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Generation of Geo-database on rural roads compatible with C-DAC Specifications and Data Standards:

A case of Dakhin Bholagaon Panchayat, Rani C&RD block, Kamarup District, Assam

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EXECUTIVE SUMMARY

Rural Connectivity becomes a critical component in the socio-economic development of rural population by providing access to amenities like education, health, marketing, etc. All weather rural road connectivity improves livelihood opportunities for the people through farm to market linkages as well as access to basic services and amenities. It has been established that investments in rural roads lift rural people above the poverty line. The evidence also indicates that as the rural connectivity improves, the rural poverty levels come down.

With this as backdrop, Government of India had launched Pradhan Mantri Gram Sadak Yojana in the year 2000. The primary objective of the programme was to provide connectivity by the way of weather roads to unconnected habitations with population of 1000 and above by 2003 and those with population of 500 and above by 2007 in rural areas. In respect of hill/desert/tribal areas, the objective is to link habitations with population of 250 and above. The programme has since been implemented by the Ministry of Rural Development, Government of India.

GIS Architecture is an essential tool to be placed on comprehending the information of spatial and non -spatial data over space and time was recommended by the working group on Rural Roads in the 12th Five Year plan. Based on the recommendations, the C-DAC (Centre for Development and Advanced Computing), Pune has carried out a 'Software Requirement Specifications' (SRS), study for formulating and designing a web-based road information system, with reference to the implementation of world bank assisted rural road projects-II, PMGSY. MoRD, GoI has decided recently (May 2015) to implement the outcome of the study in phased manner depicting the road information system under PMGSY. The states under this initiative are required to prepare the database as per the software requirement specifications and Data Standards. For the successful implementation of the web enabled GIS technology, the engineers and data managers of the implementing agencies require GIS skill to develop a database according to the above-mentioned Software Requirement Specifications (SRS).

In order to gain the experience of handling effectively the new initiative and share it as a local case with the participants in the training programme of NIRDPR, NERC, Guwahati titled **'Generation of Rural Roads Geodatabase compatible with C-DAC specifications and Data Standards': A case of Dakhin Bholagaon Panchayat of Rani C & RD Block, Kamrup district, Assam State** has been carried out**.**

In the study of Dakhin Bholagaon Gram Panchayat, both primary and secondary data related to roads have been used. The use of high-resolution satellite imageries and GPS survey have been main basis for this study. The topographic sheets of the study area on 1:50,000 scale have been obtained and were scanned with the required resolution. The scanned topo-sheets have been geo-referenced with a defined zoom level, while digitisation of all the features were performed in different layers. The GPS survey has been conducted for all the ground control points on the known roads, important places, location of habitations and the existing infrastructure of a Panchayat. Based on this, geo-database has been generated compatible with C-DAC specifications, i.e. as per Software Requirement Specification and Data Standards.

The output is presented in the form of maps and report that will benefit and help planners, decision-makers and researchers in undertaking planning and management task of rural roads spread across the country side.

The study reveals that Software Requirement Specification and Data Standards as established by CDAC is implementable in the ground. The CGARD faculty understood the issues clearly and gained the skill and experience of the generation of the geodatabase related to the rural roads. The study has also given the CGARD faculty a case in hand for presentation and sharing the same with the participants of the training with confidence.

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ABBREVIATIONS

AMPs: Annual Maintenance Plans

BMS: Basic Minimum Services

BT: Black Topped

CC: Cement-Concrete

CDAC: Centre for Development of Advance Computing

CD Works: Cross Drainage Works

CNCPL: Comprehensive New Connectivity Priority List

CUPL: Comprehensive Upgradation Priority Lists

DRRPs: District Rural Roads Plans

GIS: Geographic Information System

GPS: Global Positioning System

MDG: Millennium Development Goals

MDRs: Major District Roads

MGNREGA: Mahatma Gandhi National Rural Employment Guarantee Act

MoRD: Ministry of Rural Development

NQMs: National Quality Monitors

NRRDA: National Rural Roads Development Agency

OMMAS: On Line Management, Monitoring and Accounting System

PMGSY: Pradhan Mantri Gram Sadak Yojana

PRIs: Panchayati Raj Institutions

PWD: Public Works Department

R&D: Research & Development

SRRDAs: State Rural Roads Development Agencies

WBM: Water Bound Macadam

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION TO RURAL ROADS

Rural development has become a matter of growing urgency for ensuring social justice, national integration, and economic upliftment with inclusive growth. For rural development, the provision of rural road network is regarded as a key component to enable the rural people to have access to educational institutions, health centres, production inputs and technologies not only in North-East (Assam), but also in other parts of India. Rural roads serve as an entry point for poverty alleviation since lack of access is accepted universally as a fundamental factor in the continuity of poverty. As India launched the era of planned development in 1951, there was a reasonably good railway system, a few ports and around 400,000 kms of serviceable road network. Accessibility to villages was poor, only about 20 per cent of them had all-weather road links. The government laid down a framework for accelerated growth through investments in irrigation, power, heavy industry and transport. Side by side, stress was laid on provision of social infrastructure (education and health) and integrated rural development including agriculture.

Rural roads act as a facilitator to promote and sustain agricultural growth, improve access to basic health services, education and economic opportunities and thus holds the key to accelerate poverty reduction, achieving Millennium Development Goals (MDG), socio-economic transformation, national integration and breaking the isolation of village communities and holistic and inclusive rural development. A major thrust to the development of rural roads was accorded at the beginning of the Fifth Five Year Plan in 1974 when it was made a part of the Minimum Needs Programme. In 1996, this was merged with the Basic Minimum Services (BMS) programmes. The works of village tracks were also taken up under several employment creation and poverty alleviation programmes of the Central and State Governments.

There is growing empirical evidence that there is a link between transport investment and the improved wellbeing of the poor. A study (Fan, Hazel and Throat, 1999) carried out by the International Food Policy

Table 1.1: Progress of Rural Road accessibility till launching of PMGSY

Year	Accessibility with all-weather roads		Average distance of a village from a road (Km)
	% of villages with population above 1000	Overall village accessibility	
1950-51	**32**	**20**	**10**
1960-61	**36**	**22**	**8**
1970-71	**40**	**25**	**5**
1980-81	**46**	**28**	**4**
1990-91	**73**	**44**	**3**
2000-01	**90**	**54**	**2**

Research Institute on linkages between government expenditure and poverty in rural India has revealed that an investment of Rs. 10 crore (at 2009-10 prices) in roads lifts 16,500 people above the poverty line. States having low connectivity had higher poverty levels. Provision of good roads in rural areas also changes the characteristics of rural transport. Progress of rural roads accessibility achieved as a result of investments in the road sector has been established till the commencement of PMGSY and is depicted in Table 1.1.

INTRODUCTION TO PMGSY

1.2.1 Launching and Objective of PMGSY

As an effective poverty alleviation strategy, Government of India under the Ministry of Rural Development (MoRD) launched a country-wide programme called "Pradhan Mantri Gram Sadak Yojana" (PMGSY) on 25th December, 2000. The implementing agency for this programme at national-level is National Rural Roads Development Agency (NRRDA). The primary objective of the programme was to provide connectivity by way of All-weather roads to unconnected habitations with population of 1000 and above by 2003 and those with population of 500 and above by 2007 in rural areas. In respect of hilly/desert/tribal areas, the objective is to link habitations with population of 250 and above.

The implementation of the programme has adopted the model of decentralised network planning of rural roads. The District Rural Roads Plans (DRRPs) have been developed for all the districts of the country and Core Network (CN) has been drawn out of the DRRP to provide for at least a single connectivity to every target habitation. For prioritisation of annual project proposals, the concept of Comprehensive New Connectivity Priority List (CNCPL) and Comprehensive Upgradation Priority Lists (CUPL) have been used. The CNCPL and CUPL have been developed from the core network data. This planning exercise has been carried out with full involvement of the three-tier Panchayati Raj institutions.

1.2.2 DRRP and Core Network

Rural road plan is first prepared at block-level and for that we need to prepare Detailed District level Rural Road plan (DRRP) and Core Network Plans (CNP) that shows the entire existing road network system in the district level and also proposes new roads for the unconnected habitation to the connected habitation (PMGSY guideline of GoI). This generates large amount of information about the rural areas such as International, State and District boundaries, forest boundary, river, stream, water bodies, land use, railway track, habitations, bridge, level crossing, market centres, national, states highways, educational facilities and health centres, etc.

Core network represents the minimum network in the rural areas which ensures basic access to the eligible habitation by providing an all-weather road. Core network consists of through routes and Link routes.

Through Routes: Through routes collect traffic from different link roads and connects them to the growth centres by major district roads, State Highway or National Highway.

Link Route: Link route are the kind of routes which connect single habitation or group of habitation to the through roads.

1.2.3 Quality Checking

PMGSY also ensures quality of work and materials that are used in the construction of rural roads. As regards to the quality of the work, three-tier quality control mechanism was followed. In first-tier, the programme implementation unit ensures that field quality control laboratory was established by the contractors so as to carry out tests at specified time by skilled person. In second-tier, state government ensures to carry out periodical inspection by independent officers to ensure that materials are properly tested at state laboratory. In third-tier, NRRDA engages persons designated as national quality monitor. They collect samples from the site, and test them at technical laboratory to verify. There are many fair-weather roads which provide connectivity to rural areas during winter months and dry season. However, during rainy season people face numerous problems due to flash floods, landslides and other calamities. It is in this context proper planning is required before attempting any rural road construction project so as to ensure all weather good road connectivity.

1.2.4 Online Management & Monitoring Accounting system

To ensure proper monitoring, PMGSY ensures web-based online management &monitoring accounting system, which contains all the details about the PMGSY schemes, guidelines, agency involved, roles and responsibilities and work progress, etc. All these can be accessed through this website.

1.2.5 Maintenance of roads under PMGSY

As per the PMGSY guidelines, rural roads are to be maintained by the same contractor for a period of five years after the completion of construction. The funds for maintenance of works are also included in the bidding document. Once the five-year maintenance period is over, post construction maintenance contract shall be placed under zonal maintenance contract consisting of five-year maintenance including renewal as per cycle.

1.2.6 Other schemes

Apart from MGNREGS (Mahatma Gandhi National Employment Guarantee Scheme) the flagship programme for rural development which supports the rural infrastructure development including roads, Government of India also launched Bharat Nirman in 2005 which identifies six infrastructure sectors in rural areas such as housing, irrigation, drinking water, rural roads, rural electrification, and rural telephone connectivity, etc. PMGSY also allows up-grading the existing roads, only if habitation's population size is as per PMGSY guidelines and routes of the core network will be upgraded.

The basic time frame for completion of the PMGSY programme was perceived to be 2007. However, because of constraints of capacity of implementation in the states and availability of funds, the targets of the programme have not been achieved so far. Still there are many habitations which does not have all-weather

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The basic time frame for completion of the PMGSY programme was perceived to be 2007. However, because of constraints of capacity of implementation in the states and availability of funds, the targets of the programme have not been achieved so far. Still there are many habitations which does not have all-weather roads due to the lack of detail work plan and required standard database. Keeping in view the asset value of road, PMGSY II was developed by the government to up-grade, maintain the existing roads after the establishing new connectivity.

GEOSPATIAL TECHNOLOGIES

Geospatial technologies, with its unique ability for acquisition, integration and analysis of geographically-referenced spatial information, have in recent times are recognised as effective tools for planning, management and decision-making locally and globally. Geo-informatics includes Geographic information system (GIS), Global Positioning System (GPS) and Remote Sensing (RS).

1.3.1 Geographic Information System (GIS)

The Geographic Information System (GIS) refers to a system for capturing, storing, checking, manipulating, analysing and displaying data which are spatially referenced to the earth. Any system capable of handling spatial data can be considered as a GIS. This system processes and executes raw data to

generate information that is helpful in decision-making and planning. Hence it is extensively used for the development of Geo-database for planning, construction and management of rural roads and other infrastructure.

GIS is a computer-based tool which can easily analyse, capture, process, manage, update, store, retrieve, display and monitor the data without consuming much time as compared to traditional method. Geospatial technology can answer the particular feature's location, condition, trend patterns and can model it if required. For example, the location of any feature is identified with the help of its Geographic reference, i.e. its latitude and longitude. The difficult planning and management issues can be solved using GIS technology which makes the planning process easier as it provides a visual representation of the current situation. The main components of GIS are: i) Data acquisition, ii) Input data, iii) Data storage & retrieval, iv) Analysis of the data, v) Output representation. The main advantage of GIS is that, it gives an output in the form of report or map. The maps consist of symbols and texts which provides descriptive information about spatial object. In GIS we can link spatial and tabular data which will develop the relation between spatial features and attribute data. The kind of data handled in GIS is unique in itself. It has the location as well as attribute information. Further the spatial data can be in two forms, viz. vector (discrete) and raster (continuous) and importing such a data into GIS is a challenging task. Firstly, the data capturing method encompass a large number of capturing technologies such as GPS, laser scanning, photogrammetry and satellite based remote sensing. Next is the quality of data which again depends on care and attention paid during capturing process. Once the data is created, it needs to be stored and amended for correcting, updating and deleting keeping in mind that it has to be used for a long period of time because the ultimate goal is to transform this raw data into useful information for better decision-making. There are two components of geographic data, i.e. spatial data and attribute data.

1.3.1.1Spatial Data

Spatial data in GIS platform are captured either by digitising, from google earth or by scanning the maps. Spatial data can be captured from GPS coordinates, ground survey coordinates or can be captured by converting digital data. Digitisation is said to be one of the most common techniques used for data creation and information required for data creation are obtained digitally. Digital information is widely available from satellite, UAVs (Unmanned Aerial Vehicle) and satellite imagery, etc. GIS technology prefers obtaining information digitally as compared to traditional methods as they are time consuming and do not give us an accurate value. Spatial Data defines a location and includes shape, size & orientation. Spatial data are represented usually by points, lines & polygons.

- **Line** – Line represents roads such as national highways, state highways, village road, major and minor district roads. Line can also represent drainage system, contours, etc.
- **Points** – Points describe about any settlements such as house, school, church, bridge, sub-centre,

religious places, etc.

- **Polygon** – Polygon describes forest area, agriculture land, forest land, waste land, pond, river, etc.

All these features are created in GIS software. These may include settlements, road network, water bodies and forest, etc.

1.3.1.2 Non-spatial Data

Non-spatial data are that information which are independent of all geometric consideration. Non-spatial data or attribute data are either in the form of text or in tabular form which gives a descriptive information about the spatial features. These are also called as attribute or characteristic. Non-spatial data are linked in GIS to the spatial data. For example: height & age of a person is said to be non-spatial data because they are independent of person's location.

1.3.2 Remote Sensing

Remote sensing is the science and art of obtaining information about an object, area or phenomenon through analysis of data acquired by a device that is not in contact with the object. Through remote sensing, characteristics of an object can be identified, measured or analysed without direct contact. Remote sensing was first used in United States in 1960 and encompass photogrammetry, photo-interpretation, photo-geology, etc. The LANDSAT-1, is the first earth observation satellite launched in 1972, since then remote sensing is widely used. Remote sensing can be used to measure and monitor important biophysical characteristics and human activities on earth. Remote sensing is a broad term used to describe acquiring information about an object by means of remote observation, i.e. with no direct contact with the object. Collection of information includes ground based, aerial, satellite based remote sensing instruments that measure and record energy reflected or emitted by earth surface. This include photographic cameras and electronic imaging and non-imaging (passive and active) sensors. Active remote sensors measure the time delay between emission and return by establishing location, speed and direction of an object and the Passive sensors gather radiation that is reflected by an object or surrounding areas. The source of radiation is sunlight which is very common source. This technology can be used in various fields like geology, land surveying, disaster management, water resources, civil engineering and water resource, etc., and can also be used in military, intelligence, commercial work, planning and management apart from collecting information about those areas which are dangerous and inaccessible thus replaces slow and costly data collection process on the ground, ensuring that areas or object are not disturbed.

