan. Methodology adopted from the GIS based land use planning project initiated in India entitled 'Integrated Mission for Sustainable Development', which generates, analyzes and integrates natural resource thematic data in 1:50000 scale, together with satellite remote sensing data forms major basis for the present study (IMSD, 1995). The guiding factors described for land use plan generation have been presented in tabular form in the Table-3. Further, the information on land capability classes and recommended land treatment management practices (Stark et al., 1966; Pretall and Polius, 1981) also served as guiding tools. The water resource development and land resource development plan are shown in the Figures 18 (a & b)

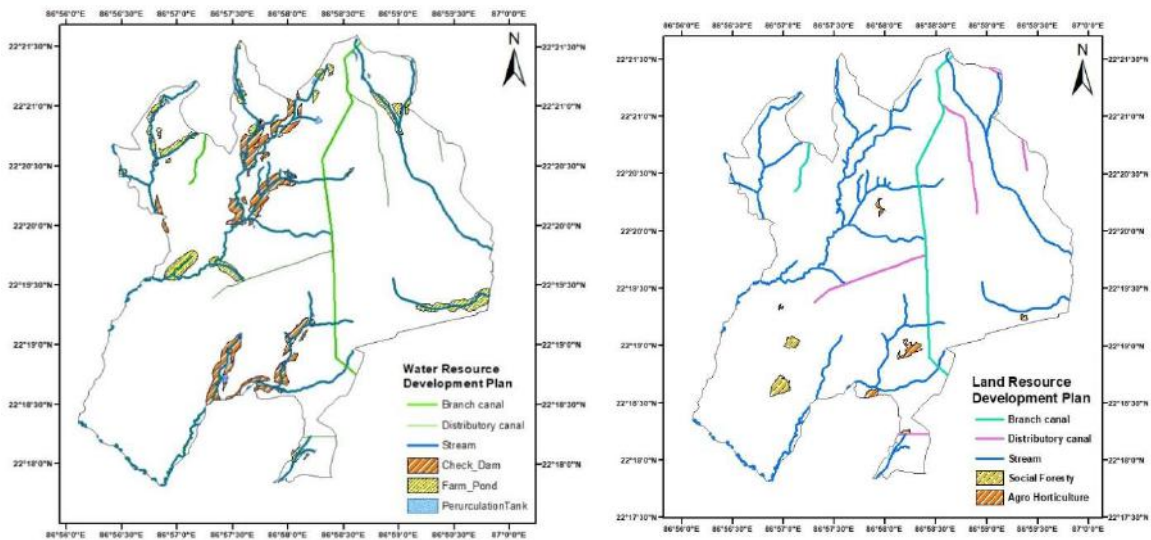


Figure -18 (a) water resource development (b) Land resource development

10. Recommendations & Suggestions for improving natural resources in GP

- Rain water harvesting measures such as farm ponds, percolation tanks and check dams are suggested in the GP considering study GP characteristics, which they have significant role in rainfed and dryland farming cultivation. To minimize the cost of construction in case of farm ponds, suitable zones were identified for two soil conditions i.e. with or without seepage control. Dimensions of the pond can be evaluated on the basis of volume of water to be stored. Further, feasible locations for check dam are identified.
- Rainwater harvesting structures reduce runoff velocity there by minimizes erosion and secondly allow the retained water to percolate and thus results in increased recharge in the wells located downstream of the structure. Some slots should be provided in the check dam so as to allow passing through early monsoon flow that carry appreciable amounts of sediment. The late/post monsoon flow can be stored by plugging the slots with either wooden planks or similar another suitable device.
- Mean runoff coefficient estimated based on the 34 years rainfall data is nearly 0.46 that indicated that nearly 46% of rainfall is converted to runoff. Number of rainy days also varied between 89 to 106 days during the period 1979-2013, which indicates ample scope for retaining surface runoff water through adoption of suitable rainwater harvesting measures.
- Water resource development plan indicated that nearly 110 ha of area is suitable for farm pond. However, cadastral map needs to be overlaid on the WRD plan for implementation purpose. Thus, these structures directly address the temporal discontinuity between the availability of rainfall and crop moisture demand. Irrigation and water supply can be planned from the wells lying in the dam command. Thus, rainwater harvesting technique helps in recycling water for raising double cropping system and agro-horticulture crops.
- In the Aguiboni GP, mostly single cropping practices are been carried out due to scarcity of water during summer season In spite of having sufficient rainfall in the study GP, 90% of the study area is under single cropped areas. Thus, by retaining surface runoff, single cropped areas can be converted to double cropped areas.

- Further, areas suitable for agroforestry and agro-horticulture areas are identified considering the current land use, soil, slope and surface and ground water potentials for agroforestry and agro-horticulture. This indicates possibilities for transformation of existing single cropped areas, fallow and wastelands to intensive agriculture, agro-horticulture, horticulture, social forestry and fodder crop etc.
- Fruit trees, if suitably integrated, would add significantly to overall agricultural production including food, fuel and fodder, conservation of soil and water and stability to production and income. Dryland fruit trees, being deep rooted and hardy, can better tolerate monsoon aberrations than short duration crops, thus can utilize off-season rains and soil moisture from deeper layers.
- Adoption of policy to earmark at least 10 – 20% of land for tree farming and grass strip cultivation. The generated grass would be utilized as fodder for the livestock, while tree wood would generate assured income and fuel wood.
- Poultry, commercial goat rearing and dairy development has not yet been organized and has lot of scope for improvement. Integrated rice-fish farming particularly suggested for the farmers of Eastern and North Eastern India by Water Technology Centre, Bhubaneswar can also be popularized in the study area.
- The strategic planning is defined as the future directions for the development of land and water resources in the GP establishing the long-term objectives and mobilizing the financial resources and government policy to achieve hierarchical goals. Further, involvement of local people is quite necessary as part of education, awareness and consensus. Implementation, monitoring and maintenance of the schemes and evaluation of implemented schemes for their end benefits are also the part of strategic planning activities.
- For successful implementation of land and water resource development plan in the study GP, suitable working scale needs to be identified for data analysis and implementation within the GIS framework. Most of the implementation by the implementing authorities of the government is being carried out with cadastral maps. The large-scale cadastral maps overlaid on the action plan details would be the best format for implementation.

11. References

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