Global Positioning System (GPS)

GPS is a satellite-based positioning system which was developed for military use initially and later on made available for civilians. Now a days GPS is used more by the civilians for day to day activity and available in every smart phone for extensive use to identify accurate location information. GPS positioning services are of two types:

Standard Positioning Services (SPS) which is meant for civil users without any charge or restrictions

Precise Positioning Service (PPS) which is meant for authorised users and is available for peaceful civil, commercial and scientific use for which Precise (P) code ranging signal with a navigation data message is reserved for authorised use.

Advantages of using GPS:

- GPS gives us a very accurate result about an object, location of a feature or person, etc.
- GPS signal is available everywhere
- GPS does not charge anything from its users
- GPS is completely satellite based
- GPS is available 24 hours
- GPS gives us 3D position information from vertical to horizontal.

GPS technology can be used in various field like Natural resources, forestry, wildlife, fisheries, vegetation identification by using aerial application, transportation mapping, and disaster management, etc.

GPS technology is extremely useful in transportation planning since it requires identification and information on various assets like:

- What are they? (bridge, road, tunnels, signals, junctions, road crossings)
- Where are they?
- What is the value?
- Require maintenance/ repair? (Because of potholes, cracks, etc.)

1.4 SCOPE OF THE STUDY

In India, about 73 per cent of population lives in rural areas and the rural roads comprise 85 per cent of the road network of the country. (Hence, it is important to keep the rural roads under good condition so that rural people can take advantage of all the social and economic infrastructure and facilities (*World Bank/ ILO document*). Lack of basic all-weather road connectivity has deprived rural population of job opportunities, market centres and basic living conditions, thus undermining the overall rural development agenda. Despite significant investments by the government in rural roads over the last decade and half, rural road connectivity remains inadequate (*swaniti.com*).

As we know, most of the people in rural areas are engaged in agricultural activities and it is important that the road connectivity in such areas is proper so as to enhance the agricultural income of the people. Many

of the rural roads are of bad quality, potholed, and are not able to bear the load of heavy farm equipment. It has been found that about 15 percent of the agricultural products are lost or damaged between the farm gate and consumer because of poor road connectivity or storage facility.

With a view to formulate the 12th Plan and improve the delivery mechanism for effective implementation of the programme, in october 2011 the Working Group (WG) was constituted under the Chairmanship of the Secretary, Rural Development. Under this Working Group, discussion on adopting GIS architecture in PMGSY, is one of the strategies for sustainable Rural Roads Maintenance of perspective planning for 12th Five Year Plan.

GIS Architecture is an essential tool to be placed on comprehending the information of spatial and non-spatial data over space and time. Rural Road Network comprises of group of nodes and links. The network configuration is a combination of these links with a directional orientation to the nodes which are the centre heads of the habitations spread over the space. As most of the features are static in nature there is a need to Geo-Reference permanently and the dynamic interactions in terms of planning, construction, maintenance can be visualised over a time on this spatial frame. To create the rural asset, GIS is a great supportive tool which connects advance technologies and the conventional practices on a common platform.

The Geo-Fenced map display system is essential for rural roads in order to identify the progress of PMGSY and other roads in reference to the access and connectivity pattern for overall development of the rural areas, locate the habitations of different ranges be it Geo-referenced, which are helpful for policymaking on connecting habitations over a time frame, to avoid multi-connectivity among the habitations rather the basic objective of PMGSY scheme can be analysed, identify rural growth corridors and track the density of roads constructed per block/constituency/district/State which may be helpful for fund allocation with justification and overlay the land use, terrain conditions and other obligatory aspects, a Geo-reference of map display system will be helpful for scientific and engineering design.

In this scenario there is a need to develop spatial mapping with vectorised display of habitations, linkages, through routes and the Core Network of the area. In the course of progress, there is also a need of seeing the compatibility of Core Network with the neighborhood Non-Core Network and other functional roads. In addition, there is a need on analysis of the Core Network with the change of scenario over a time on population density of different habitations. By considering these issues into account, a GIS map display system having user friendly/menu driven and its compatibility with different source of information should be identified.

The C-DAC (Centre for Development and Advanced Computing), Pune has carried out a 'Software Requirement Specifications (SRS)' study in 2014for formulating and designing a Web based road information system, with reference to the implementation of world bank assisted rural road projects-II, PMGSY. The MoRD, GoI has decided recently to implement the outcome of the study in phased manner depicting the road information system under PMGSY. The states under the initiative are required to prepare the database as per the SRS specifications and data standards. Towards successful implementation of the web enabled GIS technology, the engineers and data managers of the implementing agencies require GIS skill to develop a database according to the above-mentioned SRS.

PMGSY is a large-scale investment project in the country and the fulfillment of web based new initiative has been one of the mandatory conditions for all the states. Engineers and data managers of the implementing agency therefore, need to acquire new knowledge and new skill. The CGARD, NIRDPR and NERC have been conducting GIS training programmes enabling implementing agencies in the management of rural road network information system under PMGSY.

However, we lack experience of working on web-based initiatives of the given data standard and specifications, which the ministry has mandated for all the States. In order to gain the experience of handling effectively the new initiative and share as a local case with the participants, a proposal titled **'Generation of Rural Roads Geodatabase compatible with C-DAC specifications and Data Standards': A case of Dakhin Bholagaon Panchayat of Rani C & RD Block, Kamrup district, Assam State** is proposed.

1.5 STUDY AREA

Dakhin Bholagaon Panchayat of Rani C & RD Block, Kamrup district, Assam State was chosen as the unit of study. The area is spread over between Latitude 25°51'23.536"N - 26°2'26.42"N to Longitude 91°28'0.577" E. - 91°34'18.89" E. The Local name of this panchayat is Dakhin Bholagaon and Indian Government reference number (code) is 1,05,527. Dakhin Bholagaon Panchayat was established during the year 1992-1993 in a village name Belguri situated at a distance of 5 to 6 kms from the Rani Block and covers an area of 83.65 sq. km. The people living in the area have a very rich culture, and are engaged mostly in agricultural practices and rearing of livestock for livelihood.

Villagers are also engaged in sericulture activity and conserve silk worm for its silk thread which is used in weaving their traditional dress. There are 4,183 households in this panchayat having a total population of 19,893 of which 10,143 are male and 9,834 are female. The ST population is 9,398, out of which 4,757 are male and 4,641 are female.

Table 1.2 Village population and Household details of Dakhin Bholagaon Gram Panchayat

S. No.	Name of the Villages	Household	Population
1.	Mudhuki	83	406
2.	Betlaunchi	47	251
3.	Betlaunchi N.C.	29	141
4.	Batabari Pathar N.C.	18	83
5.	Batabari Pathar	15	80
6.	Batabari N.C.	72	354
7.	Batabari Gram	63	316
8.	Jimiri Gram N.C.	25	123
9.	Jimiri Gram	45	250
10.	Bhalakhowa	26	136
11.	Bhalakhowa N.C.	45	191
12.	Katal Para	44	209
13.	Katal Para N.C.	43	219
14.	Pat Gram Bandha Para	69	355
15.	Pat Gram Bandha Para N.C.	95	500
16.	Salmer N.C.	16	77
17.	Salmer	50	253
18.	Umchur	142	710
19.	Umchur N.C.	125	571
20.	Pat Gram	146	664
21.	Mairapur Grant	404	1860
22.	Mairapur	369	1781
23.	Majpara	22	111
24.	Pazi Bindha	69	324
25.	Khope Gram	116	502
26.	Thengapara	18	85
27.	Tangan Para	42	176
28.	Challi	77	343
29.	Garo Para	84	380
30.	Kumar Bori	143	707
31.	Beri Gram	77	357
32.	Balahpur	40	150
33.	Bhalla	276	1281
34.	Barpatima	240	1092
35.	Bahuwa	301	1556
36.	Pat Gram Barmokam	124	659
37.	Kuruwa	165	778
38.	Gatuwa	57	236
39.	Nal Gram	42	179
40.	Batabari	101	438
41.	Kawasing F.V.	17	84
42.	Jara Sal F.V.	36	161
43.	Joypur F.V.	95	414
44.	Hannapara	70	350

The villagers are mainly engaged in agricultural activities, livestock farming practices and sericulture for their livelihood. Sericulture activity is much preferred because of their traditional skill to conserve silk worm for its silk thread which is subsequently used for weaving dress either for their own or for trade. As per the data available at the Panchayat, it has an area of 1,336 acres of cultivated land, 118 acres of pasture/ grazing land, 102 acres of forests land, 1,336 acres unirrigated land and 79 acres other common land. In course of discussion with panchayat leaders and common people of the area it has been ascertained that their essential requirement is all-weather road connectivity, repair and maintenance of existing dilapidated roads, electricity, IAY houses, employment, modern farming system mainly poultry and piggery, veterinary aid centre, health centre, modern irrigation system for agriculture and horticulture, etc.

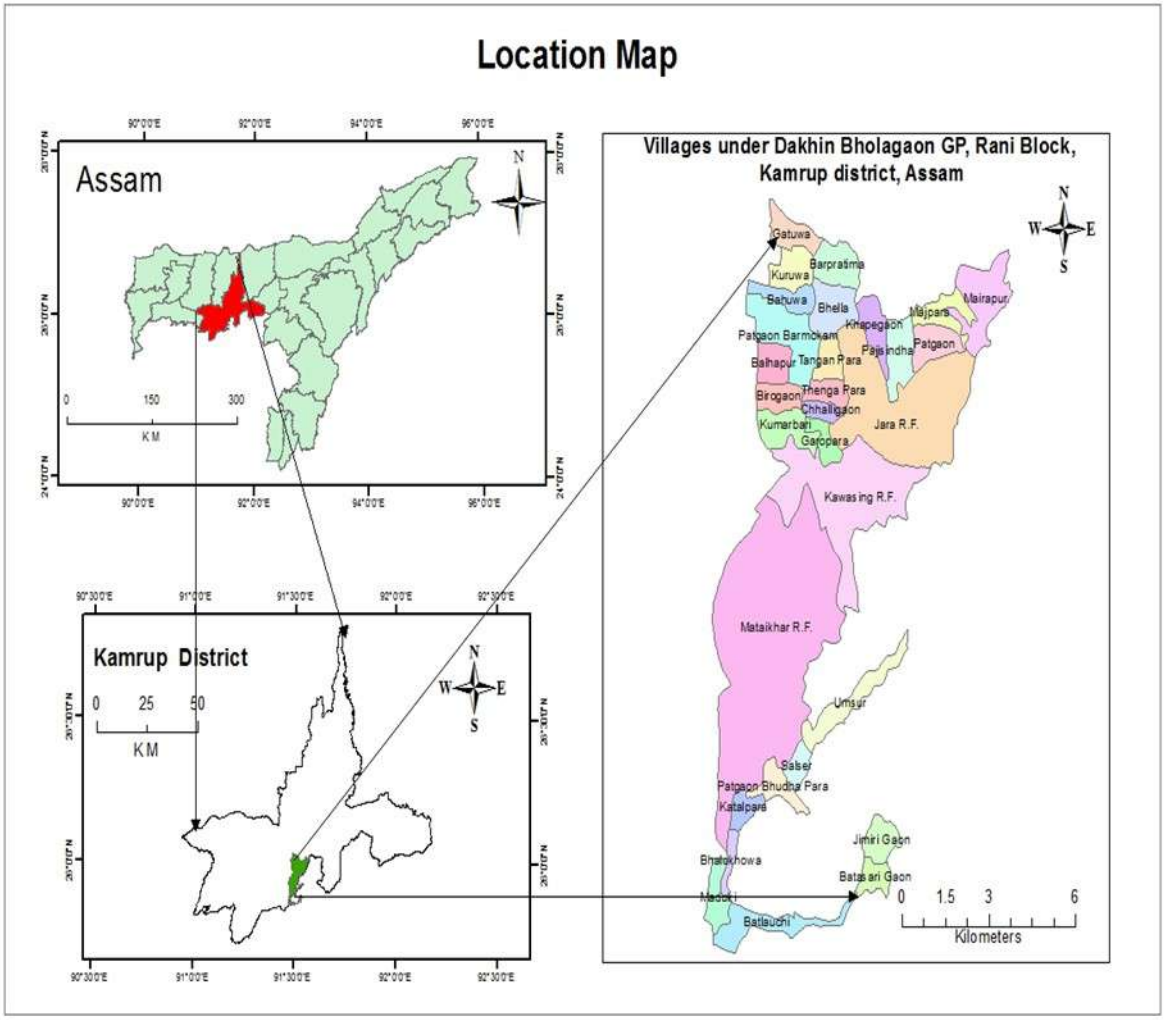

Fig 1.1: Location of Study Area

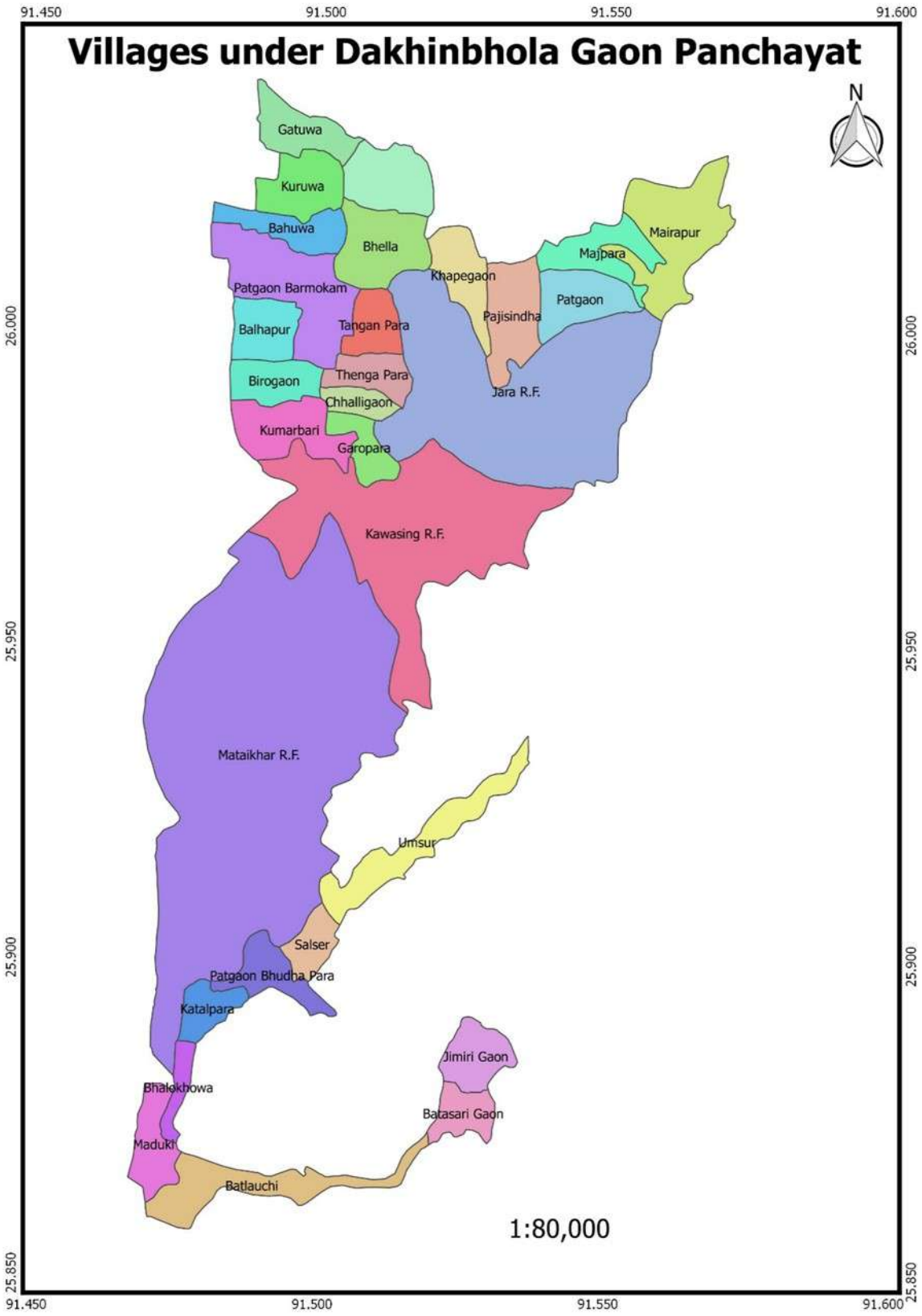

Fig 1.2: Dakhin Bholagaon Village Boundaries

1.5.1 Existing Infrastructure Facilities

The Gram Panchayat is having some important facilities and infrastructure like health sub- centre, LP schools, middle schools, secondary schools, veterinary aid centre, vulture conservation and research centre, water supply scheme anganwadi centre, etc. But important and essential infrastructures like higher secondary school, college, post office, and banks, etc., are not available which are much more essential for the new generation of today for which all weather road connectivity is the primary need. The entire panchayat has a total of 32 lower primary schools, 3 middle schools and only 5 secondary schools. No further higher educational institutions are available in the area which compel the students to travel to the nearby town and Guwahati city to pursue their studies. Villages under this panchayat do not have the facility of open and closed drains, lack of which creates a havoc during monsoon arising out of

Fig 1.3: Mathaikkar Block Library

Fig 1.4: Mannikpur Water Supply Scheme

Fig 1.5: Majpara Forest Office

Fig 1.6: Umchur Water Supply Scheme

Fig 1.7: Public Ration Store Rani

CHAPTER 2

LITERATURE REVIEW

An information system for rural road network planning was developed by Prasada Rao *et al*, (2003). As a case, it was carried out in a community development block, i.e. Rupauli block, Purnia District, Bihar, which is a middle-level spatial planning unit. The block maps were digitised and non-spatial data prepared on MS-Excel were incorporated for each of the villages under the block. The study emphasised on the accessibility approach in an integrated manner so as to provide an optimum link to each village with maximum benefit in terms of accessibility to a major village with minimum construction cost.

Mishra and Naresh (2009) examined the use of geo-informatics for development of rural roads under Pradhan Mantri Gram Sadak Yojana (PMGSY). They developed a spatial and non-spatial rural road database that can be viewed by common people and with related attributes people can get an interactive and exciting way on the map. The network analysis used to determine the optimal route between two or more destinations based on specific travel expense by Praveen *et.al* 2013.

An advanced information system for planning and maintenance of rural road using GIS technology is developed by Manyazewal *et al* (2014). It is named as Advanced Rural Road Information System (ARRIS). The case of ARRIS is to facilitate policy-makers, government departments, Non-Government Organisations, general public in planning, development and management of road facilities in the rural areas.

Chutia. *et al.* from North-Eastern Space Application Centre, Shillong presented a case of road infrastructure mapping for Ri bhoi district, Meghalaya to develop the atlas of National Highway, State Highway, major district roads, minor district roads and village roads, etc., preparing of location specific GIS maps for various public utility services, query based services based on network analysis during emergency situation and provide information system for monitoring, planning and management of roads.

Ashoke (2011) focuses on the issues and problems faced by our country in developing a sustainable rural road maintenance system. Various issues come up during expansion and up-gradation of road that need to be properly addressed for successful implementation of the maintenance system. Agarwal and Singh (2010) highlights some basic issues for sustainable maintenance of roads. This study to provide required level of funding, strategies to strengthen the institutional measures and strategies for developing database for maintenance of rural road network in India.

GIS based decision support system for transportation planning system developed by Kai Han (2006) to facilitate the planning process of transportation system. Lakshmana Rao and Jayshree, (2003) highlighted importance of GIS support in wide range of planning and management operations for rural growth. Their main objective was to develop a simpler method of demand potential of nodes which can serve as a proxy to actual travel behaviour of users, methodology that can identify uniform road connectivity, coordination

of existing road network and proposed network and develop the missing links apart from socio-economic impact of roads. Saha *et al.* (2005) in their paper on GIS based route planning in landslide prone areas generated various thematic layers, like landslide distribution, landslide hazard zonation, land use/land cover, drainage order and lithology and integrated the same using remote sensing- GIS techniques.

CHAPTER 3

OBJECTIVES

The review of literature reveals that there is no commonality of the approach of the database, model, procedure and standard, etc., besides the software. Towards bridging this gap, the Center for Development of Advance Computing (C-DAC) has come out with an approach and method by which the database generation, analysis and outcome with specific standard comes out. The application of this approach and methods in practice is not found in the state of Assam. In this context, a study is made to generate a geo-database compatible to standard specification of C-DAC. The specific objectives of this attempt are as under.

Objectives

I. Generation of geo database on rural roads as per the Specifications and Data Standards mentioned in the SRS approved by NRRDA

II. To learn and share the process of generation of rural roads database that is compatible with the specifications and data standard of SRS.

CHAPTER 4

METHODOLOGY

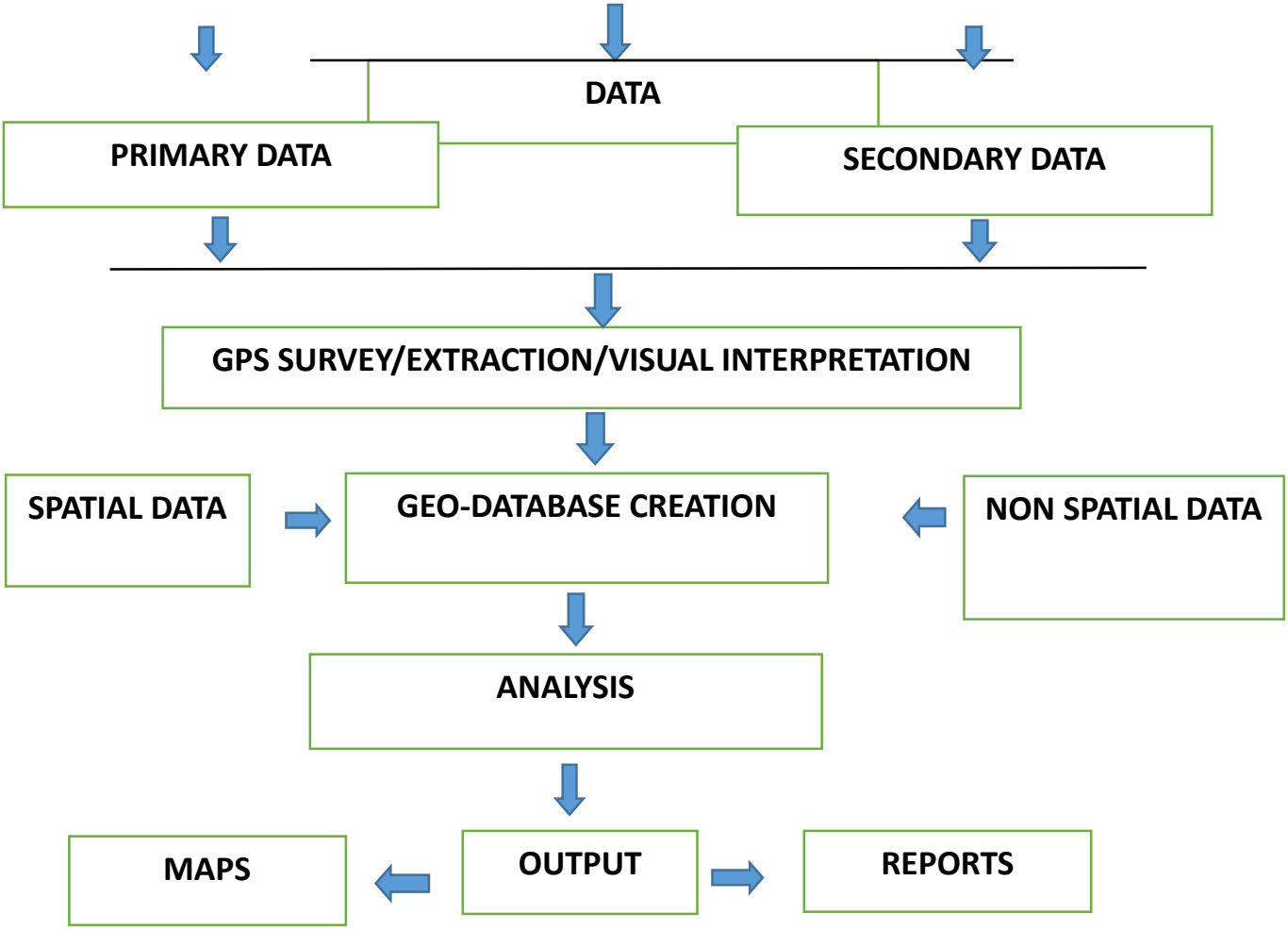

Fig 4.1: Flow Chart

DATA USED

Primary Data

I. GPS survey data

Secondary Data

I. Topo sheets

II. Satellite Imageries

III. Village Boundaries

4.1.1 Primary Data: Primary data are mainly collected through field survey of the study area and visual inspection. In order to collect exact location of the villages, cross-drainage, various infrastructure of villages like school, hospitals, health centres, banks, post office, and markets, etc., GPS equipment were used. The data collected from GPS equipment then fed in Q-GIS software.

The PCI (Pavement Condition Index) value was surveyed based on the driving speed of the vehicle to ascertain how much comfortable the driver was while driving through a particular road. In the study area, location of villages, locations of crucial facilities and culverts or bridges were collected through GPS and they were in the form of waypoints. In order to export the data in GIS software waypoints were converted to ESRI shape file so that it can be opened in GIS software.

4.1.2 Secondary Data: Secondary data were collected from several sources like Survey of India (SoI) topo sheets, which is of 1:50000 scale, satellite & google earth images, apart from Panchayat office. Various features like roads, settlements, contours, drainage, river, forest area and land use/land cover, etc., were digitised from the topo sheets as well as google earth images and Panchayat office has also provided other secondary information for comparison and analysis.

Secondary data is also collected remotely with the help of satellite imagery. Using these primary and secondary data, geo-database was prepared as per standard and specification which is an essential requirement for planning and management purpose.

The village boundaries of Dakhin Bholagaon Panchayat draped on topo sheet and google earth image are shown below:

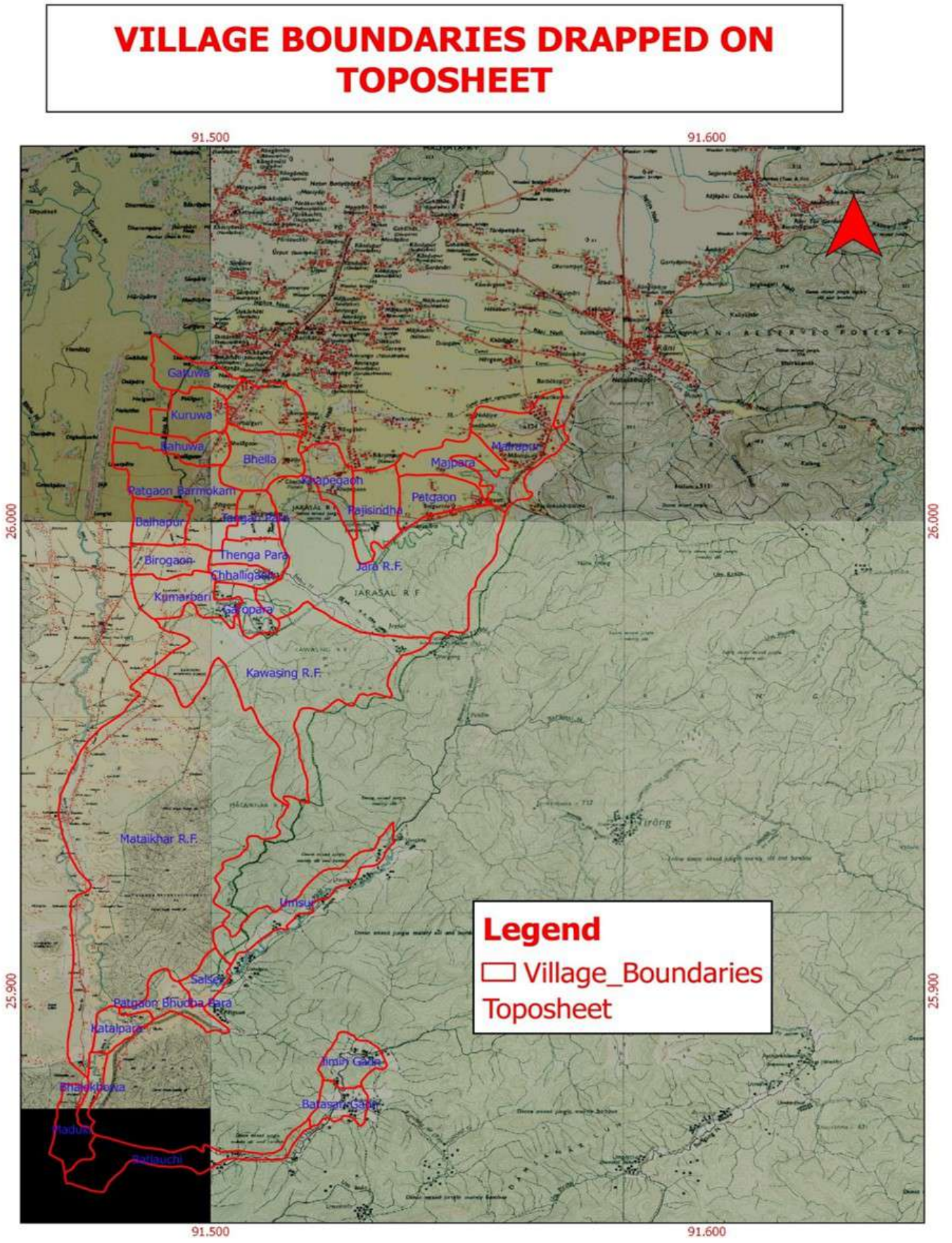

Fig 4.1: Village boundaries Draped on Topo Sheets

The Topo sheets used for the study are 78-N-12, 78-N-8, 78-O-5, 78-O-9.

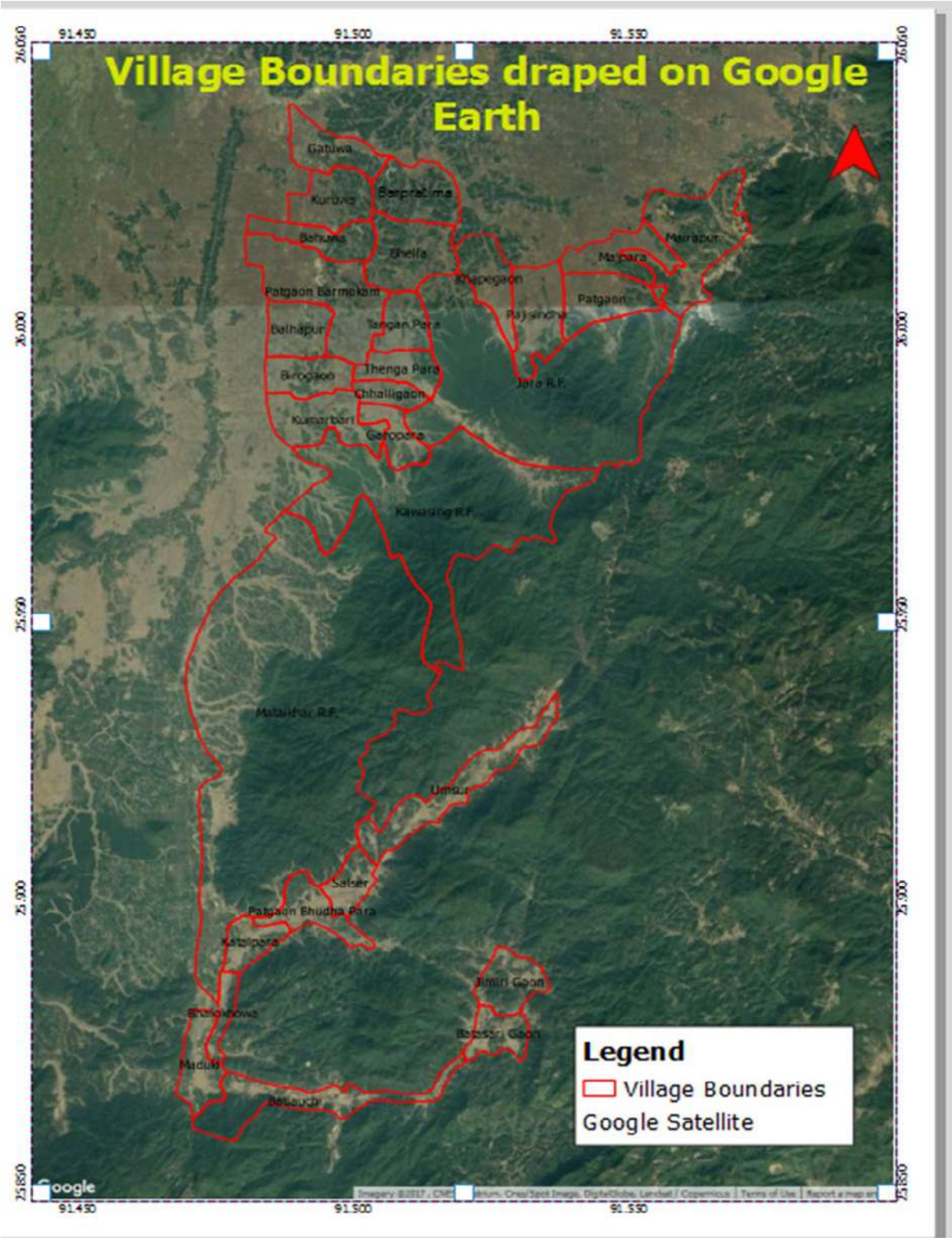

Fig 4.3: Village Boundaries Draped on Google Earth Image

4.2 GEO-DATABASE GENERATION AS PER C-DAC SPECIFICATION

The Development of Geo-database is a challenging task. This involves huge data collection and processing of the collected data as per the requirement of the organisations. Geo database is said to be a model of the real world which can mimic certain aspect of the reality. A model can be represented either in the form of words or in mathematical equations or of spatial relations displayed as map or stored in GIS soft-

To have proper planning of roads, we need to prepare an effective Geo-database which carries all the required information about roads type, category, surface type, population of habitation and name of habitation, etc. Preparing this type of database using traditional method is very difficult. Preparing geo-database will therefore be of great help for planners, decision-makers and managers in order to create geo database certain specification and standard has to be followed. Accordingly, government of India advised to follow C-DAC specifications for planning and management of rural roads (Software Requirement Specification Version 1.01 for PMGSY, GOI). The C-DAC (Centre for Development and Advanced Computing), Pune has carried out a 'Software Requirement Specifications (SRS)' study for formulating and designing a web based road information system, with reference to the implementation of world bank assisted rural road projects-II, PMGSY.

The Ministry of Rural development, Government of India has decided to implement the outcome of the study in phased manner depicting the road information system under PMGSY. The states under the initiative are required to prepare the database as per the SRS specifications and data standards. Towards successful implementation of the web enabled GIS technology, the engineers and data managers of the implementing agencies require GIS skill to develop a database according to the above mentioned SRS.

With the assistance of World Bank, PMGSY has implemented Rural Road Project-II in eight-states of the country so as to establish computerised database for rural road network through development of web-based Geographic Information System (GIS) which is linked to road condition inventories and development of social and environment screening using GIS platform. Later this has to be extended to remaining states.

For implementation of the project, the states must prepare the database as per the requirement of SRS specification and standard to make it compatible with the web-server. Spatial layers (1:50,000 scale) along with required associated attribute information (Habitation id, CN Number, DRRP Number, Package ID, etc) will be provided by states, which will be considered as base for creation of GIS database.

Creation of GIS database does not simply mean the digitisation of maps. In order to make digitised maps available in GIS domain, many other components are involved such as layer-wise data formatting; feature coding, map projection, edge matching, topology building and accuracy. Preparation of various GIS layers involves following:

1. Information regarding forest boundary, land use, river, water bodies and railway lines, if required, may be picked from available source
2. Administrative boundaries of blocks, districts, states, MP/MLA constituency, and PWD Circle/Division from paper maps will be converted to digital format
3. Rural roads (DRRP including Core network) and habitation will be converted from paper maps to digital format.

Methodology for Preparation of Geo-Database

1. Geo-referencing: Geo-referencing is a process of assigning coordinate system to the topographic maps so as to know where it actually belongs to in the globe. In this study, geo-referencing of topo sheets of entire Rani block was carried out so as to enable digitisation of required features
2. Digitisation of Feature: Digitisation is a common technique used in GIS, hence digitisation of the features was carried out on roads, culverts, settlements wherever necessary, forest areas, contours and drainage, etc., in number of layers and in defined level
3. GPS survey of the study area was conducted to collect all the ground control points of the roads, important places and location of villages
4. Apart from the above, attribute data of the ground points were also collected primarily for all the PMGSY roads and other roads in the study area
5. Attribute linking is a process of gathering information from relevant institutions and documents and linking these details to the spatial data in GIS. The said information was collected from Panchayat offices and census report for necessary linkages
6. Thereafter geo-database of the rural roads in the designated area is prepared
7. After generation of geo-database, further analysis was carried out
8. Map Preparation: The main advantage of using GIS technology is the capability of generating maps to show the output or result. Output of this work was shown in the form of Map and Report. Maps that were generated after preparation of geo-database gave all the required information on roads, important facilities, Panchayat offices, sub-centres, markets, etc., for further planning and future use.

Table 4.1- Various Vector Layers Such as Shown in the Table are be Generated

S. No.	Map Layer	Type
1	Habitations	Point
2	State Boundary	Polygon
3	District Boundary	Polygon
4	Block Boundary	Polygon
5	MP Constituency Boundary	Polygon
6	MLA Constituency Boundary	Polygon
7	PWD Division Boundary	Polygon
8	PWD Circle Boundary	Polygon
9	Forest Boundary map	Polygon
10	International Boundary	Line
11	DRRP Road	Line
12	CN Road	Line
13	Bridges	Point
14	Level crossing (Manned & Unmanned)	Point
15	Quarry (Stone & Sand)	Point
16	Market Centre	Point
17	Administrative HQ (Revenue, Block, District, Panchayat)	Point
18	Water body	Polygon
19	Tourist Place	Point
20	Railway	Line
21	Drainage	Line

CHAPTER 5

RESULTS AND ANALYSIS

5.1GEO-DATABASE

In order to plan and manage the good rural road connectivity, it is highly essential to have an effective geo-database that carries all the required information about existing roads type, category, surface type and population of habitation, etc., which is of great help for planners, decision-makers and managers. Preparing such database using traditional method is very difficult and time consuming.

GIS can answer various queries like what is the existing status or what existed in the past. This helped in identifying the gap so that effective steps can be taken for proper planning and management within a definite time frame and with minimum error. In order to prepare a scientific rural road plan, it is necessary to build a strong database, preferably in computer environment. The most important aspect of the database development process is clear understanding about the micro-level data, which should be collected from various organisations at block/district/Panchayat-level for preparation of rural road network planning (Prasada Rao et al, 2003).

In order to prepare a geo database for roads, various data are required to be collected which are broadly categorised into following three categories:

1. Village data: Village data has three main components
- Name of village
- Demographic data (Population)
- Infrastructure data (socio-economic functions, facilities available habitation and settlements)

2. Road inventory: For each road following information were collected and documented:
- Road reference data
- Road geometric data
- Road pavement condition

3. Map data: Map data should contain following items
- Location of habitations/settlements
- Boundaries
- Road network
- Water bodies (ponds, lakes)

Other facilities such as places of tourist, historical importance, quarry sites, mining areas and location of industries, if any.

Table 5.1 -As per C-DAC specifications following attributes are to be collected as indicated below:

Serial no.	**Layers**	**Features**	**Information/Attributes**
1.	Habitation	Habitation	Name
			Population
			Connectivity status
			Facilities available like school, WSS, etc.

2.	DRRP Roads	Roads	Road Name
			Road Category
			Road Length
			Road Width
			Surface Type
			Habitation Mapped
3.	CN Roads	Roads	Road name
			Road Length
			Road From
			Road To
			Road Type (Through/Link)
			Habitation Mapped

The same C-DAC specification have been followed for the creation of Geo-database in the study area and the output is indicated in the form of images and maps as shown below (Image I and II)

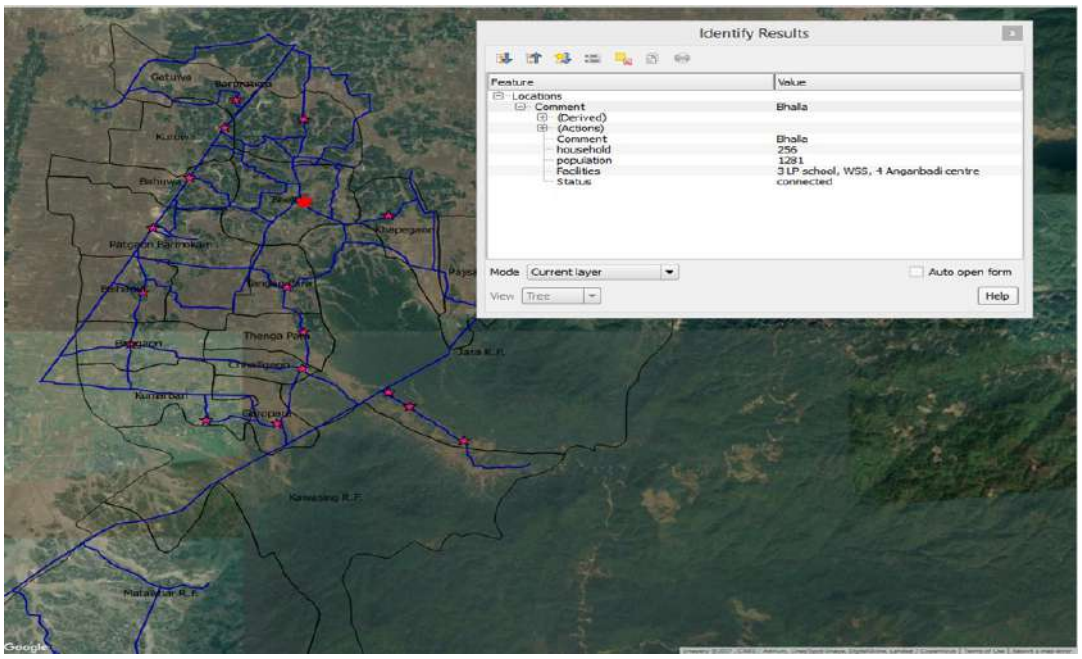

Image 5.1 - Image showing habitation information in Q-GIS software

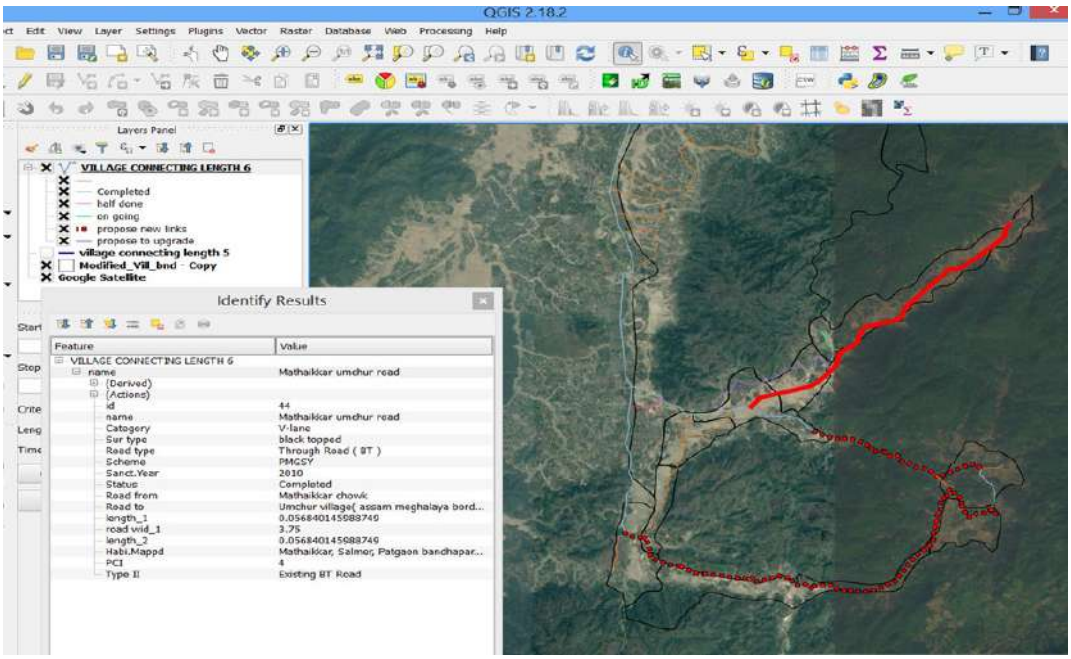

Image 5.2 - Image showing information about Road network in Q-GIS software

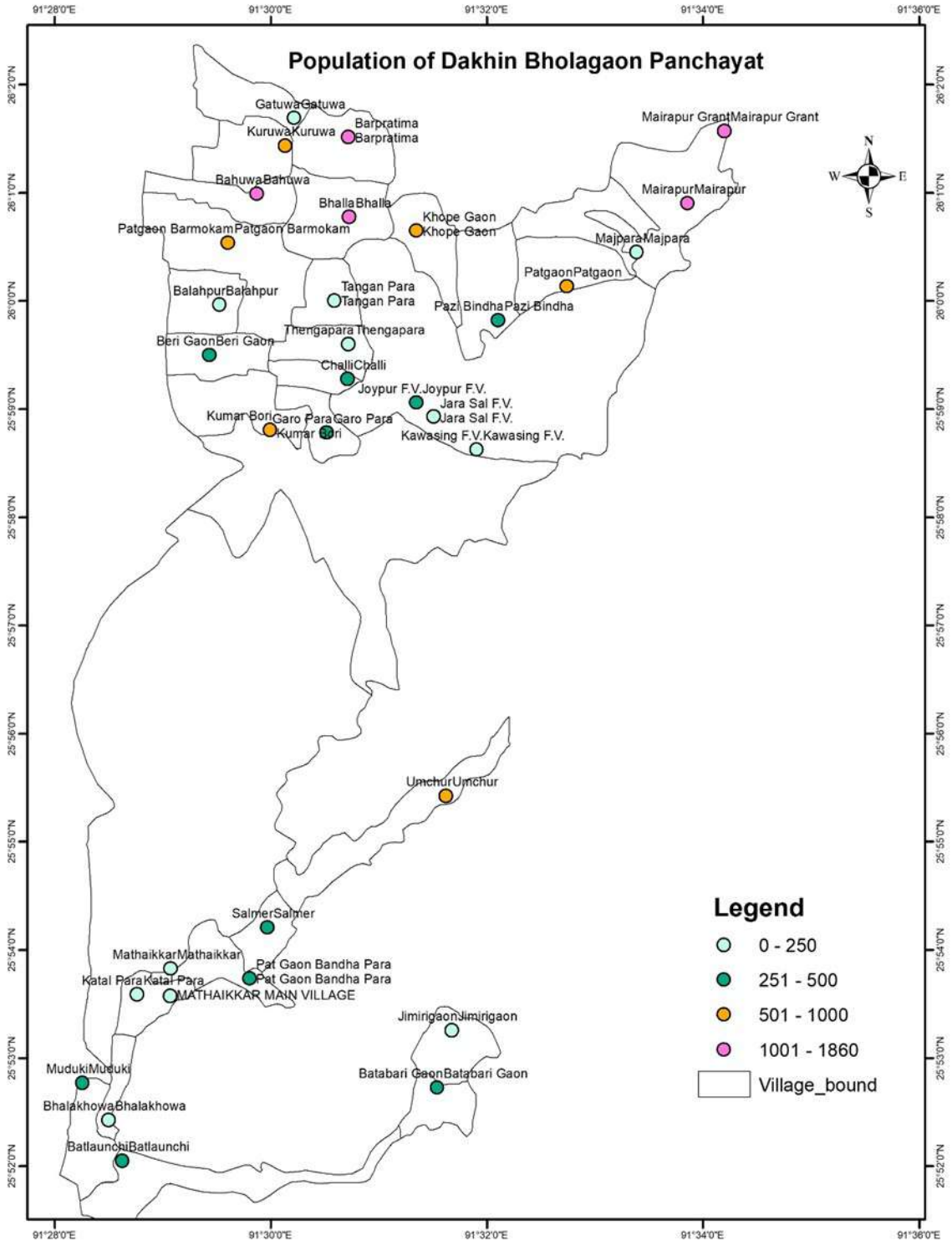

Fig 5.1: Population

5.2 HABITATIONS: The population of villages under Dakhin Bholagaon Panchayat is obtained from the census report 2011, which has been verified from the Panchayat office data. The attributes attached with this layer are Name, population, Connectivity status and facilities available like school and PHC, etc.

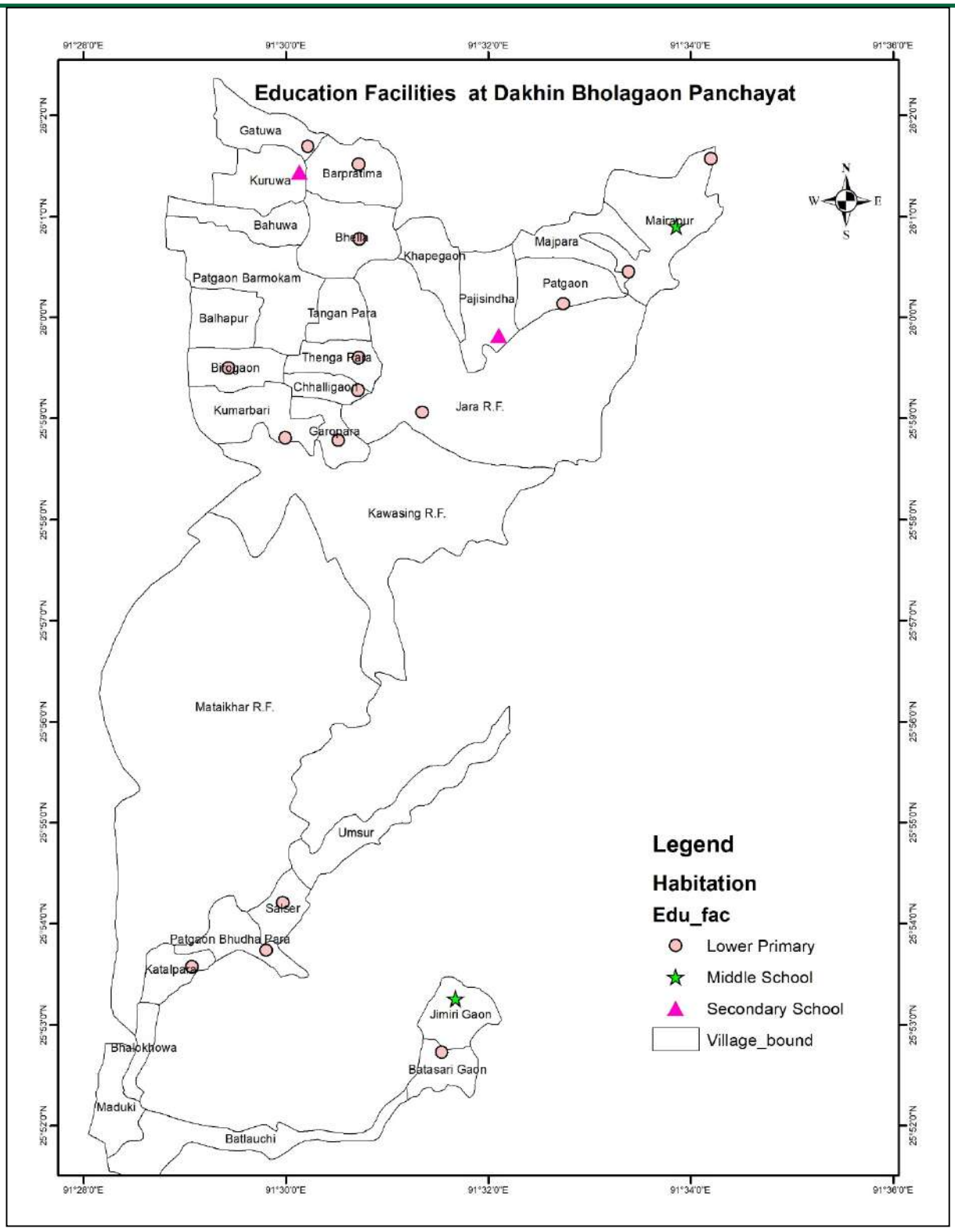

Fig 5.2: Educational Facilities

The entire Panchayat has a total of 32 lower primary schools, three middle schools and only five secondary schools. There are no further higher educational institutions available in the area which compel the students to travel to the nearby town and Guwahati to pursue their studies.

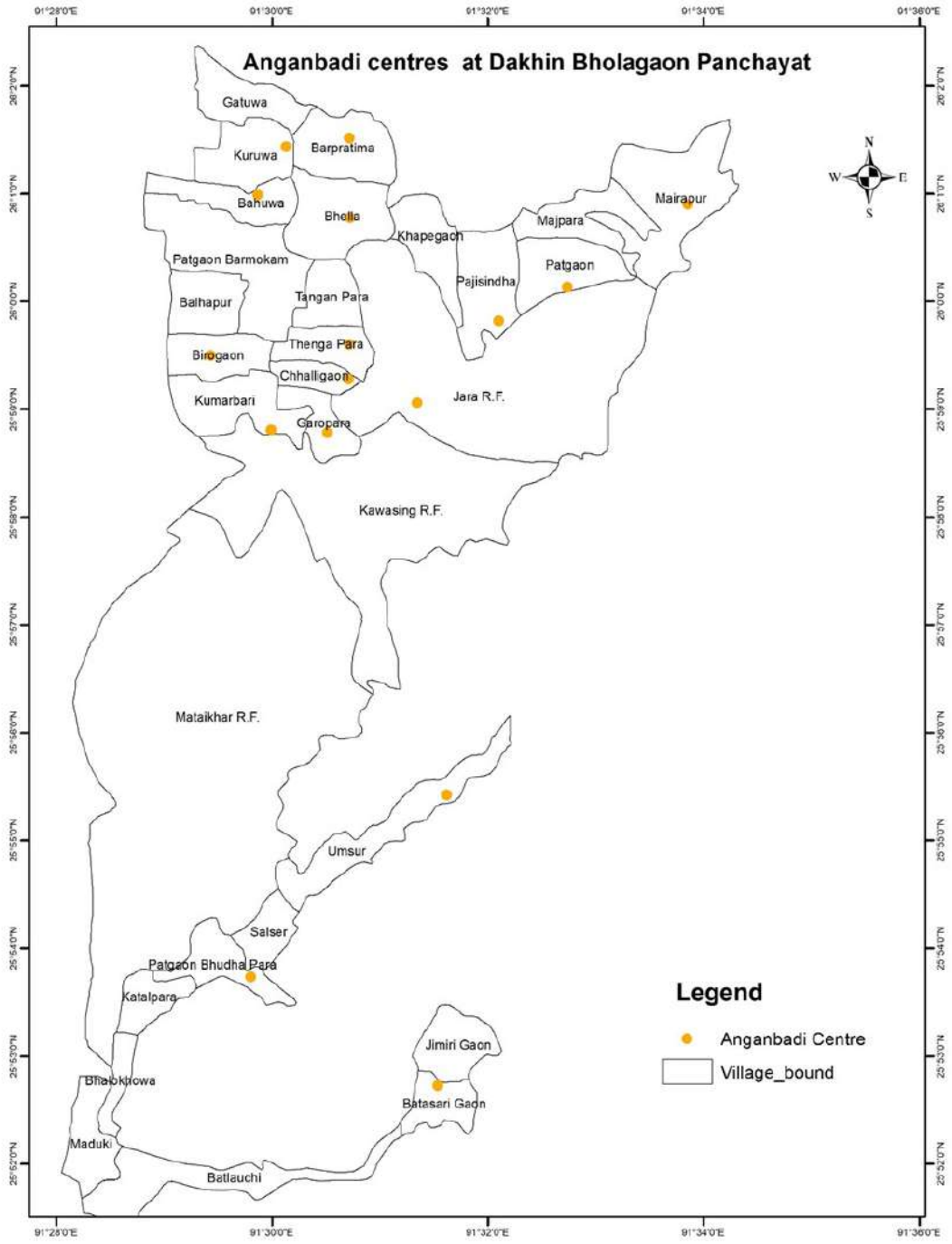

Fig 5.3: Anganwadi Centres

There are 26 anganwadi centres available in the Panchayat which provide primary health care facilities to the villagers and consists of mainly first aid, contraceptive counselling specially for ladies, nutrition education and supplementation and pre-school activities for the children.

Some of the educational facilities pictures are shown below:

Fig 5.4: Majpara Lower Primary School

Fig 5.6: Pat Gram Anganwadi Centre

Fig 5.6: Pat Gram anganwadi Centre

Fig 5.7: Joypur Anganwadi Centre

Fig 5.8: Mairapur Middle School

Fig 5.9: Pat Gram Lower Primary School

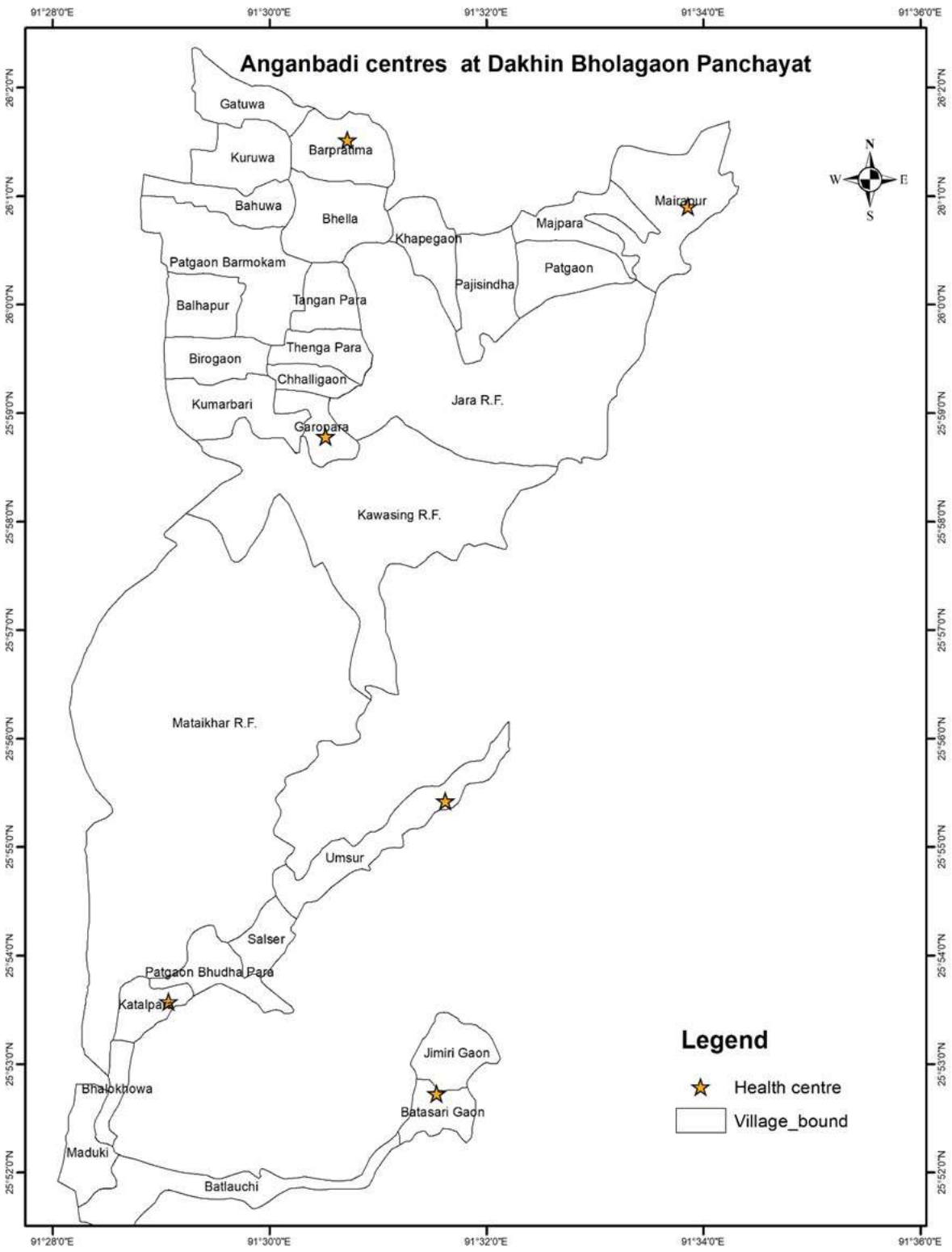

Fig 5.10: Health Centres

There are only five health care centres available in the Panchayat area, running without any medical professional. In the event of any emergency medical need the villagers will have to move to the nearest town or Guwahati.

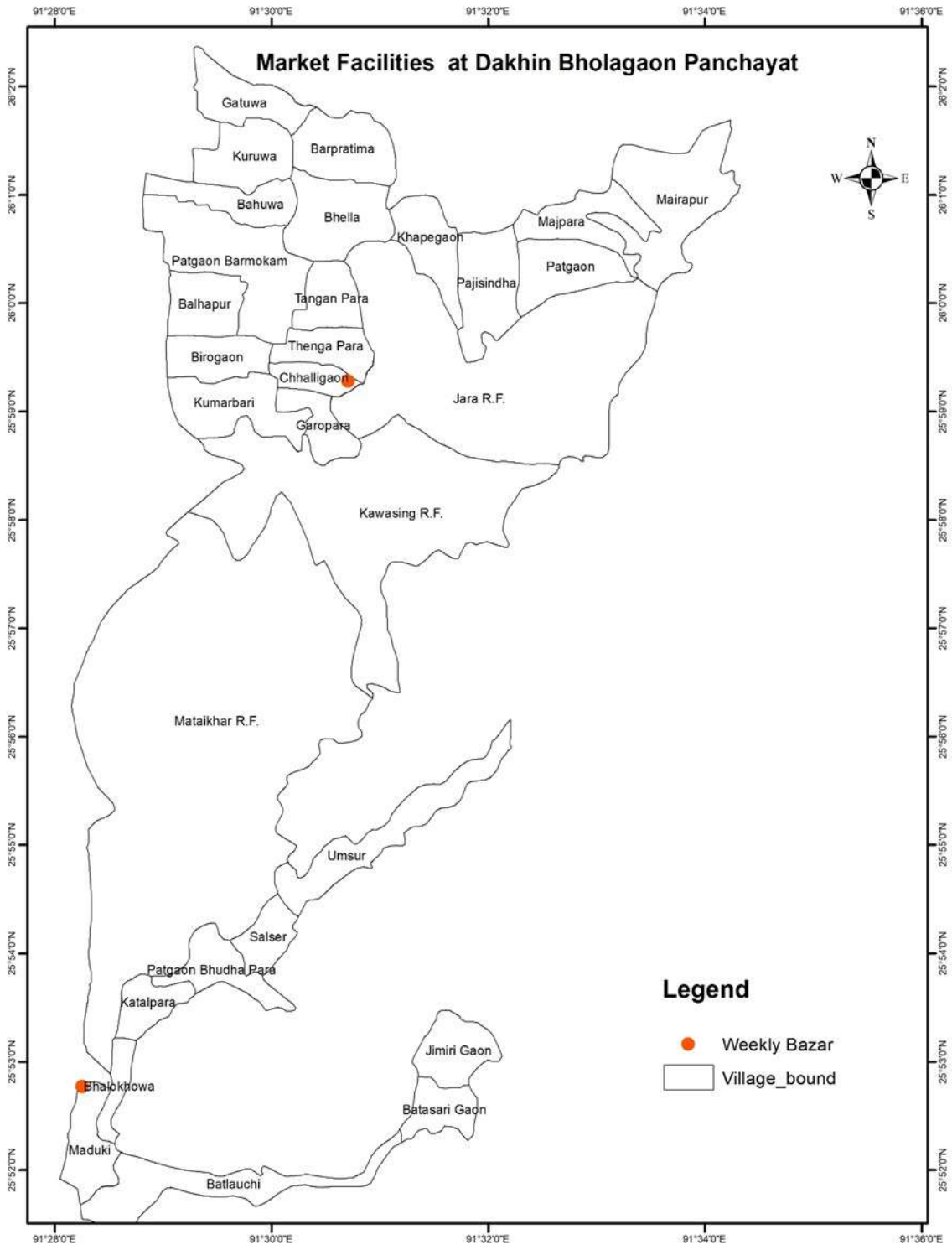

Fig 5.11: Market Places

There are two weekly markets on Saturday and Wednesday in the area which operate in two different locations where the villagers mainly bring in their agricultural produce for marketing and other essential needs for themselves.

Fig 5.12: Wednesday weekly Market Challi

ROAD INVENTORY

5.3.1 Existing transport Facilities

Survey of the study area revealed that there are severe constraints of connectivity with various activity centres, markets and bus stops, etc. This is primarily because of absolute non availability of all-weather roads in certain areas and extremely poor condition of existing network of roads. It is because of this reason the villagers face immense difficulty in transporting their agricultural produce to the markets or emergency evacuation of patients to nearest health units for medical treatment. The situation becomes critical particularly during monsoon season when most of the earthen roads get submerged under flood water which makes their life miserable. Although some tempos or three wheelers are available from Rani Gate to Rani Bazar and back but from Rani Bazar to their respective villages there is no communication facilities available and people rely on their own vehicle/bicycle, etc. In some villages where such tempos also refuse to ply because of extremely poor condition of the roads, villagers are left with no other option but to walk to reach their destination.

5.3.2 Status of Existing Road Network

Out of the total road network in the study area, a total of 133 km of roads have been digitised of which only 57.618 km roads are black topped and the remaining 76.141 km roads are gravelled or earthen roads, paved, footpaths, etc. Out of the total 75.6 km of roads, 16.640 km are gravel roads, 54.35 km of roads are earthen roads and remaining 5.147 km are paved roads. These roads are classified as village roads, through routes, link routes. Primary focus of this study is to identify critical gaps in connectivity of the areas mainly from the villages to the nearest growth centres and linking them with the major district roads.

Based on the surface condition, roads were classified as follows:

- Black topped: Black topped roads are made from a sticky, black and highly viscous liquid or semi-liquid form of petroleum. Black topped roads also called as Asphalt road or bituminous road. It may be found in natural deposits or may be a refined product. The initial cost in the construction of black

from a quarry or stream bed. They are known as 'metal roads'. If well-constructed and maintained, a gravel road is an all-weather road.

- Earthen roads: Earthen road is a type of unpaved road made from the native material of the land surface through which it passes.
- Concrete pavers (Paved road): Concrete roads can withstand extreme weather conditions without causing any crack on the road surface. In order to prevent the road surface from cracking, concrete roads can contract and expand as per the changes in weather condition. Concrete roads are highly load tolerant and can withstand constant exposure to heavy loads and they are easy to repair and replace.

Table 5.2: Details of Road Networking

S. No	Surface type	Length (km)
1.	Black topped	57.618
2.	Gravel roads	16.640
3.	Earthen roads	54.35
4.	Paved roads	5.147

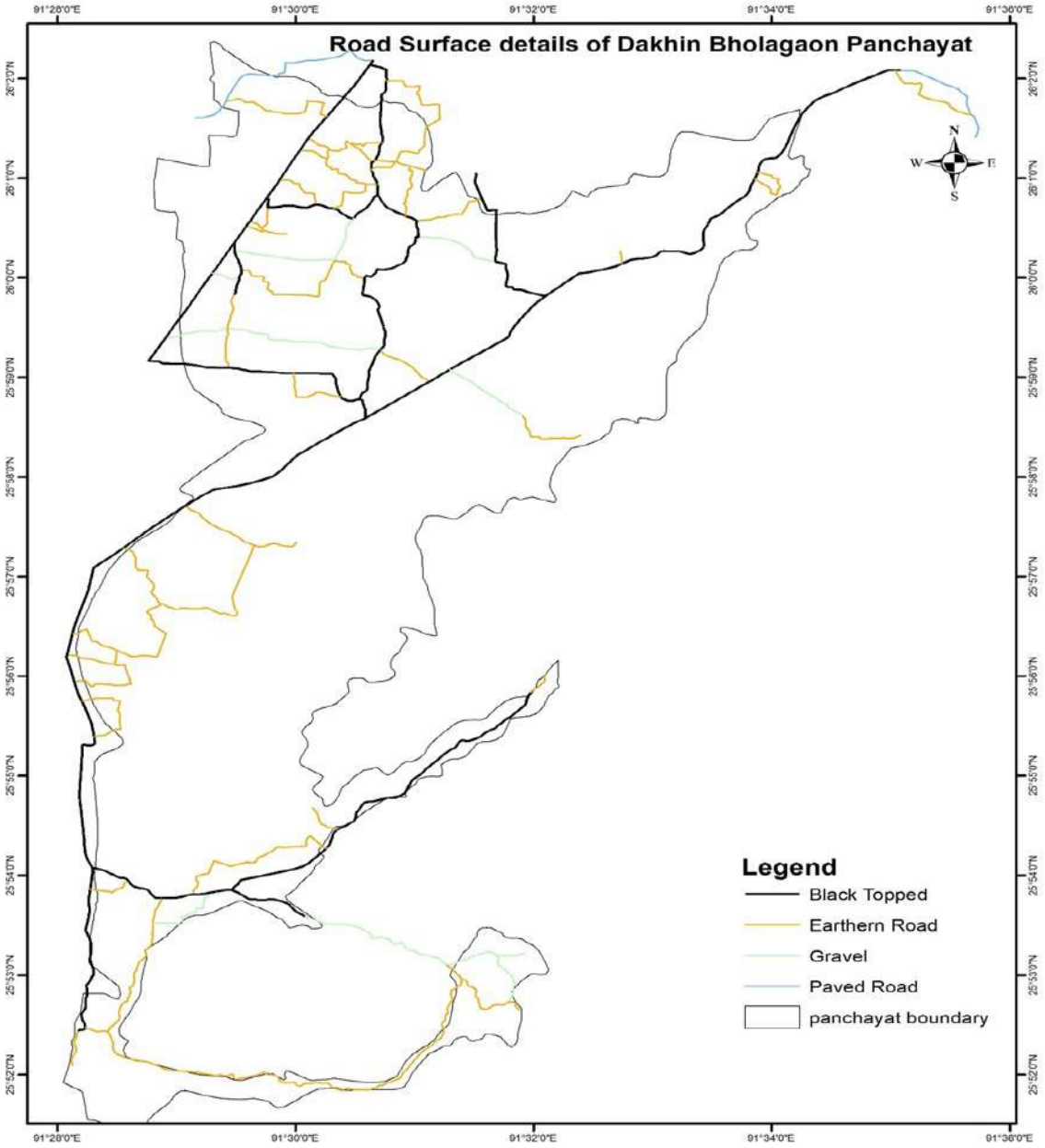

Fig 5.13: Road Network surface type in Dakhin Bholagaon Gram Panchayat

Fig 5.14: Earthen Road Nalapara

Fig 5.15: Beri Gram Chowk to kumarbari Gram

Fig 5.16: Joypur Village road

Fig 5.17: PL Rajpara PWD road to Beri Gram

Fig 5.18: Joypur Village Earthen Road

Fig 5.19: Gravel Road

Fig 5.20: Earthen Road on the Way to Batabari Gram

Fig 5.21: Earthen Road Condition during Dry Season in Batabari Gram

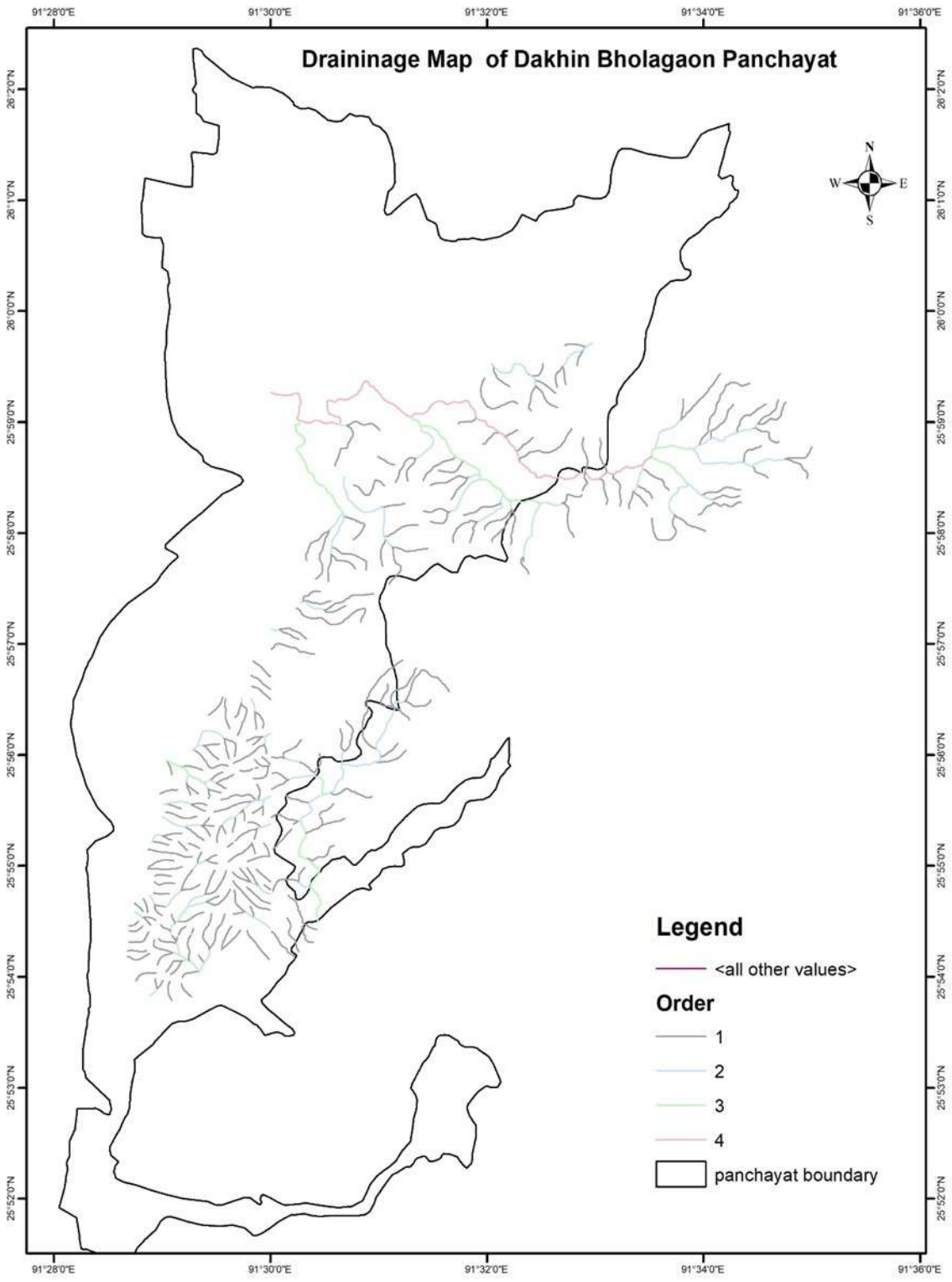

Fig 5.22: Cross Drainage Works in Dakhin Bholagaon Gram Panchayat

Fig 5.23: Wooden Bridge at Batabari Gram

Fig 5.24: Concrete Bridge at Ranibari Village

5.4 CORE NETWORK ROADS

Core network identifies the basic access (single all-weather road connectivity) to eligible habitation with essential social and economic services (PMGSY Guidelines, 2015). Thus core network consists of some of the existing roads as well as roads proposed for new construction under PMGSY. While preparing the DRRP (District Rural Road Plan) the Panchayat gives weightage to various services and select a set of socio-economic/infrastructure needs best suited for the district, categorise them and accord relative weightage. The block level district rural road plan would first be prepared and then the core network for the block is identified by making the best use of existing roads facilities in such a manner that all eligible habitations are assured of basic access. For so long this information was collected in the form of a text giving no emphasis on latest geo-spatial technologies available due to acute shortage of skilled manpower.

In the study area (Dakhin Bholagaon Gram Panchayat) emphasis was given to generate GIS based core network that helped in identifying the through roads and link roads which are an essential components of core network. The core network map of the study area as prepared shows the population distribution in the Panchayat, location of habitation, Panchayat offices, link roads, through roads and major roads (if any).

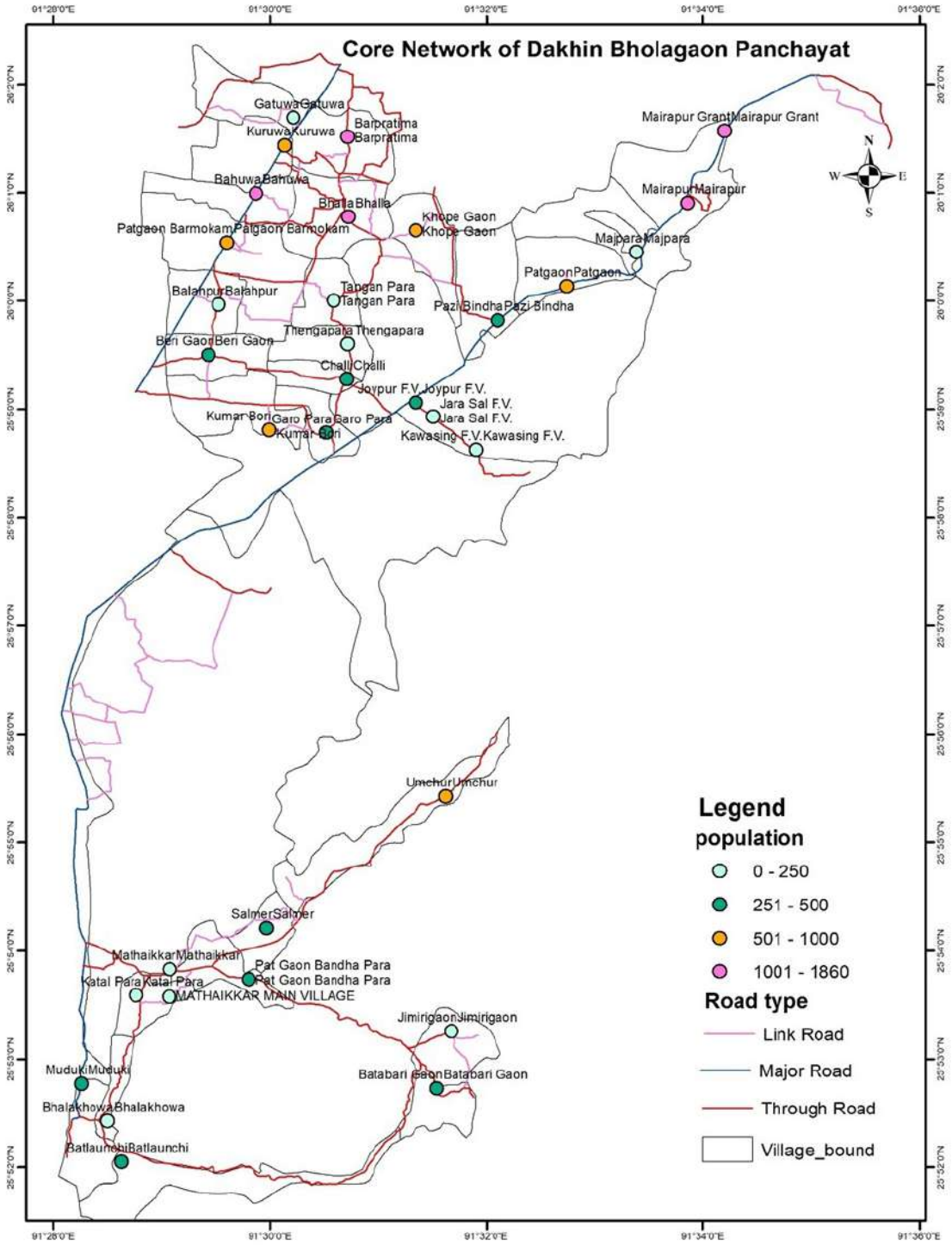

Fig 5.25: GIS based Core Network of Dakhin Bholagaon Gram Panchayat

Administrative layers

Even though the administrative boundaries like state, district and block are not passing along the Gram Panchayat, layers are generated and relevant attributes are attached.

Table 5.3 – Shows the features along with the attribute information

Layer	Feature	Attribute Information
State Boundary	Polygon	Name
District Boundary	Polygon	Habitations benefitted Road length completed Total expenditure No of road works cleared New connectivity Upgrada-tion Completed road works Completed Length (Kms) In-progress road works
Block Boundary	Polygon	Habitations benefitted Road length completed Total expenditure No of road works cleared New connectivity Upgrada-tion Completed road works Completed Length(kms) In-progress road works
Administrative HQ	Point	Name

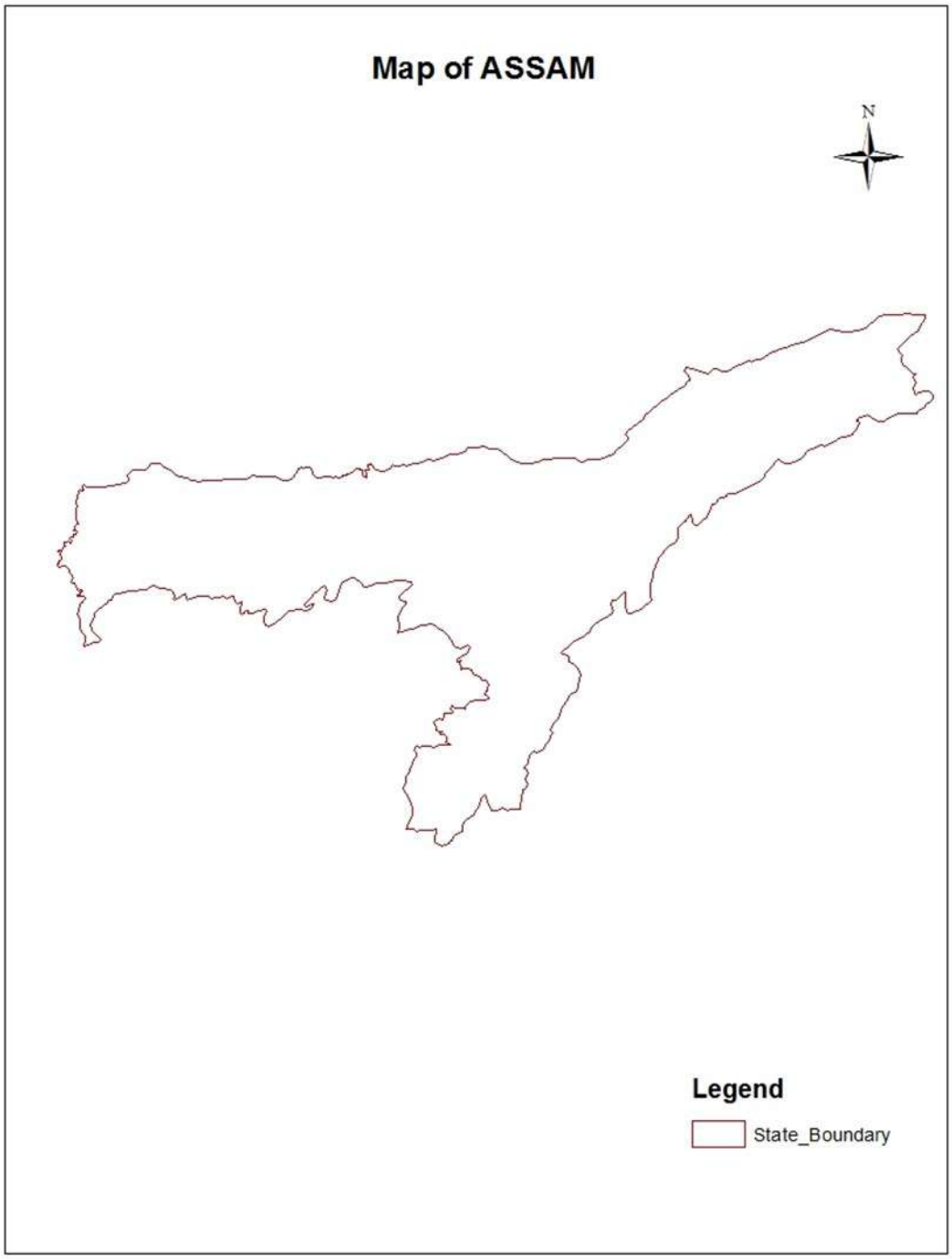

Fig 5.26: State Boundary of Assam

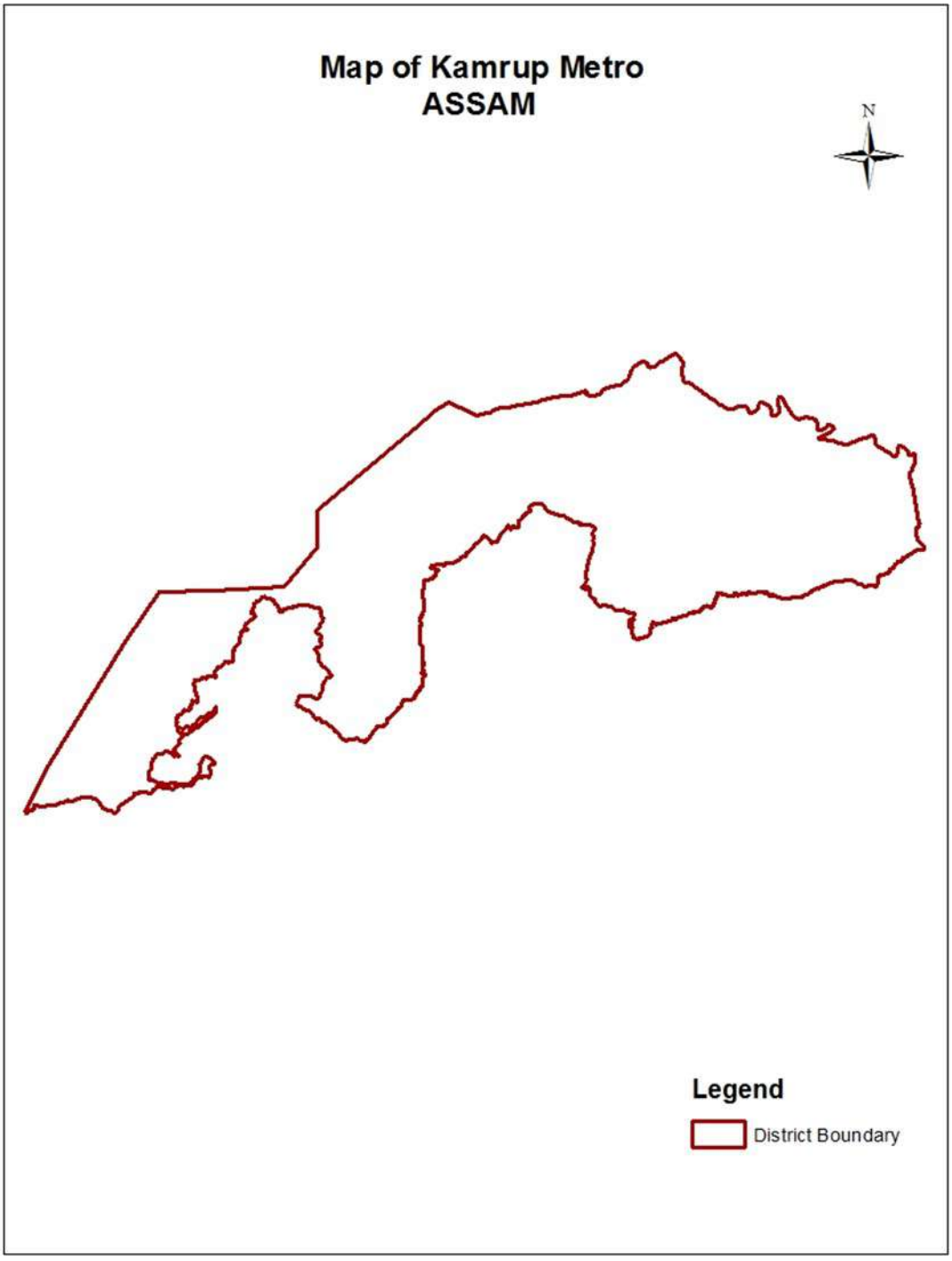

Fig 5.27: District Boundary of Kamrup Metro

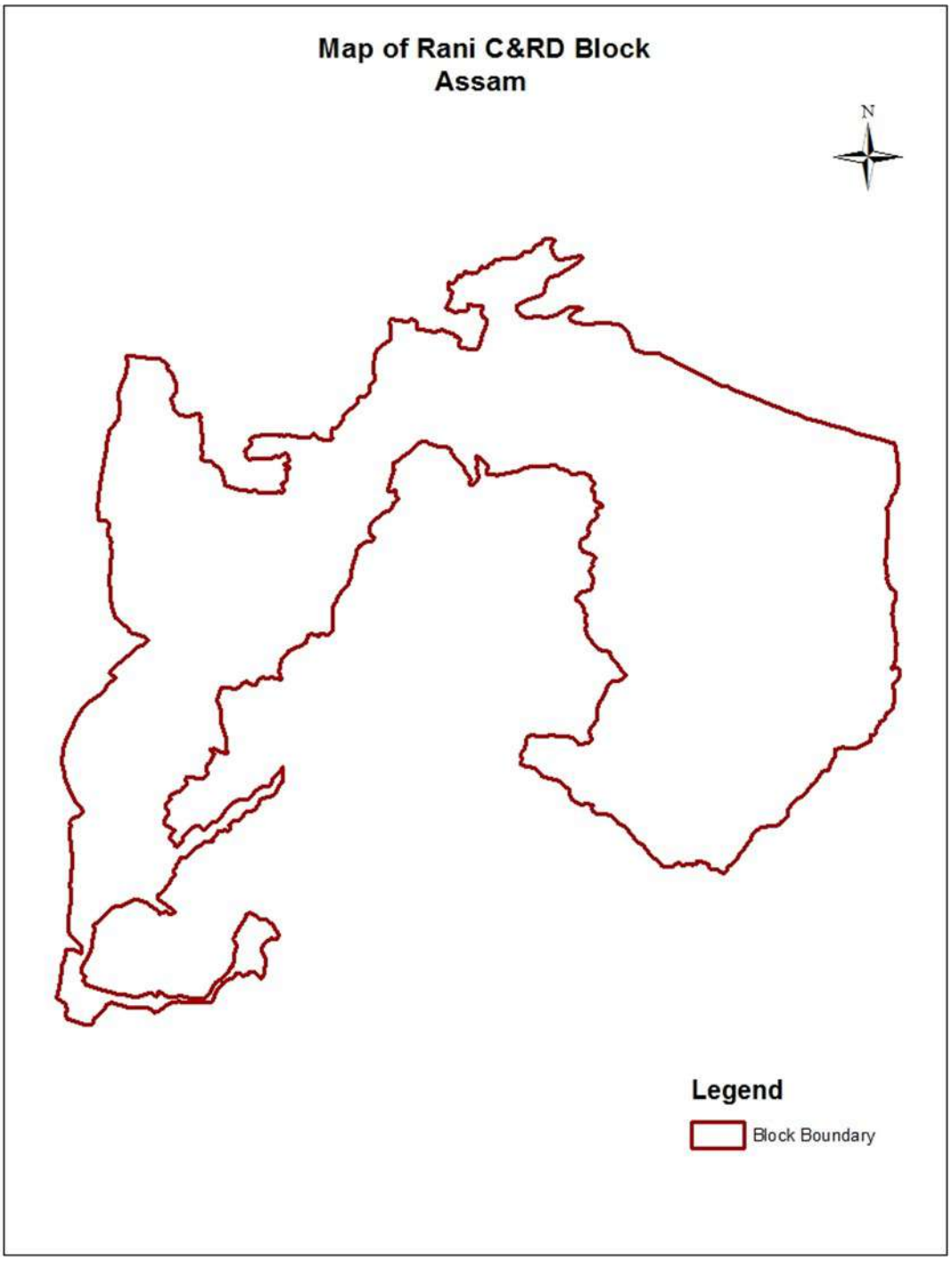

Fig 5.28: Block Boundary of Rani C&RD Block

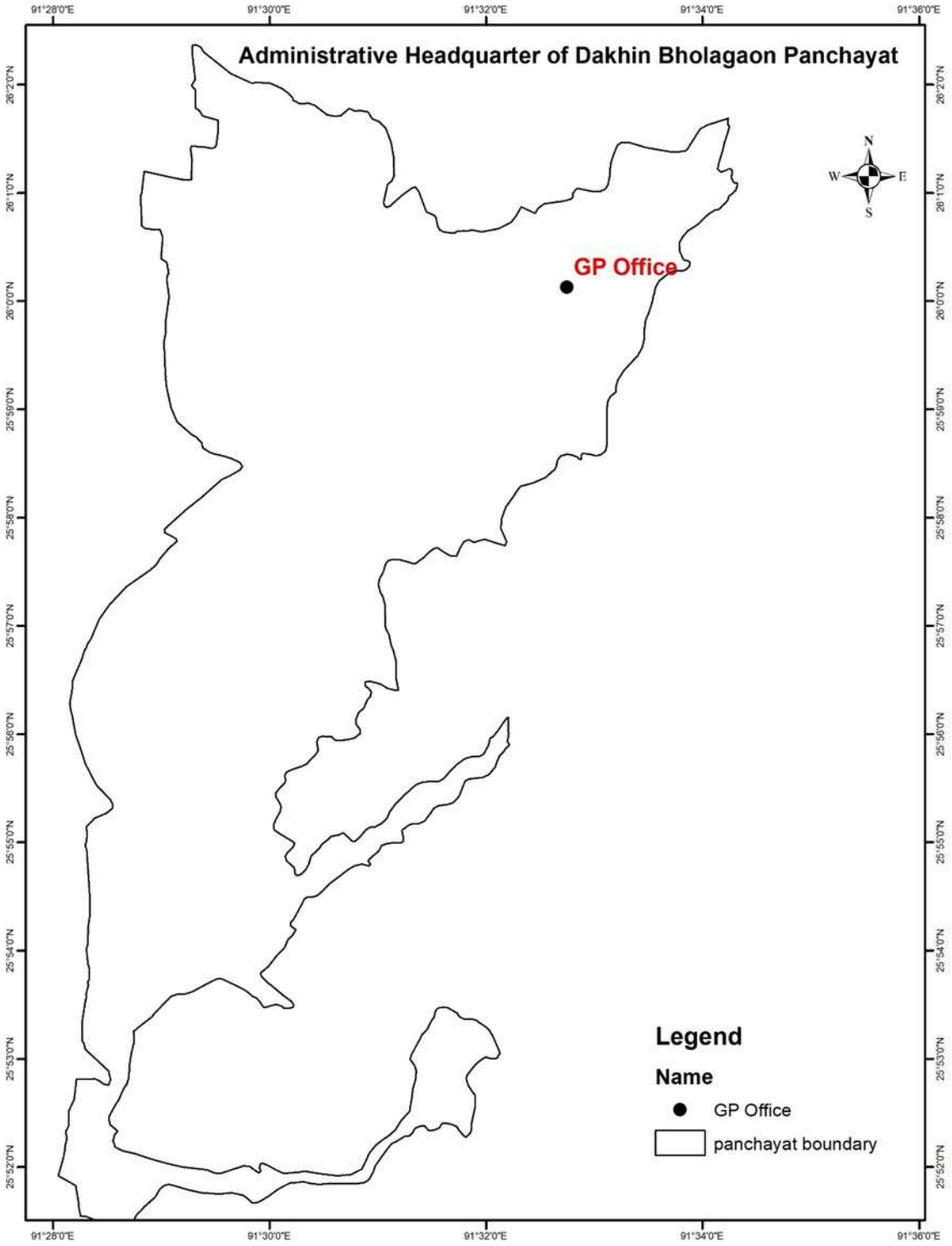

Fig 5.29: Map of Administrative Headquarters

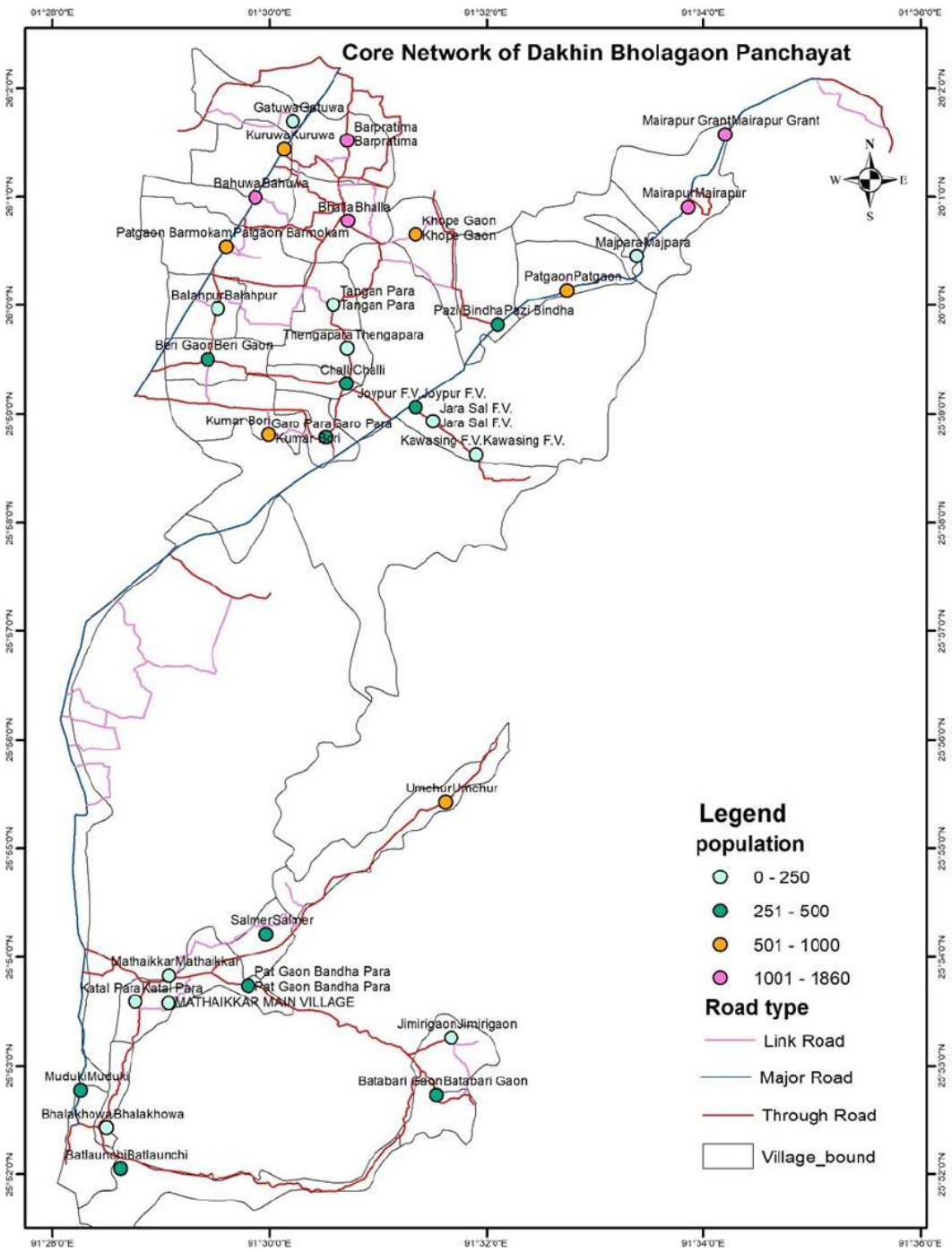

Fig 5.30: Belguri Gram Panchayat Office

5.5 OTHER MAPS INFORMATION OF DAKSHIN BOLOGRAM GRAM PANCHAYAT

5.5.1 Land Use Land Cover

Land use Land cover information in infrastructure planning plays two distinct roles. It helps development of policy rules and forming the basis on which the policy is applied to individual case (P R Bibby and J W shepherd). In this context GIS is a potential tool to support both the roles. GIS can be used to generate information about land use land cover, differentiate different types of land, apart from its comparative analysis of changes.

The Land use Land cover analysis of the study area have been carried out using the Land use data 2011-2012 from Bhuvan and represented in the form of map below. The study area consists of 5,639.38 hectare of forest land, 3,934.96 hectare of agriculture land, 821.845 hectare of built –up area, 39.120 hectare of water bodies and 28.725 hectare of waste land.

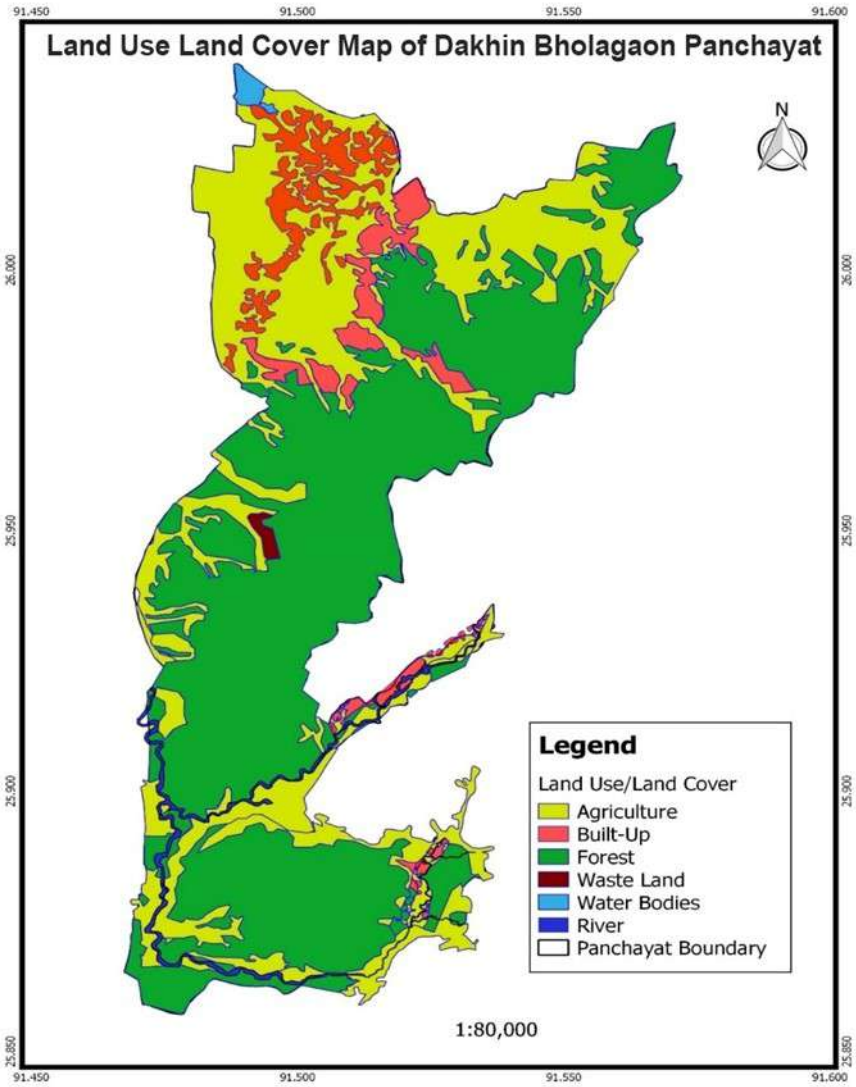

Fig 5.31: Land Use Land Cover of Study area

Drainage

A drainage basin is a natural unit of drawing run-off water to a common point (Simhachalam and Prasad 2014). Preparation of drainage map is an essential component for preparation of road plan to identify various other infrastructure needs like culvert or bridges, etc.

Drainage map of Dakhin Bholagaon Panchayat is prepared using topo sheet of Survey of India of 1:50,000 scale, which can later be updated using satellite data to ascertain further changes if necessary.

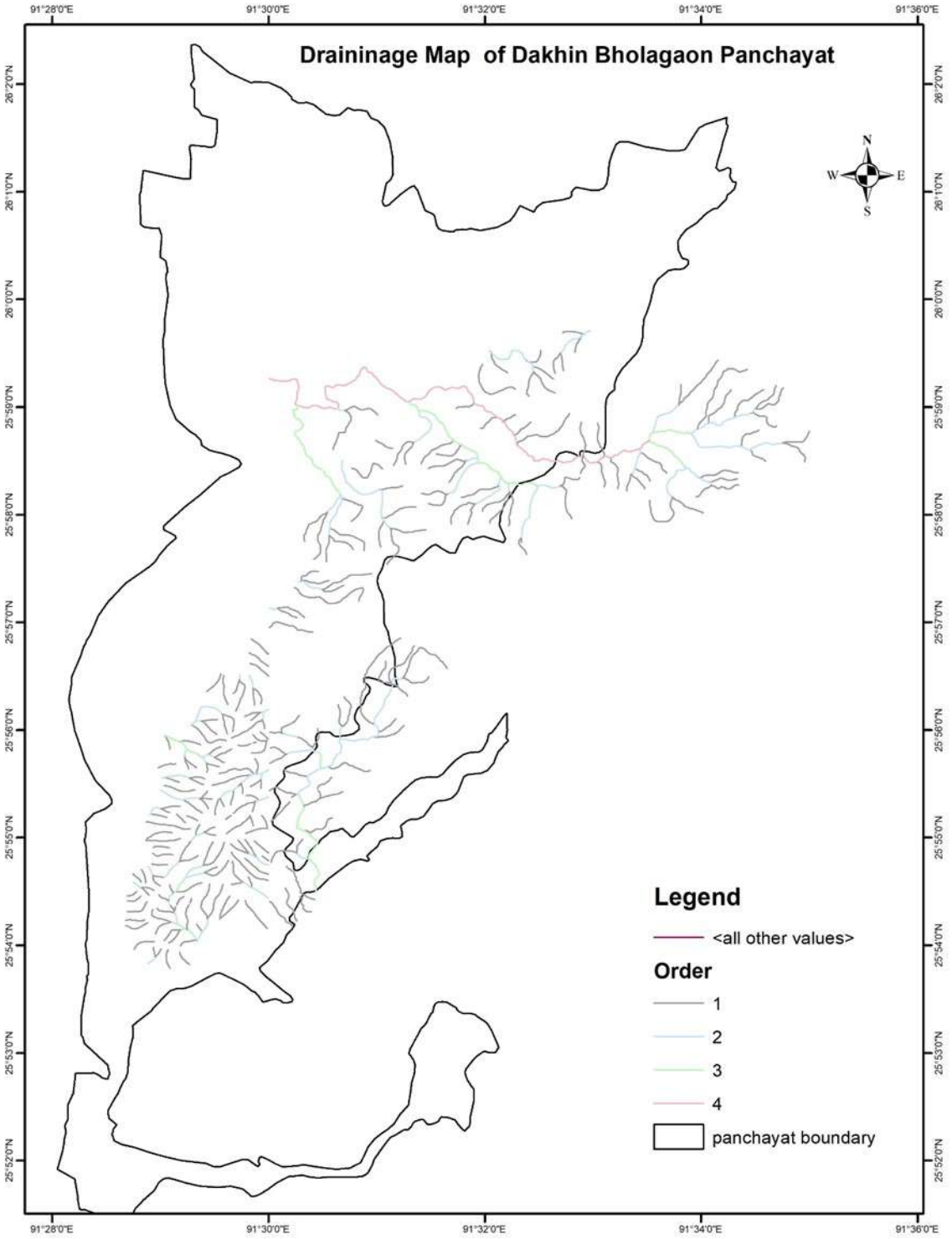

Fig 5.32: Drainage Map of Study Area

CHAPTER 6

CONCLUSIONS

In this study, geo-spatial technology with all its three components was used to generate a geo-database that helped in storing huge amount of information gathered from the study area of Dakhin Bholagaon Gram Panchayat, Rani Block in Kamrup rural district of Assam.

Geospatial technologies not only manage and integrate data, but also serve as an analytical tool that sharpen decision making and, ultimately, save time and money. This technology today uses modern software and hardware to store, access, visualise, map, analyse, and disseminate geographic data which is permeating into all fields. The most important benefit that this technology offers today is efficiency, followed by precision, monitoring, analytics and productivity. Therefore, this technology is highly preferred by the decision makers, planners and clients for better understanding of spatial data and ascertaining the existing status of roads & other infrastructures.

The importance, value and growing demand of this technology will become much higher in coming years, but it has been observed that geospatial technologies face several constraints during various stages of implementation. Of these, the most worrisome factor is the lack of skilled manpower and IT infrastructure. Non-availability of the skilled and trained professionals has an adverse effect on the quality of the project. Hence, it is imperative to increase awareness, training and mentoring to develop the requisite skills in the professional community.

- This study has given us an idea of developing the geo database on rural roads
- Designed and developed a training module for conducting the training on ‘Application of Geo informatics for planning and management of rural roads’
- Conducted about 40 training programmes during 2017- 20 on the above subject to cover all the states in India in saturation mode. Shared our case study to the participants in the training programmes
- The major outcome of our effort, MoRD launched a web based national PMGSY ‘GRRIS’ (Geospatial Rural Road Information System).

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